

Mobile Web Browsing: Usability Study

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ABSTRACT

The mobile phones are increasingly used to access different kind of information other than just to make voice calls. However, browsing large web pages which is not adapted for small-screen viewing is still very inconvenient. Web browsers are emerging which try to solve the interaction problems that occur when small-screen devices are used to access web pages designed for large screen viewing. This paper presents the results of the usability study in which users' mobile web browsing experience was evaluated in comparison to desktop Web browsing. The results indicate the users' performance was poor on mobile browser as users expected similar experience as on desktop; however for some users familiarity of web on desktop helped instead to navigate easily on mobile browser. The main problem participants had was difficulty of locating the content in long narrow page, which in turn caused extensive scrolling. This research suggests some improvement for mobile web browser and important consideration in designing mobile friendly websites that could help limit a lot of scrolling and increase the readability.

Categories and Subject Descriptors

D.3.3 [Information Interfaces and Presentation]: User Interfaces – evaluation/methodology.

General Terms

Measurement, Performance, Design, Experimentation, Human Factors.

Keywords

Internet, web browsing, mobile usability, evaluation.

1. INTRODUCTION

Nowadays, mobile devices are used to access all sorts of information and are becoming a major means of accessing the web. The mobile devices and wireless technology are being upgraded and thus providing variety of functionalities with better service. However, regardless of increasing quality of displays, their small display size limits their ability to convey information adequately in comparison to desktop computers. Even though the

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number of small Internet enabled mobile devices are growing rapidly, not all web sites today cater to mobile visitors, instead, optimizing their content exclusively for desktop clients. Thus, as W3C Director and Web creator Tim Berners-Lee said, "Mobile access to the Web has been a second class experience for far too long" [12].

Whereas people using the web tend to engage in open-ended, exploratory behaviors, mobile devices are intended to support task-specific use [1]. On the mobile web, usually users are presented with personalized portal at front which allows finding specific information. But, as Virpi Roto highlighted [25], many people have no experience on mobile sites, but on PC web sites only. Their favorite sites might not provide a mobile version of the site, or they do not know the address for the mobile site. They need to have access to the real full web, even if large pages are not highly usable on small screens. Now, it is indeed possible to use web browser and search systems in mobile devices as well, which take standard content and adapt it to make it presentable for handheld access. However, in adapting the content, the way user experiences the information will be very different from the way originally intended by the designer [13] as original design may be inconsistent in mobile web. Exploring any search result on small screen can be a tedious and frustrating task as well.

Rich internet applications using technology such as flash and AJAX are bringing better user experience to our desktop. With the availability of very high-speed broadband and wider flat screens, browsing and interaction on the desktop is simply very convenient and user experience is far more enjoyable and pleasant, whereas mobile web browsing requires effort from user to make sense of the content. However, although there are usability constraints, cheap and durable mobile devices have added flexibility in web browsing by providing users with possibility of accessing readily available information from anywhere. But, as the satisfying user experience is a major factor in successful mobile web browsing, this evaluation aims to investigate the effect on user experience by the way the content is presented in mobile devices compared to desktop browsing.

The next section is a literature review on previous research of impact of small-screen on information access. The third section of experimental design explains how the experiment was designed, the equipment and the procedure used to conduct the evaluation. It also presents the analysis of participants background information collected initially. In the fourth section, participants' performance is discussed for each of the four tasks focusing on the problems occurred. Possible reasons and result of this evaluation and collected data is analyzed and presented in fifth section. The last section concludes the evaluation findings.

2. LITERATURE REVIEW

2.1 Previous research

Even though early research on non-mobile, small-screen devices suggests small screen size (especially the height of screen) has little impact on reading, comprehension and task performance [5] [6] [13] [27], user experience is not satisfactory as the presentation and accessibility of information on small display screens are not as effective as experienced in desktop environment. Many problems occur while browsing Web content developed for PCs via cellular phones [29]. If there is a substantial amount of application content, the application must have excellent navigation features along with help and search capabilities [30]. Therefore, one of the important challenges in mobile web browsing is how to present navigation elements to optimise the browsing capabilities [9].

Today, great diversity of devices and browsers are available that are better suited to web browsing on the mobile phones with small screens and limited input facility. However, the current disparity between such devices' available computing resources and the resources required for smooth Web browsing makes it difficult and unpleasant to access Web pages with them [11]. There are different authoring and adaptation techniques used to make accessible pages by converting individual pages, but they are not yet widely used because the transformation quality has still got a lot to improve.

Performing tasks on handheld web browsers will place heavy cognitive demands on the user's short-term memory and with a small screen size; the user will have difficulty initially acquiring the information before activating a mental model for interpreting the information and will have difficulty placing information within the existing mental model as they progress through the information [1]. So, the Jones et al. finding of the research study on usability impact of small displays for retrieval tasks that users of the small screen were 50% less effective in completing tasks than the large screen subjects seems obvious [14]. Buchanan et al. also found out small screen users made many more incorrect choices while navigating the web pages and were less willing to browse deeply into the material [2]. Similarly, usability tests on narrow layout browsing carried out by Roto et al. found reading text on mobile phone easy and scrolling down to find the content simple, but identified several other usability problems [24]. Hence the research suggests the clear necessity of improvements and inventions to make web pages easily viewable on the small screens of mobile phones.

W3C Mobile Web Best Practices recommends not to put too many links on a page, but to make sure each page of site is easily reachable [23]. Therefore, the balance of depth and breadth of the hierarchy is particularly important for the usability of an information structure [7]. Some recent studies carried out by Mobile Web Initiative in conjunction with Segala M Test [23] on Scrolling vs. Pagination to test for user preferred method of navigation on small screens indicate that users prefer scrolling to click-throughs but some indicate the contrary and so it again highlights the need for more research in this area.

Kaikkonen and Roto [16] found that the optimal length of a page depends on the page type: an interactive page has to be much shorter than an information page. In their test, six screens were all too long for an interactive page, but 20 screens fine for a text page. In their usability study, a compact list of items on one page

was clearly preferred by the users and recommend close-knit information should not be split on too many pages. Similarly, the results of Giller et al. study lead to the conclusion that in general a designer should have good reasons to use a pagination mechanism instead of a scrolling one [8]. Now, with many mobiles, the scroll control mechanism is sophisticated, so the size of the document being displayed within a scrollable page does not need to be so constrained [13]. Users quickly learn how to scroll and that scrolling is necessary, so avoiding scrolling is not recommended at the cost of adding fetches [2]. Each page should contain as much relevant information as can fit within its capacity. However, depending upon the bandwidth connection, the larger size pages may take longer to load and for some users' longer page cluttered with lots of information without some clear visualizations of the content on small-screen mobile phones might be difficult to browse through. Therefore, in the study of Giller et al., the sum of data and the user statements gathered during the qualitative interviews show the tendency that users prefer deep structures to broad ones although broad ones lead to faster search performances and the most striking reason is the more concise arrangement of items [8]. The experiment presented by Gaven et al. shows that the most effective hierarchy for use with mobile devices is one with only four to eight items on each level and it is better to order in a hierarchy with more levels than in a hierarchy with more items per level [7].

It is clear that considering recommendations from various usability research studies on navigation model are all very important and should be implemented for designing well-organized sites and it may also help improving the adaptive display methods that can be more effective at directing people to the right place by matching user expectations. However, mobile computing is evolving rapidly and due to variations in mobile devices screen size, its' features and other related issues, these differences may lead to different rules, such as when the web site is adapted the preferred and optimal page length will also depend on the page's content [8] and what is recommended today may not fulfill the requirements in future changing environment.

Previous research studies show the most important aspect of mobile web browsing is providing easier navigation. If the navigation is designed properly, even very large applications are easily navigable and perhaps the single most important thing to remember when developing an application's navigation is that the user must never become lost in the application [30]. Above all, on small-screen mobile phones, it is more important that users can freely move along, focusing on their task, without having to worry about the site's structure.

3. EXPERIMENTAL DESIGN

This experimental evaluation was carried out on controlled laboratory environment to allow participants' perform the tasks on mobile device browser and desktop browser simultaneously.

3.1 Equipments

In the desktop environment, Internet explorer version 6.0 on 17" monitor was used for web browsing. For mobile web browsing Sony Ericsson W550i mobile phone was used. None of the participants have ever used this mobile phone.

With a screen size of 1.8 inches (176x220 pixels) and 262,144 color TFT screen, the W550i Walkman mobile phone allows experiencing colorful graphics and images. It has Joystick as a

main input control for scrolling & selecting, and soft keys for options, cancel, back & similar functions.

The mini Opera (Version 2.0) used in this evaluation is a freely available small (currently less than 100K footprint) a Java (MIDP) client that relies on a proxy server which pre-process web pages and sends the optimized web content to the device. It is capable of running on even the humblest of devices, as long as the device has a Java VM running on it [28].

3.2 Procedure

Participants were given instructions about how to use this particular mobile phone so that there was not any confusion and problems because of not being able to operate the mobile phone itself. Briefly, participants were informed about the mobile browser and how it represents the same content on mobile phone that is seen on desktop browser. Participants were also given an overview of the planned evaluation and agreed for voluntary participation. All the participants read and signed the informed consent form [10]. Pre-test questionnaire [17] was used to collect demographic information about participants.

Four very common goal-oriented tasks were set out for participants to perform within estimated time 20 minutes to complete. It was expected that all those tasks would be very easy to perform on desktop browser, but on mobile browser, task 1 would be very easy, 2 easy, 3 difficult and 4 very difficult to perform. The address of relevant sites for each task was provided but participants were free to use any other site they were familiar with. The tasks were:

- Find the today's top Sports news. (BBC)
- Find out the weather forecast for your area. (Yahoo)
- Find the live departure Rail time from High Wycombe to Marylebone. (National Rail)
- Check your email and send an email (short message) to your friend. (Hotmail)

The participants performed tasks under direct observation and were requested to think-aloud. While participant performed the task, for the each task - following measures were recorded in observation.

- Time taken for each task to complete.
- Different type of (incidents) and number of time it occurred.
- Task Completed or not.
- Participants' comments.

At the end of evaluation, participants completed post-test questionnaire based on Web-Based User Interface Evaluation with Questionnaires [22] to express their perceptions of the task and mobile web browsing.

3.3 Participants

Twelve under-graduate and post-graduate students from Buckinghamshire Chilterns University College took part in this evaluation. The age of participants varied from 18 to 45 years. Eleven subjects were male and one female. They all had modest to high desktop computer experience and used internet everyday or almost everyday. All the participants had different range of mobile phones from Simens A65, LG Chocolate, Samsung D600, Nokia 8310 to N80.

Out of twelve, nine participants had a good mobile using experience, one had an average and other two had below average

mobile phone experience. Seven of these participants had no experience of web browsing on mobile phones as well. Other five participants had used mobile for web browsing at least once a week. All the participants used their mobile phones mostly for making calls and text messaging and occasionally for pictures, music and alarm and were not very versatile in their mobile phone skills. Those who used mobile for web browsing used it for checking train-time and reading emails.

When asked why they do not use mobile for web browsing, participants were concerned about the cost, speed and believed browsing web on mobile will not be comfortable and convenient as well. Four participants said they do not need to use mobile phone for browsing and desktop use was sufficient and one of the participants' mobile phone simply didn't support web browsing and so never used it. However, even though none of participants have ever used this particular mobile phone that was used for an evaluation and the mobile web browser such mini Opera, initially they showed positive attitude towards its use and were interested in testing. Participants did not have to pay the browsing costs during the test period.

4. USER PERFORMANCE

4.1 Task 1

Performing Task 1 on desktop browser to find top sports news on BBC was very simple task. Before beginning the first task on mobile, all the participants expressed that it would have helped if they had some previous experience of using this particular mobile phone and the mobile browser. However, they all completed this task on mobile browser as well.

However, attempting the first task, initially participants did not intend to scroll down to find the information and were rather expecting to find it right on the top. Specially, when they clicked the link, they just forgot they had to scroll down to find the content and were clicking the same link again and again as it seemed though the page did not change because the top information was exactly same as it were before. However, once they realized they needed to scroll down, they were able to find the information. But, one of the participants knew the top sports news link was also located in the home page, so just scrolled down the home page and found the top news. So, in this case, the familiarity of web page on desktop helped find the information on mobile browser easily.

4.2 Task 2

While performing task 2 using Yahoo portal, first of all participants had a little bit of difficulty even on desktop browser to find the weather link as it was not located on main menu of links at left-hand side, which participants usually glanced through expecting to find the link there and so it took little extra time.

After completing the task on desktop and when performed on mobile browser most of the participants found difficulty to find the weather link again as it appeared as a text link without the weather icon as seen on desktop browser. It was interesting to see one participant spotted the link quickly remembering the fact that the weather link was alongside of 'Mail' and 'Messenger' link. So, when scrolling the long page on mobile browser it helped him spot the link by keeping eye on expected location of all the links as a whole.

While scrolling, participants could either scroll vertically link by link or page by page of screen size using joystick. As the page length was very long, most of the participants tried to scroll page by page to scroll down quickly, but some of them easily missed the 'search by City or Region' option and end up browsing by following 'Browse to locate a city' link which required going through few long pages many times and try locating right information again by careful scrolling, which was indeed very time consuming. It was very obvious that using search option was more convenient and quicker to use in this case.

4.3 Task 3

Similarly, participants took more time on task 3 to find the 'live departures & arrivals' form on desktop browser, because at first all the participants misunderstood the task even though clearly stated, and used the quick journey planner instead. Even after finding the right form, participants complained it did not have usual input field with labels 'From' and 'To' and instead uses drop-down menu and also there was no clear instruction about how to use it.

However, after completing the task on desktop browser, it helped them recognize the right form on mobile browser and didn't get confused with the quick journey planner. However, ten of the participants were unable to select the limit by option, as it required to use the 'more' menu on the right-hand side to select 'OK,' so that selected 'Form' or 'To' option would appear on the form.

Some participants also found difficulty recognizing the button 'Find Trains' to start searching, as it was small and rather 'Book A Hotel' label seemed very clear and obvious which was right below the button. They also found the table of result not very clear as the row was wrapped onto several lines to fit in the small screen.

4.4 Task 4

For the fourth task, participants used Hotmail (English and French), Yahoo, AOL, Gmail, Virgilio (Italian) or the university provided email depending upon their own preferences. Out of twelve participants, one participant did not feel comfortable to perform this task both on desktop and mobile browser.

Before signing in, mobile browser displayed a warning message that the communication between the phone and the page is not secure. So, as it was a matter of security, one of the participants decided not to continue. But, other participants did not have any problem to continue. But, AOL users could not sign in because the link to 'Sign in' just appeared as a label on mobile browser. Most of the participants also had problem logging in first time because of difficulty of typing combination of lowercase and uppercase letters, numbers and symbols. One participant gave up the task after just one attempt to sign in.

Gmail and Hotmail users had difficulty figuring out the input field for writing the actual message. Even though ellipses appear on the message field, it didn't seem obvious to the participants. All the fields were of same size and the message field did not have label and also there was no spacing between two unrelated fields which caused the confusion.

Also after composing email on Hotmail, participant found inconvenient to scroll back to the top of the page to find the link/button to send email. Hotmail users encountered more

problems when they tried to sign out from the page. The familiar Sign Out button seen on desktop browser appeared as the text link of dark blue font color on msn's blue background. So, out of three participants who used Hotmail, two couldn't figure out the link and were unable to sign out, but one participant worked out as he remembered from desktop browser that the button was between the link 'People & Groups' and the label 'Web Search'.

Similarly, one participant who used 'Virgilio' found very difficult to spot the 'Mail' link of dark blue font color on the blue background, which actually appears as a button on the page when viewed on desktop. After spending a lot of time finding the link and once logged in, participant was unable to find the link for the mailbox and finally gave up the task.

After completing the first three tasks, two of the participants panicked even before attempting the task 4, as from their previous experiences they presumed it would be more difficult to send emails from mobile phone. However, even with all the difficulty, one of them did manage to send email but the other couldn't complete the task.

One of three participants who completed this task said that all the advertisements, banners and images were unnecessary as they just caused confusion. One of them thought sending email from mobile is a good idea and next time he will be able to send email with fewer problems but was not sure how much it would cost him. He thought using small-screen mobile phone it is probably good idea for checking emails then writing while on the move. Because of the difficulty and very poor experience, the third participant who completed all the tasks said that he would not bother checking email on mobile again.

5. DATA ANALYSIS

All the evaluation results were analyzed to identify the user experience on mobile browser compared to desktop browser. Below results highlights the usability problems that participants faced during the evaluation and reflects on users' satisfaction and subjective feelings in using the mobile phone for web browsing.

5.1 Incidents

All the participants performed same four tasks on desktop and mobile browser. They performed each task on desktop browser before they performed on mobile, and the fact that the tasks were simple, easy and quicker to perform on desktop; they expected similar user experience even on small-screen mobile phone. In the table 1 below, the observed total number of different incidents participants encountered while performing all the tasks on mobile browser are presented.

One of the major incidents observed during the test was participants visibly seen lost very often in long web pages, and so they needed a lot of careful scrolling to locate the right information on the small screen. The fact that they said something clearly negative about the web pages considerable number of times shows the participants' frustration caused by difficulty of web browsing as they experienced. Even then, there were few occasions when participants mentioned that viewing web pages on mobile is an interestingly a good idea. The participant who encountered only two incidents completed just the first two tasks on the mobile phone, could not complete the third and did not attempt the fourth task. The participant who had the highest number of twenty-six incidents attempted all the tasks but only managed to complete the first task on mobile phone.

Table 1. Total count of incidents observed while participants performed tasks on mobile browser

Incidents	Total
Links didn't work	3
Unexpected behavior	3
Said something clearly positive about the Web site	4
Couldn't figure out what to do next for more than 30 seconds	7
Required too much input	7
Difficulty remembering what to do	7
Cursed out loud	7
Was visibly frustrated with the Web site	21
Said something clearly negative about the Web site	27
Too much scrolling	36
Was visibly lost in the Web site	36

5.2 Task Completed

All the twelve participants completed the task 1 on both browsers, but only three participants managed to complete the task 4 on mobile (see Figure 1). Participants did not have any significant problem on desktop browser. But, on mobile browser, only one participant was able to complete all four tasks. The mean total number of tasks completed for desktop browser was nearly 4 out of 4 and for mobile browser was just above 2.

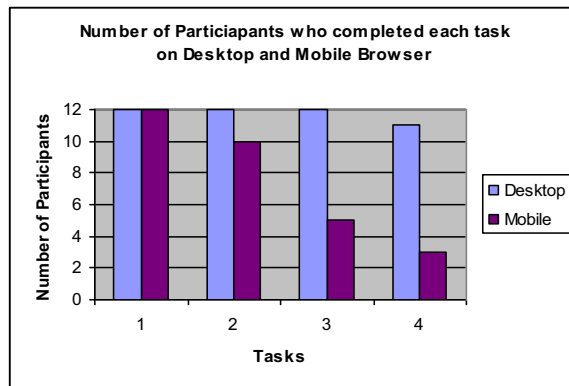


Figure 1. Number of participants who completed tasks on both desktop and mobile browser

5.3 Task Completion Time

From the total time participants spent completing four tasks on both desktop and mobile browser, 80% of the time was spent on performing tasks on mobile browser and only 20% on desktop browser. The average time participants spent on performing each task on desktop was 1.41 minutes and 5.7 minutes on mobile browser. The average task completion time for all the tasks on desktop browser for all the participants was under 6 minutes, and for mobile browser it was around 23 minutes.

Box and whisker chart (see Figure 2 and 3) show the spread of the data. It represents summary statistics for the analysis variable **time**. Parametric and non-parametric summary statistics are presented for each variable, to indicate the central tendency and the scatter/dispersion of the observations.

The blue notched lines show the requested parametric percentile range, where the blue diamond shows the mean and the requested confidence interval around the mean. The notched box and whiskers show non-parametric statistics. It shows the quartiles of the data, using these as an indication of the spread. Boxes cover interquartile ranges (IQR), whiskers extend to the normal limits of distributions, the line bisecting the box is the median, and the notches in the sides of boxes indicate 95 per cent confidence limits for the median.

Each of the box-and-whisker plots (see Figure 2) describes the total time each participant took for all task on desktop and mobile browser. In the figure below, the medians for desktop browser and mobile browser box plots are significantly different at approximately the 0.05 level as the corresponding notches do not overlap.

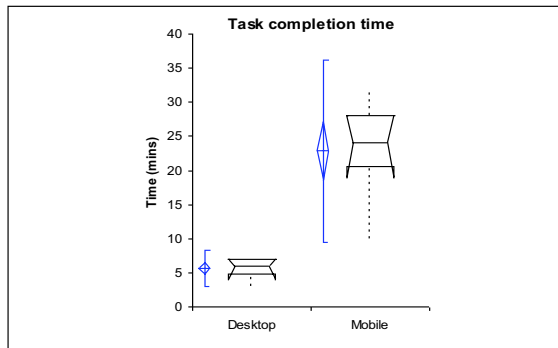


Figure 2. Box and whisker chart of total task completion time on both desktop and mobile browser

5.4 Task Rating

Participants rated each task that they performed on mobile browser for the level of difficulty, where 1 = Very Easy; 2= Easy; 3 = OK; 4 = Hard; 5 = Very Hard. The lower the score, the more positively the participant rated the task. Figure 3 shows box and whisker chart of overall ratings for all the tasks. Task 1 has a lowest rating of 2.6 and task 4 has a highest rating of 3.8.

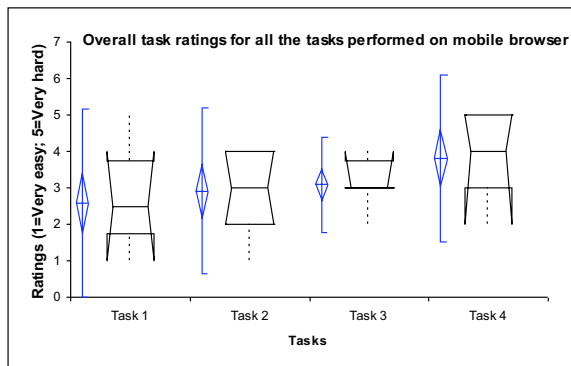


Figure 3. Box and whisker chart of overall task rating for four tasks performed on mobile browser

As initially expected (see Figure 3), participants found task 1 and 2 relatively simple, 3 medium to difficult and the task 4 which

was sending email the most difficult to perform on mobile browser.

5.5 Organization of information in mobile browser

After completion of all the tasks, participants rated how they found the organization of information when viewed on mobile browser. In the 5-point scale used, 1 meaning clear and 5 meaning confusing, the average rating was 3.6 which show most of the participants did not find the organization of information clear.

Performing the first task on mobile browser, most of the participants could not understand the page structure and thought it lacked natural visibility as they felt it did not present information instantly and were just not prepared for the scrolling down. For some participants, there was so much scrolling involved and did not know where exactly the information was in the long narrow page, they even forgot what the task actually was. However, realizing difficulty of locating the information, two participants used Google search feature of the mini Opera browser and were able to find the right information a lot quicker than others.

On a desktop browser, users intend to scan the pages rapidly while browsing through familiar web pages focusing on the content of their interest, identifying and using relevant links and information if necessary. One research study on desktop web showed 79% of users skim-read and only 16% read word by word [19] and mobile users away from a stationary computer or in a mobile environment, are likely to have limited time to access and browse a wireless application. Thus, good organization of information is critical for achieving greater efficiency [4]. In the study of web page visualization method for mobile phones, Roto et al. found the participants did not see that the mobile browsers would be suitable to be used in a hurry, which shows that a small screen makes it hard to just glance at the page and spot the needed content [26]. So, on small-screen mobile phone, browser presenting content in a tall narrow layout did not promote such a browsing behavior, as it required users to concentrate more in browsing the information by a lot of careful scrolling.

5.6 Correcting your mistakes

For the question how easy or difficult participants found correcting the mistakes in mobile browser, the average rating was 3.3 in the 5-point scale used, which shows participants did not find it easy but also did not have major problems while correcting mistakes.

On desktop browser, selecting, typing, updating and deleting is a simple activity. But on mobile, typing using keypad and different text entering method which required using joystick to move between form elements, and push it in to mark boxes and buttons or activate form field before typing was time consuming but of course not impossible. Therefore, even though it was difficult, there were not any other major problems. But most of the participants had problems working with forms, especially in the case of task 3. When they were unable to select 'Form/To' from the drop-down menu, most of them simply thought it was not working, and either carried on performing the task without making any selection or just gave up the task.

In this study, participants were on average very familiar with web browsing on desktop. When using mobile phone for web browsing, their common perception in mind was that it should

work the same way and so they expected similar straight-forward way to work with the forms and the page.

5.7 It is easy to find information I needed in mobile phone

On desktop, because of the familiarity of web pages, participants took no time to find the information. But on mobile browser, most of them struggled to follow the similar navigation path when they looked for the content and the page was different from the desktop. But in this evaluation study, some still managed to identify the links by remembering the position with respect to other links. For example, on Yahoo page, one participant spotted the weather link by its relative location even though the page was very long and appeared different from the desktop. Similarly, one participant identified the 'Sing Out' link by its location in task 4. For few participants the familiarity of the web pages on a desktop browser helped recognize the relevant links on mobile display, but for others it caused more frustration as they were expecting and not able to find the information as experienced on the desktop.

Participants thought the web pages were heavily loaded with information for the viewing on the small-screen and were just too long requiring extensive scrolling. Similar previous research studies have shown that the user do not seem to suffer much from the re-layout, as long as they are able to follow the familiar navigation path [15] [24]. But the participants were overwhelmed to see the page such as Yahoo squeezed to fit in the small display width and found difficult to get the picture of the whole site, and thus difficulty to follow the familiar navigation path. However, as they experienced, they mentioned that the information is there somewhere and it was just a matter of finding it. Therefore, possibly this is the reason why they did not really disagree with the statement that it is easy to find the information using web browser on mobile phone and so the average rating was 3.3.

5.8 Overall web browsing experience on mobile phone

According to Zhang et al. user satisfaction is the result of the interplay between the features in the web environment, user's information seeking tasks, and information seeker characteristics, and it is useful to determine what makes a user satisfied with a website as well as what are potential dissatisfiers [31].

Typically users access and retrieve information in a web environment using the web interface, which should support easy and flexible control and quality of display should be reasonably good. User satisfaction is one of the important measures of usability to study perceived success of any kind of interface. Tasks were purposely chosen simple so that they would be very common for all and the main focus of the study was to evaluate the users' experience of browsing which depend on the information environment - the mobile web interface.

The display size has always been criticized and considered as one of the major problem for presenting information effectively. Considering the limited display, the organization of information that the web browser reformats and displays plays a vital role on how effectively users can browse and thus heavily influences the user experience.

In this evaluation, participants were interested in mobile web browsing and did not have problem understanding the way web pages could be viewed on mobile browser, as in Roto et al.

evaluation [24]. But, using mobile web browser, even though the change of the usual page structure is easy to understand and participants could easily learn to work with it, they found it not very simple to interact with, which in turn affected their user satisfaction. As one of the participants said, "If I browse web on desktop computer that doesn't mean I can do so on mobile." which simply reflects his mobile web browsing experience. The average rating for overall web browsing experience on mobile phone was 3.5.

6. CONCLUSION

There are lots of differences between desktop and mobile environments and so the limitations and challenges exist that do not enable similar user experience of web browsing of desktop on small screen mobile phone. So, there are challenges desktop environment has in terms of handheld perspective. Probably there is no real unique way to adapt widescreen content to fit in mobile screens. However, there are numerous possibilities and people are talking about different architectures and rendering algorithms and attempts are being made to best fit in mobile small screen. An application of rendering like a browser is by far the best attempt to get the best of both desktop and mobile worlds. However, the analysis of the comparison between desktop and mobile phone web browsing shows mobile browser has a good potential but does not provide a consistent user experience across desktop and mobile devices. Participants were however, not completely dissatisfied.

Today's wireless environment is rapidly improving. As the evaluation was conducted in lab environment, participants did not face problems of long downloads and broken connection. But, because of the major difficulty of locating the content in the long pages, participants had frustrating experience using the mobile web browser as they spent significant time in navigation by extensive scrolling and fully concentration on browsing rather than actual content.

It may not be possible to achieve exactly same user experience on two different device but the problems can definitely be reduced. It is very important to give users a feeling of control over the site and they should never get lost within the page. Also, users should not be restricted to think this is the best way to look at the web site by looking at a particular format, as different users may have different preferences. Browser support for multiple layout modes such as natural fit, fit to screen width and text only and other possible ways of viewing the same content could give the great flexibility. In the small screen, browser should also give clear indication of how long the page is and where in the page the user is.

In the small-screen mobile phones, users had to navigate using a joystick which users are not used to of when it comes to web browsing. Possibility of selecting the scroll bar and drag it up or down the page will allow smoother and quicker navigation and easier ways to go back and forward on the visited pages will also aid easier navigation.

Eliminating or moving long lists of links is one of the main design changes that mobile-authoring guidelines suggest content providers/developers should make; Opera Mini can do it programmatically [28]. Now, Opera Mini has included the ability to detect long lists of links (like the ones generally found on the

sidebar of websites), and collapse them, which reduces the amount of scrolling. Clicking on the small icon near the collapsed links will expand the list. But, if the page has lots of collapsed sections, it might be difficult to find section where the content is located, especially if the user is not familiar with the page. It would be a good idea to let users view the page first and collapse the sections as they scroll down, including the advertisements (not just the group of links) as or when they feel necessary.

Some desirable features such as, find or search function within the page, copy text from web page to clipboard and use it in other application, bookmark manager using folders, possibility to view browser landscape, ability to use other function of the phone without existing from browser and saving web page for offline viewing could immensely enhance the functionality of the browser. The new version supports for SSL/TLS which will help increase the confidence of users to use the secure pages and will also increase the use of mobile web for commerce.

Even though, the idea of using this kind of mobile web browser is simply to be able to view the web pages designed for desktop viewing, if such web pages are designed with some consideration for small screen viewing purpose, it can reduce the considerable amount of existing usability problems that users encounter while viewing on mobile web browser. Mobile guidelines such as [20] [21] [23] can be referred for general guidelines to help create sites for the mobile web.

Below are some of the important considerations for designing mobile friendly pages that can limit scrolling and increase the readability while viewed on narrow-layout mobile web browser:

- Select the font and background color that would not hamper the visibility of text or links
- Label all the input fields and form controls, so that users can easily identify
- Limit the number of links in the list, group them and label with appropriate title, so that users will know where the link is in the collapsed or a grouped links
- Rather than images, prefer using text for links and buttons where possible, because it may increase the size of the page and thus longer time to download, and in small-screen images are sometimes difficult to interpret, especially if users are not familiar with those pages, and
- Always consider adding search function on the page; when users don't want to scroll through long pages or can't find or don't know where the content is, they can search and find easily.

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