The Online presence of the Danish public sector from 2010 to 2022: Generating an archived web corpus

Tanja Svarre, Mette Skov

Abstract: This chapter presents the generation of a web archive corpus with the purpose of studying the development of Danish public sector websites from 2010 to 2022. Websites constitute an important element in shaping electronic governments. Few studies have carried out longitudinal studies of government websites based on archived web materials. In this study, which spans three levels of administration, archived web data is gathered to analyze governments at the local, regional, and national levels in Denmark across four selected years.

Keywords: public sector, online information, e-government, web archives.

1. Introduction

E-government designates the use of technology to improve access to information and services for government stakeholders, such as citizens, companies, and fellow government administrations at the local, national, and international levels (Layne and Lee 2001). The term "e-government" started to emerge in the late 1990s with the growth of the internet (Grönlund and Horan 2005; Skiftenes Flak et al. 2009).

Various models have attempted to map the stages of e-government development, indicating that governments progress at different rates (Rooks, Matzat, and Sadowski 2017). According to Layne and Lee (2001), e-government begins as the initial stage, which is characterized by a presence akin to a catalog; it then progresses to the transaction stage, where tasks such as online form submissions become possible, followed by the vertical integration of information and systems and, finally, the horizontal integration of information, which is the highest stage. Recently, there has been a shift in the e-government literature toward smart government, suggesting that with smart technologies, digital governments can offer even more advanced solutions to their stakeholders (Lemke et al. 2020; Hujran et al. 2023).

Prior studies have highlighted factors that both facilitate and hinder the progress of e-government. At a broad level, these factors include technological, organizational, and environmental aspects (Zhang, Xu, and Xiao 2014) and, more specifically, finance, socioeconomics, politics, the government level and type, management practices, digital skills, cultural

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models, and the social environment (Ronchi 2019; Ingrams et al. 2020; Cahlikova 2021). The diversity of these factors emphasizes the complexity of e-government implementation, which is not necessarily a straightforward process.

A central element of e-governments are government websites, where governments share information with, offer services to, and interact with citizens (Sandoval-Almazan and Gil-Garcia 2012). Like the general e-government maturity models presented above, the authors have also brought forward models to characterize government websites in particular. One categorization, suggested by Fan (2018), operates at the following five levels: 1) websites as one-way communication channels for information; 2) support for two-way communication, such as through SMS, mobile apps, and social media; 3) transaction-enabled websites that enable citizens to carry out various transactions; 4) citizen participation, whereby citizens can provide input and participate in polls; and 5) one-stop portals, through which citizens can access services across governments and functionalities. An alternative categorization was offered by Fietkiewicz, Mainka, and Stock (2017) that operates with pillars, where pillars 1–3 correspond to Fan's (2018) levels 1–3 but pillar 4 concerns the operability and integration of services, while pillar 5 relates to e-participation for citizens. From these frameworks, it is clear that the assessment of e-government also takes place at the specific website level.

Like many countries, Denmark has embraced the challenge of developing its government's digital dimension. Renowned for its high level of digitalization (Pedersen 2018; Flensburg and Lai 2021), the country has consistently ranked as the world's most digitalized nation over the past three years (United Nations 2023). While government websites may not be the most frequently used platforms by citizens (Flensburg and Lai 2021), they are the core drivers of e-government initiatives. This chapter aims to discuss the methodological challenges related to the construction of a corpus for studying the online public sector in Denmark and to contribute to our understanding of the progression of digitalization in Denmark's public sector from 2010 to 2022. Archived web data is our primary source, facilitating comparative studies over time. The following research questions guide our inquiry: 1) How can a corpus be established to enable longitudinal studies of e-government development? and 2) What were the overall characteristics of Danish e-government websites in the period from 2010 to 2022?

2. Related work

Several longitudinal studies have examined the development of public sector websites over time. Within the field of internet history and web

archiving, only two studies have specifically focused on public sector websites (Schafer 2017; Raffal 2018). The following section presents an overview of these two studies, but first, we introduce other longitudinal work on public sector websites. The research aims and methodological approaches used in these studies are described to provide a contextual background for the present study.

The general methodical approach to studying e-government websites over time involves variations in inspection methods. These inspection methods can manifest in different forms, but they generally involve one or more evaluators conducting an assessment of one or more interfaces, typically based on a predefined set of criteria (Nielsen 1994; Hollingsed and Novick 2007). Some studies have adopted established government indexes that enabled comparisons between government units, typically across different countries, while others have chosen to conduct their own assessments of websites. Moreover, the focus and theoretical framework guiding the evaluations can vary. We elaborate on these studies below.

In an early study by Shi (2006), the accessibility of 30 Chinese provincial government websites and eight Australian state-level websites were compared in late 2004 and again in the autumn of 2005. Guided by a predefined set of assessment criteria, this research aimed to evaluate accessibility for people with disabilities. Most Chinese websites exhibited severe accessibility issues, while all but one of the Australian governments had only minor problems. This was surprising, given China's favorable ranking in an international e-government assessment at the time. Between the two data collection periods, no changes were observed on Australian websites, while one Chinese government reduced its accessibility problems in the repeat assessment in 2005. Lazar and colleagues (2013) also focused on accessibility in their examination of government websites in Maryland in 2009 and 2012. Fifteen webpages were manually evaluated in 2009, and 25 in 2012. A comparative analysis between the two years showed a slight improvement in the number of violations related to accessibility issues. The numbers were divided between pages with no violations (one out of 25 in 2012) and those with a significant number of violations. Most violations were found on websites that did not use a state template, suggesting that adopting a standardized template could be a means of improving accessibility.

Another study used an 86-item checklist to analyze the evolution of Spanish public hospital websites between 2005 and 2008 (García-Lacalle, Pina, and Royo 2011), finding that there were more hospitals with websites at the end of the study period than at the start. However, due to the substantial number of hospitals still lacking an online presence in 2008, the authors concluded that online information was not a priority for many hospitals during that period. Among the hospitals with a web presence, the

predominant focus was on providing information rather than facilitating interaction. Furthermore, the study identified influencing factors that determined whether hospitals had an online presence. These included the size of the hospital, the level of managerial freedom, and, notably in 2008, the extent of pressure from the outside world.

Garcia-Murillo (2013) also studied web presence, government effectiveness, and accountability over time, aiming to discern their impact on the perception of corruption. The analysis was based on various international data and indicators of corruption, governance, regulatory quality, web presence, and others, covering 208 countries over the years 2002–2005 and 2008. The findings showed that web presence, along with the effectiveness of government and accountability, had a positive impact on the perception of corruption in the years studied.

In their study examining the online presence of smaller cities, Feeney and Brown (2017) manually evaluated 500 municipal government websites in both 2010 and 2014 based on a predefined protocol that emphasized information, e-services, utility, transparency, and civic engagement. Over the two years considered in the study, it was found that all five parameters showed improvement from the first to the second evaluation in both basic and advanced features on the municipal websites. Similar to the findings of Lazar et al. (2013), Feeney and Brown's (2017) statistics revealed a significant variation among municipalities.

Epstein (2022) also studied local US governments but focused on larger municipalities with populations exceeding 50,000. The research was taken from four years between 2000 and 2019. The data collection was built upon surveys sent out to selected municipalities during these years, identifying e-government characteristics such as media use and the available services. It was found that municipalities had initially been slow to start several services, but the pace accelerated in the latter half of the period. The author found a correlation between city size and the adoption of e-government services, while median income or poverty rates in the municipalities did not have a significant effect.

Ingrams et al. (2020) used an established e-governance performance index and manual inspection to investigate the world's 80 largest cities in 2003, 2009, and 2016. A cluster analysis of the measurement variables showed differences in the studied cities at different stages of e-government development. The results indicated that GDP, population size, and regional competition influenced all identified development stages, while democratic levels mainly impacted higher development stages.

In the realm of archived web data, few longitudinal studies have focused on public sector websites. Schafer (2017) analyzed the French state, drawing from various sources, such as The Internet Archive, French web archives, and other news-related archives, newsgroups, interviews, and state

reports. Through several core events in the 1990s, including the launch of websites for entities such as the Ministry of Industry, the Louvre Museum, and the French Railways, the study explored political initiatives and reactions to regulate the emergence of the World Wide Web in France. It delved into how France had adopted and appropriated the web, considering the influence of French culture and values. In a subsequent study, Raffal (2018) used data from the UK Web Archive to study the evolution of the British Ministry of Defence and Armed Forces over a five-year period from 1996 to 2013. The corpus was supplemented with additional relevant sources to provide contextual perspectives on the development observed on the collected websites. Focusing on online communication with citizens, particularly in the context of recruiting members for the British Army, the analysis centered on website content and link structures. The author found a distinct focus on recruitment, noting changes in the terminology used to recruit new soldiers over time. In addition, the number of channels used for recruitment increased throughout the period of study. Furthermore, the Ministry of Defence was found to have used the web to shape its agenda and manage public perceptions.

As shown in this review, and highlighted by Epstein (2022), only a few studies have empirically investigated the development of e-government over time. These studies often explored similar levels of administration, such as municipalities, cities, or hospitals. While many were based on various inspection and survey methods, their use of web archive materials was limited. Rather than using surveys and inspection methods, this chapter outlines the creation of a web archive corpus to understand the development of e-government across the public sector in Denmark.

3. Establishing the corpus

The aim of this paper is to present the generation of a web corpus for studying online public information following the administrative structure of Denmark across the national (government), regional (regions), and local (municipalities) levels (Gjerding 2005; Chatzopoulou and Poulsen 2017). Following a structural reform in 2007 (Vrangbæk 2010), the country is now divided into five regions and 98 municipalities. At the national level, the number of ministries and ministry administrations varies according to specific governments and their focus, making it subject to change.

In Denmark, the Danish national web archive, *Netarkivet*, handles the collection and curation of Danish web resources through various types of crawls, including broad, selective, and event crawls (Schostag and Fønss-Jørgensen 2012; Brügger, Nielsen, and Laursen 2020). To cover the entirety of the public Denmark online, the corpus consists of two components. National-level websites undergo a selective crawl covering ministries,

government agencies, and related websites conducted four times a year. Regional- and local-level administrations are not included in this selective crawl; instead, they are captured in a broad crawl, which is also carried out four times a year. Upon data delivery from *Netarkivet*, an ETL description is carried out. ETL stands for extract, transform, and load, explicating the data extracted from, in this case, a web archive for a specific purpose (Fage-Butler, Ledderer, and Brügger 2022). In this study, the ETL description specified that the corpus should include the entire selective crawl for ministries and government agencies, along with all regions and municipal websites from the broad crawl identified by web addresses. The crawls were defined for spring 2010, 2014, 2018, and 2022. *Netarkivet* provided the data in WARC files (Maemura 2023) stored on a Linux server with a Solr interface to facilitate the search. The WARC format enabled sub-extracts from the corpus based on specific metadata for analysis purposes and offered insights into the nature of the corpus.

However, defining and indexing the corpus does not guarantee the inclusion of all relevant content, as various authors have highlighted when working with archived web data. Incompleteness is expected due to curatorial and technical challenges, coupled with the considerable time spent harvesting large datasets (Brügger, Nielsen, and Laursen 2020). Consequently, sites may be captured with varying degrees of completeness, or may not be captured at all, and thus appear as blind spots (Maemura 2018; Raffal 2018; Donig et al. 2023). We consider this condition as we transition into the analysis phase of this chapter.

4. Preliminary results

Data analysis can be approached in different ways for large web archive corpora, as outlined by Nielsen (2021). These methods include 1) variations in measuring numbers and sizes; 2) conducting text analysis focusing on word frequencies, languages, and topic modeling; 3) link analysis to identify networks between corpora websites using outgoing links; and 4) searching the source code for insights such as domains. This chapter focuses on the first type by analyzing file and domain types across the four selected years. Future papers will present both text and link analysis, along with topic modeling (Murakami et al. 2017).

Prior to the removal of duplicates, the raw corpus consisted of a total of 16,695,320 files (Fage-Butler, Ledderer, and Brügger 2022). Table 1 illustrates the distribution across the four years, with 2018 having the smallest count, at 2,917,777 files, while 2014 recorded the highest, at 4,947,301 files. The numbers indicate that fewer files were shared online and harvested in 2018 compared to the other years.

Figure 1. Distribution of files in 2010, 2014, 2018, and 2022.

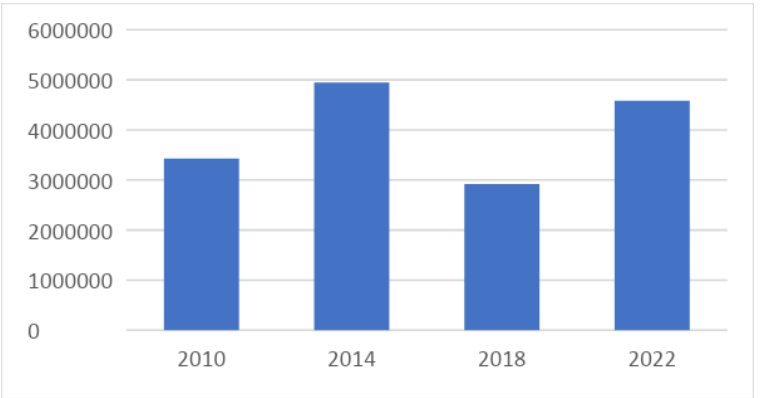

Table 1 breaks down the numbers in Figure 1 to present the dominant file types. As observed in Figure 1, commonly used files on websites included HTML, images, PDF files, and the category "other". The years 2014 and 2018 showed a higher prevalence of images and a lower count of HTML files compared to 2010 and 2022. The category "Other" included types of files such as .js (JavaScript) and .css (Cascading Style Sheets).

Table 1. File types and numbers found in the corpus for the four years.

File types	2010 (% of 2010)	2014 (% of 2014)	2018 (% of 2018)	2022 (% of 2022)
HTML	2,871,108 (83.7)	3,524,990 (71.3)	2,100,565 (72.0)	3,656,309 (79.8)
Image	338,698 (9.9)	502,156 (10.2)	360,039 (12.3)	250,578 (5.5)
Other	94,834 (2.8)	729,503 (14.7)	156,954 (5.4)	396,816 (8.7)
PDF	85,479 (2.5)	85,347 (1.7)	267,671 (9.2)	183,615 (4.0)
Text	38,497 (1.1)	104,747 (2.1)	30,447 (1.0)	93,355 (2.0)
Word	407 (0.0)	24 (0.0)	35 (0.0)	2 (0.0)
Video	346 (0.0)	323 (0.0)	305 (0.0)	344 (0.0)
Audio	270 (0.0)	211 (0.0)	1761	65 (0.0)
Excel	5 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Total	3,429,644	4,947,301	2,917,777	4,581,084

We also conducted an analysis of the distribution of domain types in the corpus. Municipalities and regions were represented by their domain names in the ETL descriptions, with the expected number known in advance—that is, 98 municipalities and five regions. However, a comparison with Table 2 reveals some blind spots in the corpus. Thus, only 44 municipalities were captured in 2022, although the other years showed better representation. Regional representation was comparable to this, with only one or two regions captured, as opposed to the expected five.

As mentioned, the selective crawl on ministries and government agencies included not only the anticipated entities but also related institutions and websites. To specifically isolate ministries and government agencies, we classified the domains into three categories—namely, 1) ministries and government agencies, 2) state institutions, and 3) others. The first category included entities such as the Ministry of Employment and the Danish Authority of Social Services and Housing. The second category was included in the corpus to identify institutions operating at the state level but not in the form of an agency or ministry. Among these was borger.dk, the national portal providing citizens' access to information across local, regional, and state levels, offering information from hospitals, local municipalities, housing and tax authorities, the public message system (e-boks.dk), and more. Other examples of state institutions in this category included the State Archives, the Accident Investigation Board of Denmark, and the Geological Survey of Denmark and Greenland. The category "Others" encompassed a variety of web domains. Some were directly associated with state institutions, such as sites providing information on study support in Scandinavian countries and the unit governing traffic on the bridge between Funen and Zealand. Moreover, educational institutions, such as universities and university colleges, were placed in the "Other" category. Lastly, websites loosely linked to government administrations, such as the campaign site for Tour de France in Denmark, a national lottery website, and the Union of Municipalities, were also included.

With these definitions in place, Table 2 shows that 2010 and 2022 had the highest occurrence of ministries, government institutions, and state institutions, with 2010 harvesting a significantly higher number of websites in the "Other" category. While Table 1 reveals that 2014 had the largest number of files, in Table 2, the year is shown to be ranked second lowest in terms of domains. This discrepancy suggests that there was a more extensive harvest of domains in 2014 compared to the other three years. Further exploration of this will be conducted in subsequent analyses.

Table 2. Domains retrieved from the corpus for the four years.

	2010 (% of 2010)	2014 (% of 2014)	2018 (% of 2018)	2022 (% of 2022)
Municipalities	89 (16.3)	72 (30.8)	89 (38.7)	44 (13.5)
Regions	2 (0.4)	1 (0.4)	1 (0.4)	1 (0.3)
Ministries and government agencies	59 (10.8)	50 (21.4)	46 (20.0)	69 (21.2)
State institutions	53 (9.7)	35 (15.0)	32 (13.9)	54 (16.6)
Others	343 (62.8)	76 (32.5)	62 (27.0)	157 (48.3)
Total	546	234	230	325

5. Discussion and next steps

This chapter details the construction of a corpus for studying the online public sector in Denmark, of which a preliminary analysis was conducted. As demonstrated both in the literature and through empirical work, archived web data does not necessarily capture the entire web when it is crawled for national archives. This inherent limitation should be considered when analyzing the data in future work. Nevertheless, the corpus presented in this chapter contributes valuable insights into e-government based on archived web materials.

Future work will extend the analyses of the data and include a more in-depth examination of the text and links within the harvested websites. In addition, to detect potential variances between the different types of public administrations, we will also analyze how the local and national levels of e-government have evolved over time. The categorizations of e-government websites (Fietkiewicz, Mainka, and Stock 2017; Fan 2018) can serve as the theoretical basis for these comparisons. Several studies have investigated the role of background measures, such as outside pressure, size, and regulatory quality (García-Lacalle, Pina, and Royo 2011; Garcia-Murillo 2013; Epstein 2022; Ingrams et al. 2020), in the development of e-government. Future work could incorporate similar background measures when analyzing municipalities.

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