Four Public Self-Service Applications: A Study of the Development Process, User Involvement and Usability in Danish Public Self-Service Applications

Jane Billestrup, Jan Stage
Institute of Computer Science
Aalborg University
Aalborg, Denmark
{jane,jans}@cs.aau.dk

Marta Larusdottir
School of Computer Science
Reykjavik University
Reykjavik, Iceland
marta@ru.is

Abstract— This paper presents a case study of four software companies in Denmark developing self-service applications for the same self-service area. This study outlines the process of how the four companies developed their self-service applications and a usability study of the completed software solutions. In this study, we have analysed the customer and end-user involvement and compared these results to the results of the usability evaluations. The main findings show that the usability varied in the four cases, and the ones who had the most customer involvement from case workers showed the highest number of usability problems in the self-service solutions for the citizens. We discuss the user-centred design approaches used, the drawbacks and benefits of customer and user involvement, and case workers acting as citizen representation during the development process of the software.

Keywords-Case Study; Self-Service Applications; Usability; Development Process; User-Centred Design; Software Development

I. INTRODUCTION

This paper is an extended version of the paper "A case study of four IT companies developing usable public self-service solutions" [1].

European countries are currently developing digital self-service solutions for their citizens. These efforts are being launched to improve citizens' self-services and to reduce costs [2]. Though public self-services have been on the agenda in many countries for years, getting the end-users to use these applications is not easily achieved. For citizens to accept public digital services and websites, these sites need to have a high degree of usability for the citizens to accept the public digital services and websites [3]. Wangpipatwong et al. found that public digital websites in Thailand lack usability due to poor design and they recommend focusing more on the needs of the citizens to ensure that they will use these websites continuously [4].

The Digital Economy and Society Index (DESI) describes the level of digitalisation of the countries in EU [2]. The digitalisation level is measured in five areas, connectivity, human capital, use of the Internet, integration of digital technology, and digital public services, respectively [2]. The level of digitalisation varies in the countries in EU, from Romania, Bulgaria and Greece at the bottom to Sweden, Finland, and Denmark at the top [2]. Denmark is one of the top 3 countries in regards to all digitalisation areas

in EU and is one of the leading countries in the world in regards to the level of digitalisation [2].

Denmark has a population of 5.6 million people and is divided into 98 municipalities as a single point of contact for citizens in regards to the public sector [5]. In 2012, a digitalisation process was launched with the goal that by the end of 2015, 80% of all communication between citizens and the municipalities should be conducted digitally. This digitalisation also included digital public self-service applications [6].

Until 2012, a contract based approach was used for developing digital public services, where the software companies competed by bidding. As of 2012, the software companies no longer had to put in a bid. Instead, they have to compete with other companies about selling their self-service applications to the municipalities. For the individual municipalities, it means that they can choose between competing designs for each digitalisation area for the citizen self-service applications.

To support the Danish initiative, the joint IT organisation of the municipalities in Denmark developed two set of user centred guidance materials in 2012, to help the self-service providers in developing user-friendly self-service applications for the citizens [7]. Similar initiatives have been taken in other countries like the United States, United Kingdom, and South Africa [8] [9] [10].

Development of self-service applications for all citizens involves a broad array of different stakeholders, including citizens, public institutions such as municipalities, support organisations like the joint IT organisation of the municipalities, IT companies that produce the applications and third party purveyors that the public institutions use to provide services to the citizens. In Denmark, the joint IT organisation of the municipalities has created guidelines to ensure that public digital self-service applications and websites are usable for all citizens [6].

From the self-service providers' point of view, focus on usability will increase the price of the product, making the developed solution harder to sell [11]. But studies show that the quality of the software and the cost are complementary, e.g., [12] [13]. To get public self-service providers to focus on usability, it has to be made a requirement. Both Jokela et al. [14] and Mastrangelo [15] describe the importance of usability being specified in the requirements specification document. Mastrangelo describes that public administration needs guidelines and guidance to get usability placed in the requirements to get the intended impact [15].

Jokela et al. found that to acquire usable digital self-service solutions the specified usability requirements have to be performance-based, as only these types of requirements would be verifiable, valid and comprehensive [11]. Additionally, the usability of digital self-service solutions should be validated before the solutions are sold to the municipalities [11].

According to Tarkkanen et al., formal and detailed criteria for validation will cause usability workarounds by the self-service providers as they will focus only on the verification of their applications in regards to what is stated in the usability requirements, instead of focusing on getting the usability of the digital self-service solutions optimised and, finding and fixing usability issues [16].

In this study, we have focused on analysing the development of public self-service applications, based on analysing each case based on the following four themes

- the development process used
- the customer involvement (case workers)
- the end-user focus (citizens)
- the characteristics of the products developed

These four themes were found by conducting a descriptive coding on all collected data as proposed by Saldana [17].

Additionally, we have analysed the number of usability problems found in each of the self-service solutions and compared it to the findings related to the four themes stated above.

In this paper, we have focused on analysing the customer and user involvement during the software development process. We discuss the user-centred design approaches used, the drawbacks and benefits of customer and user involvement found in these four cases, and describe the quality of each of the four self-service applications based on the analysis and the conducted usability evaluation.

Section II describes the background of this study. Section III presents the method of this case study. Section IV presents the results. Section V provides the discussion and finally, Section VI presents the conclusion.

II.   BACKGROUND

In opposition to the traditional development process based on a set of requirements and a fixed contract the joint IT organisation of the municipalities in Denmark decided on a new approach in 2012. According to the project manager at the joint IT organisation of the municipalities, the goal of conducting this change was to ensure that the developed self-service applications had a high degree of usability and that all relevant stakeholders were involved in the development process. The first wave was deployed in December 2012 and the last wave in 2015. Each wave released a new set of digital self-service applications. Table I shows the plan for the deployment of the four waves.

This study was conducted in 2013-14 mainly focusing on the development of one application for the second wave.

Since 2012 approximately 30 different public self-service application areas have been made mandatory for citizens to use. Across these self-service areas, around 100 different self-service applications have been sold to the municipalities from more than twenty self-service providers [18].

Table I.   Plan for deployment of self-service applications [18]

	Public self-service applications area
Wave 1 2012	- Address change - National health service medical card - European health insurance card - Daycare - After school care - School registration
Wave 2 2013	- Aid for burial - Free day care - Assistive technologies for handicapped or elderly - Exit visa - Unlisted name or address - Reporting of rats - Loan for real estate tax - Letting out facilities - Changing medical practitioner - Marriage certificate - Passport - Drivers license
Wave 3 2014	- Garbage handling for citizens - Garbage handling for organisations - Construction work - Building permission - Loan for deposit - Registration in CPR - Services in roads and traffic areas - Notification of digging or work on pipelines - Certificates for Lodging - Parking permits
Wave 4 2015	- Personal supplement - Sickness benefits - Sickness supplement - Extended sickness supplement

The municipalities' joint IT organisation developed two sets of guidance materials supporting a user-centred approach in the development of public self-service applications [19] [21]. A User Journey and a set of 24 Usability Criteria, respectively.

The user journeys can be described as a person in a use situation described in a scenario [20] using graphical illustrations. An illustration showing six pictures from one user journey is presented in Figure 1. The usability criteria are a set of guidelines listing requirements for all developed self-service applications. An overview of the usability criteria for the development of public self-service applications can be seen in Table II.
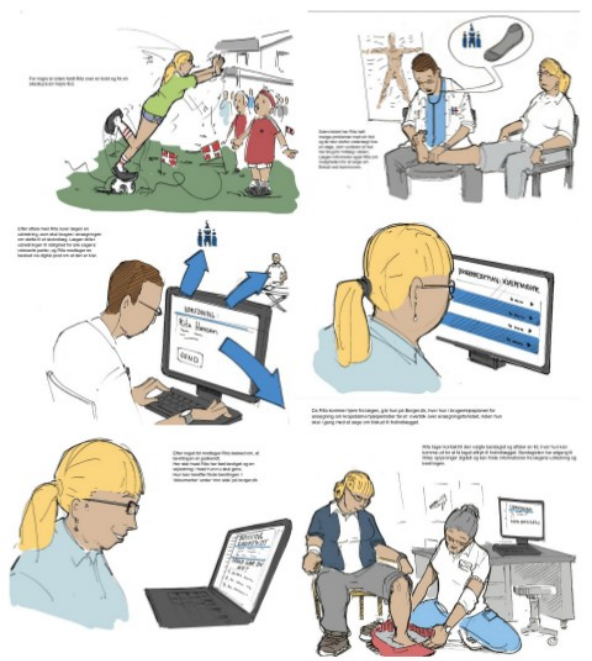
Figure 1.   Six pictures from one user journey [19]

TABLE II.   24 usability criteria [21]

	Language and text
1	Texts should be short and precise without containing legalised or technical terms
2	Text should be action-oriented and guide the citizens to fill out the form
3	Citizens should be informed of which information will be needed, before filling out the form
4	Citizens can access additional information if needed when filling out the form
5	If an error is made it should be made very clear to the citizens what they did wrong
6	Error messages should be in Danish
	Progress and flow
7	The form should be organised in logical steps
8	Before filling out the form, the extent of the form should be clear to the citizens
9	When filling out the form, the citizen knows the progress made and how many steps are left
10	A receipt should be made after finishing filling out the form
11	The receipt should also be sent by email to the citizens
12	After submitting the form, the next steps should be clear to the citizen
	Data and information
13	If login is required, NemLogin (National Danish Identity Service) should be used
14	Existing data should be reused as much as possible; citizens should not provide the same information more than once
15	A summary is shown before submitting the form
16	Submitting a form should only be possible if all required information is provided
17	The solution should validate the information provided by the citizens when possible
18	The solution should adapt questions to prior answers given, when possible
	Design and accessibility
19	It should be made clear to the citizens when are beginning to fill out a form
20	There should be a clear distinction between buttons like yes/no, forward/backwards, and the positioning should be continuous through the form
21	The authority behind the form should be clear
22	Navigating in the form should be possible both using mouse and keyboard
23	The form should be filled out by citizens who does not possess a high degree of IT skills
24	The solution meet relevant accessibility criteria for self-service solutions

The overall purpose of these materials was to provide the IT self-service providers with tools to keep a focus on the citizens and their needs to ensure that the developed self-service applications were usable for all citizens. The joint IT organisation of the municipalities functioned in a supporting role during the development process. All interested IT companies could decide which specific services they wanted to develop. The services were developed and made available for all of the 98 municipalities in Denmark. The municipalities buy individual solutions and are not bound by one self-service provider but can choose freely between all developed solutions in each area.

III.   METHOD

We have conducted an empirical study of four competing IT development companies implementing usable digital self-service solutions for the same application area. Next, the four cases are presented, and the data collection and analysis are described in more detail.

A.   The Cases

Below, the four companies are described. The companies have developed similar solutions and are competitors regarding the 98 municipalities in Denmark who are the potential customers. The SME scale (small and medium scale enterprise) [22] has been used to categorise the size of the four companies involved in this case study, in regards to the number of employees and turnover. The SME scale is shown in Table III.

TABLE III.   SME Scale [22]

Company category	Employees	Turnover	or	Balance sheet total
Medium-sized	<250	≤ € 50 m		≤ € 43 m
Small	<50	≤ € 10 m		≤ € 10 m
Micro	<10	≤ € 2 m		≤ € 2 m

The four companies were chosen because they were the only companies developing applications for this particular self-service area, and the companies and their developed self-service solutions were different in terms of maturity of the company and if the company was developing a new solution or was optimising an existing solution. The applications for this self-service area had some degree of complexity, and the self-service area would be relevant to all types of citizens, though mainly older citizens. Next, the four companies are categorised.

Case A is a micro/small company in regards to the SME scale and the turnover and number of employees. The company has not previously developed other public digital self-service solutions, so it is categorised as immature. Their digital self-service solution is categorised as new for the same reason. This company is an independent consulting and software company.

Case B is a large company in regards to the SME scale. The company is categorised as mature in regards to digital self-service solutions in general as they have developed several public digital self-service solutions previously. This

self-service solution is categorised as new, though they already have an existing solution, as they redid both the analysis and design phase, before developing this solution. This company has departments all over Scandinavia and creates and sells software solutions to several different markets.

Case C is a large company on the SME scale. The company is described as both immature and mature in regards to digital self-service solutions, as they are experienced in regards to developing self-service applications. This area of application is relatively new to them, though having an existing solution in this self-service area. This company has departments all over Scandinavia and creates and sells software solutions to different markets. Case D is a large company on the SME scale. The company is described as mature in regards to digital self-service solutions and has developed digital self-service applications for years. For this self-service area, their self-service solution is an optimisation of an existing self-service application. This company is an independent consulting and software company. Table IV shows the placement of the four cases in regards to maturity and if the digital self-service solution was new or an optimisation of an existing solution.

Table IV. Categorisation of the four companies and self-solutions in regards to maturity of the company and if the self-service solution is new or an optimisation

We have defined the organisation's maturity according to their experience developing self-service applications in general. We defined the self-service application as new if the organisation had no existing self-service solution in this area or had an existing solution, but the problem area was re-analysed before redesigning the system. Otherwise, the self-service solution was defined as an optimisation of an existing self-service application.

The data used for this categorisation was collected from each of the companies by the conducted interviews described in the following section.

B. Data Collection

This section describes the process of the data collection. The first sub-section describes how we collected the data that was analysed to determine the scope of this study in regards to which self-service area to focus on, and which companies it would be relevant to include in the study. The second sub-section describes the data collection for this study, which is the results documented in this paper.

1) Exploratory Preparation

All data was gathered over a period of one year. Qualitative interviews were conducted by phone with project managers from 11 of 12 identified digital self-service providers for all self-service providers identified for the

second wave at this time. The primary objective was to learn how self-service providers were accepting and using the user-centred materials and learn about each company and their development approach [23]. Additional data was gathered on how the user-centred requirements were used, and how existing requirements were redesigned [24]. All interviews were transcribed and analysed by coding, using Dedoose [25].

This analysis leads to narrowing the focus on one public self-service area with four identified self-service providers.

2) Gathering the Data

For this case study, we had one half-day meeting with each of the four companies. The people present at the first meeting had the following job titles; for case A; CEO, Project Manager, and Usability Expert. For case B; Product Owner. For case C, Business Developer and, Senior Manager. For case D; Chief Consultant and, Chief Product Owner. The agenda for these meetings was an introduction to this study including a discussion of their gain of participating, as we offered inputs on their self-service solution and conducting a usability evaluation at the end of the process. The results of these activities would be usable to improve the four companies self-service applications.

Before the meetings, we had identified the roles of the people we would like to interview, as these functions were named differently in each company and some people would have more than one of these roles. The identified roles were the following; project manager, developer, interface designer, and the person responsible for the user experience and usability of the public self-service application. These roles were chosen to ensure to get different views of the development process and end-product, in relation to the user focus and involvement.

After the introduction the interviewee presented his/her company overall and, more specifically, how the practitioners were developing this chosen self-service application, including describing the development process and method, collaboration with stakeholders and end-user involvement. The product owner or project manager also gave a demonstration of the self-service application in its current state and handed over relevant internal documents describing their development process and showing design documents. Lastly, it was discussed which people they suggested for further interviews in the next part of our study to ensure we would cover all perspectives. At the meetings, we conducted a list of people covering the following roles previously described. We interviewed 14 people distributed across the four companies.

The purpose of the interviews was to determine current practice at each of the four companies in regards to customer and citizen involvement, and how the end-users were taken into consideration during the design and development process. We found that interviewing people with different roles and responsibilities would provide us with more data on different perspectives and areas of expertise inside each company. All interviews were conducted as semi-structured qualitative interviews as described by Kvale [26]. The interviews were conducted by phone and transcribed afterwards.

Table V shows the number of people involved in this study, from each of the four companies.

Table V. Number of participants from each company in each phase

	Preparation Meeting	Interviews	Workshop	Total amount of participants from each company
Case A	3	3	1	**3**
Case B	1	3 (2)	2	**3**
Case C	2	3 (1)	2	**3**
Case D	2	5 (3)	2 (1)	**6**
Total (in all)	**8**	**14**	**7**	**15**

The number of participants from each company is shown for all phases of this study. The number in () represents new people, who were not part of the previous step, e.g., case D had two people present at the preparation meeting, and five employees were interviewed. Of these five people, three were not present at the preparation meeting. At the workshop with case D, two people were present, of these two, one had not been present at the preparation meeting and was not interviewed.

Table VI. Shows the data collection process of the exploratory preparation and for this study
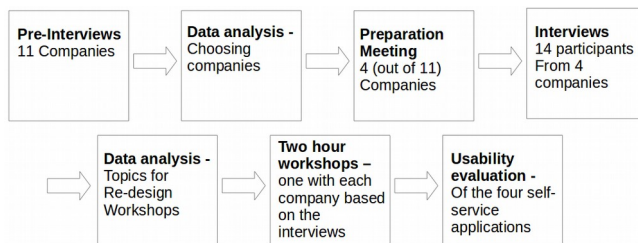
The workshops were used to discuss the results from the interviews in regards to their user-centred approach and how the user-centred materials developed materials from the joint IT organisation of the municipalities were used during the development process, and to clarify our results from the interviews and preparation meetings.

3) Usability Evaluation of Products

To evaluate if the development process had resulted in usable self-service applications for the citizens, a usability evaluation of these four self-service solutions was conducted. This evaluation was conducted as a think-aloud usability evaluation in a usability laboratory, with eight test persons. For the evaluations, all test persons received the same instructions explaining what they were meant to do during the evaluation, e.g., conduct a set of tasks and think aloud during the evaluation. All participants received the same tasks, and evaluated all four systems, but evaluated them in a different order to even out any bias.

The test persons were chosen to represent a user segment as large as possible. Our test persons ranged in age and had different educational backgrounds. The test persons varied in skill level and experience with computers, though all use the Internet on a regular basis. Most test persons had experience with other public digital self-service areas but not this specific area. An overview of the test persons can be found in Table VII.

All test persons received a small gift after participating in the evaluation. After conducting the evaluations, the data was analysed using the method Instant Data Analysis, as this method is also used på practitioners (IDA) [27]. The usability problems were categorised after the criteria described in Table 8. The problems were categorised in regards to levels of confusion and frustration of the participants, and whether they were able to fill out the forms correctly. These criteria and categorisations were described further by Skov and Stage [28].

Table VII. Overview of the demography of the test persons

Test person	Gender	Age	Education	Experience with public services
TP1	F	44	High school degree (early retirement because of health issues)	Yes, also for this application type, and done digitally
TP2	F	31	PhD-student in Social science	Yes, for other service areas, and done digitally
TP3	M	52	Accountant	Yes, for other service areas, and done digitally
TP4	F	64	Retired school teacher	Yes, for other service areas, but not digitally
TP5	F	66	Technical Assistant	Yes, also for this service area, and done digitally
TP6	M	30	Msc. Engineering	Yes, for other service areas, and done digitally
TP7	M	65	Retired computer assistant	Yes, for other service areas, and done digitally
TP8	M	22	Bachelor student in computer science	No experience

Table VIII. Defining the Severity of the Usability Problems in the Digital Self-Service Solutions [28]

	Slowed down	Understanding	Frustration or confusion	Test monitor
Critical	Hindered in solving the task	Does not understand how the information in the system can be used for solving the task	Extensive level of frustration or confusion – can lead to a full stop	Receives substantial assistance, could not have solved the task without it
Serious	Delayed in solving the task	Does not understand how a specific functionality operates or is activated	Is clearly annoyed by something that cannot be done or remembered or something illogical that one must do	Receives a hint, and can solve the task afterwards
Cosmetic	Delayed slightly in solving the task	Do actions without being able to explain why (you just have to do it)	Only small signs of frustration or confusion	Is asked a question that makes him come up with the solution

C. Data Analysis

The data was analysed with regard to the different perspectives of each interviewee and their job function to get an idea of what each company did during the development process.

The aim of these activities was to study the development process of the four companies developing the digital self-service solutions in this specific self-service area, into more detail. The cases were analysed exploratively.

We completed a content analysis of relevant documents from the companies. Both, interviews and documents were analysed using descriptive coding [17], and Dedoose [25] as a tool. All coding was conducted by one researcher and categories were discussed and verified by another researcher.

IV. RESULTS

In this section, we present our results. Our findings are divided into four subsections for each case, focusing on the development process, customer involvement, end-user focus and the final product, then the results are compared between the four cases for each focus area. All results are reported from the perspectives of the companies and their interviewed employees and the documents we got from them.

A. Case A

1) Development Process

Company A uses an agile development method and primarily in accordance with Scrum [29]. They describe their development process as flexible. "*Our development method is agile, primarily Scrum. We use a pragmatic approach and a flexible model, meaning we can add features quite late in the process.*" They describe choosing this approach as it makes the development process easier and more dynamic, also, needing fewer people working on each project, e.g., they primarily have a project manager involved in the development process, who is also the designer and the developer. This is doable because they can make changes quite late in the process and they feel that correcting errors are not a big deal. "*We are not afraid of making mistakes; we don't have a great need to get everything right the first time*". One municipality was involved giving the company a greater understanding of the entire field of application.

2) Customer Involvement

The company collaborated with one municipality as a customer and stakeholder. It was insisted that the involved personnel should be case workers who understood their own and the citizens' needs and not necessarily people with IT skills. From the case workers, they have learned about the field of application. "*We held a new workshop with the municipality every couple of weeks; here we created mock-ups that we used to design a new prototype, which was evaluated and redesigned at the next workshop, [...] until we were satisfied with the final prototype*". The Interviewees were confident that they had developed a solution that lives up to the wishes and needs of their on-site customer but is less confident that their solution is covering the needs of other municipalities. "*We have discussed if we should have created a standardised solution covering the needs of as many municipalities as possible.*" It was described as a problem as they were not aware of the fact that the interpretations of legislation are not the same in all municipalities.

3) End-User Focus

The citizens are not involved in the development process, but the company describes taking them into consideration by ensuring that the procedures for sending an application are as simple as possible. "*We have created the solution so it should be understandable for all types of people. We have a good feeling here and our self-service application have been verified several times (by case workers)*". They have built an application that in the simple cases can send a decision back to the applicant right away without a case worker having to go through the application first. One interviewee also described that their primary focus is on the customer and not the citizens. "*We have been focusing on the customers' needs and work procedures; it has been important for us to understand what they wanted the citizens to do*". This perspective was chosen because the municipalities are the paying customers and not the citizens.

4) Products

It was perceived as a strength that they have developed a "whole solution" covering both the necessities for the case workers and the citizens. "*Our solution has a good flow for the citizens with understandable screen displays. It is not heavy on wording, and we only ask for information that is relevant for the municipalities to keep things as simple as possible.*"

The company also identified some weaknesses in regards to their digital self-service application. They described that the fact that they only collaborated with one municipality might have been an issue, although they did not see it as a real option for them to have involved 3-5 municipalities in the development process. The company also recognises that there might be usability issues in the digital self-service application but argues that this is substantiated in what the municipalities are willing to pay for. "*Reality is just different than theory. If you want to pay for it, you can get the great solutions focused on usability, but that is not what the municipalities want to pay for*". One interviewee described that if the customers do not care about usability they will not focus on that either.

B. Case B

1) Development Process

Company B uses Scrum [29] as their development method, and they use an adjusted version of the project management method PRINCE2 [30].

One interviewee described that the company develops one solution to fit all municipalities. "*Our aim is to make one solution to fit all, [...] We only create products were we keep the property rights [...], so we can sell the same product to several customers*". All digital self-service applications are built in a module-based platform. This approach is chosen to give a certain amount of flexibility in regards to changing the design during the development process or when the system is tested by municipalities. Municipalities are involved early in the process.

2) Customer Involvement

The primary focus of the digital self-service application is on the back-end of the system, and to ease the workload of the case workers. *"Our primary focus is to simplify the working procedures for the case workers. Otherwise, this would never be a priority for the municipalities".* Before developing this solution, the company hosted workshops with five municipalities that are already customers, with the purpose of analysing the working procedures, used for creating a specification of requirements and a business case. *"On the first workshop we are not presenting anything, typically we say – we don't know anything, tell us about your work […] we use these workshops to learn how we digitally can support the digital workflow."* This information is used in the development phase, where the first iteration is developed, and a prototype is created. The prototype was presented at the next workshop to case workers from the municipalities involved in the development process. The prototype shows the mapping when a citizen fills in a form and until it lands with the case worker. One interviewee also described sending emails to all municipalities that are existing customers, asking the case workers to answer questions in regards to their workflow.

3) End-User Focus

The company does not involve citizens in the development process, but two interviewees described involving the municipalities and case workers as a representation of the citizens' needs. *"The municipalities give us feedback in regards to what is not working for the citizens, e.g., parts of the application that citizens consistently fill out wrong".* Though the focus is not directly on the citizens, it was stated by one interviewee that an optimisation of the back-end also brings value to the citizens as this will give a better flow with the handling of their applications. It was stated that focusing on accessibility of the system is more important than focusing on usability for the citizens.

Two interviewees did describe testing the application with users before launching the digital self-service application. *"We have some pilot municipalities […] they are part of a test phase where we assemble data for statistics".* For the municipalities and case workers, the focus is on improving the efficiency of the workflows.

4) Products

The company perceives it as a strength of their digital self-service application that different kinds of professionals were involved in the development process. It was stated that the role of the product owner creates more value as he or she also has to ensure that the digital self-service application follows the legislations even if it changes. Two interviewees showed confidence in that they were ensuring to develop usable and intuitive digital self-service applications.

Late changes are described as being possible because the application is built in modules making changes less expensive. A perceived weakness is creating one solution to fit all needs. This approach was chosen as updating or testing would be too expensive if municipalities wanted something changed.

C. Case C

1) Development Process

Company C uses its own process, which is not a name given development method. *"We use our own method which is built on several different methods. It also varies if we work agile, it depends on the project and the customers and if they wish to be and have the skills to be involved in the development process. In regards to the public self-service solutions, we are not working agile".* The digital self-service applications are developed by the company without text and descriptions in the form the citizens are filling in. The municipalities have to write that information themselves. This approach was chosen to give the case workers at the municipalities the flexibility to get the information they think they need in a digital self-service application from their citizens and to be able to sell the same solution to all municipalities. The thought behind this is that all municipalities have different needs. *"There is a great difference between designing a solution for a large municipality or if it is a very small one. There is a great difference in usage and working procedures".* One interviewee described that providing each municipality with the flexibility for adjusting as a key element in regards to the digital self-service applications they are developing.

2) Customer Involvement

The focus of the company is creating a solution that all municipalities can use. *"It makes a very big difference if you are designing something for a large or small municipality. There is a very big difference in relation to how things are done or used."* One interviewee described developing an application that fits all types of municipalities, by developing a blank form that the municipalities can set up as they wish to get the citizens' to provide the information that each municipality finds important. This also means that each municipality buying this solution has to write all the text going into this digital self-service application.

Case workers at the municipalities are involved in the development process by a forum for the exchange of experience that the company is hosting for the municipalities that are existing customers. These workshops are hosted several times a year. *"In regards to this specific solution we already have a solution that the citizens can access to fill out other applications or to get an overview of their own records, so this new application will be developed to be part of this existing system."* Existing customers have been involved through these previously held workshops, but no customers are directly involved in the development of this digital self-service application.

3) End-User Focus

The company does not involve citizens in the development process. Two interviewees described creating a system that the municipalities can change to fit their needs. *"We have structured it so the municipalities can make adjustments where and if they see fit, e.g., in regards to rewriting phrasings or functions that can be added or removed".* The municipalities and case workers were involved before the design and development phase. The design and workflow were designed at workshops held

before the redesign of this digital self-service application. The company focuses on usability by having usability specialists hired.

4) Products

It is perceived as a strength of their digital self-service application that they have developed a solution where the citizens can do everything in one place. *"The citizens never leave their medical file when they need to fill in the self-service application".* Two interviewees also perceive it as a strength that they have tried to cover all aspects of the needs that both citizens and case workers have.

A perceived weakness is that an interviewee feels they might not have spent enough time on usability when developing the digital self-service application for the citizens. *"The self-service application might be kind of crude. People need to have prior knowledge to be able to use it."* The interviewees also raised a concern about if less IT skilled citizens would be able to fill out the application.

D. Case D

1) Development Process

Company D use a staged development method but have implemented some agile techniques in the past years. They described involving customers as much as possible in the development process. *"We use agile processes evolving around the customers. If we involve customers earlier in the process, we will learn earlier if there are processes we haven't understood".* One interviewee did describe that this approach has been implemented in recent years and that the company earlier had the philosophy that they were the experts and not the customers.

The company have a department of User Experience Designers who are involved in designing and testing the front-end of the systems. Though they are isolated from the development teams and are mainly involved at the end of the development process by conducting summative usability evaluations.

The municipalities are involved several times during the development process, by conducting online meetings discussing prototypes. Two interviewees find this valuable as the company are developing one solution to fit all. The data collected from involving the municipalities are used for creating user-stories. *"We always start by creating user-stories. [...] The user-stories are primarily used when the system has been developed".* The company described using the user-stories to check if the developed system lives up to the needs specified in the user-stories.

2) Customer Involvement

The primary focus of this company is on the back-end of the digital self-service application. The company has involved municipalities by conducting a workshop with people from municipalities who are already customers. Representatives from six municipalities participated as on-site customers. The company hosted a workshop to learn about the number of applications and generating of ideas. At the end of this workshop, a specification of requirements was generated.

The case workers from the municipalities were involved several times during the development process but mainly

through online meetings or email. This approach was chosen as a consideration for the employees. *"Every time we have to pull the employees away from doing their regular job in the municipalities [...] Online meetings still gives them the ability to provide inputs. [...] Whenever we have a question we send an email asking if we are doing the right thing."* One interviewee described that involving the customers during the development process is a relatively new procedure and that they now see this as best practice as it means they can do changes during the development process as changes late in the process are expensive and complicated.

3) End-User Focus

For this digital self-service solution, two interviewees described focusing on the citizens' needs and their flow through the application. *"We know that this system is developed mainly for senior citizens, meaning that this system needs to be as simple as possible. This includes that all descriptions and wordings need to be easily understandable".* One interviewee described that there had been a discussion about if they spent too much time on the citizen angle. *"The end-user is not the one buying our product, it is the municipalities, [...] what matters is if they think our self-service solution is good".* The digital self-service application is described as being part of a larger health care system, where citizens will have access to, e.g., former applications and the municipality will have everything in regards to one citizen in one record. For this digital self-service application, senior citizens without much experience with computers, have been involved in filling out a digital self-service application. In regards to the case workers and municipalities, they described focusing on full automatic digital self-service applications when possible.

4) Products

It was described as a perceived strength that they had integrated this application in their general healthcare record solution. *"The citizens can see the full catalogue of the services the municipality offers and, after they have applied for something once, it is possible to make a reorder without starting over with the application."* One interviewee described that they have simplified processes that otherwise might be difficult for less IT skilled citizens. For the case workers the solution is perceived as a strength in regards to, when an application ends up with the case worker, the system has already validated that the citizens are entitled to what they have applied for.

It is perceived as both a strength and weakness that they always make applications that follow the legislation though some municipalities might have other requests. It is perceived as a weakness that they have been bound by an existing design on the general healthcare record solution. They feel this application might lack usability and that some written information might be too small for the application.

E. Summary of Results

1) Development Process

Case A and B describes using a module-based platform as this provides flexibility to make changes, also late in the development process. Case D tries to avoid late changes by involving the customers early in the process. The cases A, B,

and D finds customer involvement to be a key element. Case C only work agile and involve customers if they find it relevant. Case B, C, and D describe making one solution to fit all municipalities, though case C describes developing a solution that is flexible so the municipalities can set it up as they wish, in regards to getting the information each municipality needs from the citizens.

2) Customer Involvement

Cases A, B and D asked on-site customers to participate during both design and development process. Cases A and B held continuously design workshops, where case D held one at the beginning and later primarily had remote access to the involved municipalities. Case C gathered information from workshops before the design phase but had no customer involvement besides that. Cases B and D stated that they mainly focused on the back-end of the system to be used by the case workers. Cases B, C, and D all stated that they were aware of that the municipalities have different needs as it depends on the size of the municipality and their interpretation of legislation. Case A described that they learned eventually that the municipalities have different needs, though learning this quite late in the process.

3) End-User Involvement

Neither of the companies has citizens directly involved in the design or development process, although cases B and D described testing their developed public self-service application on citizens after the development has been completed. Cases A and D implemented automatic decisions when possible, benefiting for both citizens and case workers. Cases A, B, C, and D all described that focusing on the needs of the citizens has not been made a priority, only the needs of the municipalities as customers. Case D described that they needed to focus less on the citizens and more on the municipalities as customers.

Cases A and D have mainly focused on the target user-group in regards to keeping the design simple for the citizens. Case B focused primarily on the flow of the end-users in their solution, and case C has used usability specialists to check if the design was usable for the citizens.

4) Products

Cases A and D highlight simplified processes as strengths in regards to their public self-service applications. Cases B and D find the fact that they focus on developing applications that follow the legislation as a strength. Cases C and D both describe it as a strength that the self-service application is integrated into one healthcare solution for all public healthcare applications. Cases A, C, and D believe that a weakness of the citizen-centred self-service applications is lacking usability. Usability has not been made a priority by the companies as it was not a priority for the municipalities.

The applications from Case C and to some extent Case D were significantly smaller and less complex than the applications developed by cases A and B, e.g., the application from case C was created as a paper application.

F. Usability of the self-service Solutions

In the previous sections, we have focused on how the four self-service applications have been developed and how it was ensured that these applications were usable for the citizens, and would save time for the caseworkers. In this section we look at the state of the finished self-service applications and whether these applications are usable for citizens.

Of the identified problems, 11 were found across all four digital public self-solutions. Among these general problems was a lack of understanding of the purpose and flow of the self-service solutions, problems with attaching files. Also, test persons getting annoyed or confused by not being able to understand helping texts and the descriptions of the rules and regulations of the application area, leading to test persons filling in the wrong information in the text fields. And, misunderstanding data fields, also leading to the test persons filling in the wrong information in the text fields. An overview of the usability problems is shown in Table IX.

Table IX. Usability Problems in Each Digital Self-Service Solution

	Company A	Company B	Company C	Company D
Critical	2	5	0	1
Serious	17	18	11	15
Cosmetic	17	14	6	13
Total	**36**	**37**	**17**	**29**

The self-service applications developed by case A and B were much more comprehensive than the applications develop by cases C and D. The self-service applications from cases C and D were both part of a larger healthcare system, meaning that less information had to be filled out manually by the participants. Especially the self-service application from case C was very simple compared to the self-service applications developed by cases A and B.

Two critical problems were found in the self-service application from case A. one was about test persons not understanding which information to put in where and ending up writing the wrong information at the wrong place. The other critical problem was about file attachment. The test persons experienced problems because the helping text was not optimised for the browser and when they tried following the written steps the test persons got confused and stopped as what they read did not match the options they had.

Five critical problems were found in the self-service application from case B. Examples of these problems could be in regards to file attachment, as the test persons do not realise when a file has been attached. Another problem is about test persons not understanding the search function and how to enter search parameters.

No critical problems were found in the self-service application from case C, and one critical problem was found in the public self-service application from case D. With this problem the test persons got into a full stop. They had to click a drop-down menu on the left side of the screen at all test persons experienced a lot of trouble trying to figure out what to do. Test persons mainly figured out what to do when they started clicking different menu options and then got the right one.

V. DISCUSSION

In this section, the results are discussed. First, the results are discussed for each case, and then the user-centred approach is discussed.

A. Discussing the results for each case

For supporting the discussion of the results from each case, we have made an overview of the results from the four cases in Table X.

1) Case A

In case A, the company is micro/small in the SME classification and considered immature, since this is the first time they developed public self-service applications. The product is classified as new since the company does not have other existing products to base this product on. Their product is module based, so it is easy to make changes quite quickly to the product if needed. Their key features are that they frequently collaborated with one municipality through workshops and evaluating prototypes gathering information on the needs and getting feedback from case workers (the customer), but not the citizens (the end-users). The result of the usability evaluation showed 36 usability problems, but only two serious problems.

The high number of usability problems could be because the development team has not gained experience in developing products for this kind of customers. Another issue could be that they only involved one single municipality in their process, though having 98 municipalities as potential customers.

The company focused on easing the work process of the case workers and therefore involved the caseworkers as much as possible in the development process. This was done under the assumption that the caseworkers understood the citizens and their needs, but the high number of usability problems indicate that this is not the case, which means that citizens have to be involved in the development process to represent themselves and their own needs.

2) Case B

In contrast, to case A, case B is a large company and mature in developing public self-service applications, though this application is classified as new. Their product is module based on making it easy to conduct changes quite quickly to the product if needed. In case B, the developers collaborated with five municipalities through workshops, prototypes and emails, but did not collaborate with the citizens, although testing was done with citizens in pilot releases. The self-service application from case B had 37 usability problems, which was the highest amount of usability problems found in each of the four self-service applications. This self-service application also had the highest number of critical usability problems. This is surprising since it is a large, mature company and collaborated with several municipalities. Like in case A, case B also developed a solution focused on making the case workers activities more efficient. The fact that case B collaborated with five municipalities and experienced approximately the same amount of usability problems in their self-service application indicate that it is not the number of municipalities, and case workers involved that makes a difference.

Table X. An overview of the four companies in regards to the focus areas.

Theme	Sub-theme	Case A	Case B	Case C	Case D
The Cases	**Company size**	Micro/small	Large	Large	Large
	Maturity	Immature	Mature	Immature/mature	Mature
Development Process	**Method**	Agile, Scrum	In phases, SCRUM in development Phase Prince 2	In phases, own method	In phases, agile elements
	Team	Project Manager mainly, CEO part of analysis and sales process	Product Owner, allocating needed resources through the process	Project Manager, allocating needed resources through the process	Project Manager, allocating need resources through the process
	Platform	Module based, easy to make changes	Module based, easy to make small changes	Part of health care system, changes can be costly	Part of health care system, changes can be costly
Customer Involvement	**Focus area**	Case workers and their needs	Case workers and their work-load	System fits needs of municipalities	If System is needed customers' willingness to pay
	Involved municipalities	One	Around five	All existing customers	Six
	Involvement type	4-5 workshops, Prototypes, Customer involvement	Workshops, emails Prototypes, Customer involvement	Workshop	Workshop, emails Online meetings
End-users	**Citizen representation**	Primarily Case Workers	Primarily Case Workers	Primarily Case Workers	Primarily Case Workers
	Goal	Decisions at once	Optimizing work flows	Flexibility to fit each municipality	Decisions at once
	Usability	Verified by Case Workers	Testing on citizens in pilot releases	Hired specialists	Testing on citizens Hired specialists
Product	**Perceived strengths**	Applications verified right away	Follows legislation	Part of healthcare system	Part of healthcare system Applications verified right away Follows legislation
	Perceived weaknesses	Lacking usability	One solution fit all	Lacking usability	Lacking usability
Usability Problems	**Critical problems**	2	5	0	1
	Total number of problems	36	37	17	29

It also indicates that citizens should be involved in the development process, as stated in the previous section.

3) Case C

Case C is a large company developing a solution that is an optimisation of existing software. They are grouped as mature since they have been developing self-service applications, but also as immature since this area of application is new to them. They involved all existing customers while developing this solution but also hired specialists for gathering feedback on their solution. Their solution showed 17 usability problems, which was the lowest of the four evaluated self-service applications. None of the usability problems were critical problems. The reason could be the specialist's advice, and involvement made the solution usable. Another reason could be that the solution is more limited than the solution from case A and B as this application is part of a larger healthcare system, meaning that much less information has to be put in when filling in this application. Also, it was decided to make the solution from case C very simple, with actually little support for the caseworkers, so they still had to do some activities manually. Where case A and B are trying to optimise workflows and activities, which also makes the self-service applications more complex for the citizens and raises the risk of usability problems than transforming paper applications into digital self-service applications.

4) Case D

Case D is also a large company developing a solution that is an optimisation of existing software. It is grouped as mature since the company has been developing public self-service applications for years. They involved six municipalities in the development, did some testing with citizens and hired specialists to give advice. Still, there were 29 usability problems found, but only one critical problem. This might be the biggest surprise in the results since this company is using user-centred design processes and is experienced. This system is part of a larger healthcare system, meaning that much less information has to be filled in when filling in this application. So the solution is rather limited, but still, contains many usability problems. In case D usability professionals are a bit isolated from the development team and are mostly involved in a summative evaluation at the end of the development. This approach could have resulted in higher number of usability problems in the solution than if the usability professionals had been more integrated into the development process. But this also indicate that it is not a matter of how many municipalities, caseworkers or usability specialist's that is involved in the development process, but it might make a difference if citizens are involved in the development process.

B. Discussing the User-Centred Approaches used

The Danish digitalisation effort has been launched to support the development process and provide each municipality with more digital self-service solutions to choose from, and enhancing usability in these solutions. For this purpose, two sets of guidance materials were created, a user journey and a set of 24 usability criteria, respectively. The aim was that this approach would facilitate competition between the self-service providers, resulting in better and more user-centred self-service applications for the citizens. All four companies involved the municipalities in the design process both in regards to the back-end of the system meant for the case workers and in regards to the self-service applications meant for the citizens. Two of the companies described involving citizens quite late in the process for testing of the features, either by going live in a few "pilot-municipalities" or conducting a usability evaluation.

Though a user-centred approach has been taken, our results correspond with the findings of Wangpipatwong et al. who found that e-government websites are lacking usability due to poor design and non-employment of user-centred design methodologies [7]. The reason for this is that the municipalities according to the companies are only focusing on this to a small extent and are not willing to pay more than the bare minimum. This shows a mismatch between what the joint IT organisation of the municipalities and the municipalities are trying to achieve. The public self-service providers are focusing on what the municipalities are willing to pay for and want the citizens to do and not taking the user-centred approach with a citizens' perspective unless this is being requested by the municipalities. If the user-centred approach should be a success, it is important to involve the municipalities as well. They need to understand that quality and cost are complementary [12][13] and why usability needs to be a focus area and why a usable system will be a sound investment though it might be a bit more expensive to develop. Bruun and Stage have found that redesigning a digital self-service application focusing on usability, can reduce the amount of time the case worker has to spend on each application, with more than 50% [31].

Jokela et al. [11] and Mastrangelo [15] describe the importance of usability being specified in the requirements. It is questionable whether this approach will be successful unless the municipalities learn the values of these requirements and get the understanding that focusing on usability will reduce cost over time. The municipalities have some responsibility in this whole process also. If they are demanding that their solutions are assisting caseworkers in doing their job digitally in a fast and easy process, the software companies have more motivation for focusing on usability. The companies will not focus much on usability unless the municipalities are demanding usable products.

As described in Section IV.f we found 11 usability problems across self-service applications from different companies; this shows that self-service providers have problems understanding the end-users needs in general, though usability has been on the agenda for more than twenty years. If we compare the general problems we found with Nielsen's usability heuristics from 1995, we found that the self-service providers have violated three of these heuristics. Number 2, Match between the system and the real world. Number 6, Recognition rather than recall. And, number 10, Help and documentation [32]. This lack of understanding shows that the self-service providers have trouble understanding the basics of usability theory, and even more trouble understanding the needs of the end-users in general.

C. Benefits and Drawbacks of Customer and User Involvement

This paper documents the development process of four different self-service solutions and shows the use of three different approaches to digitalise self-service applications.

One approach used by case A and B was having case workers from the municipalities as onsite customers to represent both their own and the citizen's needs. This lead to self-service solutions that tried to simplify the caseworkers work processes and thereby ease their workload.

The second approach used by case C was not having an onsite customer but involving the caseworkers before starting the development process. This lead to a self-service solution less focused on easing the workload of the case workers, and this self-service application was closer to being a simple digitalised version of the paper applications used in the past.

The third approach used by case D was not having a direct onsite customer but involving caseworkers when it was felt to be needed. This approach leads to a self-service solution that was simple in some aspects but also trying to solve some tasks to ease the workload of the caseworkers.

From a citizen's point of view, the self-service solution from case C would be the most usable of these four, with 17 documented usability problems. Where the self-service solutions from case D had 29 documented usability problems, and the self-service solutions from case A and B had 36 and 37 usability problems, respectively. But looking at this from a caseworkers point of view, the self-service solution from case C would not be the optimal choice as this will not in any way ease their work processes or workload. Though it can be an argument that neither does the self-service solutions from case A, B or D at this time, as citizens experiencing problems filling out, self-service applications will mean that they are making mistakes. These mistakes will have to be corrected by the caseworkers later in the process, as documented by Bruun and Stage [31].

Both case A and B, and, partly case D all used caseworkers as onsite customers. Our results show that this approach is not sufficient when developing self-service solutions for the citizens, with the purpose of easing the workload of the caseworkers. The caseworkers simply do not understand the needs of the citizens to a degree where this approach would be sufficient. This means that to get an understanding of citizen's needs, citizen's have to be involved.

VI. CONCLUSION

In this study, we focused on analysing the customer and user involvement during the software development process, and the characteristics of the four products developed, and the results of usability evaluations thereof. We have discussed user-centred design approaches used, the drawbacks and benefits of customer and user involvement found in these four cases.

Our results show that citizens were not involved in the development process and that case workers were expected to represent and understand the citizen's interests. We conclude that this approach has not been successful as our usability evaluation of the four self-service application showed 17 – 37 usability problems experienced by the test persons. Several problems leading to a full stop or a high level of frustration for the test persons.

This lead us to conclude that case workers are not suitable for citizen's representation and if the goal is to ease the workload of the case workers, citizens have to be involved in the development process too.

We recognise that it is a limitation that four companies were involved, in regards to drawing conclusions in a broad term about the entire development process of self-service solutions. As future work, it would be interesting to learn the perspectives of the municipalities from themselves, and not only through the self-service providers. And if the focus was contrasted to more structured opinions coming from developers side. As future work, accessibility could also be a focus area.

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