ACCESSIBILITY OF eSERVICES ON MOBILE PHONES

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ABSTRACT

European governments are taking quantum leaps towards the implementation of electronic self-services (eServices). Currently, most eServices are implemented as web-based solutions on PC-platform. The use of mobile technologies for eServices is lurking just behind the corner. The usability and accessibility of mobile eServices can be improved by the application of appropriate accessibility guidelines on the interaction design of mobile devices. This, in turn may have a great impact on the inclusion of large user groups in the information society, for example elderly and cognitively disabled people. In this paper, we show how to operationalize common accessibility guidelines for eServices on mobile phones, and thus how increase accessibility of mobile eServices. We present a synopsis of accessibility guidelines for eServices on mobile devices, and illustrate the application of these in the context of a data capture application within public eServices (the Mobile Tax Demonstrator).

KEYWORDS

Accessibility, eServices, Interaction Design, Mobile eServices, Universal Design

1. INTRODUCTION

The emerging self-service society has a great impact on all citizens as it affects nearly every area of our lives. We expect to find the information we need on-line. Daily we get cash dispensed by automatic teller machines, we buy train tickets at self-service kiosks, we keep our own banking accounts over the internet, and we file our final tax statement electronically. Self-service thinking is transforming the way many businesses and public organizations operate. Both the service provider and the customer benefit from this. For the user the opportunity to control the timing and method of transactions is appealing. The driving force for the service provider is the opportunity to reduce administrative overhead and still give a better service.

Besides the technological advances – such electronic payment systems – made during the last decades, an equally important driving force behind the development is the commercialization of services: cost-effectiveness must be gained and maintained. Since electronic solutions and self-services offer significant potential benefits for businesses and public organizations, these are and will be important drivers of this development The self-service "movement" is also reinforced by societal reforms, governmental policies (e.g. Ministry of Government Administration and Reform, 2007), and international strategies and development programmes. At the European level, i2010 is the EU policy framework for the information society and media (EU, 2005). It promotes the positive contribution that ICTs can make to the economy, society and personal quality of life. One example is the goal of "round-the-clock service" as displayed by many Nordic public administrations. Over the internet the citizen may use all kinds of electronic services in the middle of the night if he or she so desires. Another typical programme in the Nordic countries is aid to disabled and elderly citizens to enable them to lead as autonomous lives as possible. Therefore, both these groups are becoming increasingly important users of digitized self-services accessed from the home or from public places, such as day-care centres for the elderly, or libraries. Finally, maintaining the population of rural areas is an important governmental policy goal in the Nordic countries. To ensure sustainable settlement, services need to be broadly available and accessible.

Accessibility of electronic services has typically been connected to internet-based services on a PC-platform. Here, radical changes are occurring. All over the world companies are preparing for the mobile internet. Mobile data networks with increasing bandwidth together with advanced mobile phones and other handheld devices are bringing a new generation of services into use. In fact, in many European countries, the

penetration level of mobile devices has by-passed the penetration lever of PCs, and it is rapidly approaching the penetration level of TV. The number of mobile phone connections is increasing in a similar manner all over the world (World in Figures, 2007). Obviously, the concept of electronic self-services – or eServices – is entering yet a new stage, and governments are playing an important role.

This development – i.e. new eServices to *all* citizens – introduces new challenges to the usability and accessibility of the content and services. This is perhaps even more so in the context of mobile devices; both the mobile use context and the small screen introduce constraints to the interaction design. These challenges become even more demanding when user groups with high accessibility requirements enter the scene. Examples of such users are elderly and disabled people.

In this paper, we present our work with accessible mobile eServices. Our case comes from the Norwegian public administration, more precisely the Directorate of Taxes. We illustrate how to operationalize accessibility guidelines in the context of eServices on mobile devices (Chapter 2). Our contribution concerns eServices where data capture from citizens to public bodies is the issue. In the remainder of this paper, we first leaf through our work with accessibility guidelines. We then apply these to the case eService (Chapter 3). Finally, we discuss ongoing and future work (Chapter 4).

2. ACCESSIBILITY GUIDELINES FOR MOBILE eSERVICES

Many issues that are important to accessibility can be achieved by following accessibility *guidelines*. By using accessibility *tools* it is also possible to detect missing table headers, missing Alt-texts and so on. Moreover, it is becoming more and more common to provide options that make web-content accessible for users suffering from sensory disabilities. Large fonts and high contrast increase accessibility for users with vision impairments. Voice on the web may make content (more) accessible for people with dyslexia or other learning disabilities and people with impaired vision (e.g. elderly). In fact, many of the existing accessibility guidelines and accessibility tools based on established guidelines focus primarily on vision impairments. Other types of common disabilities, such as the cognitive ones, have not received an equal amount of attention. Even though this category of disability may appear conceptually and analytically difficult to handle, our work with mobile accessibility and has focused most on these users.

Loads of different design and usability guidelines are available for content carried by modern information and communication technologies. In order to approach accessible interaction designs for mobile devices we have analyzed the principles of universal design as published by the Center for Universal Design (Connell et al., 1997). The principles are: 1. Equitable use. 2. Flexibility in use. 3. Simple and intuitive use. 4. Perceptible information. 5. Tolerance for error. 6. Low physical effort. 7. Size and space for approach and use. For the mobile phone, examples of guidelines are Mobile Web Best Practices, as recommended by the World Wide Web Consortium (W3C, 2006), or the guidelines suggested by Nikkanen (2004), Hays (2007) or Jones and Marsden (2006). Based on these principles and guidelines for accessible design, we have synthesized design guidelines for the accessibility of eServices on mobile devices. Our design advices are organized into ten categories of guidance (cf. I – X below), each contributing to the accessibility of the eServices through the user interface (UI). Below we present a synopsis of these.

2.1 Navigation and Work Flow

As we see it, navigation makes the eService work. The main navigation should be placed identically on all pages/cards/tabs[1] of the UI, and critical functions should never disappear. The service should clearly express where the user is in the dialogue, and which tasks are active. The system should make it possible to go back to earlier phases of the dialogue, and it should be possible to end or terminate the dialogue at all times. In order to allow multiple navigation modalities the system should allow navigation by the device's physical keys (including soft keys) and by screen buttons.

The small size of the screen typically implies splitting the task into a number of sub-tasks implemented on a number of tabs. However, one tab should only contain related elements, and actions which are implemented

[1] 'Page', 'card' and 'tab' all refer to the organization of information or content in the user interface, typically information or content displayed on one screen at a time.

as a series of tabs should be organized as a path of tabs, not a network with unlimited navigation. Scrolling should be reduced to a minimum. During complex tasks the system should inform the user about his/her progression. If the user can initiate several simultaneous tasks, the method of initiation should differ from ordinary navigation and input. In electronic forms it should be possible to proceed between (uniquely named) fields by using the Tab-key.

2.2 Errors

Error messages disturb any user, and even after decades of usability studies they are still often presented as cryptic alarms. However, error messages that are connected to the use of the service should be explanatory, easily read and presented in the user's mother tongue or the language he/she prefers. If the information is intended for the technical support personnel, this should be explicitly stated. It is also important that the error message is shown immediately after the occurrence of the error. In case of repeated errors, the system should offer additional information or propose an alternative way to proceed.

Not troubling the user needlessly implies that if any input is out of range or illegally formatted, the system should accept the valid input, and only invalid input and /or uncompleted input fields should be shown to the user. In case of web-applications the service should return automatically if the target page does not exist. Finally, it should be possible to present all error messages in an alternative modality, such as voice (cf. categories XII and IX).

2.3 Search and Queries

One of the most basic and frequently used functionalities is search. That is why it should be placed visibly. In order to manage the information (over)load, the presentation of the search results should be well-structured and easy to read. In connection with search it is often possible to choose advanced alternatives. In our case, the service should offer the use of simple search as default and advanced search options as optional. To support users who suffer from impairments connected to reading or writing, the search function should automatically correct misspellings. This can be based on lists of usual typing errors or alternative spellings. The user should also be able to build personal lists of words or even abbreviations.

2.4 Input/output-Techniques

Multi-modality applies to input and output, too. It should be possible to give input and to confirm or end input both by using the physical keys of the device and by screen buttons (if appropriate). Multiple choices should be presented in a simple and consistent manner: alternatives in a menu or a list should be displayed together, and if necessary due to the number of alternatives, as layers or a hierarchical structure. The system should support self-population of input fields. Word lists or dictionaries should be enabled in connection with input fields. Finally, the focal area or the working area should be clearly accentuated.

2.5 Time

Users' need for time to accomplish a set of tasks depends on many different factors. Familiarity with the task or application is an obvious factor. Cognitive challenges affect the need for time as well. The more complicated the task flow becomes, the more flexibility should be offered with respect to elapsed time and requirements to user response. The eService should allow the user to work in his or her own pace, and it should show progression. Instead of time-out, the service should automatically save status and data input. Finally, when valid data input has occurred, or when the task is accomplished, the service should respond with appropriate feed-back.

2.6 Text and Language

For this point we simply present a set of common rules. Information to the user should be available in her/his mother tongue or the language he/she prefers. Foreign or professional words, or extraordinarily long words or

abbreviations should be avoided whenever it is possible to use ordinary words and everyday language. Sentences should be very short and grammatically correct, and long texts should be divided into sections or summarized as a list.

The most important content should be presented first in all textual text units. All titles and labels should describe the content that follows, and all textual content should be relevant in the current use context. Text lines should not continue horizontally beyond the edge of the screen or the window. The text should not move unless the user explicitly allows this. Links should differ from ordinary text. Links in a text should not consist of one very short word or a string of many words. The name of a link and the title of the target page should correspond. Finally, links should indicate if they have been followed.

2.7 Voice and Sound

In case of cognitive challenges, multi-modality may support the user (although, too many choices may again confuse her/him). The user should be able to choose text and other information elements to be read aloud, and it should be possible for the user to choose precisely what should be read aloud (in a logical and meaningful order). The implementation of the UI should make it possible to read any user input aloud, and it should be possible to start and stop the reading at any time. An even more advanced feature, based on voice, is the management of the use session by speech input, with respect to both input and navigation.

2.8 Graphics

The use of graphic elements may support or confuse the user. For cognitively disabled users the requirements in this category are strict. We argue that graphic elements should only be used to support focus, orientation or work flow. Moving elements should only be used when this feature adds information or supports the user. In that case, blinking and movement should be slow and non-persistent.

As far as colour is concerned, it is obvious that the contrast should be high and consistent, and opposite colours should not be used, in particular not combinations of red and green. Screen fonts should be used, and it should be possible to enlarge the text. Further we argue that it should be possible for the user to choose between different colour schemes, and that information should – naturally – be accessible even if multi-colour scheme is not available. It should at least be possible for the user to choose a simple high-contrast presentation. (Colour schemes in connection with links should follow established conventions.)

Icons or symbols should be consistent, and follow established conventions or standards. Otherwise the symbol or icon should clearly illustrate the functionality. Pictures, animations, illustrations or icons should not be used as links except those that are standardized symbols. If icons are used as links, an Alt-text should be provided.

2.9 Figures and Numbers

Figures and numbers easily represent a barrier for many users and in particular for those suffering from dyslexia or dyscalculia. Therefore the service should minimize the need for, and support alternatives to PIN-codes and other figure-based codes deployed as user identification. The service should also support alternative presentation forms for quantity and volume, such as diagrams or verbal descriptions of quantity.

2.10 Help and Information

Help and information functionalities are of crucial importance for all users. These should be placed and visualized identically all over the UI by using accepted principles or symbols. For instance, a question mark or an ‘i’ for information, are established conventions. Moreover, help or information functionality should be connected to all input fields, and when it is used it should be shown so that the use context remains unchanged. Finally, it should be possible to turn off any automatic help or information functionality.

3. CASE: THE TAX DEMONSTRATOR

In this chapter we illustrate the implementation of the above-presented guidelines in our case eService: the Mobile Tax Demonstrator of the Directorate of Taxes (www.skatteetaten.no). The demonstrator provides functionality for updating information required for calculation of income tax and consequently for ordering a new tax deduction card. (Other eServices included in the demonstrator are notification of move, and change of name). This is a suitable service for demonstrating the accessibility solutions, as it is meant to be used by all citizens, including the elderly and disabled.

In order to demonstrate the realization of the accessibility guidelines, we have selected a small number of examples. The screenshots below show the demonstrator's user interface. The screenshots have been produced by an emulator running on a laptop PC. The implementation has been tested by heuristic evaluation (Molich and Nielsen, 1990) Usability walkthroughs were conducted with 14 users in October-November 2007. Improvements based on these evaluations have been implemented in the demonstrator.

The demonstrator was developed with ServiceFrame. ServiceFrame is an application execution and creation framework based on Java. It provides functionality for communication with users connected through different types of terminals such as mobile phones, PCs or PDAs. ServiceFrame has been developed by Tellu AS (www.tellu.no) together with Ericsson NorARC as part of the ARTS research project (ARTS, 2003). It was created to support rapid development of internet and telecom services.

According to usability studies done in the project (heuristic evaluation), one of the most important areas of accessibility design in the context of eServices is that of managing the navigation and flow of tasks. In Figure 1 the use of 'tabs' is illustrated. The phases of the task are organized as a sequence of tabs, so that the user may maintain understanding of position and progression. The number of the active tab is clearly marked. Within one task the information may – reasonably enough – often be more comprehensive than the size of one screen. We take it for granted that *two-dimensional* scrolling should be avoided. We allow vertical scrolling, but we make an effort to manifest the position by a clearly visible scroll-bar. The scroll-bar also illustrates the relative vertical position on the active tab (Figure 1).

The input-output techniques deserve a good deal of attention. In connection with input or output users often arrive in error situations. In order to avoid some of these we have implemented a colour scheme that indicates invalid or incomplete input. The colour scheme changes when the (sub)task is completed. Before completion a field or a tab is identified in a colour that differs from the ordinary colour scheme of the design. This mechanism also ensures the quality of input data (Figure 2). In Figure 2, the mark-out concerns mandatory income information. The colour scheme is connected to the definition of a so-called 'skin', i.e. the colour palette for the UI. This can be freely modified according to user requirements or preferences.

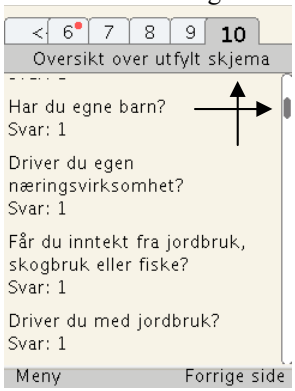

Figure 1. Task tabs and marking of the active tab (no. 10 which in this case is the final tab showing all input that the user has given). Scroll-bar showing the relative position on the right.

In a flow of tasks and in a sequence of dialogue activities the user needs a focal point. This may be connected to input or output, or to any information that the user manipulates. In the Mobile Tax Demonstrator, this challenge is solved by implementing a strong focal frame. This frame follows the active input or output area while the user scrolls up or down on the task tab (Figure 3). Such a frame can also be applied on any icons or other UI-elements.

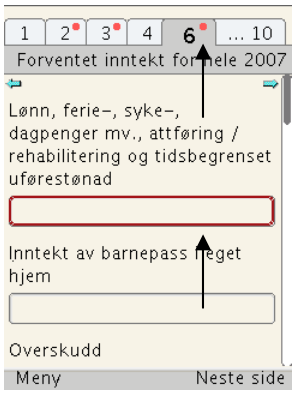

Figure 2. Changes in the colour scheme indicate invalid or incomplete input. Red •-marks on the tabs 2, 3 and 6 indicate that these tabs contain invalid or incomplete input fields or multiple choices. The strong frame on the active tab is red as well, indicating which input field needs to be completed.

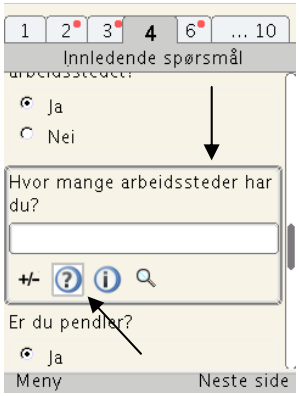

Figure 3. Active working area and active help-icon are accentuated by a focal frame.

Figure 4. Changes in font size *all over the UI* may be chosen from the menu: large font (alternative 1), medium font (alternative 2) or small font (alternative 3). Larger font *locally in the active working area* can be chosen by selecting the magnifying glass icon as shown in Figure 3.

Another design feature connected to the visualization of the content is the size of the font. Obviously, both visual and cognitive impairments dictate the need to let the user choose both the density of information on the screen and the resolution of the presentation. In Figure 4 the possibility to adjust the size of the text is visualized in two different situations: a) the user chooses to enlarge all textual information, or b) the user only wishes to see one field of textual information in large font.

Services on a mobile phone may often appear quite complex. Walking through a dialogue which is composed of several phases requiring navigation, selection, input, output, confirmations and so on, may easily lead the user into a trap. Hence, the help functionality can hardly be good enough. In order to prevent

errors and to help the user out of trouble we have implemented two help functionalities in the Mobile Tax Demonstrator. One is voice-based help. Research shows that there is a clear connection between multimodal UI design and accessibility (Obrenovic et al., 2007). In our demonstrator, help texts connected to an input field can be read aloud by choosing the audio icon (Figure 5). Moreover, if the user stops to proceed, a slowly blinking question mark appears on the screen. Behind this icon, additional information is available (such as formatting information and the like). In this context it seems appropriate to mention that the appearance of icons can be modified according to any convention or preference.

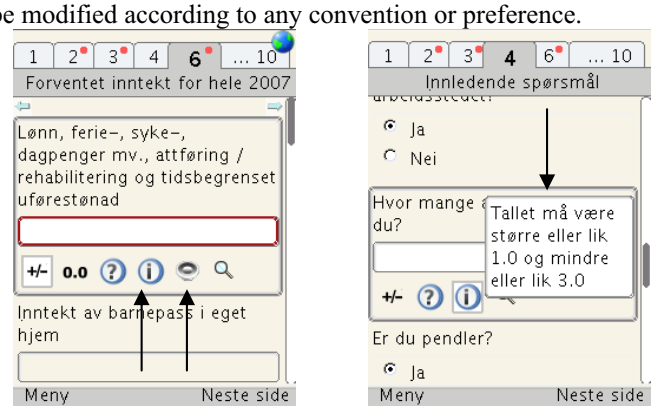

Figure 5. In the current version of the Mobile Tax Demonstrator, audio output is connected to help information (loud speaker icon). Additional help is available through the question mark icon.

As a conclusion to this chapter, we wish to emphasize that not *all* eServices necessarily benefit from *all* guidelines and pieces of guidance as presented in Chapter 2. Moreover, it is not possible to demonstrate all applicable pieces of advice in the context of one eService. In Chapter 4, additional points of view are given.

4. CONCLUSION

In this paper, we have presented pieces of our work to increase the usability and accessibility of the mobile UI. The topic has been treated by the application of accessibility guidelines to a Mobile Tax Demonstrator. As a conclusion, there are four areas that we wish to address: usability testing, further development of accessibility guidelines, challenges connected to multimodality, and finally issues related to knowledge of use contexts. All these issues demand the researchers' attention in the future.

The demonstrator is real. Early versions of the service (Hellman, 2007) were tested by university students, and valuable feedback was received (Flaten, 2007). Later, several improvements have been made, and the current version has been evaluated by 14 expert users. Feedback from the expert users concerned a) support to position and navigation, including mechanisms to hinder unintended navigation, b) visual clarity in connection with the active working area, c) error detection and recovery, and finally d) gradually increasing the available information and help, depending on the situation. Heuristic evaluations and walkthroughs were applied as the main test methodology, allowing the designers and developers to observe the user's position including all break-downs and dead-locks.

The overall impression from the test sessions is that governmental eServices, although formal and even somewhat complex, offer an excellent point of departure for the development of electronic self-services for citizens. Further, there are no obvious restrictions that make such solutions solely applicable within the public sector and its electronic case handling. In order to take mobile eServices in production use, usability testing has to be performed by representative samples of the potential user population, i.e. *all* (adult) citizens. This includes people that belong to user groups with special requirements. Examples of such users are elderly and cognitively disabled people. Truly representative user populations have to test the usability of the demonstrator before the eService can be introduced to a wider audience.

The vast majority of communication between citizens and public bodies is based on the use of forms. The Mobile Tax Demonstrator shows that electronic forms on the mobile phone may display accessibility. There is, however, no doubt about the necessity to keep up the work with accessibility guidelines that meet the special requirements connected to physically small screens and interactivity designs that apply to mobile

devices. Moreover, mobile technologies evolve rapidly. Interactivity paradigms and guidelines for practitioners have to develop hand in hand with technological changes.

Further, it is necessary to address the constraints of multimodality. The flexibility afforded by multimodality raises considerable challenges for the users interacting with their systems, services and devices. This concern is connected to the overload that may be generated by the introduction of several modalities, such as combinations of visual and audio information, and the opportunity to *choose*. Intuitively, at some point multimodality reaches breakeven. The research question is when, and for which user groups.

Finally, there is the question of suitable use contexts for the mobile phone. There are many situations in which the mobile phone will be superb. The user is "always" connected, and even small time-slots may be utilized to case-handling. On the other hand, crowded places with lost of background noise are not optimal environments for any kind of work. This makes us conclude that there is no doubt about the advantage of good connectivity between mobile and stationary eServices. It is not 'either-or', but rather 'both-and'.

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