The Usability State of Nine Public Self-Service Applications in Denmark

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Abstract—**Empirical usability research have documented usability problems in public websites and self-service applications. This paper uses data from usability evaluations of nine Danish public self-service applications from six self-service areas by five different self-service providers, to examine similarities in the usability problems found across self-service applications. The study found that the types of usability problems are present across self-service applications, self-service areas, and self-service providers. However, it is also found that the total number of problems have decreased significantly in the self-service applications that were usability evaluated in 2016. In this paper, we have shown that though the amount of found usability problems is significantly lower, three types of usability problems were present in both old and new self-service applications. These general types were button placement, attaching of files, and meaning of concepts.**

Keywords-Digitalisation; Usability; Usability Evaluation; Self-Service Applications; User-Centred Design

I.   INTRODUCTION

European countries are currently developing digital self-service applications for their citizens. These efforts are being launched to improve citizens' services and to reduce costs [7]. The Digital Economy and Society Index (DESI) measures the level of digitalisation in EU countries. According to DESI, Denmark is one of the leading countries in regards to digitalisation [7]. In 2012, a digitalisation process was launched in Denmark, with the goal that by the end of 2015, 80% of all communication between citizens and the municipalities should be conducted digitally; this also included digital public self-service applications [17]. In this paper, applications and self-service applications refer to digital forms used for applying for e.g., a new passport, this activity was until recent times conducted on paper, but has been digitalized in recent years.

Having public self-service applications does not mean that citizens are necessarily willing to use these applications. The usage depends on whether citizens find these applications easy to use [5] as poor design can prevent citizens from using these websites [15].

In Denmark self-service applications are developed by different companies, and several companies are developing similar self-service applications and competing about selling their applications to the municipalities 98 municipalities. The citizens do not experience that the applications are developed by different self-service providers as all applications follow the same design style guide, though the content and layout vary between the different companies.

To support the Danish initiative, the joint IT organisation of the municipalities in Denmark (KOMBIT) developed two sets of user-centred guidance materials in 2012 and early 2013, to support self-service providers in developing user-friendly self-service applications [2]. Similar initiatives have been taken in countries, such as the United States, the United Kingdom, and South Africa [18] [22].

In this paper, we analyse the usability problems found across self-service applications and self-service providers to find commonalities in the usability problems. The purpose was to ascertain if the usability of self-service applications has been improved and if there are general usability problems across self-service applications. The categories of usability problems identified here have previously been published. The purpose and the content of this paper differs from [21].

In the following section, we present the method of collecting and analysing the data for this study, Section III describes the findings. Section IV discusses these findings, and Section V presents the conclusion.

II.   METHOD

For this study, we use lists of usability problems gathered from usability evaluations of nine Danish self-service applications developed by five self-service providers for six different self-service areas. These evaluations were conducted between 2010 and 2016 [1] [3] [11].

A.   Case Companies

This study includes three of the largest and most experienced companies in regards to developing public self-service applications in Denmark, one medium sized experienced company, and one small company with little experience in developing public self-service applications. Table 1 shows the year the usability evaluations were conducted and the relation between companies and self-service applications.

Usability evaluations were conducted of nine different public self-service applications from five different self-

service providers, in six different self-service areas. The table also shows that the applications were evaluated in four usability evaluations.

TABLE I.   SHOWS THE RELATION BETWEEN COMPANIES AND SELF-SERVICE APPLICATIONS AND NUMBER OF USABILITY PROBLEMS FOUND

Year of Evaluation	Tested Self-Service Solutions	Number of Test Persons	Company and Usability Problems	Total number of usability problems
2010	Building permits	10	Company E 7/26/38 +4	75
2014	Assistive technologies	8	Company A 2/17/17	36
			Company B 5/18/14	37
			Company C 0/11/6	17
			Company D 1/15/13	29
2014	Marriage certificates	4	Company B 1/3/2	6
2016	Address change	6	Company E 2/3/0	5
	Rent subsidy		Company D 1/3/3	7
	Medical practitioner		Company C 2/4/0	6

B. Self-Service Applications

This section provides a description of each self-service area included in this study.

1) Building Permits (2010)

The self-service application for building permits is used when citizens apply for conducting construction work where a building permit is needed, such as building a garage. The evaluated building application was a digitalised paper application developed by company E. The application was developed before the approach of user-centred design was introduced in the development of public self-service applications.

2) Assistive Technologies (2014)

The self-service application for procurement of assistive technologies is used if a citizen needs to apply for assistive technologies, such as a hearing aid. These applications were developed just after the introduction of user-centred design in public self-service applications by companies A, B, C and D.

3) Marriage Certificates (2014)

The self-service application for marriage certificates is filled out by citizen's wanting to get married either in a church or by having a registry-office wedding. This application was developed just after the introduction of user-centred design in public self-service applications by company B.

4) Address Change (2016)

The self-service application for an address change is used when citizens are moving to a new address. This application was developed more than two years after the introduction of user-centred design in public self-service applications. This self-service application was developed by company E.

5) Rent Subsidy (2016)

The self-service application for rent subsidy is used if citizens have a low income and live in rented accommodation. This application was developed more than two years after the introduction of user-centred design in public self-service applications by company D.

6) Medical Practitioner (2016)

The self-service application for changing medical practitioner is used if a citizen wants to change to another medical practitioner. This application was developed more than two years after the introduction of user-centred design in public self-service applications by company C.

C. Usability Evaluations

All usability evaluations were conducted as think-aloud evaluations on a PC in a Chrome browser. The building application, assistive technology applications, and marriage certificate application were conducted in a usability laboratory. The applications of address change, rent subsidy and medical practitioner were conducted at a student café.

1) Test Persons

In regards to the number of test persons for each evaluation, we are aware that the correct number of test persons has been discussed extensively in the research community e.g., [6] [10] [13] [16] [20]. All usability evaluations in this study were conducted with between four and ten test persons. All test persons in each test received the same instructions and the same tasks. The tasks were scenario based and were tasks a user would typically complete in these systems.

For the building application, the evaluation was conducted in 2010 with ten test persons. All test persons were experienced in conducting "do-it-yourself" (DIY) work. Their DIY experiences varied; two had only painted their homes, and eight had either restored parts or all of their homes. Experience with filling out online forms for the municipality varied from none to a few times for eight of the participants. The two remaining participants were more experienced and had filled out forms for the municipality more than ten times.

For the procurement of assistive technologies, the evaluation was conducted in 2014 with eight test persons. The four different self-service applications in this self-service area were usability evaluated during the same usability evaluation, where the four applications were given to the users in a different order to even out bias. Seven participants had experience with filling out public applications, of these, three had experience with public self-service applications; of these three, two had experience with the public self-service application for assistive technologies.

For ordering of a marriage certificate, the evaluation was conducted in 2014 with four test persons. Three test persons had experience with public self-service applications, though neither with this particular application.

The three self-service applications for address change, rent subsidy, and changing medical practitioner were usability evaluated in one evaluation with the same test-persons in 2016 with six test persons. All users had filled out a self-service application for an address change in the past; four participants had used the self-service application for a rent subsidy and changing medical practitioner before this usability evaluation.

2) Data Analysis from Usability Evaluations

All data were analysed using the instant data analysis (IDA) method [12] by researchers. All usability problems were categorised as either critical, serious or cosmetic, in regards to levels of confusion and frustration of the participants, and whether they were able to fill out the forms correctly [14].

3) Results of Usability Evaluations

All results were documented in a list describing and categorising each usability problem. At least two people took part in the characterisation of the problems. The lists of usability problems across all nine self-service applications consisted of a total of 218 usability problems (21 critical, 100 serious, 93 cosmetic, and four uncategorised problems); no usability problems were removed prior to the analysis. The distribution of the usability problems across self-service applications, self-service providers and severity can be found in Table 1. The +4 by company E in the building application means that there were two problems where the severity was uncategorised as this categorisation required a deeper knowledge of the domain than the researchers had acquired; it was left to the case workers to conduct the classifications of these four usability problems.

D. Data Analysis

The usability problems were analysed using a descriptive coding as described by Saldana [19]. All 218 problems found across the lists of usability problems were coded in regards to the character of the problem. The descriptive coding provided us with a list of three categories after removing all specific problems only found in one self-service application. Subsequently, all the problems in each category were discussed between two researchers to validate the categories and ascertain if the problems in each category were comparable across self-service applications and self-service providers. All problems not directly comparable were removed, leaving only the problems appearing across self-service applications. The three categories were named: button placement, attachment of files, and meaning of concepts.

III. FINDINGS

In this section, we present the findings from the categories button placement, attachment of files, and meaning of concepts, respectively. We also compare the results of the usability evaluations between applications from each self-service provider.

A. Button Placement

Usability problems in relations to button placement were found in four of the six self-service areas. It was mainly the placement of the "next-button" that confused the test persons.

In the building application, the buttons were placed at the top of the application, which made the test persons overlook the buttons, as this placement made these buttons difficult for them to find. Similar problems were found in two assistive technology self-service applications. The "next" button was hidden until the test person scrolled down to the bottom of the page, in the self-service applications for address change, and changing medical practitioner. It was later discovered that the buttons were only hidden in some Internet browsers. Subsequently, four different browsers have been checked: Chrome, Firefox, Safari and Internet Explorer. In Chrome the "next" button was hidden, in Firefox the button was partly visible and in Internet Explorer and Safari, the button was fully visible. The only indication of hidden buttons was the scrollbar located on the left side, which some test persons missed.

B. Attachment of Files

In the applications for building permits, rent subsidy, and changing medical practitioner, some test persons did not understand how to attach a file. When the test persons had chosen a file to attach, they did not understand that they then had to press the "attach" button to get the file attached. Instead, some test persons clicked the "next" button, which meant that the document did not get attached.

When trying to attach files, the test persons in both the building application and two of the assistive technologies applications had difficulties seeing that a file had been attached. When a test person experienced problems understanding how to attach a file they tried to follow the guidelines; however, these were constructed to be browser specific and did not match the actual flow in the Chrome browser used for the usability evaluations.

C. Meaning of Concepts

Meaning of concepts is used as a broad categorisation of problems in regards to what the users read in the applications. This category covers wording, and term users do not understand, consequences of a conducting a specific action, like clicking yes or no, and unclear use of language, meaning that users do not understand what is expected of them.

The test persons experienced problems understanding the wording and terms used in the applications for building permits and all four applications for assistive technologies. The test persons had insecurities about clicking yes or no, as the consequences of choosing one or the other were not clearly stated, e.g., the test persons had to decide whether the municipality was allowed access to their medical file, but neither an explanation as to why or the consequences of choosing no was stated if they chose not to allow access.

In one of the applications for assistive technologies, the test persons had to click either yes or no in a radio button to the question "Do you consent to this?" The wording confused the test persons as they became insecure about what "this" meant. In the marriage application, one section had to be filled out by both parties which confused the test persons as the wording made them believe both parties had to be present in the same room to do that, which was not the

case. In the application for address change, several test persons did not understand when to use a power of attorney, or what to use it for.

IV. DISCUSSION

In this section, we discuss our findings. Each of the three categories of usability problems described in the results section is compared to Nielsen's ten usability heuristics.

A. Comparison of Applications From One Self-service Provider

We have only evaluated one self-service application from company A, and both evaluations of the self-service applications from company B was conducted in 2014, which means that neither of these would be interesting to compare. Self-service applications from company C and D were evaluated in 2014 and 2016, and self-service applications from company E were evaluated in 2010 and 2016. In this section, we will compare the number of usability problems compared to the type of applications and describe the tendencies in regards to the design of self-service applications.

1) Company C

In 2014 the application for procurement of assistive technologies was usability evaluated. This evaluation provided 17 usability problems in total, of which none were categorised as critical, 11 were categorised as serious, and six were categorised as cosmetic problems. This application was developed as a digitalized paper application and was part of a larger healthcare system.

The application looked identical to a paper application citizens used to fill out by hand, both in terms of format and design. The application was developed to provide the basic information the caseworkers needed to handle the application and did not intend to ease the workload of the caseworkers or to make the application process easier for the citizens [1].

In 2016 their application for changing medical practitioner was evaluated. This usability evaluation showed six problems in total, of which two were critical, and four were serious, and none were cosmetic. The application from 2016 was developed as a wizard and not as a digitalized paper application.

A segment of the application from 2014 is shown in Figure 1 on the top, and the application from 2016 is shown at the bottom.
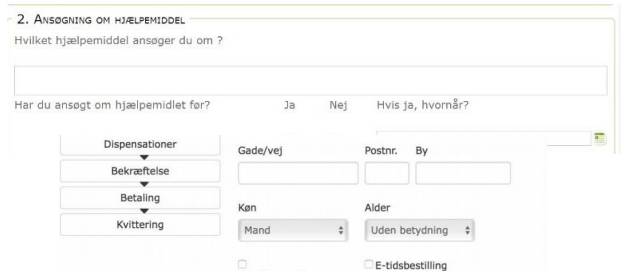

Figure 1. Shows parts of both applications from company C

2) Company D

In 2014 the application for procurement of assistive technologies was usability evaluated. That evaluation provided 29 usability problems in total, of which one were categorised as critical, 15 were categorised as serious, and 13 were categorised as cosmetic problems. This application was developed as a digitalized paper application and was part of a larger healthcare system. In 2016 the application for rent subsidy was evaluated; this evaluation identified seven problems. Of these, one usability problems was categorised as critical, three as serious, and three was classified as cosmetic usability problems.

The application from 2016 was developed as a wizard and not as a digitalized paper application. Segments of both applications are shown in Figure 2. The application from 2014 is shown at the top and the application from 2016 is shown at the bottom of Figure 2.
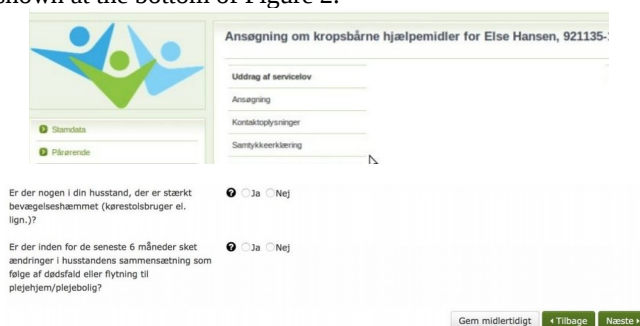

Figure 2. Shows parts of both applications from company D

The application from 2014 is shown to the left, and the application from 2016 is shown to the right.

3) Company E

In 2010 the application for applying for a building permit was usability evaluated. That evaluation provided 75 usability problems in total, of which seven were categorised as critical, 26 were categorised as serious, and 28 were categorised as cosmetic problems. This application was developed as a digitalized paper application.

In 2016 the application for changing address was evaluated; this evaluation identified five problems. Of these two were critical, three were serious, and none were classified as cosmetic usability problems.

The application from 2016 was developed as a wizard and not as a digitalized paper application. Segments of both applications are shown in Figure 3.
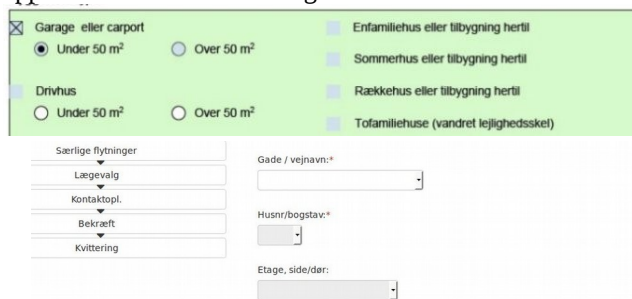

Figure 3. Shows parts of both applications from company E

The application from 2010 is shown on the top, and the application from 2016 is shown on the buttom of Figure 3.

B. Button Placement

In the building application, the "next" button was placed counter-intuitive to the test persons. However, most problems in regards to button placement were present because the self-service applications were not optimised to different browser types.

Geminus Ranking logs Internet activity in Denmark to give access to statistical data about technology and Internet usage. According to Geminus, Chrome is the most used Internet browser on computers in Denmark [8].   This indicates that a large amount of Danish citizens would experience hidden "next" buttons, which could lead to confused and annoyed citizens who might not be interested in using self-service applications[5] [15].

C. Attachment of Files

Our results showed two types of problems in regards to file attachments. One type of problem was test persons not understanding how to attach a file; they pressed the "next" button instead of the "attach" button. Some tried to follow the guidelines in the self-service application. However, the guidelines were optimised for another browser, meaning that the steps did not fit.

A citizen experiencing these types of problems will likely lead to their inability to correctly attach a file. This means that they will either need to ask for help or send an application that might be incomplete. If they press the wrong button, they may not even be aware that their application is incomplete.

The other problem type is users not seeing when a file has been attached, which shows that the relevant information was either too small, or too much information was on the screen meaning that there was too little focus on the essentials, leading to users not noticing when a file had been attached.

D. Meaning of Concepts

Test persons experiencing problems with understanding meaning of concepts were found in all the evaluated self-service applications. The wording used was mainly directed at professionals or people with some amount of domain knowledge, and was not necessarily understandable for citizens. Or, the language was simply unclear. This problem made some test persons confused and afraid to make mistakes; as a result, some test persons stopped for a longer period, trying to figure out the consequences of choosing one option over the other. Several test persons stated that they would have given up and contacted the municipality by phone if this was not a test and they experienced this kind of doubt when filling out a public self-service application.

E. Usability Problems Across Self-Service Providers and Year of Evaluations

Table 2 shows a decrease of the numbers of found usability problems between 2014 and 2016 for company C and D, and between 2010 and 2016 for company E.

TABLE II.   SHOWS THE NUMBER OF FOUND USABILITY PROBLEMS FROM EACH SELF-SERVICE PROVIDER AND USABILITY EVALUATION

Company	Year	Critical	Serious	Cosmetic	Uncategorised	Total number of usability problems
C	2014 2016	0 2	11 4	6		17 6
D	2014 2016	1 1	15 3	13 3		29 7
E	2010 2016	7 2	26 3	38 0	4	75 5

Billestrup et. al. found that the Danish self-service applications for procurement of assistive technologies, which were usability evaluated in 2014, were not developed with a user-centred approach, though this approach had officially been implemented as guidelines by the joint IT organisation of the municipalities during this period [1].

As the number of found usability problems have dropped significantly between the evaluations conducted in 2010 and 2014 to the ones conducted in 2016, this indicates that some improvements have been made; this could indicate that a more user-centred approach has been enforced by companies during this period or simply that the evaluated applications from 2016 have been developed as wizards, designed to help the users. Also. In 2014 it was decided that all new public self-service applications should be usability evaluated which itself also could have had an impact [4] as usability evaluations might have caught some issues before the citizens had to use these applications. A decreasing number of usability problems could also indicate that citizens have increased their understanding of using public self-service applications over the past few years.

V. CONCLUSION

In this paper, we analysed the usability problems across self-service applications and self-service providers. The purpose of this study was to gain a greater understanding of the broader usability issues in public self-service applications. Our results show three types of usability problems found across self-service applications and self-service providers.

We have shown that public self-service applications need to be optimised for different browsers as this otherwise can lead to usability problems for the users. This should also include optimisation for different technologies such as tablets and smartphones, as Geminous rankings show that 56% of Internet usage in Denmark is not conducted from a computer but other devices, e.g., smartphones and tablets [9].

The first evaluation was conducted in 2010, two years before the user-centred design approach was implemented in the development of public self-service applications in Denmark. In 2012 the user-centred design approach was implemented, meaning that the systems usability evaluated in 2014 and 2016 were evaluated after the introduction of a user-centred focus. Though Billestrup et al. found that this was not the case in with self-service applications developed in 2014 [1].

This study showed that the number of problems has decreased since the introduction of the user-centred design approach, and we have shown an indication of more usable self-service applications, as the number of usability problems was significantly lower in 2016. However, we have also shown that though the amount of found usability problems was significantly lower, three types of usability problems were present in both old and new self-service applications.

This means that the approach taken by focusing on a user-centred approach, using wizards, and conducting usability evaluations has not been sufficient in eliminating some general and reoccurring usability problems found across self-service applications, self-service providers and self-service areas.

A. Limitations and Future Work

This study is limited to a single country by its focus on the Danish self-service applications and problems found across these self-service applications. As for future work, it would be interesting to compare our findings to similar studies from other countries.

Another limitation is that the lists of usability problems we have analysed for this study did not state how many test persons experienced each of the listed problems.

We are aware that many unknown factors could implicate the changes in the self-service applications besides the companies using a more user-centred development approach these unknown factors should be investigated further.

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