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Abstract

Research on text simplification is commonly motivated by the assumption that available text is too complex. So far, an empirical basis for this claim is missing. This paper provides a starting point for substantiating the claim that complex text is ubiquitous. With a focus on German public administration, this paper reports the results of a data-mining audit study investigating more than 49,900 websites of 26 large counties in Germany. We show that difficult text is a universal problem. The vast majority of text on official German county websites is either difficult or very difficult. Despite slight differences between counties, text across counties was difficult to understand. We also found no strong correlation between the number of inhabitants, a county's area, or population density. We make actionable recommendations on how to continue studying this in the future.

Additional Key Words and Phrases

Text Simplification, Text Understandability, Public Administration, Readability, Digital Accessibility, Government Communication.

1 Introduction

The ability to read and understand text is a central prerequisite for participation in public life. In Germany, the Online Access Act (OZG) and other initiatives try to increase digitization and make interactions with public administration efficient. This development poses challenges for people who struggle with reading. Therefore, the goal of this investigation is to understand how comprehensible the text in German administrations is.

In the fields of human-computer interaction and accessibility, a strong focus has been on those who struggle with reading. Less attention has been put on what text is available to read. This investigation provides an empirical basis for the text understandability of text in German public administration. This is especially important because, despite Germany's comparatively high level of literacy, more than one in eight Germans (12.1%) are either functionally or fully illiterate [11, 12]. These people struggle to engage in activities requiring literacy for their own and their community's development [33]. Such activities can include finding information about an upcoming election, receiving a bill from a doctor, and understanding the COVID-19 rules [13, 14]. If official text provided by German public administration is not understandable, this is a big problem for everybody, especially those who struggle with reading. A lack of understandable text can also increase the workload for the administration.

To provide an empirical basis for the claim that the text available in German public administration is complex, we used data-mining techniques and audited the websites of the 26 out of the 30 largest counties in the Federal Republic of Germany. We were unable to scrape for counties. With the homepage of each county as a starting point, we followed all links on the website. We repeated this three times (recursion depth). Overall, we collected more than 49,9000 individual web pages. Using natural language processing, we extracted all text content. We ignored headings and other text that did not relate to the main content. Using the readability scores Flesh reading ease formula and the Fog Index [15], we computed the understandability of each website.

We find that the understandability of text on German public administration websites ranges from difficult to very difficult. While slight variations exist among the counties, all sites predominantly exhibit difficult or very difficult readability levels, as measured by readability scores. These readability scores are an empirically established proxy for understandability based on the number of syllables per word and the number of words per sentences into account. We conducted a correlation analysis, suggesting that factors such as population size, geographical area, and population density do not significantly predict whether a website is understandable. Our findings imply that complex language is widespread on the examined German county websites. We discuss the implications of this and make research recommendations.

2 Background

2.1 Terminology

Our investigation was conducted in the spirit of universal design. According to the United Nations Convention on the Rights of Persons with Disability, universal design is described as "the design of products, environments, programs, and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design" [29]. Universal design is closely related to the idea of Design for All [3].

In the context of text and language, several different terms are used to describe text that is understandable by people who struggle with reading. For German, Maaß differentiates between Easy Language, Easy Language Plus, Plain Language, and Expert Language [19]. Easy Language (German "Leichte Sprache" [5, 18]) strongly focuses on helping people with cognitive disabilities. The comparatively more complex Plain Language (German "Einfache Sprache" [21]) was meant to enable laypeople to consume expert content. According to Maaß, Easy Language is concerned with perceptibility and understandability. Plain Language strongly focuses on acceptability and avoiding stigmatization [19].

There is also prior work on understanding what makes a text comprehensible. According to the Hamburg understandability model, four aspects make a text understandable: 1. linguistic simplicity (for example, the use of everyday vocabulary, definitions for complex terms, and straightforward, concise sentences), 2. arrangement structure / cognitive structure (such as a logical organization of information), 3. concision (ensuring that the text length aligns with the intended information), and 4. motivation (utilizing relatable examples to engage the audience) [17, 20].

2.2 Text Understandability & People Who Struggle With Reading

A 2019 study from Sweden by Ågren et al. found that 67% of adolescents with intellectual impairments have access to smartphones, compared to 98% of those without such impairments. However, only 20% of young people with intellectual impairments actively seek knowledge online, compared to 86% of their counterparts without impairments. Notably, 21% of individuals with intellectual impairments express never understanding online information, while another 24% find it very challenging to comprehend. Of this sample, 52% of individuals with intellectual impairments report using social media to connect with friends, a significantly lower percentage compared to 93% of individuals without impairments.

These findings are consistent with a 2017 study from Spain. Chiner et al. discovered that 90% of individuals with intellectual impairments use smartphones, compared to 69% who

utilize laptops and 61% who utilize computers [6]. Again, only one-third (33%) of individuals with intellectual impairments engage in reading texts online, and merely one-fourth (25%) read newspapers, highlighting the importance of text that can be easily understood. More common Internet activities among this group include listening to music (84%), watching videos (77%), and chatting with friends (70%).

This connects to a 2004 study by Wehmeyer et al., which identified several obstacles that hinder the utilization of the Internet by individuals with intellectual impairments, including limited computer access, the absence of suitable and cognitively accessible software, the complexity of operating systems, and how much reading is required [30].

In a study conducted in 2010, Feng and colleagues delved into the utilization of computers by children diagnosed with Down syndrome [10]. Their examination revealed various challenges such as language obstacles and frustration, broader cognitive difficulties, physical constraints like typing or mouse manipulation issues, software-related challenges, and societal barriers.

2.3 Automatic Text Simplification

Automatic simplification has a long history. Numerous researchers have contributed to the development of automated text simplification techniques [1, 2, 23–25]. Text simplification approaches have been explored across languages, including English [7, 35], Spanish [4], and German [16, 28]. Recognizing the complexity associated with manually crafted rules, more recent approaches have utilized more advanced techniques such as statistical machine translation [27, 36], deep recurrent neural networks such as long short-term memory networks [22], or deep reinforcement learning [37]. A breadth of resources, corpora, evaluation metrics, and simplification approaches have been identified. Al-Thanyyan and Azmi distinguish between lexical, syntactical, machine translation, and hybrid methods [1].

These approaches have in common that they are motivated by the assumed complexity of available text. Until now, however, the empirical basis for this assumption is anecdotal. This motivated us to conduct a large-scale investigation using data mining to understand how complex available text is. Due to its social importance and the increasing digitization that makes reading more and more important, we focus on public administration in Germany.

3 Methods

Motiviated by prior work, this paper answers the following three research questions using data mining methods:

RQ1: How high is the readability of the websites of German counties?

RQ2: What difference in readability level can be observed between different German counties?

RQ3: What influence do a county's number of inhabitants, the area, and the population density have?

This paper centers on German, the 12th most frequently spoken language globally [34]. Literacy rates in Germany surpass the global average [32]. Nonetheless, findings from the

2018 Living With Low Literacy study indicate that approximately one in every eight adults in Germany struggles with functional illiteracy [11, 12].

To obtain the different websites, we used wget, a non-interactive network downloader available on UNIX-based systems. We started with the main domain and visited all links. We repeated this process three times (our recursion depth). Using the tool trafilatura, we stripped all content that was not explicitly labeled as a text paragraph. We then split the text of the paragraphs into sentences using spacy 3.5.2 (de_dep_news_trf) and only kept the sentences that contain at least one clause. A clause is determined by the presence of at least one verb and a corresponding subject, which are determined on the basis of the dependency structures.

We used the command line tool style with the language set to German to compute the Flesh reading easy formula and the Fog Index [15].

For this investigation, we focused on the websites of 26 of the 30 largest counties in Germany shown in Figure 1.

We were unable to collect the websites of the following counties: Rhein-Kreis Neuss, Main-Kinzig-Kreis, Landkreis Böblingen, and Landkreis Göttingen.

Name of County	URL
Region Hannover	https://www.hannover.de
Kreis Recklinghausen	https://www.kreis-re.de
Rhein-Sieg-Kreis	https://www.rhein-sieg-kreis.de
Städteregion Aachen	http://www.staedteregion-aachen.de
Rhein-Neckar-Kreis	https://www.rhein-neckar-kreis.de
Landkreis Ludwigsburg	https://www.landkreis-ludwigsburg.de
Landkreis Esslingen	https://www.landkreis-esslingen.de
Kreis Mettmann	https://www.kreis-mettmann.de
Rhein-Erft-Kreis	https://www.rhein-erft-kreis.de
Kreis Wesel	http://www.kreis-wesel.de
Rhein-Kreis Neuss	http://www.rhein-kreis-neuss.de
Kreis Steinfurt	http://www.kreis-steinfurt.de
Landkreis Karlsruhe	https://www.landkreis-karlsruhe.de
Ortenaukreis	https://www.ortenaukreis.de
Rems-Murr-Kreis	https://www.rems-murr-kreis.de
Main-Kinzig-Kreis	https://www.mkk.de

Name of County	URL
Märkischer Kreis	http://www.maerkischer-kreis.de
Landkreis Böblingen	https://www.lrabb.de
Kreis Unna	http://www.kreis-unna.de
Kreis Borken	http://www.kreis-borken.de
Kreis Gütersloh	https://www.kreis-guetersloh.de
Landkreis Osnabrück	https://www.landkreis-osnabrueck.de
Landkreis Offenbach	https://www.kreis-offenbach.de
Landkreis München	https://www.landkreis-muenchen.de
Landkreis Heilbronn	https://www.landkreis-heilbronn.de
Kreis Lippe	https://www.kreis-lippe.de
Landkreis Emsland	https://www.emsland.de
Erzgebirgskreis	http://www.erzgebirgskreis.de
Regionalverband Saarbrücken	http://www.regionalverband-saarbruecken.de
Landkreis Göttingen	http://www.landkreisgoettingen.de

Table 1. The counties included in our sample sorted by the number of inhabitants. We highlight the four counties that we were unable to scrape in gray.

Germany is organized according to the principle of subsidiarity. This means that "a central authority should have a subsidiary function, performing only those tasks which cannot be performed at a more local level" [9]. Therefore, the counties play an essential role in citizens' everyday lives. Subsequently, the understandability of the different counties' websites is crucial for different citizens.

The study was conducted in collaboration with capito, a social enterprise based in Austria. Capito is linked to a network that spans 13 locations across Germany, Austria, and Switzerland. The network provides services and software to assist with writing in German plain and easy language, drawing on the knowledge and skills of the capito network's members. These members specialize in clarifying text and also offer workshops and training for those interested in learning to simplify text. The company was helped with the webscraping and provided feedback on the draft.

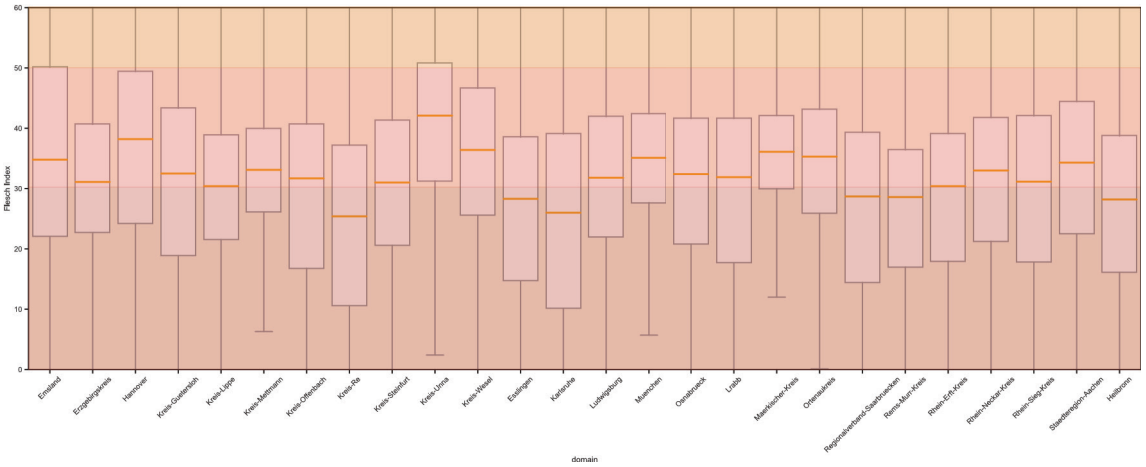

Fig. 1. Boxplots of the Flesch Reading Scores for each of the 30 counties and the 49,900 websites that we investigated.

4 Results

4.1 Readability Scores of Country Websites (RQ1)

Table 1 provides an overview of the readability scores for different scores across all 30 counties. The mean Flesch reading score is 31 (SD = 23). Following Sparado et al.'s classification of understandability scores [26], this means that, on average, the text on the counties' websites is complex and at a reading level that can only be expected of people who attended university. The median of the scores is 34, implying that more than half of the texts on the counties' websites are at a university reading level. The first quartile has a score of 22, which implies that a quarter of texts are considered very difficult and at the level of college graduates. Regarding the third quartile, we find that three out of four texts on German country websites are considered fairly difficult and only suited for higher education.

The Gunning Fog Index, a score that maps a text to a school grade, leads to a similar conclusion. The mean school grade calculated by Fog is 16 (SD = 5). More than 75% of the county websites we analyzed would require schooling in grade 14, which is longer than the 13 years of schooling required to graduate with a matriculation examination (German: "Abitur"). However, even well-educated students who pass the German matriculation exam only attend 12 or 13 school years.

4.2 Differences Between Counties (RQ2)

The previous section showed that, overall, text on German county websites is very complex. In the following, we will analyze the differences between the different counties. Figure 1 shows each county's box plot of the Flesh reading ease score. The figure has a color coding. The fairly difficult reading ease of 50-60 is coded in orange, the difficult college level of 30-60 is light red, and the very difficult level of college graduates and a score between 0 and 30 is colored in dark red. The figure shows that all counties' box plots are difficult or very difficult. The media is never above the level of difficulty. In the counties Offenbach, Esslingen, Karlsruhe, Saarbrücken, Rems-Murr, and Heilbron, the median in the dark red area, i.e., more than half the text on the website, is very difficult.

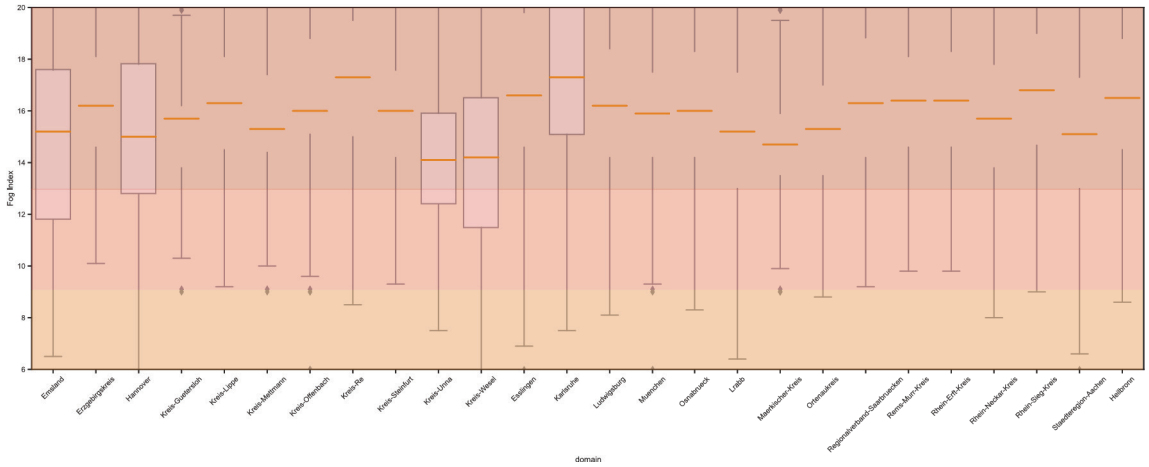

Fig. 2. Boxplots of the Fog Reading Scores for each of the 30 counties and the 49,900 websites that we investigated.

The text complexity is even more noteworthy when we consider the Gunning Fog Index, which maps text to the years of schooling required to understand it. Figure 2 shows the results per county. The color coding is as follows:

Anything that requires nine years of schooling or less is orange, grades 9 to 13 are colored light red, and anything that requires more than 13 years of education, the level commonly needed for the university entrance exam in Germany, is dark red. As you can see, most of the text is in the dark red area. The counties with the highest score are Rems-Murr, Karlsruhe, and Rhein-Sieg. That said, considering the median, a significant proportion of counties provide websites where half the text requires 15 years of schooling or more.

4.3 Influence of Number of Inhabitants, Area, and Population Density (RQ3)

The third question was whether the readability scores correlate with other statistics, such as the number of inhabitants, the area of a country in square kilometers, and the population density as inhabitants per square meter [31]. Despite our focus on the thirty largest counties in Germany, we observed a difference in the counties in our sample. The smallest county has 328,850 inhabitants, the largest has 1,173,891. The median size of counties was 398,866 inhabitants. The least densely populated county has 117 inhabitants per square kilometer, and the most densely populated 1796. The median is 536. Regarding the area in square kilometers, we also identify a large spread. The smallest county in the top 30 is 254 square kilometers; the largest is 2884. The median is 707.

Our analysis identified no strong correlation between readability scores such as Flesh reading ease and Fog scores and the number of inhabitants, the area of a country, and its population density. Using Spearman's ρ, we found that there was a very weak positive correlation between the Flesh reading ease score and the number of inhabitants, $r(49934) = .03$, $p = < 0.001$, and the area in square meters, $r(49934) = .03$, < 0.001. There was a very weak negative correlation between the Flesh reading ease score and the population density, $r(49934) = -.05$, $p = < 0.001$. The correlation is higher for the Fog Index but still comparatively weak. The negative correlation between the Fog Index and the number of inhabitants is $r(49934) = -.07$, $p = < 0.001$. The negative correlation between the Fog Index and the area in square kilometers is $r(49934) = -.08$, $p = < 0.001$. A weak positive correlation exists between Fog Index and population density, $r(49934) = .11$, $p = < 0.001$.

Overall, we find no strong relationship between the readability measured by these scores and aspects such as the number of inhabitants, the area in square kilometers, and the population density.

5 Discussion

5.1 The Complexity of German County Websites

Our investigation is motivated by research that showed that most readers struggle with reading [11]. This paper shows that the problem is not only due to readers who struggle with text. We find that a lot of text that can be found online is hard to read, even in high-stakes domains like public administration and local government. As we showed, most of the available text for the 30 counties we investigated is at a reading level considered difficult or very difficult.

The reading scores imply that a college education is required to understand the texts. This is problematic when the educational attainment of the population in Germany is considered. Only one in five Germans (17.6%) has a higher education degree [8]. One in three (31.9%) Germans have received the higher education entrance qualification. While these numbers are improving rapidly, with more than half of 20 to 24-year-olds having higher education entrance qualifications, complex text excludes many German citizens. In addition to that, a large group of Germans are considered functionally illiterate, i.e., their reading and writing abilities limit their everyday life [33].

The statistics on the education level of German citizens and the high complexity of the available text imply an important challenge for German citizens' everyday life and political participation. We found that the text available to citizens is too complex to understand. Even today, this is highly problematic today. However, considering the plans of the German government to increase digitization and make many services available online, this problem will likely only worsen. It is, therefore, of central importance to monitor the understandability of German websites and to increase the political pressure on decision-makers to ensure that everybody understands text on public administration websites.

5.2 Complex Text Is Universal Problem

Our analysis of more than 49,900 websites from the 30 largest counties in Germany showed that complex text is a universal problem. We found a large abundance of complex text in all counties. Virtually all text was difficult. The median text complexity was either at the level difficult or very difficult.

In the Results section, we provide an in-depth correlation analysis that investigates how the reading complexity of the 49,900 websites relates to the number of inhabitants, the size of an area, and the population density. The goal was to understand how these factors interact with the readability of websites. We hoped this knowledge would help us identify similarities between counties that provide particularly readable text. As this investigation showed, we did not find any counties where the text was not difficult. We also did not identify any patterns regarding what the different counties looked like. In this context, it is important to remember that we focused on the largest counties. How well these findings generalize beyond these counties remains hypothetical. Despite our focus on these large counties, we still cover a broad range. Based on these findings and almost 49,900 websites, we found no strong correlation between the number of inhabitants, the

number of square kilometers, and the population density. This implies that complex text is a universal problem that these demographic factors cannot explain.

5.3 The Difficulty of Measuring Reading Complexity

For our investigation, we used reading scores for German text as a proxy to measure the understandability of different websites. As mentioned, these readability scores are only a proxy to measure this complex phenomenon. Considering the low readability we observed through the different websites, this proxy was sufficient, especially since we did not draw strong conclusions about individual counties and which one is better. For more nuanced investigations in the future, it will, however, be necessary to develop more fine-grained and sensitive metrics that go beyond using counts of syllables, words, and sentences. Future work should explore the feasibility of including more advanced syntactic and semantic information to assess the understandability of a text. We believe that recent advances in large language models could be used for this. We invite others to join us in exploring such approaches in the future.

5.4 Understandability Auditing as a Field

This investigation explored the understandability of text in the largest German counties. This paper aims to serve as a starting point for more inquiries in this domain. In the future, more measuring points, counties, levels, languages, and countries are needed. We will discuss each of these aspects in the following paragraphs.

More Measuring Points: This line of work's first extension is to collect multiple measuring points. This would allow users to see whether the understandability of text on German county websites is improving or worsening.

More Counties: Another extension would be adding more counties to the investigation. For this investigation, we focused on the largest counties in Germany and collected more than 49,900 websites. Overall, Germany has 294 counties and 107 urban districts.

More Levels: Our investigation focused on counties. Public administration does, however, have many levels, including the local, state, and federal levels. For future work, it might also be insightful to consider these levels and compare them to each other. It might also be beneficial to go beyond public administration and to identify different aspects of public life that are essential to citizens but hard to read.

More Languages and Countries: Our investigation focused on Germany and the German language. The approach that we outline is independent of country and language. Readability scores can be computed for many language families.

5.5 Limitations

Measuring the understandability of text is a complex problem. As discussed, we relied on readability scores as a proxy for complexity. For this investigation, this was sensitive enough to understand the general tendency of the understandability of different websites. However, it prevented us from making fine-grained comparisons or rankings of the different counties based on their understandability.

Another limitation of the investigation is our focus on the 30 largest counties. We chose to accept this limitation to keep the research project manageable. As explained, we focused on the 30 largest counties as a starting point because they affect the most citizens in Germany. Regarding the ecological validity of our findings, we also showed a large

difference in terms of the number of inhabitants, the area in square kilometers, and the population density we assessed.

Finally, how well readability scores reflect understandability remains debated. The basic assumption that the number of syllables per word and the number of words per syllables reflect the complexity of writing should be carefully considered. While the readability scores have been widely used and can be regarded as a useful proxy, further work is needed on how well they reflect the complexity of human language.

6 Conclusion

This paper provided the first audit of the understandability of the official websites of 26 German counties with the largest population. Using two different metrics, we showed that text on these websites is difficult to read (RQ1). While small differences exist between the different counties (RQ2), all websites can be considered difficult or very difficult to read. Our correlation analysis also indicates that there is no strong influence on the number of inhabitants in a country, its area in square kilometers, or its population density (RQ3). Our findings indicate that complex text is a universal problem of official German county websites. We discussed the limitations of our approach and made actionable recommendations on how the auditing method that we demonstrated in this paper can be scaled up by including more measuring points, counties, levels of government, and more languages and counties. We hope this paper can serve as an empirical basis to make the text more understandable to citizens. We think the methodology outlined in this paper can help monitor progress and ensure that text understandability is increasing. We hope this can make it easier for politicians and other decision-makers to increase the understandability of public websites effectively.

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