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A Story About Digitalization and Those Left Out

A quantitative study exploring the effect of digitalization on web accessibility.

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Executive Summary

This thesis examines the influence of digitalization on web accessibility for people with disabilities (PwD). The central research question addressed is: "How does digitalization affect web accessibility for people with disabilities?" The hypothesis proposed in this study is that web accessibility decreases as digitalization advances, irrespective of legislation and awareness regarding the accessibility gap. The hypothesis is grounded in the observation that visual aspects are prioritized during web development, potentially overlooking the importance of web accessibility. This is an important topic of research since nearly 20% of the world's population (World Health Organization 2023), have a disability and almost everyone will experience disability at some point in their life (World Health Organization n.d.).

Utilizing quantitative methods to conduct an empirical test this research evaluated the web accessibility of 49 Canadian Universities over a 15-year time period, from 2008 to 2022. Data collection utilized online sources such as the Wayback Machine.

The research findings reveal that during periods of web advancements, there is an initial increase in web accessibility issues, validating the negative impact of digitalization on web accessibility. However, over time, there is a noticeable reduction in these issues, indicating an overall improvement in web accessibility. One significant factor negatively impacting web accessibility identified in this study is, the visual advancements brought about by digitalization. The effectiveness of legislation in enhancing web accessibility was investigated, focusing on compliance deadlines. The study demonstrates that compliance deadlines do not lead to increased accessibility on the web, meaning legislation fails to effectively improve web accessibility.

Overall, this research highlights the immediate inaccessibility of the web resulting from digitalization. These findings emphasize the ongoing need to prioritize web accessibility amidst digital advancements. From these findings, stakeholders can work towards a more inclusive and accessible web environment for PwD.

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1. Introduction

The digital world is radical, and as seen globally and throughout time, the world as we know it continues to change due to technological innovations. Digitalization has become so powerful and has grown so massively that 99% of Canadians have accessed the internet in 2022 (Petrosyan 2023). The overall perception of digital technologies is positive, it showcases our advancements in knowledge and the opportunity for technology to better serve our needs in a variety of forms. It is the general perception that digital products improve and become better when there is a visual advancement and with each technological advancement, life changes in the process (Thielsch 2019). We have seen it with the inclusion of JavaScript to HTML and CSS; our interaction with digital products changes, as does the experience we have when they are based on visual and usability components.

However, there are always two sides to every coin, and this positive perception may not be universally shared. With society so enthralled by the internet it raises questions about the shortcomings of digitalization. Along with the opportunity to change lives, I question who is on the outskirts of this change, invisible to the majority and unable to take part in this digital revolution.

Nearly 20% of the world's population, an estimated 1.3 billion individuals (World Health Organization 2023), have a disability. As identified by the World Health Organization (WHO), “almost everyone will temporarily or permanently experience disability at some point in their life” (World Health Organization n.d.). Hence, digitalization brings forth the investigation into inequalities and digital outsidership.

The United Nations: Sustainable Development Goal 10 is to reduce inequality. Target 10.2 has set out to “empower and promote the social, economic and political inclusion of all, irrespective of … disability…” (United Nations n.d-a.). This target, set to be 2030, showcases the importance and urgency of accessibility. Although many are impacted by disabilities it is still a commonly overlooked step as the world becomes increasingly digital.

Persons with Disabilities (PwD) face challenges in different aspects of life ranging from communication, transportation, employment, interaction with public spaces, etc. Disability is defined as "any impairment, including a physical, mental, intellectual, cognitive, learning, communication or sensory impairment — or a functional limitation — whether permanent, temporary or episodic in nature, evident or not, that, in interaction with a barrier, hinders a person's full and equal participation in society" (Government of Canada 2023, Consolidated federal laws of Canada, *Accessible Canada Act*). Disabilities can present themselves as occasional, temporary, and/or permanent. For example, a hearing disability could present itself in different ways: occasionally, while riding on the bus you may not be able to use audio; temporarily, while experiencing an ear infection you may not be able to hear properly; and permanently, deaf individuals cannot hear at all. These examples all illustrate the need for hard-of-hearing support, because even if it is for different needs, it can support a variety of interactions.

The issues that come along with digitalization for PwD have commonly been overlooked. Permanent disability interactions with the web can look like someone who is colour blind not being able to read text because the colour contrast is not correct, hearing-impaired individuals may rely on subtitles for audio, or someone who has vision impairments may have assistive technology such as screen readers that rely on web accessibility. There are various situations in which web accessibility can impact the lives of users regardless of age, and background.

The inaccessibility of the web is a barrier for PwD, it "often hinder[s] the full and effective participation of [PwD] in society on an equal basis with others" (World Health Organization n.d.), and it specifically could impact individuals with visual, hearing, neurological, cognitive, and/or motor disabilities (What is web accessibility & why is it so important? n.d.). Accessibility legislation has been created globally to address the barriers that PwD face. The inaccessibility of the web is why the Web Content Accessibility Guidelines (WCAG) were created, to allow PwD to access websites by taking away the barriers. "Different definitions [of access] yield somewhat different conclusions about inequality" (Neckerman, 2004). Accessibility is "known as the ability to access, [and an example of what that is through] … devices, services, and products [that] are [made] accessible to [PwD]" (Wallwood 2019). PwD "can [not] access … products, devices, and services if their disabilities are not taken into account", which is where web accessibility comes into the

discussion (Wallwood 2019). Web accessibility is the process of integrating accessibility within the web and it "focuses on designing and developing websites that are more accessible [for PwD]" (Wallwood 2019). A 2010 study found that the legislation in most of the researched group had significant deficiencies to the point of violation against their federal accessibility legislation, which puts organizations at risk of a lawsuit from PwDs (Bradbard 2010). The creation of federal legislation and WCAG's global application demonstrates how relevant web accessibility is in society and how its lack of prioritization throughout digitalization is creating inequality.

With the knowledge that legislation exists, and a general understanding that the web is not accessible, it is important to understand what factors could be impacting web accessibility and in what direction web accessibility is heading in during a 15-year digitalization period.

The problem formulation I will pursue in this research is as follows:

How does digitalization affect web accessibility for people with disabilities?

The group of focus here is PwD and how they are interacting with the web which is represented through web accessibility. I hypothesize that with the advancements of digitalization, web accessibility will decrease. I hypothesize that regardless of legislation and the awareness of the lack of accessibility, that due to digitalization, web accessibility is continuously decreasing. My belief in this is rooted in the visual aspect of digitalization. During web advancements we can see a stark difference in visual elements. I suspect that in prioritizing visual elements, web accessibility is not being prioritized which is why I hypothesize that with digitalization the web has become less accessible.

Additionally, to be specific in this research, I have created sub questions:

i. If visual advancements of the web affect web accessibility.
ii. What factors mitigate web accessibility.

Following this introduction, I will lay down the research setting. In the research setting section, I will explain what the setting is and the rationale behind my choices. Afterwards, I continue with a literature review, this provides the reader with an understanding on what has

been previously researched to create a general knowledge and awareness that will inform this study. In the methodology section, I will go on to explain the approach, purpose, and strategy used to answer my research question. The analysis and results section is dedicated to sharing the findings from this study. In the discussion section I will explain limitations and areas for future research. Finally, the conclusion is where I will make my closing remarks and clearly lay out my findings.

2. Research Setting

The research setting is the context in which I will be exploring the inequalities of digitalization from the lens of web accessibility. I ensured that the setting would be general enough that any findings could be applied to other industries, allowing this research to have a broader application.

2.1 The Setting: Canadian Universities

To conduct this research, I have set the research setting as Canadian Universities for multiple reasons. Firstly, their value offering does not change over time. Universities are consistent in their goals; to teach, learn, and transfer knowledge. This is a strength, because in the style of research being carried out, if the research setting were to change their value offering through their product or service during the observation period, it could skew the results and findings. Through selecting this research setting I know that any change in web accessibility is due to digitalization and not to a change in the research settings offerings.

Secondly, Universities have a long-standing history, making it a prime organizational industry to pull upon information from 15 years ago to understand the possible relationships that I hypothesize exist. This is a strength for this research setting, because for other industries there could be a large fluctuation in companies' founding and operational years, which could limit the observations made and cause discrepancies across companies.

Thirdly, Universities are oftentimes less affected by external factors such as crises compared to other industries. Education is seen as a human right and as identified by the UN "higher education shall be equally accessible to all …" (United Nations n.d.-b). Although the education industry is not immune to external factors, the importance that is placed upon the higher education induction industry makes it a more stable industry. This is another strength to this research setting, because compared to other industries, which may be highly impacted by external crisis to the point of layoffs or the business going under, Universities are stable and consistent since they are a pillar of society.

Lastly, the target demographic for universities is broad, and covers a wide variety of disciplines, ages, ability levels, etc.. At Canadian Universities, PwD "account for 22% of the general population and 22% of faculty, … [and] about 5% of senior leaders at Canadian universities (this may also be due to a reluctance to self-identify and slight differences in how the Canadian Survey on Disability and our self-identification form define disability)" (Universities Canada 2019). This setting is beneficial, as it can then be extrapolated to cover other industries with smaller, more niche demographics. This is a strength for this setting, as it allows for strong generalizability into other industries.

Due to the four reasons listed above, Universities are a logical choice for the research setting since it allows for the findings to address web accessibility in general, which can then be applied to other industries, allowing for generalisability.

Canada has both public and private post-secondary structures, with "over 150 … recognized public colleges and institutes" (*Council of Ministers of Education, Canada* n.d.). "Publicly funded universities are largely autonomous, … [and] government intervention is generally limited to funding, fee structures, and the introduction of new programs" (*Council of Ministers of Education, Canada* n.d.).

In the 2020-2021-year Canadian Universities had a total revenue of $46 Billion (Government of Canada, Statistics Canada, 2022 August 9). The highest revenue categories are 'Non-federal' at $15 Billion 'Tuition and other fees' at $13 Billion 'Investments' at $5 Billion and 'Federal' at $5 Billion (Government of Canada, Statistics Canada, 2022 August 9).

The remaining sections are as follows: literature review, methodology, analysis and results, discussion, and conclusion. In the next section I will create a foundation of knowledge using literature to better understand the topics that will be further explored in this research. The literature review sets the stage to understand what existing knowledge there is from the research that has already been done.

3. Literature Review

This section will pull on existing literature to create a relevant theoretical background that creates a base understanding on these topics: digitalization, policy, and web accessibility. Gaining an understanding on the topics listed above, will aid in the identification of the problem and how this study aims to build upon, and explore new areas, as it relates to digitalization and web accessibility.

3.1 Digitalization and the Digital Divide

Termed as the Fourth Industrial Revolution, there is an "emergence of entirely new ways in which to live. In both subtle and explicit ways, technology is also changing what it means to be human" (Schwab 2017). The Digitalization Commission has defined digital competence as the need to "provide all citizens with sufficient digital capabilities to be part of the digital society … [and the] ability of all people to use digital technology to facilitate everyday life, to be able to seek information and communicate" (Wiggberg 2022). "Observers noted that some kinds of people used the Internet more than others and that those with higher Internet access also had greater access to education, income, and other resources that help people get ahead" (Neckerman 2004). "Digitization has accelerated the pace of competition in many industries" (Catlin 2019). Not only is digitalization massively accelerating since its inception, 91% of businesses "are engaged in some form of digital initiative" (*Digitalisation Strategy for Business Transformation* 2022). In 2022 the worldwide spending on digital transformation was 1.85 trillion USD and it is forecasted to reach 3.4 trillion U.S. dollars worldwide by 2026, demonstrating the increase in digitalization on a global scale (Sava 2022). The world as we know it has become extremely digital and to strive for equality it is important that accessibility is considered as the digital world continuously evolves.

The book Social Inequality's chapter on Digital inequality contributed to the UN SDG 10, to reduce inequality (Dimaggio 2004). In this chapter it states three conclusions of technology as they apply to the internet. "First, *the specific forms that new technologies take, and therefore their social implications, are products of human design that reflect the interests of those who invest in them*. … The Internet's architecture is currently changing to better serve

the economic interests of commercial enterprises" (Neckerman 2004). This first conclusion shows how over time the need for technology has changed, as the ones that are investing in it are becoming increasingly aware of accessibility concerns. It has been noted that "the need for the Web to be universal and accessible to everyone has been present since the beginning of the Web, as it was a requirement perceived in its design by its creator Tim Berners-Lee" (Campoverde-Molina 2020). The idea of 'accessible' may have changed over time, but as it stands today there is an importance being placed on accessibility that should reflect in the web, because it is in the interest of those that invest in the internet, such as organizations and government, to create products and services that more people can use.

The "second [conclusion is that], *technologies are continually reinvented by their users as well as their designers*. As the Internet's user base has shift[ed] … government policy has sought to support emerging e-businesses, sites and technologies that enhance commercial uses and easy access to information have displaced more complex technologies that emphasized interaction and technical problem-solving" (Neckerman 2004). This second point reaffirms that as digitalization occurs users' needs are considered.

The "third [conclusion] … follows from the first two principles that *technologies adapt to ongoing social practices and concerns rather than "influencing" society as an external force* … Technology may contribute to change by influencing actors' opportunities, constraints, and incentives, but its relationship to the social world is co-evolutionary, not causal" (Neckerman 2004). This third finding reveals that although there may be a consideration for accessibility, not prioritizing it as a society will inadvertently make the web less accessible because of society's influence.

"In the … years that the Internet has been widely available, it has diffused widely. Some inequalities in access have already closed [while] other gaps persist" (Neckerman 2004). This perspective to look into the future is promising, since, although there may be a digital divide currently due to inaccessible websites, as time progresses gaps in inequality caused by a lack of web accessibility could decrease. Based on the argument set forward, I formulate the following hypothesis:

Hypothesis 1: Web accessibility will decline as a result of visual advancements.

3.1.1 Digital Outsidership

Digital outsidership terminology in literature is commonly mentioned when referring to an organization's relationship to digitalization. “Digital firms may suffer from liabilities of outsidership …, [it is noted that] such liabilities can be mitigated by the diffusion of digital technologies and development of the digital economy in markets with higher digital … [power]” (Ye 2022). As for “the development of the digital economy [it] can generally be described as the process by which information technologies, such as the Internet or other means of communication, change economic and social relations in such a way that a number of barriers in international economic relations disappear altogether or minimize” (Kravchenko 2019). This finding on the development or digitalization of the digital economy, and its ability to alleviate issues with barriers, is a transferable concept into digital outsidership and the barriers for PwD minimizing as digitalization occurs. These ideas, that digitalization will or will not impact digital outsidership, is what I seek to understand in this research.

For the purpose of this research, ‘digital outsidership’ refers to individuals that are not able to take part in the digital world. A specific aspect of digital outsidership that can shed light on the inequalities created from digitalization is in the education sector. Technology is ever evolving and changing with a vast reach into a variety of industries, and this is no exception for the education sector. Universities globally use technology and websites to deliver learnings, attract new students and connect with a variety of individuals. But, with nearly 20% of the world's population having a disability (World Health Organization 2023), how accessible is the internet to this population? Digital outsidership is commonly used when referring to people who are not able to take part digitally due to their inability to access digital products either through lack of internet connection, lack of the devices needed to access the digital world and geographical restrictions. The concept of digital outsidership itself has left out PwD and for the purpose of my research, there has been no previous research and linkage between web accessibility and digital outsidership. Research has found that “highly developed countries have the best level of digitalization of their own economies, because they have high-quality access to the Internet, a high level of scientific and technological capacity development and wide information access” (Kravchenko 2019). Accessibility can be looked at from a multitude of areas, an area that is pressing when focusing on the inequalities in digitalization, is accessibility in a digital sense.

Another research paper found “that digital exclusion is compound and sequential in nature [which] fits stratification theories and the amplification mechanism (Kraut et al., 2002; Kvasny, 2006; Toyama, 2011) of digital exclusion, suggesting that the Internet is a magnifier of existing offline inequalities” (Deursen 2017). This research explains how PwD are even more excluded from the digital world than the real world. With digitalization we need to strive for equality and prioritize accessibility in technology and digitalization that should be offering a massive opportunity for helping PwD. However, there is now evidence proving that technology and digitalization is hindering PwD in ways that are going unnoticed.

3.2 Policy Adoption

The Multiple Streams Framework (MSF) created by John Kingdon in 1984 “is a well-respected approach for analyzing policymaking” (Hoefer 2022). The MSF is a “theoretical framework to explain how policy actors sort through ambiguous circumstances during policy processes” (Fowler, L., 2020). The Policy Problems Stream states that “situations must be defined as problems before political action will be taken” (Hoefer 2022). Yet, the problem can be identified differently by different groups, and “generally, each particular view of what the problem is has champions” (Hoefer 2022). “Problem definitions can result from the slow development of information over time or sudden focusing events” (Hoefer 2022). At which point, “the problem is put on the government agenda for action. It may be seen to be a problem in search of a solution” (Hoefer 2022).

This framework can be applied to all types of policies and can provide insight into the specific sections that accessibility policies may lean towards in Canadian politics. For example, human rights policy historically has a changed over time to include additional groups, and today refers to equity for all groups of people. The *Canadian Humans Rights Act* (CHRA) of 1977, “prohibited discrimination on the basis … race, religion and national origin; it also included relatively newer grounds such as sex, ethnic origin, age, marital status, physical disability and pardoned conviction. Over time, the (CHRA) was amended to add sexual orientation (1996) and gender identity or expression (2017) as protected categories” (Kirkup 2018). This understanding of policy and the cycles it takes can lay the foundation for understanding how legislation comes into fruition from the onset of a

problem, and specifically the identification that digitalization plays a role into the digital outsidership that PwD experience.

3.2.1 Equality Practices in the Education Sector

A study done on American Universities in 2010 found that many institutions have developed their own accessibility policies unrelated to federal legislation. However, results from the study found that "the policies of most schools have significant deficiencies. The deficiencies are of sufficient magnitude that some schools are potentially in violation of the ADA (*Americans with Disabilities Act*) and at risk for a lawsuit from a disabled person" (Bradbard 2010). From this research it shows that there is an awareness of the importance of accessibility at educational institutions. Based on the research from this section I formulate the following hypothesis:

Hypothesis 2: Legislation will fail to result in improving web accessibility.

A 2020 study done on the Equity, Diversity, and Inclusion (EDI) Strategies at Canadian Universities uncovered that, "[EDI] activities have become a policy priority. … [This has] result[ed in], … an increase in institutional strategic activities including institutional political commitment (e.g. new equity offices, new senior administration positions, mandatory training), student and faculty recruitment with programmatic and research supports (e.g. diversity admission policies, scholarships, access programs, curriculum changes), accompanied by broader efforts to create supportive institutional climates (e.g. student advisors, awards, celebrations)" (Tamtik 2020). From this research it appears there is an importance placed on EDI and accessibility, the question now becomes, how is this awareness being addressed in a digital sense.

3.3 Web Accessibility

"Web accessibility is expressed as the ability of all target users, including the disabled, to access, use, understand and interact with the website" (Macakoğlu 2022). Studies done on web accessibility have found "that despite a growing awareness of Web accessibility issues, people are still experiencing barriers" (Brophy 2007). Previous research shows that compliance with web accessibility does result in a more positive experience for both PwDs

and people without disabilities (Vollenwyder 2023). Statistics from WebAim found that in 2022 “96.8% of home pages … [have] WCAG 2 failures” (*The WebAIM Million, the 2023 report on the accessibility of the top 1,000,000 home pages* n.d.). Additionally, a 2014 assessment on web content accessibility found that 97.62% of the websites examined had problems adhering to the WCAG standard of the time, WCAG 2.0 Level A (Roig-Vila 2014). These findings reaffirm my third hypothesis.

The Web Accessibility Integration Model “highlights the multiple points within web development where accessibility can be incorporated or forgotten” (Lazar 2004). This model states there are three categories that could influence web accessibility, they are; societal foundations, stakeholder perceptions, and web development (Lazar 2004). The focus on webmasters and “their perceptions of when and why web sites should or should not be accessible” was an insightful background (Lazar 2004). This research solidifies that it is general knowledge that web accessibility is not what it should be considering factors such as government legislation. Yet the realities of webmasters’ perspectives indicate that due to “roadblocks to accessibility such as lack of time, lack of training, lack of managerial support, lack of client support, inadequate software tools, and confusing accessibility guidelines” web accessibility has not been prioritized (Lazar 2004). This research found that “some webmasters … outright objected to the idea that web sites should be accessible, [they] did not like the interference in ‘‘their’’ web design and would only make web sites accessible if the government forced them to” (Lazar 2004). The overall theme here is that, despite the knowledge of web accessibility and external factors such as government legislation pushing web accessibility, there is still a lack of prioritization. This background on webmasters’ perspectives provides interesting insight into the current realities of what impacts changes to the web.

More research on web accessibility and the challenges to comply uncovers the theory that “simplifying guidelines and making them more applicable will encourage web developers to follow them. Moreover, [they] suggest[ed] the need for accessibility legislation enforcement by countries rather than … voluntary guidelines” (Abuaddous 2016). The legislation enforcement federally and provincially is analysed in the following research, in order to better understand its impacts on web accessibility. The research I conducted will address the suggestion that countries enforcing legislation will have an impact on web accessibility compliance, again addressing my third hypothesis.

A systematic literature review conducted in 2019 found there were 216 papers pertaining to accessibility, after filtering for papers written after 2009 published in a Journal in English with the keyword ‘accessibility’. “The countries with the greatest contribution to the topic of web accessibility are United States, Ecuador, India, Malaysia and Portugal” (Campoverde-Molina 2020). Additionally, of the 25 selected papers, 19 used WCAG 2.0 as the evaluation tool (Campoverde-Molina 2020). This literature found that “the increase in the number of people with disabilities in the world, the right to education and their access into regular education in some countries is a determining factor in the compliance of educational websites with the WCAG” (Campoverde-Molina 2020). This research further proves Neckerman 2004 and Hoefer 2022 findings, that as accessibility is addressed as a problem, society can influence legislation and the prioritization of web accessibility.

A similar study on web accessibility over time was conducted from 1997 to 2002. This study used the Wayback Machine where “websites were retrospectively evaluated to see how they have changed over time with respect to accessibility and the use of more complex webpage design components” (Hackett 2005). Digitalization from the late 90s to early 2000s was on a completely different level, utilizing HTML, CSS, and Java, websites from 2002 to today are very different, now utilizing HTML, CSS, and JavaScript. “Java is an object-based programming language, JavaScript is an … object-oriented program. JavaScript is more commonly used in web applications like browsers, while Java is more widely used in app development, smart devices, and back-end applications” (Eboka 2022). It has been noted that “the capability of both languages vary significantly” (Albanero 2020), “JavaScript lets you add functionality and behaviors to your website, allowing your website’s visitors to interact with content in many imaginative ways” (Brown 2018). JavaScript was widely adopted in “in the early 2000s, [when] big platforms like Facebook and Google began using JavaScript” (Brown 2018). I believe that this continued emphasis and the development of websites from Java to JavaScript, and this change of functionality and design which we see through digitalization, will continuously expedite web accessibility errors. The study on web accessibility from 1997 to 2002 found “that along with a statistically significant increase in accessibility barriers there has been a concurrent statistically significant increase in complexity in the … websites studied” (Hackett 2005). There is no doubt that there has been an increase in awareness and legislation, yet there has also been an increase in website

complexity and visual components as seen through the overtake of JavaScript on the web. These findings further support my first hypothesis.

What I research in this paper builds well upon the ideas from Lazar in the sense that it is a fact that web accessibility has not been prioritized, and the research done from Hackett lays a good background on how digitalization has affected web accessibility in the past. In my research I investigated what factors could be influencing web accessibility and how digitalization has affected web accessibility in the present day.

3.3.1 Web Accessibility Evaluation Tools

When testing for web accessibility it is crucial to understand what testing options exist and specifically what evaluation tool limitations there may be. As identified in the paper *Benchmarking Web Accessibility Evaluation Tools: Measuring the Harm of Sole Reliance on Automated Tests* an over-reliance on web accessibility evaluation tools can lead to the halting of additional testing that can occur with 'expert evaluation' (Vigo 2013). Of the six evaluation tools tested in that study it was found that "tools help to assure this 'minimal' accessibility level, [yet they] should not overshadow accessibility evaluation by experts" (Vigo 2013). Researchers revealed that "relying on just automated tests entails that 1 of 2 success criteria will not even be analyzed and among those analyzed, only 4 out of 10 will be caught at the further risk of generating false positives" (Vigo 2013).

Another research paper looked at two web accessibility evaluation methods: conformance testing and barrier walkthrough (BW). This research found that "with more experienced evaluators it is likely that reliability, sensitivity, correctness and F-measure improve when using BW, since more experience would probably lead to reduced variance" (Brajnik 2008). These research papers provide a background into understanding the implications that come from using evaluation tools. For this research, as I am not an accessibility testing professional, I will use a web accessibility evaluation tool. It is, however, crucial for readers to acknowledge that the websites analysed in this research could possibly be less accessible than the accessibility evaluation tool captured.

3.3.2 Web Accessibility in the Education Sector

A 2016 research study of global universities found that “most of the educational institutions [they tested] follow less than 50% of the [WCAG 2.0] guidelines” (Kesswani 2016). As previous literature established there is a lack of web accessibility in educational websites. In an academic sense “the Web has become a significant part of student experiences within and outside of the classroom” (Bradbard 2010).

Looking at international educational websites and their compliance to web accessibility, there has been lots of research from all over the globe. It has been discovered that for American “Institutions, intending … to offer students a glitzy, appealing and educational home page, fail miserably … to accommodate the visually, hearing, or motorically impaired” (Harper 2008), and, in order to make websites more accessible, especially as they “include more sophisticated visual features, institutions must now learn how to deal with accessibility barriers” (Harper 2008). This finding on the impact of visually appealing websites brought into question the impacts of website updates in a visual sense. As a digital society we are placing continuous importance on the visual elements of a website through features such as images, videos, animations and moving elements. This understanding of the realities that visual components of websites do, in fact, decrease accessibility again supports my first hypothesis.

When it comes to identifying the existence of web accessibility issues there has been vast amounts of research done to show the inaccessibility of Universities across the globe. A 2013 study on American University special education departments’ websites found that “most (97 %) of the pages evaluated had accessibility problems, many (39 %) of which were severe and should be given a high priority for correcting” (Ringlaben 2013). The findings concluded that although there are a high number of accessibility “errors [they] can easily be corrected” (Ringlaben 2013). Another study from 2014 done on Spanish online education platforms found that “despite the increasingly high number of legal and regulatory measures about accessibility, their practical application still remains unsatisfactory” to the WAI Guidelines 2.0 (Roig-Vila 2014). Additionally, a 2018 study on South African University web sites found “that none of the websites [tested] met all the WCAG 2.0 accessibility criteria” (Verkijika 2018). Another evaluation of top-ranking university websites in Spain, Chile and Mexico was conducted in 2019 and found that there are “low levels of web

accessibility…, proving that there still exist many shortcomings with regard to meeting the regulation and respecting the fundamental rights of all people" (Máñez-Carvajal 2019). An accessibility analysis conducted on Turkish University web sites found "results [that] indicated that all university homepages show some accessibility problems" (Kurt 2010). These studies, although different in focus, all elaborate on the shortcomings of university webpages. It is without doubt that University websites are not accessible and up to the respective federal and/or global standard. An area that has been yet to be explored are the impacts that different factors have on website accessibility, which is what this research aims to do.

From this literature it is apparent that digitalization and web accessibility has an existing knowledge base that is being researched. It is also clear that from digitalization, it is general knowledge that web accessibility, although important, has not been prioritized and introduced to the proper standard according to WCAG and federal guidelines. My research aims to identify the impact of digitalization on web accessibility, to understand what factors could be mitigating web accessibility. This research illustrates the forces at play and how there has yet to be a proper balance. The need for organizations to stay relevant and appealing to the majority is the same need to move forward in digitization. Webmasters and organizations must weigh the importance of the need for inclusion and the prioritization of web accessibility from legislation against the need to move forward in digitization. It is not impossible to make accessible design, and it is easier to include accessibility in the design process than to add it on later, as an afterthought. The thinking that PwD represents a small fraction of the population and using that as reason to forgo the prioritization of web accessibility will be the downfall. As outlined earlier, according to the WHO, most individuals, at some point in their life, will experience disability. From this section I outlined my hypotheses, it is important to keep my hypotheses in mind for the remainder of this paper.

Hypothesis 1: Web accessibility will decline as a result of visual advancements.
Hypothesis 2: Legislation will fail to result in improving web accessibility.

The remaining sections are as follows: methodology, analysis and results, discussion, and conclusion. In the next section methodology will be discussed. The methodology section is the detailed account of how I conducted research and the explanation behind those decisions.

4. Methodology

I will introduce the research design that will be used in my study. Included within the research design will be the approach, purpose, and strategy. I will explain the methods that best fit this research, and, in the process, lay out the research design, data collection style, analysis methods, research aim and objectives, and research quality.

4.1 Research Design

The research design is the general plan of how I will go about answering my research question (Saunders 2019). I will explain the plan to answer my research question by introducing the approach, strategy, and purpose to create an understanding of the research design. My research question and interests were best suited for a concurrent quantitative study with an inductive approach for an explanatory purpose. Quantitative research is defined as "examin[ing the] relationships between variables, which are measured numerically and analysed using a range of statistical and graphical techniques" (Saunders 2019). Since my research relied on the numerical evaluation of web accessibility for 49 different Canadian Universities over a period of 15 years, a quantitative approach was most advantageous, rather than a qualitative approach.

4.1.1 Quantitative

This study utilized quantitative research through an empirical test. I investigated the relationship between cause and effect in different variables (Saunders 2019). Explanatory research purpose is apparent in this research since there is an "emphasis … to study a situation or a problem in order to explain the relationships between variables" (Saunders 2019). The independent variable (IV) is the "variable that is being manipulated or changed to measure its impact on a dependent variable" (Saunders 2019) and the dependent variable (DV) is defined as the "variable that may change in response to changes in other variables; observed outcome or result from manipulation of another variable" (Saunders 2019). In my research the relationships will be analysed between different IV's and the DV. The IV's I used were; University Size, University Ranking, Visual Layout Changes, Federal &

Provincial Policy. The DV, University Web Accessibility Score will be researched to explain the linkage I hypothesize it shares with any individual and/or combination of IV's.

The purpose of this research is to identify factors impacting web accessibility. Principles from econometrics are seen throughout this research. As identified in *Introduction to Econometrics* "modern empirical applications share some common characteristics [present in my research is that] the data set … ha[s] many observations (hundreds or more)" (Stock 2020). The data in this study utilizes structured observation which is clear since I observed the behaviour (web accessibility) of universities. I accounted for standardisation, since it was "repeated … to produce data that [was] comparable between … groups, and across events or different times" (Saunders 2019). The process of "observing actual behaviour outside an experimental setting" (Stock 2020) is what makes this data observational.

4.1.2 Approach

The research approach that was best suited to answer my research question is inductive. My research is inductive and longitudinal, which is clear through how the data was "collected and analysed to test [my] theory" (Saunders 2019). The data in this research was looked at over a specific duration and was used to study a particular phenomenon (digitalization and web accessibility) during that timeline (Schmeisser 2022). This longitudinal study used information from the Wayback Machine Internet Archive that was collected over the duration of this Master Thesis for the Spring 2023 semester. This study is inductive in nature due to the lack of specific recent research within the digitalization and web accessibility field. In this paper I generated data, analysed, and reflected upon what theoretical themes the data suggested, which are all indicators of inductive research (Saunders 2019).

This analysis was left censoring, since the evaluation period was set from 2008 to 2022, for multiple reasons. The most recent WCAG version that Canadian legislation references for web accessibility compliance is WCAG 2.0, which was released in 2008. Additionally, due to the reliance on the Wayback Machine, the farther back data was collected the more sporadic the availability of data became which would decrease the university sample size. Therefore, the timeline of 2008 to 2022 was selected. Since Canadian accessibility legislation has been released prior to 2008, the start of my observation period, my data is left

censoring, meaning that an event of interest may have occurred before the research time period was observed (Klein 2003).

4.2 Data Collection

The data in this research was collected from multiple digital sources; the Wayback Machine, The Canadian Information Centre from International Credential (CICIC), axe DevTools, Statistics Canada, Center for World University Rankings (CWUR), Government websites, and University Websites.

4.2.1 University Selection

To remain unbiased, Universities were selected randomly. The exception to this is in provinces with five or less Universities, in which case the respective Universities were automatically selected to be in the research pool, this was the case for Newfoundland and Labrador, Prince Edward Island, Saskatchewan, and Yukon. Universities were collected from CICIC where the 'Directory of Educational Institutions in Canada' was used with the filter to only view *recognized Universities* in each province (Find an educational institution n.d.). After using Excel to randomize all the universities from each province (with the exceptions listed above), the next step was to identify the Universities that had available data on the Wayback Machine from 2008 to 2022. After identifying the viable University options, the top eight were picked from each province, where possible, resulting in a total of 49 Universities used to conduct research.

Dependent Variable

In regard to the total data collected for my dependent variable, I have observed n = 49 Canadian Universities' (entities) for T = 180 months (time periods) from January 2008 to December 2022. Thus, there are a total of n × T = 49 × 180 = 8,820 observations.
I have collected data on the four categories scoring web accessibility: critical, serious, moderate, and minor for each of the observations above. 8,820 (observations) × 4 (web accessibility scoring categories) = 35,280 total web accessibility observations.

To prove relationships with the support of a large data sample size, a web accessibility score was collected for every month between 2008 to 2022 for each respective University. The

extensive data collected allowed for each University to have 180 individual data points on their web accessibility score, and the entire dataset to have a total of 8,820 data points on web accessibility score. Due to some of the recorded scores being unavailable due to limitations from the Wayback Machine the number of data points that can be analyzed are 7,379. The purpose of this research is explanatory as it aims to understand the "relationship between cause and effect" (Saunders 2019).

Wayback Machine

To view previous versions of a webpage, the Wayback Machine, owned by the Internet Archive was used. This tool utilizes Alexa Internet, and the Internet Archive that has "a three-dimensional index that allows browsing of web documents over multiple time periods" (Wayback Machine General Information n.d.), this index browsing is the Wayback Machine. The Wayback Machine technology "relie[s] on donations of web crawls, technology, and expertise from Alexa Internet and others" (Wayback Machine General Information n.d.).

A limitation of the Wayback Machine is that it cannot store a webpage that contains dynamic "JavaScript, or other elements that require interaction with the originating host, the archive will not contain the original site's functionality" (Wayback Machine General Information n.d.). However, "dynamic page[s] render[ed with] standard html" does work" (Wayback Machine General Information n.d.). During the data collection process only websites with a functioning website were documented to avoid data skewed by websites that cannot be fully rendered which could affect the evaluation rating.

Web Content Accessibility Guidelines

The "WCAG explains how to make web content more accessible to people with disabilities. WCAG covers websites, applications, and other digital content. It [was] developed by the World Wide Web Consortium (W3C) Web Accessibility Initiative (WAI)" (W3C Web Accessibility Initiative 2020). WCAG has identified three levels of conformance, "Level A is the minimum level, Level AA includes all Level A and AA requirements (many organizations strive to meet Level AA), Level AAA includes all Level A, AA, and AAA requirements" (W3C Web Accessibility Initiative 2020). WCAG is a standard that evolves as technology does. Starting in 1999, WCAG introduced WCAG 1.0 that focused mainly on HTML (Birney 2020). In December 2008, WCAG 2.0 was released, with the focus to "make

all digital content accessible as opposed to only addressing content implemented using HTML" (Birney 2020). In WCAG 2.0 a set of four guidelines were created: perceivable, operable, understandable, and robust. Those four principles can be seen "as categories for the success criteria which constitute WCAG; each success criterion addresses a barrier or barriers to making content perceivable, operable, understandable, and/ or robust for all users" (Birney 2020). In June 2018, WCAG 2.1 was released. Unlike the clear changes from WCAG 1.0 to 2.0, WCAG 2.1 standards are built upon 2.0. There is no recreation of the rules but rather, it adds on to the existing success criteria from WCAG 2.0 (Birney 2020). Although WCAG 2.2 has yet to be formally released, a working draft has been available as of 2020. The most recent working draft, WCAG 2.2, builds upon the 2.1 standards.

Evaluation Tool

To check web accessibility, the evaluation was conducted using axe DevTools, Google Chrome Dev Tools tab extension. The accessibility checker provides numerical data for total issues, automatic issues, guided issues, and breaks down the issues into four categories: critical, serious, moderate, and minor.

The category definitions are as follows: *critical*, "results in blocked content … prevent[s PwD] from accessing fundamental features or content. This type of issue puts your organization at risk, [and should be] prioritize[d in] fixing" (Dequelabs n.d.). Issues identified as *serious*, "results in serious barriers for [PwD], and will partially prevent them from accessing fundamental features or content. People relying on assistive technologies will experience significant frustration as a result. Issues falling under this category are major problems, and remediation should be a priority" (Dequelabs n.d.). *Moderate* issues "result in some barriers for [PwD], but will not prevent them from accessing fundamental features or content. [Moderate issues] will get in the way of compliance if not fixed" (Dequelabs n.d.). *Minor* issues are "considered to be a nuisance or an annoyance bug [and]... will still get in the way of compliance if not fixed" (Dequelabs n.d.). The specific categories to take note of are the *critical* and *serious* categories since they are fundamental to the usability experience for PwD.

This specific tool was ideal for this research for numerous reasons. When using the axe DevTools with the Wayback Machine website, it would look specifically at the site and

exclude the header for the Wayback Machine, unlike other tools that included the Wayback Machine header in the accessibility evaluation, which could have skewed the results. This tool was available in Chrome Dev Tools, making it easy to use and allowed for it to work on all sites when using Google Chrome.

This tool allows evaluations to be done using WCAG 2.0 (Kumar 2021). The DevTools GitHub repository contains the rule descriptions and breaks down each rule for the corresponding WCAG standard. Each rule has been linked to Accessibility Conformance Testing (ACT) which is an "open forum set up to document and harmonize the interpretation of W3C accessibility standards…, for testing purpose[s]" (ACT Rules community n.d.). "The ACT Rules Community Group is a group of accessibility tool vendors, test procedure authors, and accessibility test experts" (ACT Rules community n.d.), with the focus of this group being to "research and document accessibility interpretations" (ACT Rules community n.d.).

To be consistent for the analysis, only one WCAG version was documented. With the evaluation period set to 2008 to 2022, and considering that the federal accessibility standard is set to WCAG 2.0 AA, that was the standard use for this entire study. This approach was also the most logical, since federally, and for the provinces with their own Accessibility policies, WCAG 2.0 AA is the universal legislation.

This tool evaluates only one page, which is a limitation of this tool, since it is not possible to get a comprehensive website accessibility score for the entire University sitemap. Although this is a limitation of the tool, the evaluation page set as the University landing page is a good indicator of the presence of accessibility throughout the entire sitemap. A University web landing page is the face of the University and will represent the topics of importance for each respective University, including web accessibility.

Independent Variables

In this section I will discuss the IVs that are being researched and the limitations they may possess.

University Size

The purpose of this variable is to understand the number of students that each University supports. This value will allow me to see if there is a relationship between having a larger body of students and more accessible websites. This variable, independently and/or in conjunction with other IVs, could determine whether bigger and more respected (University Ranking) Universities have more accessible websites or vice versa. This variable is represented by a proxy of Postsecondary enrolments, a proxy is "an indirect measure of the desired outcome which is itself strongly correlated to that outcome" (What is a proxy measure? n.d.). Postsecondary enrolments data was gathered from Statistics Canada (Government of Canada, Statistics Canada, 2022 November 22). A limitation of this specific data source is that it does not represent the entire size of the University population. Although this Postsecondary enrolment is only representative of total enrolment, I believe it serves the purpose of identifying large, medium, and small Universities apart from each other. Another limitation of this data source is that it did not include information from two Universities chosen for this study. To work around the missing data on the two Universities, they were excluded when using this variable in an analysis.

Additionally, the timeline of this observation period was set from 2008 to 2022 but the data from this source did not include the years 2008 and 2022, excluding two years from the observation period. Again, this limitation was not detrimental to the study since it still serves the purpose of differentiating university size from one another. Although this was a limitation of the Statistics Canada data, I believe it was the best data source to represent University size despite the limitations listed above, because this source is reputable and served the purpose of framing Universities. Data regarding University size can be varied from other sources and when investigating alternative ways to represent university size I found a lack of past information from specific Universities, meaning some Universities would only represent the most recent year of university size. Another issue with using other sources on university size is that some universities would round their data while others would be specific, this discrepancy may have skewed results. For the reasons listed above, the Statistics Canada data is best suited for this variable despite the limitations.

University Ranking

The purpose of this variable is to represent the perception of each University. Universities with a higher ranking means that they are comparatively 'better'. This variable was used to see if there is a difference in web accessibility from Universities that are doing 'better' than others. This variable is an exact measure using the university rankings from a global source, the Center for World University Rankings (CWUR) (*Best universities in Canada in 2021-2022* n.d.-a). A limitation of this source is that it is a global ranking so the number of Canadian Universities on the list could fluctuate from year to year. After I explored all the university ranking options, this proved to be the best, encompassing multiple Canadian Universities with all different standings, as will be discussed in the Analysis and Results section.

The University Ranking from CWUR methodology uses *Education*, "based on the academic success of a university's alumni and measured by the number of a university's alumni who have won prestigious academic distinctions relative to the university's size" worth 25% (*Methodology: CWUR* n.d.). *Employability* is "based on the professional success of a university's alumni and measured by the number of a university's alumni who have held top positions at major companies relative to the university's size" worth 25% (*Methodology: CWUR* n.d.). *Faculty* is "measured by the number of faculty members who have won prestigious academic distinctions" and worth 10% (*Methodology: CWUR* n.d.). *Research*, is broken down into 4 sections each worth 10%, "research output [which is] measured by the total number of research papers, high-quality publications [which is] measured by the number of research papers appearing in top-tier journals, influence [which is] measured by the number of research papers appearing in highly-influential journals, [and] citations [which are] measured by the number of highly-cited research papers" (*Methodology: CWUR* n.d.).

Federal & Provincial Legislation

The purpose of this variable is to understand the relationship between legislation and web accessibility. This variable allowed me to see if there was a relationship between having legislation introduced, last updated, and/or implemented (royal assent) and a change in web accessibility. "Royal assent is the stage that a bill must pass before officially becoming an act of Parliament … Once a bill has been granted royal assent, it becomes law and comes into force on that day, unless the act provides otherwise" (House of Commons of Canada

n.d.). This is an exact measure of policies down to the month of introduction, last update, and implementation. Federal and Provincial legislation was used in the data analysis. This information was collected from official Government websites. A limitation to this data is that policies could have been revised, and policy revision dates are not included in this research except for the last update.

Canadian Legislation

The legislation relevant to this research are as follows: The *Canadian Charter of Rights and Freedoms*, 1982 "guarantee[d] … the right to *equality*, democracy, and mobility" (Norman-Eady 1998). The focus of equality at that point in time, in 1982, was between women and men (Norman-Eady 1998). Although the term of equality is referenced differently in 1982 to present day *The Canadian Charter of Rights and Freedoms* was the start of the ongoing legislation into equality. The *Canadian Human Rights Act*, 1985 has been amended numerous times since its introduction. The purpose of the *Canadian Human Rights Act* current to 1/25/2023 is that "all individuals should have an opportunity equal with other individuals … without being hindered in or prevented from doing so by discriminatory practices based … disability" (Government of Canada 2023, Consolidated federal laws of Canada, *Canadian Human Rights Act*). In 2019, Canadian legislation passed Bill C-81, the *Canadian Accessibility Act*, this act set out to make Canada 'barrier-free' by 2040, and only pertains to "organizations under federal responsibility" (Summary of the Accessible Canada Regulations 2022). As identified in the Act "a barrier is anything that prevents persons with disabilities from fully and equally participating in Canadian society" (Summary of the Accessible Canada Regulations 2022).

There is also specific Canadian legislation relating to web accessibility. An Internet Guide was published for The Government of Canada websites in 1998 (Guidance on Implementing the Standard on Web Accessibility 2013). This internet guide "provided information on common resources – tools and tips – on web accessibility" (Guidance on Implementing the Standard on Web Accessibility 2013). Additionally, in 2000 "the government approved its own first set of Web accessibility standards known as Common Look and Feel (CLF) 1.0" and required government divisions to meet WCAG 1.0 standards in 2002 (Guidance on Implementing the Standard on Web Accessibility 2013). The CLF continued updating new versions and in 2010 it was decided "that the existing CLF 2.0 standards would be replaced

by three new standards: the Standard on Web Accessibility, the Standard on Web Usability and the Standard on Web Interoperability" (Guidance on Implementing the Standard on Web Accessibility 2013). The creation of the new standards is referred to as the start of the "move toward adopting WCAG 2.0" (Guidance on Implementing the Standard on Web Accessibility 2013), which was the most recent WCAG standard at the time.

The Canadian Standard on Web Accessibility was introduced in 2011 and last updated in 2013 (Standard on web accessibility 2013). This web accessibility standard impacts only Canadian Government websites (Standard on web accessibility 2013). Both the *Canadian Accessibility Act* and the Canadian Standard on Web Accessibility build on each individual province's digital accessibility standards. These standards note that "web technologies and standards are constantly evolving … [this standard was created in the effort of] … making the Government of Canada Web channel[s] more … inclusive" (Standard on web accessibility 2013). In this standard the specified WCAG level for Canadian Government websites to comply with has been set as WCAG 2.0 AA (Standard on web accessibility 2013). The consequences of non-compliance with the *Canadian Accessibility Act* and Canadian Standard on Web Accessibility applies only to those organizations that are a federal responsibility, with a the penalty of "up to $250,000" (Summary of the Accessible Canada Act 2020).

Provincial Legislation

Four of the ten provinces in Canada have their own Accessibility legislation to "address accessibility barriers for matters under provincial jurisdiction" that applies to organizations within the province (McKay-Panos 2021). Provincial legislation is presented in chronological order of legislation implementation below. Not included in this section are two provinces that have some accessibility legislation but is not applicable for the study due to a focus on government entities (Quebec) and a Bill to allow legislation creation, however not the actual legislation (Newfoundland and Labrador) and for that reason Quebec and Newfoundland and Labrador's legislation will not be included in this research.

Ontario

"Ontario is the first Canadian Province to pass a law to improve accessibility in the areas that impact the daily lives of people with disabilities" with the *Accessibility for Ontarians with*

Disabilities Act (AODA), 2005 (Government of Ontario 2015). The AODA is imposed on "government, businesses, non-profits and public sector organizations" (Government of Ontario 2015). Part two of the AODA focuses on 'Information and communications standard' which involves web accessibility (Government of Ontario 2015). Websites within Ontario that the AODA is enforced on conforms to WCAG 2.0 Level AA, the only exceptions are for criteria 1.2.4 Captions (Live) and 1.2.5 Audio Descriptions (Pre-recorded) (Government of Ontario 2018). For "government, businesses, non-profits and public sector organizations" failing to comply with the AODA comes with a monetary penalty (Government of Ontario 2015). The penalty for non-compliance ranges, yet "the largest lump sum penalty amount … [for] an individual or an organization that is not a corporation is $2,000 and the maximum for a corporation is $15,000" (Cohen Share 2011). Additionally, "a corporation/organization that is guilty can be fined up to $100,000 per day, and directors and officers of a corporation/organization that is guilty can be fined up to $50,000 per day" (Cohen Share 2011). The "deadlines for compliance began as of January 1, 2010" (Cohen Share 2011).

Manitoba

The *Accessibility for Manitobans Act* (AMA), 2013 was set out to "remove barriers affecting people with disabilities" (Government of Manitoba n.d.), the act sets out to "achiev[e] significant accessibility progress by 2023" (Government of Manitoba n.d.). Similar to the AODA, there is a focus on an Accessibility Standard for Information and Communications, which "addresses barriers to accessing and providing information … includ[ing] information provided … on websites" (Government of Manitoba n.d.). These regulations are enforceable onto "public sector organizations [that] include large municipalities, health authorities, crown corporations, colleges, universities and school divisions" (Disabilities Issues Office 2016). The Accessible Information and Communication Standard under the AMA underwent changes that became effective in 2022 (Accessibility Services Canada n.d.-a). The Information and Communication Standard requires organizations to adhere to WCAG 2.1 AA by 2024 for public sector organizations such as Universities (Accessibility Services Canada n.d.-a). Non-compliance with the AMA can result in a fine of up to $250,000 (Government of Manitoba 2013).

Nova Scotia

The *Nova Scotia Accessibility Act*, Bill 59, was introduced in 2016 and passed in 2017 (Government of Nova Scotia 2018), it was "aimed at developing accessibility standards in five areas, including information and communication" (An overview of Canada's accessibility laws 2020). Technological barriers are specifically mentioned when defining different barriers (Government of Nova Scotia 2016). However, the Bill does not go in depth into technological web standards to eliminate the technological barriers. The penalty to be "guilty of an offence [could result in] a fine of not more than $25,000" (Government of Nova Scotia 2016).

British Columbia

Bill 6, the *Accessible British Columbia Act* (ABCA) of 2021, was created to "promote accessibility [by] remov[ing] and prevent[ing] barriers to individuals in or interacting with the organization" and applies to "the government and a prescribed organization" (Legislative Assembly of the Province of British Columbia 2021). A prescribed organization is "an organisation prescribed by the Minister" (Prescribed Organisation Definition n.d.). The ABCA has a specific section for information and communications where no specific practices are documented. The monetary penalty for non-compliance with the ABCA does not exceed $250,000 (Legislative Assembly of the Province of British Columbia 2021). "All covered organizations have been given a grace period of one or two years … to achieve compliance with these new accessibility requirements" making the deadline September 1, 2023, and September 1, 2024, respectively (Accessibility Services Canada n.d.-b).

Saskatchewan

Saskatchewan has introduced the *Accessible Saskatchewan Act* in 2022 which has yet to be passed. With the introduction of an accessibility act nothing has changed yet, if/once the *Accessible Saskatchewan Act* is passed then "the government will have two years to come up with accessibility plans" (Accessibility Services Canada n.d.-c).

A limitation of this variable is that only legislation that is within the research timeline (2008 to 2022) will be used in the analysis which causes the data to be left censoring which was addressed above.

Federal & Provincial Government

The purpose of this variable is to understand how different leading governments could impact web accessibility. There is no question that different political parties have different priorities; it could be insightful to see the impact that specific parties have on web accessibility during times of power. This is an exact measure of political party ruling that was sourced from Government websites and the Canadian Encyclopedia.

Universities are federally and provincially supported, however, since Public Universities are operating institutions, they largely follow their provincial policies, as are maintained and regulated by the political parties in power. Due to each political parties' differences in policy and their stance on accessibility, I believe this variable could identify a higher acceleration of accessible web during specific parties' ruling over others.

Liberal Party of Canada

The Liberal Party of Canada's stance is "to invest in the middle class, grow an economy that works for everyone, and [to] protect our environment" (*Our progress* n.d.-b). Their platform has a section for 'an equal Canada, for everyone' which delves into 'Support for Canadians with Disabilities' where they state their "focus on removing barriers and addressing disability discrimination and exclusion and forging new opportunities for Canadians with disabilities to work, contribute to their communities, and enjoy the same quality of life all Canadians deserve" (*2021 Platform: Liberal Party of Canada* n.d.-a). Since 2015 this party has "passed the *Accessible Canada Act* to advance the rights of and accessibility for Canadians with disabilities" (*Our progress* n.d.-b).

Conservative Party of Canada

The Conservative Party of Canada states they are "founded on the principles of peace and freedom…, [have] responsible management of taxpayers' money; [and are] a welcoming land of refuge for the world's persecuted and afflicted" (*About Us* n.d.). Their social policy, released in 2008, states "[their belief that] the government should work with the provinces and territories to strengthen the social fabric of Canada to improve the quality of life for all Canadians but especially children, seniors and the disabled" (Conservative Party of Canada 2021). Additionally, under *The National Disability Act* in their 2008 Policy, they explained what it is and expressed their support.

Federally and Provincially

Stephen Harper served as the Prime Minister of Canada from 2006 to 2015, he was the leader of the Conservative Party of Canada and oversaw Canadian politics for nine years (Parliament of Canada n.d.). Justin Trudeau became the Prime Minister of Canada in 2015 and continues to lead the country as the leader of the Liberal Party of Canada (Parliament of Canada n.d.). Each province has their own political party leading them. Alberta, Manitoba, New Brunswick, Nova Scotia, Ontario, and Prince Edward Island are currently being led by Conservative representatives. Newfoundland and Labrador, and Yukon are currently being led by Liberal representatives. British Columbia is currently being led by a New Democratic Party (NDP) representative. The Northwest Territories and Nunavut are being led by independent leaders. Saskatchewan is being led by a Saskatchewan Party representative, and Quebec is being led by a Coalition Avenir Québec (CAQ) representative (*Premiers of Canadian Provinces and Territories* n.d.).

A limitation of this study is that due to outdated Federal and Provincial legislation according to the global WCAG standards, most Canadian guidelines are outdated. Because there are minor additions and/or changes between the 2.0, 2.1, and now 2.2 WCAG guidelines, the findings in this study may be only slightly skewed from the current global WCAG standards. It would be worth considering the compliance not only to provincial and federal legislation but also international legislation. This consideration is particularly relevant for Canadian Universities that welcomed 373,599 international students (Statista Research Department 2022) many of which could be better adapted to more recent web accessibility standards.

Visual Layout Changes

The purpose of this variable is to represent when there was a change in the visual look of a website. This variable helps to represent digitalization through a visual lens. This variable is in the form of true or false during every individual evaluation and was measured by me visually. Below is an example from this study to show what is described as a “true” under visual layout. A limitation of this variable is that it is based upon my perspective and interpretation, however as seen in the example below it is not difficult to see if there is a change in layout. I determined a change in layout through the addition and/ or change in the following: homepage structure, graphic elements, text elements, and banners. I documented

'true' for a visual layout change when it was clear there was a change, as illustrated by the layout change example below, Figure 1.

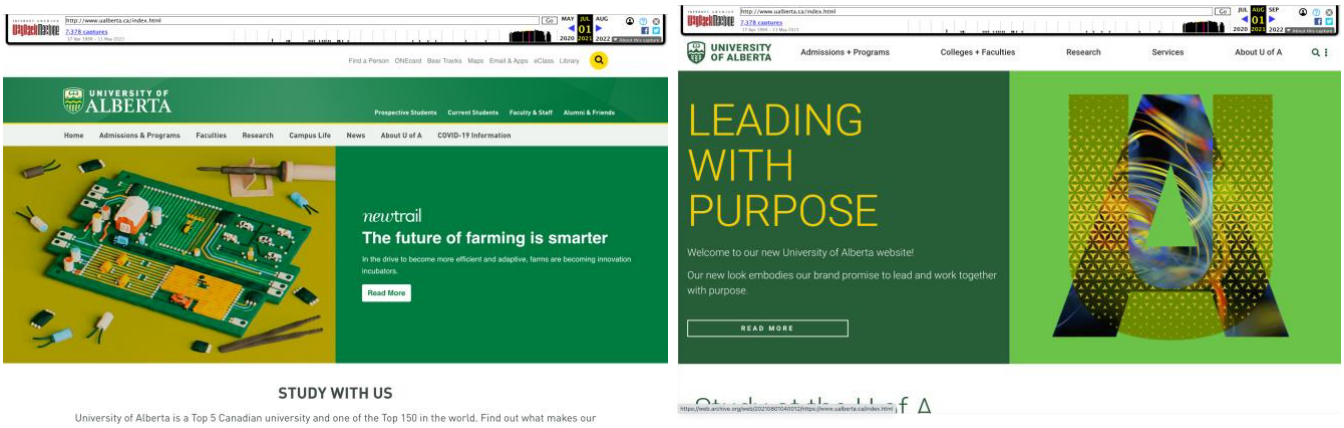


Figure 1, Example of visual layout change at the University of Alberta.

A limitation that has been yet to be mentioned is the chosen variables. All the analysis done accounts for the variables chosen, but in not considering and analysing other variables, it limits the findings. With topics such as accessibility there is always a plethora of impacting factors that cannot all be accounted for. Although this was a limitation of this dataset it was accounted for in the analysis section through the fixed effects regression.

4.3 Analysis Methods

4.3.1 Volatility Test

To test the volatility in the one-year period, three universities were tested to see if there was a significant fluctuation in the five evaluation sections: total issues, critical issues, serious issues, moderate issues, and minor issues. To test the volatility, the first available date of every month was looked at for the year 2022 and 2012. This volatility test was conducted to get an appropriate accessibility measure so as not to skew any potential patterns. After the volatility test was conducted it exposed that the data did fluctuate somewhat. After conducting the volatility test to allow for the data to be most gradual I used the same approach of taking the first available day from each month. Although more time consuming, taking the first available day from each month over the first score of every year created more

available data that would be extensive when identifying patterns, which would create better research of higher value.

Regression Analysis

I used multiple regressions, known as the mainstay of econometrics (Stock 2020). This analysis method was relevant for my research purpose because it "provide[d] a mathematical way to quantify how a change in one variable affects another variable" (Stock 2020). In my research there are multiple variables that can have different levels of effects, which is why this is the most effective method for my hypotheses.

Difference-in-Difference

Difference-in-Difference (DID) is "the average change in Y for those in the treatment group minus the average change in Y for those in the control group" (Stock 2020). The DID analysis "involves comparing results from two groups, with data from each group being recorded over two time periods" (Glen n.d.). DID regression is a good fit for my dataset when analysing legislation events since the focus in on the changes occurred.

Panel Data

The specific regression technique I used was fixed effects panel data. Panel data works well for my research because it "comprises characteristics of both [cross-sectional data and time-series data] into one model by collecting data from multiple, same objects over [a period of] time" (Brugger 2021). This works well for my data since it consists of multiple entities in the form of 49 different Universities that are then observed during multiple time periods from 2008 to 2022 (Stock 2020).

An advantage of this regression type is that "by studying changes in the dependent variable over time, it is possible to eliminate the effect of omitted variables that differ across entities but are constant over time" (Stock, J. H 2020). Additionally, "in panel data, variables are typically autocorrelated—that is, correlated over time within an entity. Standard errors need to allow both for this autocorrelation and for potential heteroskedasticity, and one way to do so is to use clustered standard errors" (Stock 2020). Heteroskedasticity is "the variance of the regression error term, conditional on the regressors, is not constant" across the

observations (Stock 2020). Fixed effects was chosen since “entities have individual characteristics that may or may not influence the outcome and/or predictor variables” (Torres-Reyna 2007). This is visible in my research since individual characteristics, IV’s, may or may not influence the outcome of IV relationships. “The fixed effects model is an appropriate specification … [to] focus on a specific set of N [Universities] … [the] inference is restricted to the behaviour of these sets of [Universities] … inference in this case is conditional on the particular N [Universities]” (Baltagi 2013).

Endogeneity

Endogeneity is a “correlation of the right-hand side regressors and the disturbances” (Baltagi 2013). It could be caused by “the omission of relevant variables, measurement error, sample selectivity, self-selection or other reasons” (Baltagi 2013). “The fixed effects model allows for endogeneity of all the regressors with … individual effects” (Baltagi 2013). Firstly, I looked at my variables to identify if there were any causal relationships. There are some endogenous areas in this study, one possible endogenous variable in this research is University size. If students at university require more accessible websites, that would directly impact web accessibility, since universities would then be made aware of accessibility concerns, and it could turn into a pressing issue. On the other side, university size could be influenced by web accessibility, for example, if a school is not accessible, PwD may choose to study at other, more accessible, universities. Since I use this variable only for descriptive purposes there is no need to control for the possible endogeneity. Other possible variables that could impact endogeneity is legislation since it is concurrent, legislation occurred prior to the observation period. Additionally, endogenous issues could arise from the unobserved variables in my research. Policy change may be driven by societal change from an awareness of web accessibility. Essentially, legislation and web accessibility change could both be impacted by society. In my second hypothesis I look at how web accessibility changes around legislation. However, it is possible that both legislation changes and web accessibility changes simultaneously due to society, which is an unobserved variable.

To account for endogeneity, I used an instrument free approach through fixed effects regression models. Since I suspected endogeneity, the fixed effects model was a good fit for this dataset, because it allowed for time-invariant confounding factors. Fixed effects regressions allow for dummy variables for each individual university, which helped to

mitigate the endogeneity concern. “Fixed effects methods control for the potential confounding effects of all unobserved, time-invariant variables” (Allison 2009). Through this approach to endogeneity, I was able to look at the relationship between university size and web accessibility, since I could see how each firm changed over time since fixed effects allows for changed in relatively homogenous organizations to be seen, which will be visible in the analysis and results section below.

4.4 Research Aim & Objectives

The research aim was to evaluate the impact of digitalization on web accessibility. My first research objective was to assess the effects that visual website changes had on web accessibility which addresses my first hypothesis. My second research objective was to explore how legislation impacts web accessibility, which was aimed at addressing my second hypothesis.

Hypothesis 1: Web accessibility will decline as a result of visual advancements.
Hypothesis 2: Legislation will fail to result in improving web accessibility.

4.5 Research Quality

4.5.1 Internal Validity

Internal validity refers to the “extent to which findings can be attributed to interventions rather than any flaws in [the] research design” (Saunders 2019). To address internal validity, I used regressions that showed the effect that specific variables had on web accessibility. Fixed effects regressions are a good way to address and ensure internal validity, since it “is commonly used to reduce selection bias in the estimation of causal effects in observational data by eliminating large portions of variation thought to contain confounding factors” (Mummolo 2018).

4.5.2 External Validity

External validity is referred to as the "extent to which the research results … are generalisable to all relevant contexts" (Saunders 2019). Through the careful selection of the research setting, I ensured that the research findings would be generalisable to a variety of different contexts and settings. The variables I decided to look at were selected on the basis that they apply to all universities and they are also characteristics of other institutions, which means that the same research can be transferred to look for web accessibility in other industries.

4.5.3 Reliability

Reliability refers to the "extent to which data collection technique(s) … yield[ed] consistent findings" that could later be reached by other researchers (Saunders 2019). One possible issue to reliability is from the observations I made for the layout change variable, since I was personally interpreting this variable. To address the possible reliability issues, I outlined specifically what would constitute a visual layout change. In order to be reliable, I ensured that the data collection method was easily replicable to allow for transparency and to guarantee reliability (Saunders 2019). In the Methodology section I go in detail regarding the methods that were used in this research, allowing it to be replicated by others, ensuring reliability.

4.5.4 Objectivity

Objectivity is defined as the "avoidance of (conscious) bias and subjective selection during the conduct and reporting of research" (Saunders 2019). The emphasis on objectivity and remaining unbiased, was crucial so as not to sway the results and/or the reader. Objectivity during data collection, analysis, and in presenting the results of this study was achieved by randomization of university selection and through web accessibility evaluation using the axeDev tool.

4.5.5 Ethics

To remain ethical during this research period, multiple steps were taken to ensure quality research. Internal/External validity, reliability and objectivity were of the utmost importance

while researching and analysing. Transparency was another key area in this research. In order to remain transparent in my findings and analysis, my data can be made available upon request. Throughout this paper the different limitations, decisions, and impact have been clearly documented.

The remaining sections are as follows: analysis and results, discussion, and conclusion. The analysis and results section is where the findings are shared; I will describe the analysis I conducted and the interpretation of the results. The findings from this research will contribute to the overall purpose of this paper and answer the research question '*How does digitalization affect web accessibility for people with disabilities?*'.

5. Analysis & Results

In this section I will examine the empirical evidence, which is evidence based on data, to understand the relationships I hypothesized between the DV and IV's (Stock 2020).

"A good place to start any empirical analysis is plotting the data" (Stock 2020). With the use of two specific IVs I was able to get an idea of general patterns that universiteis of certain size and rank demonstrate certain behaviours around web accessibility.

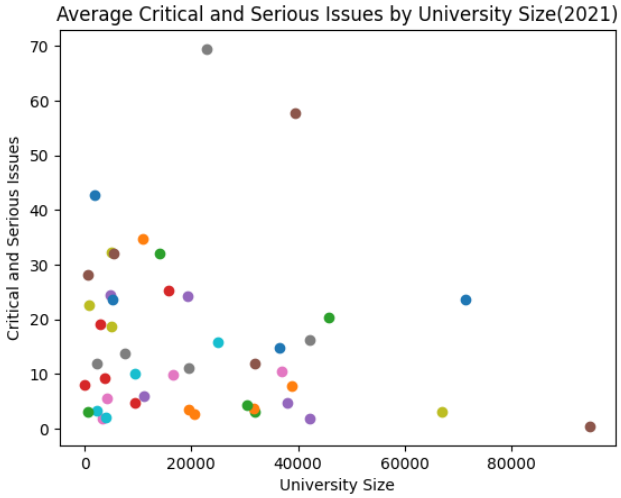


Figure 2, Average critical and serious issues by university size 2021.

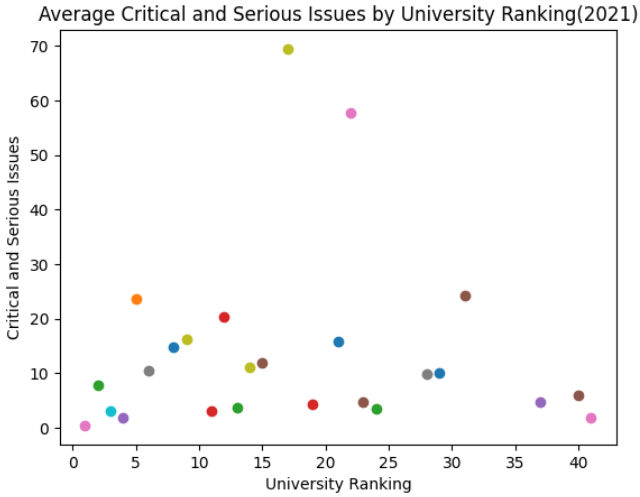


Figure 3, Average critical and serious issues by university ranking 2021.

In order to a get a general idea about Universities, I utilized the IVs University size and university rank to see if I could find any trends between the each IV and web accessibility. I

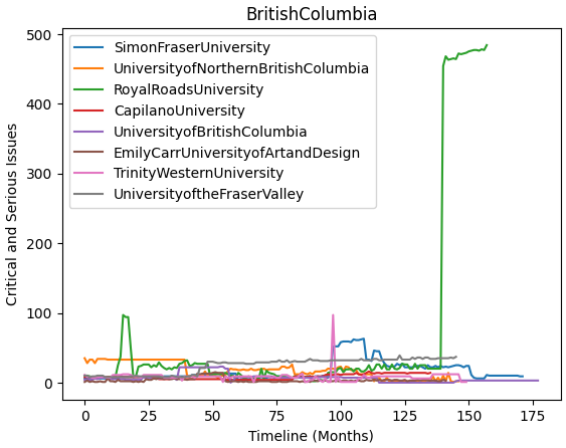
used critical and serious web accessibility as the measure, since those are the two categories that inhibit a PwD from interacting with the site. I decided to show these results specifically for the year 2021, since that is the time frame with most observations on web accessibility, university size and university ranking combined, as compared to other years within the observation period. Although these graphs do not show all the years and data collected, it serves the purpose of identifying trends between the IVs and web accessibility.

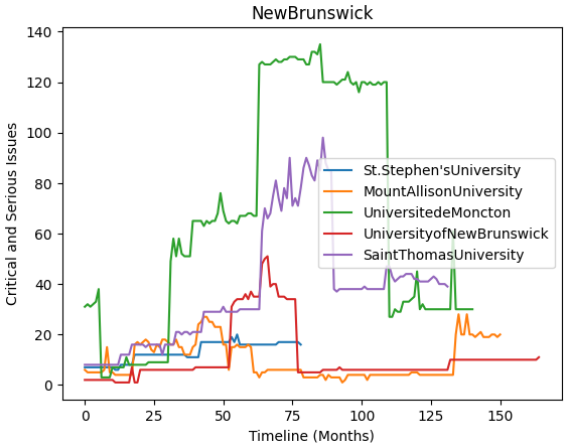
From Figure 2 there is a trend suggesting that larger universities are more web accessible. This visualization relied on 48 universities, excluding Royal Roads University from this analysis because it was a significant outlier which is made visible in Figure 2. The quantity of universities is gathered near the bottom left quadrant of the graph, suggesting that most universities have enrolment between 0 to 40,000. With significantly fewer observations falling into the bottom right quadrant, it is clear that most universities have somewhat similar size. Noticeable in the graph is the decline in critical and serious web accessibility issues as observations move towards the bottom right quadrant suggesting larger universities have less critical and serious web accessibility issues.

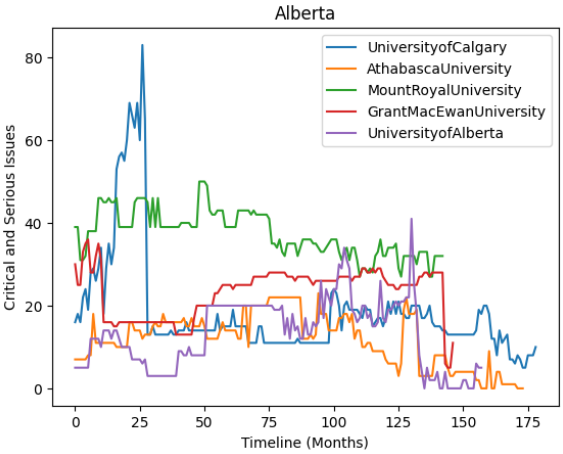
From Figure 3 I found that universities ranking high and/or low tend to have similar web accessibility scores. Interestingly, the universities that ranked somewhere in the middle have the most variation in their web accessibility. This creates a wave showing that universities ranking high and low tend to have lower web accessibility issues compared to universities ranking in the middle.

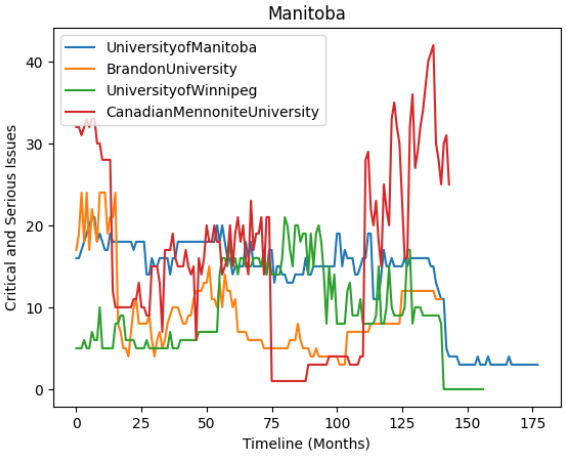
These figures and findings start the process of analysing web accessibility at universities to create a background knowledge on the university characteristics within the observation group that could show patterns worth further investigating. Next, I look at each university from a provincial perspective to visualize web accessibility issues over time, to further expand on the background and to start the process of looking for trends worth investigating.

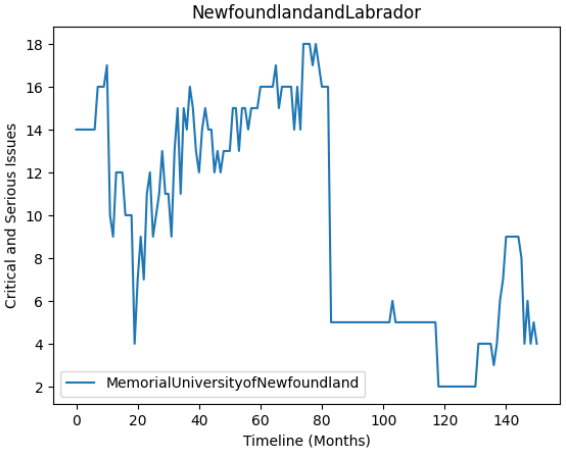
To visualize each University's web accessibility performance I compared each University in their own province, on the x-axis I plotted the timeline in months, and on the y-axis, I plotted critical and serious web accessibility issues. The results are as follows:

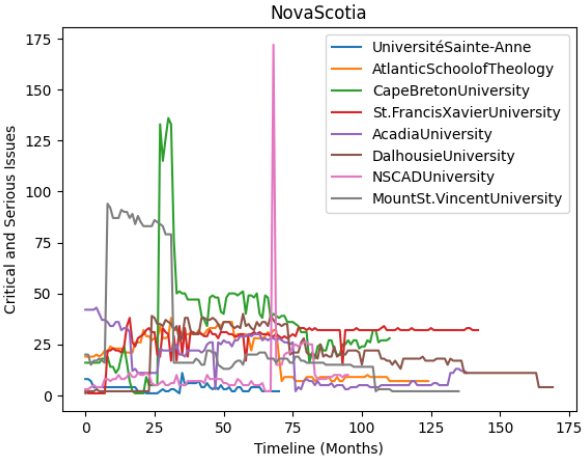

BritishColumbia
SimonFraserUniversity
UniversityofNorthernBritishColumbia
RoyalRoadsUniversity
CapilanoUniversity
UniversityofBritishColumbia
EmilyCarrUniversityofArtandDesign
TrinityWesternUniversity
UniversityoftheFraserValley
Critical and Serious Issues
Timeline (Months)

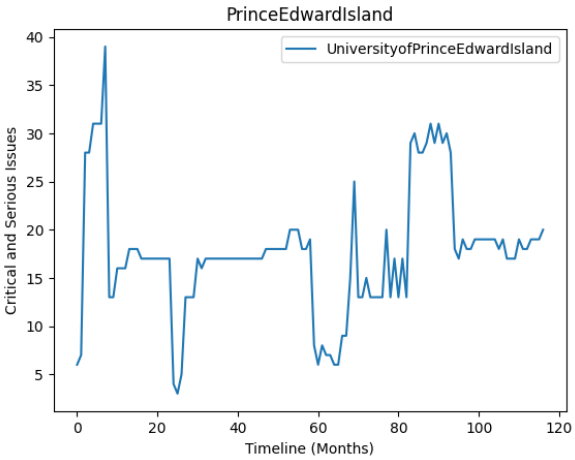

NewBrunswick
St.Stephen'sUniversity
MountAllisonUniversity
UniversitedeMoncton
UniversityofNewBrunswick
SaintThomasUniversity
Critical and Serious Issues
Timeline (Months)

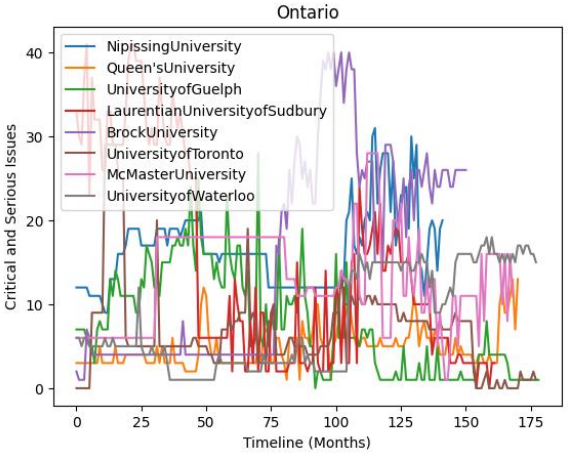

Alberta
UniversityofCalgary
AthabascaUniversity
MountRoyalUniversity
GrantMacEwanUniversity
UniversityofAlberta
Critical and Serious Issues
Timeline (Months)


Manitoba
UniversityofManitoba
BrandonUniversity
UniversityofWinnipeg
CanadianMennoniteUniversity
Critical and Serious Issues
Timeline (Months)


NewfoundlandandLabrador
MemorialUniversityofNewfoundland
Critical and Serious Issues
Timeline (Months)


NovaScotia
UniversitéSainte-Anne
AtlanticSchoolofTheology
CapeBretonUniversity
St.FrancisXavierUniversity
AcadiaUniversity
DalhousieUniversity
NSCADUniversity
MountSt.VincentUniversity
Critical and Serious Issues
Timeline (Months)


PrinceEdwardIsland
UniversityofPrinceEdwardIsland
Critical and Serious Issues
Timeline (Months)


Ontario
NipissingUniversity
Queen'sUniversity
UniversityofGuelph
LaurentianUniversityofSudbury
BrockUniversity
UniversityofToronto
McMasterUniversity
UniversityofWaterloo
Critical and Serious Issues
Timeline (Months)

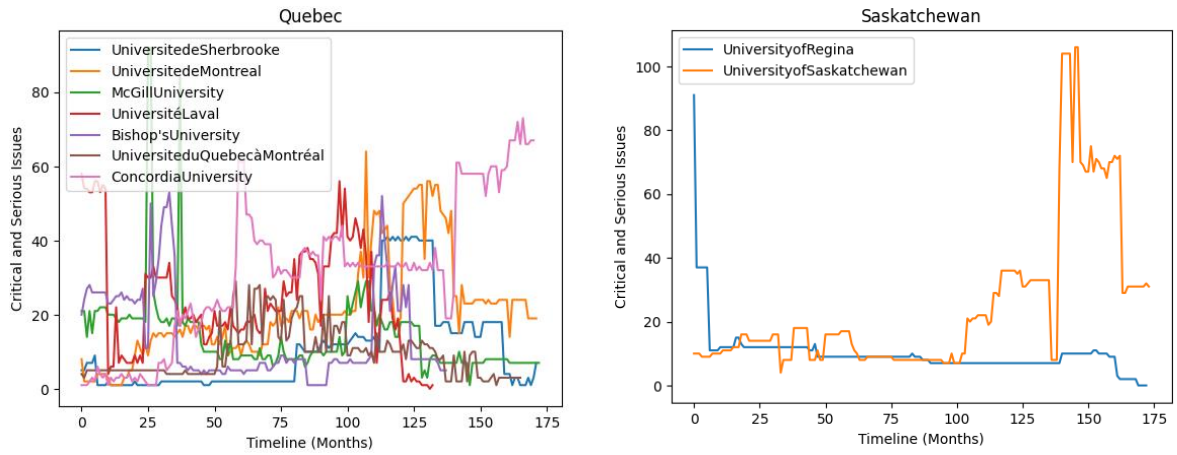


Figure 4, University performance by province from 2008 to 2022, critical and serious issues.

The visualization from Figure 4 utilized critical and serious accessibility issues as a way to show the true inaccessibility for PwD interacting with the web of each University broken down by province. These results can be read in a variety of ways.

In general, each province's average, critical and serious web accessibility issues fluctuate quite significantly. Three provinces do not excede 40 total critical and serious web accessibility issues, which can be seen as the standard quantity of errors. On the other hand there are outliers with 18 critical and serious web accessibility issues and 500 serious and critical web accessibility issues. In British Columbia's graph there is cleary a high variance due to the outlier, Royal Roads University. The remaining graphs are relatively similar, each University relatively similar, with different spikes and drops that do not appear to follow a pattern. When looking into whether these drops are related to layout changes, I found interesting trends that are represented well for two universities in Figure 5 below.

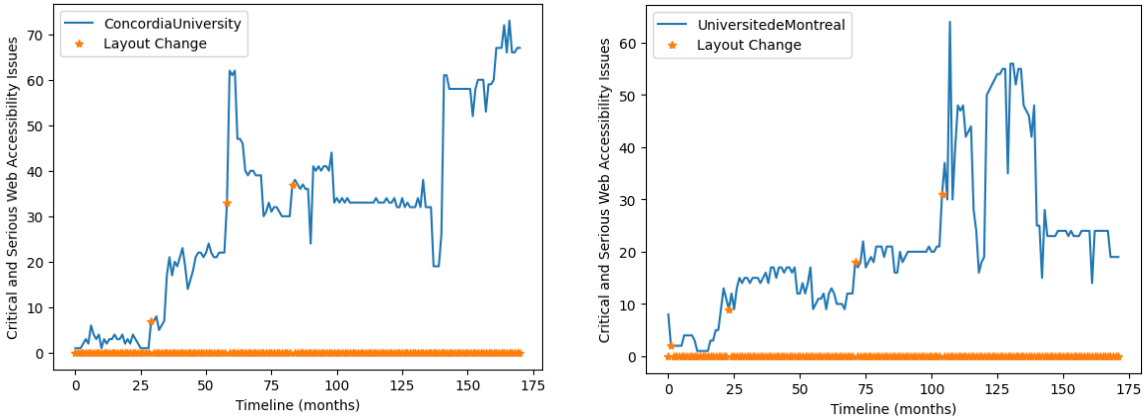


Figure 5, Trends from layout changes at two universities.

As seen in Figure 5, the star indicates when a layout change occurred. From these two visualizations it show a trend that Universities' web accessibility issues increase after a visual layout. To explore this futher I used another strategy to look into visual changes and web accessibility.

To further investigate layout changes I look at web accessibility over time. I looked at the mean total issues recorded for the first 5 years of data collected, from 2008 to 2012, and compared it to the middle 5 years, from 2013 to 2017, and last 5 years, from 2018 to 2022 as seen in Figure 6.

Time Period	Average Total Issues
2008-2012	37.876
2013-2017	39.801
2018-2022	37.996

Figure 6, Average total web accessibility issues over time.

Figure 6 shows that accessibility has changed minimally from the first 5 years of data collection to the last 5 years of data collection by 0.1. What is interesting, however, is that in accessibility issues increased the middle time period. This can indicate that between 2013 and 2017 accessibility issues increased but eventually tapered off back to the 'normal' range. Since I am intersted in investigating the impact of visual advancements through layout changes I took it a step further to see when layout changes occurred within the observation time period.

Figure 7's table shows the number of layout changes by year and the layout changes falling within three time periods. From Figure 7 it is clear that the largest number of visual layout changes occurred in the middle time period, from 2013 to 2017, followed by the first time period from 2008 to 2012, and then the last time period from 2018 to 2022.

Year	Number of Layout Changes	Total Layout Changes in Time Periods
2008	7	55
2009	14	
2010	14	
2011	11	
2012	9	
2013	15	67
2014	6	
2015	13	
2016	12	
2017	12	
2018	9	37
2019	6	
2020	6	
2021	7	
2022	9	
Total Layout Changes	150	150

Figure 7, Layout changes by year.

From the findings done in each time period it is clear that most layout changes happened in the middle time period. From this it can be inferred that during times of digital visual advancements, accessibility is worsening. Since there is significantly no change in the first 5 years compared to the last 5 this shows that as time has gone on and technology has evolved, the web has not changed much on average.

I hypothesized that with websites' visual development increasing there would be a decrease in web accessibility. I specifically investigated whether web visual upgrades caused a decrease in web accessibility.

My second hypothesis was that legislation would fail to result in improving web accessibility, I used multiple strategies to investigate this hypothesis. In Figure 8, I took the

average total issues score for every University between visual layout changes, then I found the difference from before and after a web visual upgrade and then averaged the total differences. If the total issue average is positive that would mean that accessibility issues increased and would cause the web to be less accessible and vice versa, if there was a negative average that would mean accessibility issues decreased which would cause the web to become more accessible.

Average Total Accessibility Issues Change After Visual Layout Change

Province	Province Average	Canadian Average
Alberta	3.41	2.57
British Columbia	-13.69	
Manitoba	7.83	
New Brunswick	1.53	
Newfoundland and Labrador	6.22	
Nova Scotia	-0.14	
Ontario	-0.75	
Prince Edward Island	4.63	
Quebec	2.08	
Saskatchewan	14.60	

Figure 8, Average total accessibility issues change after visual layout change.

Figure 8 shows that in Canada the total accessibility issues increased by two when a layout change occurred. There was a decrease in total issues for some provinces that have their own provincial accessibility legislation: Ontario, British Columbia, and Nova Scotia meaning that after a web visual upgrade their websites were more accessible. An exception to this is Manitoba which underwent an Accessibility Policy change in 2022 and will require organizations to adhere to WCAG 2.1 AA by 2024. This demonstrates that provinces that have their own accessibility policy are more accessible than those which do not. Provincial legslation is most effective for this research setting since Canadian Universities primarily follow their province's regulations.

Next, I investigated if there was a difference in web accessibility before and after legislation implementaton. To investigate this, I looked specifically at Ontario, since they are the only province that had a January 2010 deadline to compliance with accessibility requirements in the observation period. I looked at two years before compliance was set, January 2008, and two years after compliance was set, January 2012.

I calculated the average change in critical and serious web accessibility issues for the treatment group (Ontario) from the 2 year pre-period (2008 - 2009) to the 2 year post-period (2011 – 2012). Then I calculated the average change in critical and serious web accessibility issues for the control group (other provinces) over the same period. Finally, I subtracted the control group's average change from the treatment group's average change to obtain the difference-in-differences (DID) estimate. This estimate represents the causal effect of the Ontario deadline to compliance on critical and serious web accessibility issues.

	Control Group	Treatment Group	DID
	Ontario	All other provinces	
2 years before deadline to compliance (Jan 2008 - Dec 2009)	10	15	-5
2 years after deadline to compliance (Jan 2010 - Dec 2011)	11	17	-6

Figure 9, The difference in web accessibility before and after a deadline to compliance.

From Figure 9 it is clear that Ontario is performing better than the other provinces combined when it comes to critical and serious web accessibility issues. Looking at the impact of the deadline to comply, set as January 2010, it is clear that the web, on average, has not become more accessible. Although Ontario does have more accessiible websites, the difference between before and after the deadline to comply is different by one, showing that Ontario's deadline for compliance did not result in a decrease in web accessibility. These findings show that as time progresses, regardless of legislation and the enforcment to comply with it, the web is still becoming less accessible within a two year time period. To conduct this finding I averaged the critical and serious web accessibility issues before the deadline to

complaince (January 2008 to December 2009) and did the same thing for after the deadline to complaince (January 2010 to Decemeber 2011), more specifc visualization can be seen in Figure 10 in the Appendix.

Interestingly, from this anaysis, all the Universities in the control group (Ontario), except for two, had an increase in the amount of critical and serious issues after the deadline for compliance. This was similar for other provinces, and was even intensified in some universities. On average, for other province's 50% of universities had an increase in critical and serious web accessibility issues, 33% had a decrease in web accessibility issues, and 17% stayed the same. These findings show that in the two year observation period the web became less accessible. However, they also reveal that in the control group (Ontario) where there was a deadline for compliance, there was a less drastic increase in critical and serious web accessibility issues, indicating that the deadline for complaince has a positive impact in making the web more accesible. I can now infer that, although legislation changes do not erase accessibility issues, they do result in decreasing the number of web accessibility issues, although not significanlty. This addressed my second research objective to explore how legislation impacts web accessibility.

In order to generate a more detailed analysis on what is happening, the fixed effects regression analysis in Figure 11 and 12 explains the trends in my earlier visualizations and tables.

University Fixed Effects

	Model 1 Total Issues	Model 2 Critical	Model 3 Serious	Model 4 Critical + Serious	Model 5 Moderate	Model 6 Minor
Layout Changed	2.456	0.781	3.765*	4.546*	-1.369+	-0.509
	(2.09)	(0.52)	(1.56)	(1.90)	(0.81)	(0.47)
1st Layout Event	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)
2nd Layout Event	-8.768***	-4.844***	-5.687***	-10.53***	0.474	1.004***
	(1.23)	(0.31)	(0.92)	(1.12)	(0.48)	(0.28)

3rd Layout Event	-5.155**	-5.304***	-5.240***	-10.54***	0.978	4.167***
	(1.68)	(0.42)	(1.26)	(1.53)	(0.65)	(0.38)
4th Layout Event	-11.34***	-7.392***	-7.809***	-15.20***	0.522	3.039***
	(2.13)	(0.53)	(1.59)	(1.94)	(0.83)	(0.48)
5th Layout Event	-28.83***	-10.41***	-22.55***	-32.96***	0.354	3.528***
	(2.78)	(0.69)	(2.08)	(2.53)	(1.08)	(0.62)
6th Layout Event	94.81***	8.931***	64.40***	73.33***	17.19***	3.978***
	(4.14)	(1.03)	(3.09)	(3.76)	(1.61)	(0.93)
7th Layout Event	-29.74***	-10.54***	-27.61***	-38.15***	4.306	3.724*
	(8.27)	(2.06)	(6.17)	(7.52)	(3.21)	(1.85)
Deadline for Compliance (Ontario)	-0.424	1.189+	-7.758***	-6.569**	-0.964	7.018***
	(2.61)	(0.65)	(1.94)	(2.37)	(1.01)	(0.58)
Provincial Policy Introduced	-15.09***	-0.473	-11.79***	-12.27***	-1.203	-1.563***
	(1.93)	(0.48)	(1.44)	(1.75)	(0.75)	(0.43)
Constant	34.17***	6.083***	6.758***	12.84***	19.83***	1.435***
	(1.77)	(0.44)	(1.32)	(1.61)	(0.69)"	(0.40)
R-sq	0.193	0.121	0.187	0.184	0.129	0.069
N	7379	7379	7379	7379	7379	7379

Standard errors in parentheses

p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Figure 11, University fixed effects.

Figure 11 shows a fixed effect regression looking into the Universities. The results above show the estimated coefficients and corresponding standard errors for each of the independent variables in the regression model. I controlled for years and month effect, I found year effects which can be seen in a Figure 11 table in the Appendix. The coefficients are indicating the direction and magnitude of the relationships between the independent

variables and the dependent variables. Model 4 (Critical + Serious) combines critical and serious issues, as these are the categories that inhibit PwD from accessing a website.

In this table, in Model 3 (Total Issues), the coefficient for "Layout Changed" is 2.456, indicating that a layout change is associated with an immediate increase in total issues by 2.456. The coefficient for "2nd Layout Event" is -8.768, this suggests that the second layout event is associated with a decrease in total issues by approximately 8.768. In this table we can see that when a layout change occurs there is an increase in accessibility issues. Interestingly, when a layout change occurs it bumps up accessibility errors, but over time, we can see that accessibility errors are decreasing through the layout events, except for in the 6th layout event. The fact that subsequent layout changes have lower scores is some indication that even though the layout change itself increases the web accessibility issues, the average web accessibility issues seem to decrease following the initial change. Also, not all Universities have 5th , 6th or 7th layout change events which can skew some of the later events. This could explain the increase of accessibility errors over time for the 6th layout event.

The policy deadline has lower serious issues yet higher critical issues, although not significantly. This decline is lower compared to provinces that did not have policy introductions, indicating that policy introduction influences web accessibility, overall making the web more accessible.

Layout Fixed Effects

	Model 1 Total Issues	Model 2 Critical	Model 3 Serious	Model 4 Critical + Serious	Model 5 Moderate	Model 6 Minor
Layout Changed	0.896	0.332	2.190***	2.522***	-1.039*	-0.360
	(0.95)	(0.27)	(0.60)	(0.71)	(0.47)	(0.22)
Deadline for Compliance (Ontario)	-4.130**	-1.404**	-6.397***	-7.801***	3.262***	-0.203
	(1.55)	(0.43)	(0.98)	(1.16)	(0.76)	(0.36)
Provincial Policy Introduced	-7.433***	-2.665***	-4.118***	-6.783***	-0.448	-0.177
	(1.89)	(0.53)	(1.19)	(1.42)	(0.93)	(0.44)

Constant	28.50***	1.050***	2.928***	3.978***	21.46***	2.494***
	(1.13)	(0.32)	(0.71)	(0.85)	(0.56)	(0.26)
R-sq	0.054	0.048	0.086	0.088	0.046	0.021
N	7379	7379	7379	7379	7379	7379

Standard errors in parentheses

p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Figure 12, Layout fixed effects.

Figure 12's table is showing the impact of layout changes through a fixed effects regression. The fixed effects approach controls for unobserved heterogeneity across universities by including dummy variables for each university layout. By including these fixed effects, the analysis accounts for any systematic differences in web accessibility across different university layouts. The coefficient, 0.896, suggests that a change in the web layout is associated with an increase in total web accessibility issues. This analysis allowed for a deeper understanding of web accessibility that was able to address my first research objective to assess the effects that visual website changes had on web accessibility.

My findings offer some interesting theoretical contributions into the inequalities that come from digitalization. Building upon existing research from Hackett, S., et al, 2005, I looked at the effect of digitalization on web accessibility. This paper adds new findings from researching new visual and political advancements. I have found that when visual advancement occurs, web accessibility worsens. However, after each visual advancement, regardless of the initial web accessibility decrease, over time web accessibility improves. When looking into legislation, I found that there was an impact on web accessibility from legislation when there was a deadline to compliance set in Ontario, proving that legislation does influence web accessibility although not significantly.

This research builds upon existing web accessibility findings to support the general finding that the web is not accessible. Of all the 49 Universities tested, every one of them had issues from 2008 to 2022, regardless of global, federal, and provincial legislation. These research findings provide additional new empirical knowledge regarding web accessibility at Canadian Universities; web accessibility is still not up to par with legislation on any level.

In the next two sections, discussion & conclusion, I will wrap up this paper and completely finish the story. I will touch on theoretical contributions, limitations and future directions, and practical implications surrounding this research and conclude on my findings.

6. Discussion

The purpose of this research was to understand how digitalization affects web accessibility. Throughout this paper I have worked towards framing, structuring, and analyzing information to answer my research question 'How does digitalization affect web accessibility for people with disabilities?'. I did find evidence that digitalization is affecting web accessibility that proves my first hypothesis; with the advancements of digitalization web accessibility worsens. Next, I will discuss the theoretical contributions, limitations and future directions, and practical implications surrounding this research.

6.1 Theoretical Contributions

My findings during this research offer important contributions to the field of digitalization, digital outsidership, and web accessibility. Firstly, I found that digitalization is negatively impacting web accessibility. In regard to the specific interaction between digitalization and web accessibility, which builds upon the dated research from Hackett 2005, I found that the immediate effects of visual changes, which is a sign of digitalization, is creating more web accessibility issues, thus proving my first hypothesis. However, adding onto the same findings as Hackett 2005, I discovered that web accessibly overall is improving.

Secondly, this research adds to the increasing amount of research done on web accessibility in educational settings. The previous literature relating to lacking web accessibility in educational institutions globally (Kesswani 2016; Bradbard 2010; Harper 2008; Ringlaben 2013; Roig-Vila 2014; Verkijika 2018; Máñez-Carvajal 2019; Kurt 2010) is re-affirmed with my findings at Canadian Universities. Inaccessible websites at Canadian Universities provides new empirical knowledge within this region, that is in line with global findings.

Thirdly, this study contributes to the addition of web accessibility to the concept of digital outsidership, with the lens of web accessibility issues inhibiting PwD from accessing websites at all and/or to their full potential. As with the development of digitalization, as earlier compared to Kravchenko's 2019 research on the digital economy, the advancement of digitalization does not immediately result in the barrier free access to the web for PwD.

However, as Kravchenko's 2019 research suggests, over time there is a minimization to the number of web accessibility issues, which is in line with Kravchenko's 2019 findings on the digital economy, further demonstrating the transferability of these findings into different aspects of digitalization.

The findings uncovered that digitalization is negatively impacting web accessibility in Canadian universities, which is transferable to other organizations due to the generalizability of this research setting. Since all organizations in each province must follow their respective provincial legislation, it is fair to assume that similar results could be found in other industries. Many countries have a similar trajectory as Canada when it comes to accessibility. Due to the awareness that WCAG provides, many countries have mandated that government websites comply with WCAG guidelines. Canada started the introduction of compliance in the same manner, through the mandates on government organization and subsidiaries. Moving down a level and later in time is when provincial law has come into force, and is continuously coming into force, regarding web accessibility. It could signal a similar pattern for other countries and for that reason the findings here can be transferred not only to other organizations within Canada, on the provincial and federal level, but it also extends to the global level for other countries following the same trend as Canada.

6.2 Limitations and Future Direction

My research is not without limitation, which may be investigated through additional research. Firstly, the research setting is set specifically in Canada; if the research setting was expanded to a global setting of Universities it would be more generalisable. In this case, of course, each country's legislation would need to be taken into account. Increasing the sample size to include universities from around the world would make these findings more applicable on an international scale, further adding to the generalisability. Therefore, I suggest that future research considers expanding the research setting to further explore web accessibility and allow for a broader solidified application.

A second limitation is that the variable for visual layout change is documented through interpretation. Although I explained the rationale behind what a layout change is, having a more standardised and easily replicable way to distinguish a layout change would enhance

the replicability of this study. For that reason, I would suggest that future research explores a standardisation process for the visual component of digitalization to ensure transparency in findings and allow for a replicable dataset.

Thirdly, I used a web accessibility evaluation tool that may not capture the entire extent of web accessibility issues. As outlined in Vigo 2013, the best option, when evaluating web accessibility, is through an expert, therefore, my recommendation for future research is to include a web accessibility expert in the data collection process to ensure the results are an accurate reflection of web accessibility.

Fourthly, by using a web accessibility evaluation tool that is testing compliance to WCAG, I forgo the true web experience that a PwD might encounter when using inaccessible websites. Similar to my third limitation of not including a web accessibility expert, this research has a lack of perspective that only someone with a disability could have brought to this study. This lack of interpretation from a PwD means I had to rely on the WCAG guidelines as a representation of the experience element that a PwD may encounter. The inclusion aspect was present in Vollenwyder's 2023 research, demonstrating the possibility of including PwD in researching things that directly impact them. The consideration and perspective that a PwD could bring to this research would be invaluable in understanding digitalization. Gaining the perspective that only a PwD could provide would help inform this research in exploring if websites from the past, that focused primarily on HTML, CSS, and Java, provide a different and/or more valuable experience than the websites of today. And again, similar to my third limitation, I would recommend future research in the field of web accessibility include the true experience that PwD have when using website. However, it is important to note that the inclusion of "lived experiences" from PwD in this study would change the nature of the research to include a more qualitative approach.

Lastly, as mentioned previously when considering endogeneity in this research, the unaccounted and unobserved variables in this research are another limitation. As seen from my analysis and results, web accessibility over time is improving. Due to the focal point of my study not focusing on the reason behind web accessibility improving over time I did not investigate what could be causing the advancements. The driving factors impacting web accessibility have been alluded to in previous literature as webmasters (Lazar 2004), legislation (Abuaddous 2016), awareness (Tamtik 2020), digitalization (Hackett 2005), and

specifically visual elements (Harper 2008). Yet, due to the numerous varying factors at play there is no definitive force that has been identified to be making a large significant positive impact on web accessibility. I suggest that future research continue to explore the driving factors improving web accessibility.

6.3 Practical Implications

This research exposes the realities of inaccessibility of the web at Canadian universities. Within specific provinces this should not come as a surprise due the web accessibility reporting that takes place. Within Ontario, after the deadline to compliance, annual web accessibility reports are required from universities which indicates the awareness present within Ontario Universities specifically. However, for other provinces without accessibility legislation, this may be a wake-up call to the extent that the web is inaccessible. It is without a doubt that these findings on the inequalities of digitalization have crucial practical implications regarding web accessibility for Canadian Universities. Digitalization is affecting web accessibility, and for those organizations not prioritizing web accessibility, specifically Canadian Universities, this research provides the knowledge of where web accessibility is heading. Excluding a valuable part of society will likely not be acceptable for much longer, as legislation advances and accessibility becomes a priority, it is advantageous to be proactive instead of reactive when responding to web accessibility.

This study examines digitalization and creates knowledge on the implication of digitalization on web accessibility. As discussed earlier, awareness is growing around accessibility, and specifically web accessibility, yet the realities of web accessibility, as it relates to digitalization, appear as an afterthought, due to the immediate inaccessibility of the web and later improvement. Understanding that the web becomes less accessible immediately after an update occurs, the research from Lazar 2004 highlights the important role that webmasters play in web accessibility. Bringing this information to Canadian webmasters would help them understand the immediate impacts that visual layout changes have on web accessibility, thus, enhancing awareness and accountability for future visual advancements as digitalization progresses.

The element of legislation in this study provides insight into the effectiveness of a deadline for compliance. As seen in the analysis and results section, legislation is not resulting in proactive nor reactive actions to combat inaccessibility of the web through implementing WCAG standards. Non-compliance to WCAG can result in monetary fines, so to avoid this possibility it is advisable to follow government regulations to comply with web accessibility standards.

7. Conclusion

This research covered a simple story about how captivated most of society is with digitalization, focussing on those who are left out. My research on digitalization and web accessibility utilizes past literature and relevant methodology that informed this study. Through my research and analyses I was able to execute my research aim to evaluate the impact of digitalization on web accessibility.

My first research objective to assess the effects that visual website changes had on web accessibility turned out to somewhat prove my hypothesis. My original hypothesis was that:

Hypothesis 1: Web accessibility will decline as a result of visual advancements.

I found that as the web visually advances, web accessibility issues initially increase showing the negative impact that digitalization has on web accessibility. This results in less accessible websites, proving my first hypothesis. However, in the long term, after a visual advancement, there is a clear decrease in web accessibility issues; the web is becoming overall more accessible. In this research I identified one factor which is negatively impacting web accessibility, visual advancements of the web brought on by digitalization. This finding builds upon existing literature to provide a relevant study on the impact of digitalization on web accessibility in the 21st century. Additional research on this topic found that there is a predicted time at which the web becomes completely compliant, although it is set to be 20 years in the future, as seen in Figure 15 and 16 in the Appendix. Although this research is not comprehensive on all the impacting factors on web accessibility it does shed light on the realities and where we are headed.

My second research objective was to explore how legislation impacts web accessibility, which was aimed at addressing my second hypothesis.

Hypothesis 2: Legislation will fail to result in improving web accessibility.

I found that legislation does fail to create more accessible websites, proving my second hypothesis. Due to the multitude of variables impacting web accessibility, I chose to look at

legislation through deadlines to compliance. It is not possible to confirm that the presence of legislation directly results in more accessible website due to unobserved variables. However, when looking into the deadline for compliance, I found that it does not result in more accessibility on the web. This finding suggests that legislation does fail to improve web accessibility, supporting my hypothesis.

It is important to note that the provinces with provincial legislation, on average, had better accessibility during times of digitalization, as seen in Figure 8. However, this could be due to a number of unobserved factors, and it is not possible to confirm provincial legislation was the cause of this improved web accessibility.

This research and the findings derived from it outline the inaccessibility of the web as an immediate and direct result of digitalization within Canadian Universities. Despite the initial decrease in accessibility of the web during periods of digitalization, over time web accessibility is improving as a whole, as seen through the fixed effects regressions.

To further explore this topic, beyond my own findings, it is important to continue to investigate web accessibility as it relates to digitalization. With this research I hope to have contributed to the knowledge on accessibility through my exploration on digital outsidership through the lens of digitalization and web accessibility.

The reality of the web not being accessible is setting everyone back. Web accessibility does not take away from usability, rather it opens opportunities for interactions whether individuals are experiencing an occasional, temporary, or permanent disability. As stated earlier, everyone at some point in their life will experience disability as found by the WHO. How well we prioritize web accessibility now will impact our own web interactions in the future as supported in Neckerman's findings that technologies are continually reinvented by their users (2004). It is reassuring to uncover that over time the web has become more accessible, but the journey is not over, and as a society we need to continuously strive for equality, to create an open and inclusive place for all members of society to interact and strive within. If equality is not reason enough to take a stance on the priority of web accessibility through digitalization, the realization that everyone will likely benefit from web accessibility, and the negative consequences to not comply with web accessibility standards should drive home the severity and necessity of web accessibility.

8. Appendix

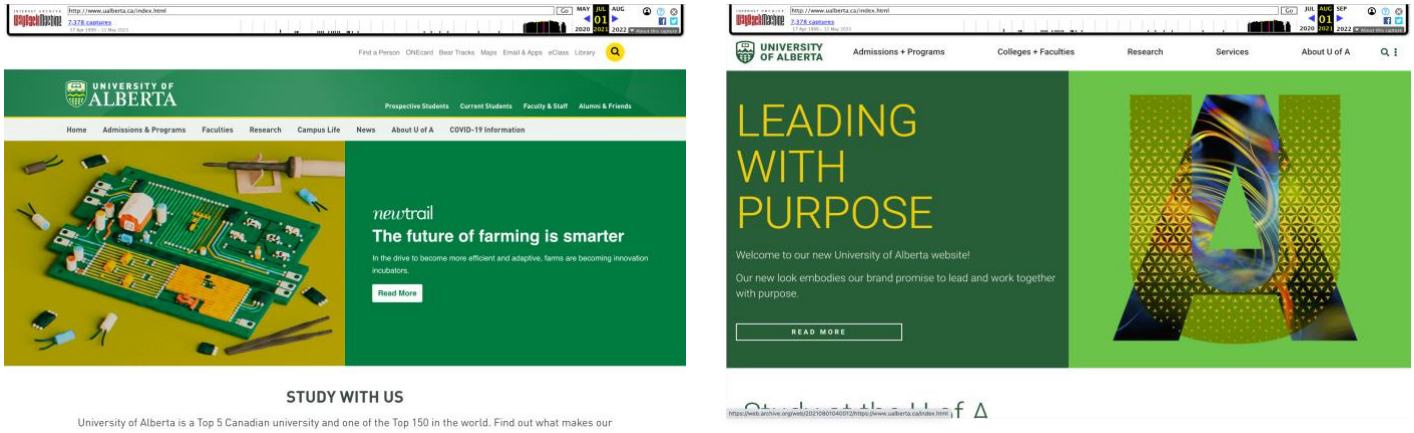


Figure 1, Example of visual layout change at the University of Alberta.

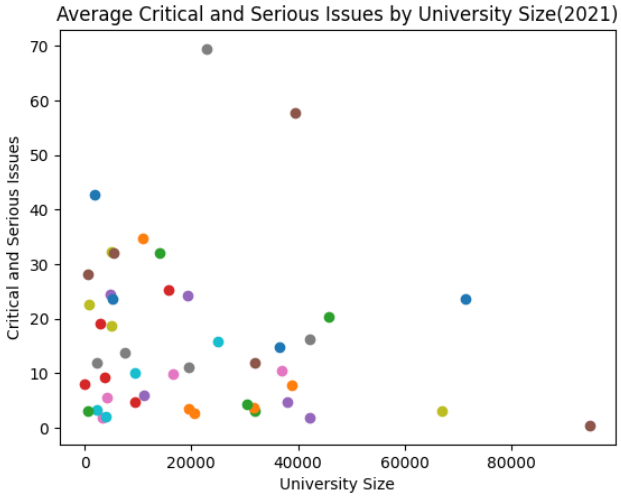


Figure 2, Average critical and serious issues by university size 2021.

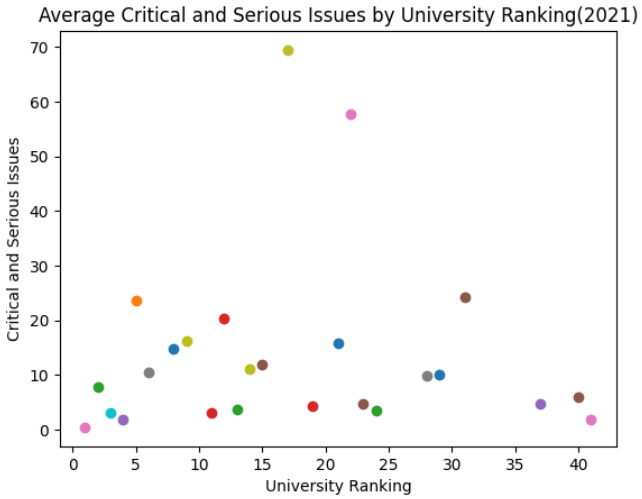
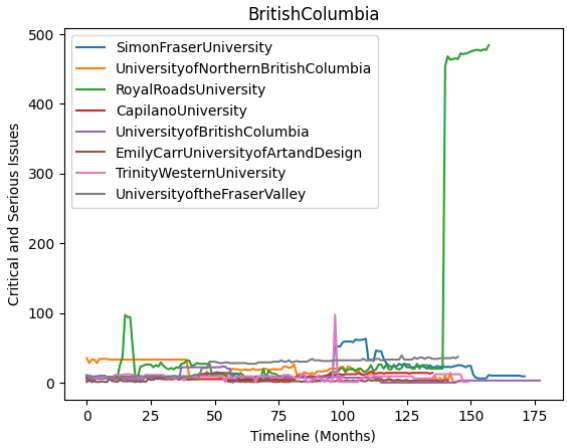
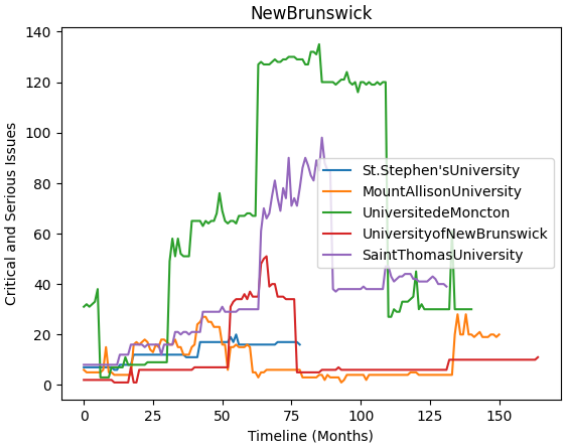
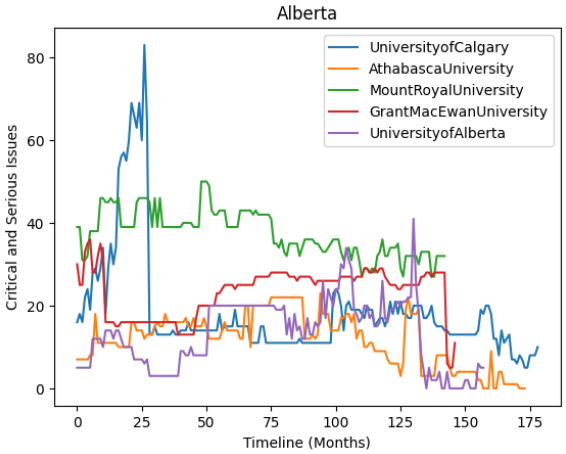
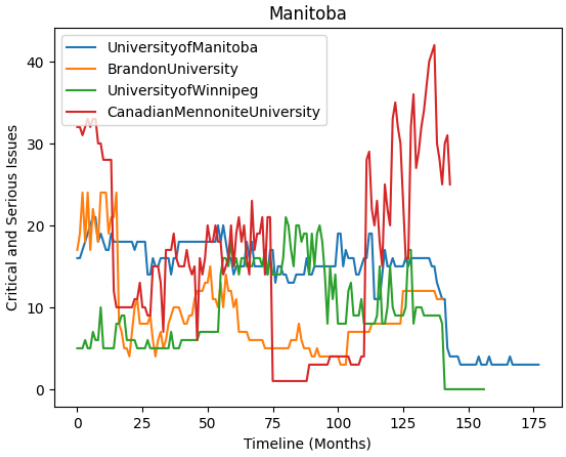


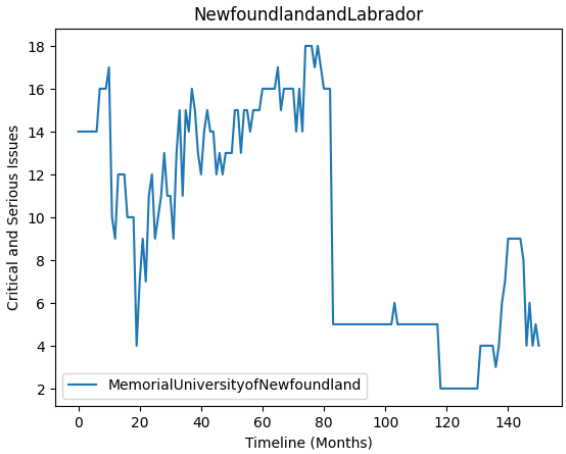
Figure 3, Average critical and serious issues by university ranking 2021.

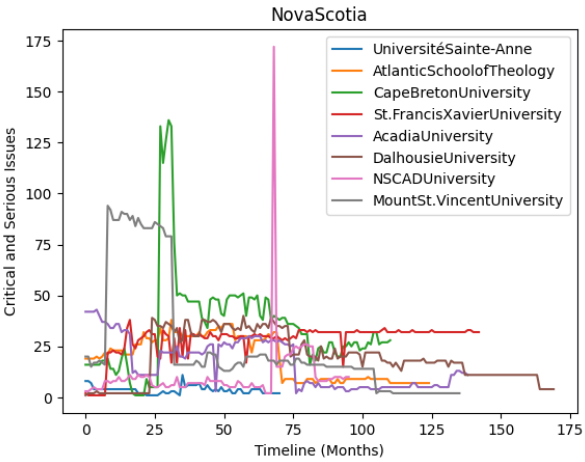

BritishColumbia
SimonFraserUniversity
UniversityofNorthernBritishColumbia
RoyalRoadsUniversity
CapilanoUniversity
UniversityofBritishColumbia
EmilyCarrUniversityofArtandDesign
TrinityWesternUniversity
UniversityoftheFraserValley
Critical and Serious Issues
Timeline (Months)

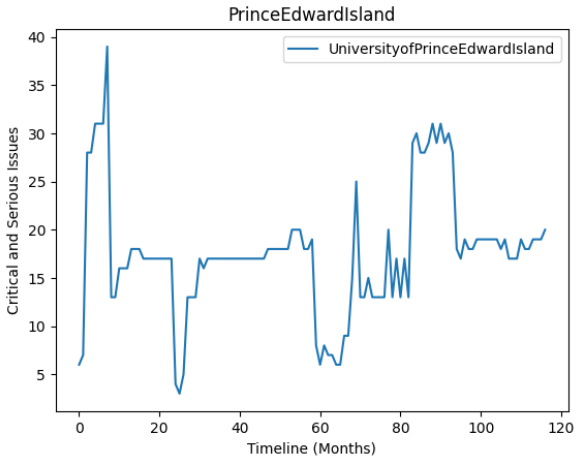

NewBrunswick
St.Stephen'sUniversity
MountAllisonUniversity
UniversitedeMoncton
UniversityofNewBrunswick
SaintThomasUniversity
Critical and Serious Issues
Timeline (Months)

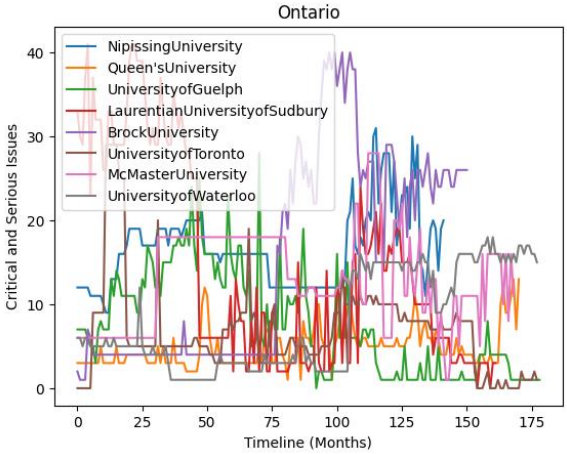

Alberta
UniversityofCalgary
AthabascaUniversity
MountRoyalUniversity
GrantMacEwanUniversity
UniversityofAlberta
Critical and Serious Issues
Timeline (Months)


Manitoba
UniversityofManitoba
BrandonUniversity
UniversityofWinnipeg
CanadianMennoniteUniversity
Critical and Serious Issues
Timeline (Months)


NewfoundlandandLabrador
MemorialUniversityofNewfoundland
Critical and Serious Issues
Timeline (Months)


NovaScotia
UniversitéSainte-Anne
AtlanticSchoolofTheology
CapeBretonUniversity
St.FrancisXavierUniversity
AcadiaUniversity
DalhousieUniversity
NSCADUniversity
MountSt.VincentUniversity
Critical and Serious Issues
Timeline (Months)


PrinceEdwardIsland
UniversityofPrinceEdwardIsland
Critical and Serious Issues
Timeline (Months)


Ontario
NipissingUniversity
Queen'sUniversity
UniversityofGuelph
LaurentianUniversityofSudbury
BrockUniversity
UniversityofToronto
McMasterUniversity
UniversityofWaterloo
Critical and Serious Issues
Timeline (Months)

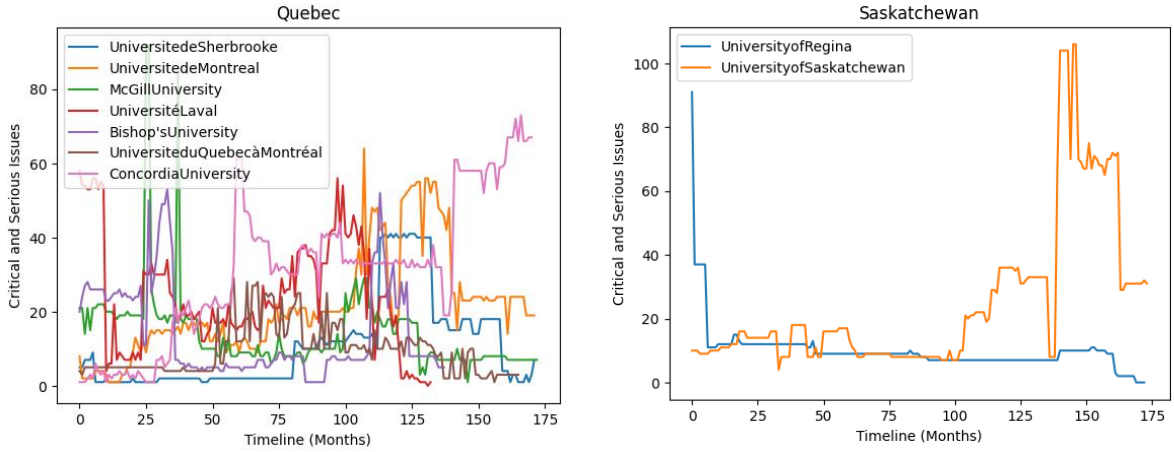


Figure 4, University performance by province from 2008 to 2022, critical and serious issues.

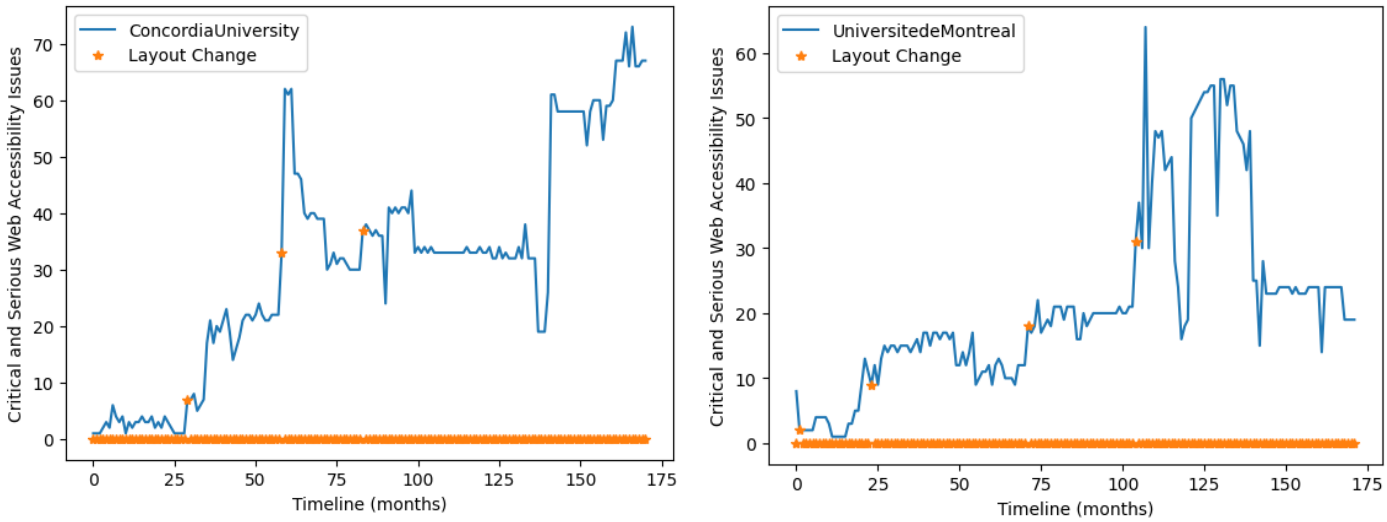


Figure 5, Trends from layout changes at two universities.

Time Period	Average Total Issues
2008-2012	37.876
2013-2017	39.801
2018-2022	37.996

Figure 6, Average total web accessibility issues over time.

Year	Number of Layout Changes	Total Layout Changes by Periods
2008	7	55
2009	14	
2010	14	
2011	11	
2012	9	
2013	15	67
2014	6	
2015	13	
2016	12	
2017	12	
2018	9	37
2019	6	
2020	6	
2021	7	
2022	9	
Total Layout Changes	150	150

Figure 7, Layout changes by year.

Average Total Accessibility Issues Change After Visual Layout Change

Province	Province Average	Canadian Average
Alberta	3.41	2.57
British Columbia	-13.69	
Manitoba	7.83	
New Brunswick	1.53	
Newfoundland and Labrador	6.22	
Nova Scotia	-0.14	
Ontario	-0.75	
Prince Edward Island	4.63	
Quebec	2.08	
Saskatchewan	14.60	

Figure 8, Average total accessibility issues change after visual layout change.

	Control Group	Treatment Group	DID
	Ontario	All other provinces	
2 years before deadline to compliance (Jan 2008 - Dec 2009)	10	15	-5
2 years after deadline to compliance (Jan 2010 - Dec 2011)	11	17	-6

Figure 9, The difference in web accessibility before and after a deadline to compliance.

Ontario								
	University 1	University 2	University 3	University 4	University 5	University 6	University 7	University 8
2 years before deadline	11.4	3.2	8.7	31.2	3.0	12.8	6.0	5.3
2 years after deadline	16.1	3.8	15.2	33.6	4.0	5.7	9.8	3.3

Alberta					
	University 1	University 2	University 3	University 4	University 5
2 years before deadline	35.8	9.9	39.0	30.3	6.0
2 years after deadline	25.0	14.9	37.7	21.5	10.9

British Columbia								
	University 1	University 2	University 3	University 4	University 5	University 6	University 7	University 8
2 years before deadline	6.5	32.7	24.9	N/A	4.9	N/A	8.9	10.0
2 years after deadline	8.4	33.0	24.7	8.0	12.0	2.0	10.1	8.7

Manitoba				
	University 1	University 2	University 3	University 4
2 years before deadline	18.1	21.0	5.8	30.7
2 years after deadline	16.6	7.1	6.2	11.1

New Brunswick					
	University 1	University 2	University 3	University 4	University 5
2 years before deadline	7.0	5.4	15.1	1.7	8.0
2 years after deadline	7.4	14.7	14.6	5.2	14.6

Newfoundland and Labrador	
	University 1
2 years before deadline	13.7
2 years after deadline	9.7

Nova Scotia								
	University 1	University 2	University 3	University 4	University 5	University 6	University 7	University 8
2 years before deadline	N/A	20.8	16.5	1.1	35.7	2.0	3.0	26.0
2 years after deadline	N/A	25.2	16.3	26.9	16.4	30.6	5.0	87.1

Quebec							
	University 1	University 2	University 3	University 4	University 5	University 6	University 7
2 years before deadline	2.8	2.7	19.7	39.4	25.0	4.7	2.7
2 years after deadline	1.6	13.0	28.1	20.2	30.2	4.9	6.5

Prince Edward Island	
	University 1
2 years before deadline	17.3
2 years after deadline	21.0

Saskatchewan		
	University 1	University 2
2 years before deadline	22.4	10.3
2 years after deadline	12.0	13.8

Figure 10, Legislation impact by university and provience.

	University Fixed Effects					
	Model 1 Total Issues	Model 2 Critical	Model 3 Serious	Model 4 Critical + Serious	Model 5 Moderate	Model 6 Minor
Layout Changed	2.456	0.781	3.765*	4.546*	-1.369+	-0.509
	(2.09)	(0.52)	(1.56)	(1.90)	(0.81)	(0.47)
1st Layout Event	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)
2nd Layout Event	-8.768***	-4.844***	-5.687***	-10.53***	0.474	1.004***
	(1.23)	(0.31)	(0.92)	(1.12)	(0.48)	(0.28)
3rd Layout Event	-5.155**	-5.304***	-5.240***	-10.54***	0.978	4.167***
	(1.68)	(0.42)	(1.26)	(1.53)	(0.65)	(0.38)
4th Layout Event	-11.34***	-7.392***	-7.809***	-15.20***	0.522	3.039***
	(2.13)	(0.53)	(1.59)	(1.94)	(0.83)	(0.48)
5th Layout Event	-28.83***	-10.41***	-22.55***	-32.96***	0.354	3.528***
	(2.78)	(0.69)	(2.08)	(2.53)	(1.08)	(0.62)
6th Layout Event	94.81***	8.931***	64.40***	73.33***	17.19***	3.978***
	(4.14)	(1.03)	(3.09)	(3.76)	(1.61)	(0.93)
7th Layout Event	-29.74***	-10.54***	-27.61***	-38.15***	4.306	3.724*
	(8.27)	(2.06)	(6.17)	(7.52)	(3.21)	(1.85)
Deadline for Compliance (Ontario)	-0.424	1.189+	-7.758***	-6.569**	-0.964	7.018***
	(2.61)	(0.65)	(1.94)	(2.37)	(1.01)	(0.58)
Provincial Policy Introduced	-15.09***	-0.473	-11.79***	-12.27***	-1.203	-1.563***
	(1.93)	(0.48)	(1.44)	(1.75)	(0.75)	(0.43)
January	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)
February	0.353	0.117	0.344	0.461	0.0399	-0.139

	(1.43)	(0.36)	(1.07)	(1.30)	(0.56)	(0.32)
March	0.912	0.131	0.957	1.087	0.0189	-0.190
	(1.44)	(0.36)	(1.08)	(1.31)	(0.56)	(0.32)
April	0.641	0.129	0.834	0.963	-0.152	-0.170
	(1.43)	(0.36)	(1.07)	(1.30)	(0.56)	(0.32)
May	0.783	0.241	1.028	1.268	-0.266	-0.211
	(1.44)	(0.36)	(1.07)	(1.31)	(0.56)	(0.32)
June	0.381	0.157	0.991	1.148	-0.450	-0.341
	(1.44)	(0.36)	(1.08)	(1.31)	(0.56)	(0.32)
July	0.291	0.273	1.211	1.484	-0.674	-0.366
	(1.45)	(0.36)	(1.08)	(1.32)	(0.56)	(0.32)
August	0.405	0.323	1.350	1.674	-0.679	-0.271
	(1.45)	(0.36)	(1.08)	(1.32)	(0.56)	(0.33)
September	1.119	0.378	1.447	1.825	-0.590	-0.136
	(1.45)	(0.36)	(1.08)	(1.32)	(0.56)	(0.32)
October	1.393	0.426	1.503	1.929	-0.460	-0.0431
	(1.44)	(0.36)	(1.07)	(1.31)	(0.56)	(0.32)
November	1.349	0.360	1.623	1.983	-0.626	-0.00829
	(1.45)	(0.36)	(1.08)	(1.32)	(0.56)	(0.33)
December	0.463	0.405	1.313	1.718	-1.074+	-0.136
	(1.44)	(0.36)	(1.08)	(1.31)	(0.56)	(0.32)
Year 2008	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)
Year 2009	2.173	-0.252	1.969	1.717	0.430	0.0979
	(1.94)	(0.48)	(1.45)	(1.76)	(0.75)	(0.44)
Year 2010	2.554	0.698	4.642**	5.340**	-0.648	-1.630***
	(2.05)	(0.51)	(1.53)	(1.87)	(0.80)	(0.46)
Year 2011	11.95***	1.749***	9.158***	10.91***	3.181***	-1.792***

	(2.03)	(0.50)	(1.51)	(1.85)	(0.79)	(0.46)
Year 2012	12.63*** (2.09)	2.482*** (0.52)	8.905*** (1.56)	11.39*** (1.90)	3.545*** (0.81)	- 2.033*** (0.47)
Year 2013	10.71*** (2.15)	3.027*** (0.53)	7.786*** (1.60)	10.81*** (1.95)	3.020*** (0.83)	- 2.876*** (0.48)
Year 2014	11.70*** (2.22)	3.669*** (0.55)	9.180*** (1.66)	12.85*** (2.02)	1.899* (0.86)	- 2.795*** (0.50)
Year 2015	11.98*** (2.26)	2.971*** (0.56)	11.75*** (1.69)	14.72*** (2.06)	-0.0724 (0.88)	- 2.427*** (0.51)
Year 2016	13.04*** (2.36)	2.900*** (0.59)	13.45*** (1.76)	16.35*** (2.15)	-0.698 (0.92)	- 2.309*** (0.53)
Year 2017	16.27*** (2.47)	3.553*** (0.61)	16.74*** (1.84)	20.29*** (2.25)	-1.902* (0.96)	-1.778** (0.55)
Year 2018	15.27*** (2.57)	3.617*** (0.64)	17.18*** (1.92)	20.80*** (2.34)	- 3.423*** (1.00)	-1.827** (0.58)
Year 2019	13.85*** (2.62)	3.320*** (0.65)	16.33*** (1.95)	19.65*** (2.38)	- 3.662*** (1.02)	-1.839** (0.59)
Year 2020	10.94*** (2.67)	3.979*** (0.66)	14.76*** (1.99)	18.74*** (2.43)	- 5.189*** (1.04)	- 2.306*** (0.60)
Year 2021	10.75*** (2.70)	4.505*** (0.67)	16.16*** (2.01)	20.66*** (2.45)	- 7.094*** (1.05)	- 2.489*** (0.61)
Year 2022	12.89***	4.851***	18.73***	23.58***	-	-

					8.048***	2.339***
	(2.75)	(0.68)	(2.05)	(2.51)	(1.07)	(0.62)
Constant	34.17***	6.083***	6.758***	12.84***	19.83***	1.435***
	(1.77)	(0.44)	(1.32)	(1.61)	(0.69)	(0.40)
R-sq	0.193	0.121	0.187	0.184	0.129	0.069
N	7379	7379	7379	7379	7379	7379

Standard errors in parentheses

p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Figure 11, University Fixed Effects Regression.

Layout Fixed Effects

	Model 1 Total Issues	Model 2 Critical	Model 3 Serious	Model 4 Critical + Serious	Model 5 Moderate	Model 6 Minor
Layout Changed	0.896	0.332	2.190***	2.522***	-1.039*	-0.360
	(0.95)	(0.27)	(0.60)	(0.71)	(0.47)	(0.22)
Deadline for Compliance (Ontario)	-4.130**	-1.404**	-6.397***	-7.801***	3.262***	-0.203
	(1.55)	(0.43)	(0.98)	(1.16)	(0.76)	(0.36)
Provincial Policy Introduced	-7.433***	-2.665***	-4.118***	-6.783***	-0.448	-0.177
	(1.89)	(0.53)	(1.19)	(1.42)	(0.93)	(0.44)
January	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)
February	-0.0688	0.0885	0.0499	0.138	-0.180	-0.0162
	(0.64)	(0.18)	(0.40)	(0.48)	(0.31)	(0.15)
March	-0.401	0.0167	0.129	0.146	-0.465	-0.0774
	(0.64)	(0.18)	(0.40)	(0.48)	(0.32)	(0.15)
April	-0.0402	0.0963	0.345	0.442	-0.411	-0.0605
	(0.64)	(0.18)	(0.40)	(0.48)	(0.31)	(0.15)
May	0.0392	0.129	0.450	0.579	-0.394	-0.127

	(0.64)	(0.18)	(0.40)	(0.48)	(0.32)	(0.15)
June	-0.129	0.123	0.519	0.642	-0.558+	-0.229
	(0.64)	(0.18)	(0.40)	(0.48)	(0.32)	(0.15)
July	-0.701	0.213	0.312	0.525	-0.874**	-0.190
	(0.65)	(0.18)	(0.41)	(0.49)	(0.32)	(0.15)
August	-0.502	0.185	0.664	0.849+	-0.923**	-0.104
	(0.65)	(0.18)	(0.41)	(0.49)	(0.32)	(0.15)
September	0.194	0.169	0.830*	1.000*	-0.741*	-0.0807
	(0.65)	(0.18)	(0.41)	(0.48)	(0.32)	(0.15)
October	0.597	0.214	0.784+	0.998*	-0.228	-0.138
	(0.64)	(0.18)	(0.40)	(0.48)	(0.32)	(0.15)
November	0.517	0.270	0.881*	1.151*	-0.550+	-0.0744
	(0.65)	(0.18)	(0.41)	(0.49)	(0.32)	(0.15)
December	-0.181	0.244	0.604	0.848+	-0.865**	-0.108
	(0.64)	(0.18)	(0.40)	(0.48)	(0.32)	(0.15)
Year 2008	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)
Year 2009	1.995*	0.442+	0.676	1.118	0.880+	0.167
	(0.93)	(0.26)	(0.59)	(0.70)	(0.46)	(0.22)
Year 2010	6.049***	2.807***	4.100***	6.907***	-0.314	0.296
	(1.12)	(0.31)	(0.70)	(0.84)	(0.55)	(0.26)
Year 2011	8.251***	3.028***	6.071***	9.099***	-0.316	0.192
	(1.15)	(0.32)	(0.72)	(0.86)	(0.57)	(0.27)
Year 2012	9.584***	3.785***	6.746***	10.53***	-0.845	0.593*
	(1.18)	(0.33)	(0.74)	(0.89)	(0.58)	(0.27)
Year 2013	10.37***	4.556***	7.613***	12.17***	-1.064+	-0.0464
	(1.20)	(0.34)"	(0.75)"	(0.90)	(0.59)	(0.28)
Year 2014	12.48***	4.971***	9.043***	14.01***	-1.368*	0.514+
	(1.22)	(0.34)	(0.77)	(0.92)	(0.60)	(0.28)

Year 2015	13.05***	4.832***	10.87***	15.70***	-2.730***	0.757**
	(1.23)	(0.34)	(0.77)	(0.92)	(0.61)	(0.29)
Year 2016	14.41***	4.601***	12.93***	17.53***	-2.614***	0.217
	(1.26)	(0.35)	(0.79)	(0.95)	(0.62)	(0.29)
Year 2017	17.77***	4.620***	15.58***	20.20***	-2.137***	0.456
	(1.30)	(0.36)	(0.82)	(0.97)	(0.64)	(0.30)
Year 2018	16.46***	4.467***	16.44***	20.91***	-4.101***	0.315
	(1.33)	(0.37)	(0.84)	(1.00)	(0.65)	(0.31)
Year 2019	15.86***	4.450***	16.57***	21.02***	-4.735***	0.252
	(1.35)	(0.38)	(0.85)	(1.01)	(0.66)	(0.31)
Year 2020	12.08***	4.580***	14.96***	19.54***	-6.271***	-0.530+
	(1.36)	(0.38)	(0.86)	(1.02)	(0.67)	(0.32)
Year 2021	10.50***	4.445***	14.16***	18.60***	-6.653***	-0.764*
	(1.37)	(0.38)	(0.86)	(1.03)	(0.67)	(0.32)
Year 2022	9.627***	4.173***	13.97***	18.14***	-6.950***	-0.954**
	(1.40)	(0.39)	(0.88)	(1.05)	(0.69)	(0.33)
Constant	28.50***	1.050***	2.928***	3.978***	21.46***	2.494***
	(1.13)	(0.32)	(0.71)	(0.85)	(0.56)	(0.26)
R-sq	0.054	0.048	0.086	0.088	0.046	0.021
N	7379	7379	7379	7379	7379	7379

Standard errors in parentheses

p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Figure 12, Layout Fixed Effects Regression.

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