

# The Relationship between Website Accessibility and Usability: An Examination of U.S County Government Online Portals

Yang Bai

Donald P. Bellisario College of Communications, Pennsylvania State University

[ymb5037@psu.edu](mailto:ymb5037@psu.edu)

**Abstract:** Although providing accessible online services to people with disabilities is a legal requirement in the U.S for the federal government and highly recommended for other government agencies, severe accessibility issues persist on E-government portals. One potential cause of this problem is that the government lacks strong incentives to adopt a higher accessibility standard because people with disabilities constitute a small proportion of E-government users. By demonstrating that website accessibility is positively associated with usability, this study provides a potential solution to incentivize the government to adopt a higher accessibility standard. To test the relationship between accessibility and usability, 342 county government online portals were selected by a stratified sampling method. The conformance of the homepage of the websites to the WCAG 2.0 accessibility standard was evaluated using an automated tool. Then, an 18-item heuristic checklist was assembled based on prior works and used to assess the usability of the websites. After controlling for the potential confounding factors such as broadband availability and county budget, the correlation between the usability and accessibility scores was tested. The analysis shows a significant positive relationship exists between the usability and accessibility scores. This positive relationship suggests that improving the accessibility could also enhance the usability of websites. As a result, the online experience of non-disabled users could also be improved. The finding of the study implies that web accessibility could be approached and framed from a different perspective: it does not only benefits users with disabilities but also general users. This positive relationship could be leveraged to give the government more incentives to make E-government portals more accessible to people with disabilities.

## 1. Introduction

By 2016, 88% of American adults have become Internet users (Pew Research Center, 2017a). As citizens migrate to online spaces, government agencies have also invested many resources in the construction and promotion of E-government portals<sup>1</sup>. While the accelerating availability of E-government portals can greatly facilitate the obtaining of critical information, use of public services and political participation, it also makes accessibility – the ease of use of the websites for people with disabilities – a prominent challenge for the government. According to an estimate by the Centers for Disease Control and Prevention (CDC, 2015), 22% of Americans have at least one type of disability. As many studies (Sachdeva et al. 2015; Duplaga, 2017) have shown, people with disabilities are often severely disadvantaged in the Internet era. For these people, E-government, a facilitating and empowering tool for many others, can be an insurmountable obstacle. In the United States, providing accessible online services is a legal requirement for the federal government mandated by Section 508 of the Rehabilitation Act and highly recommended for state and local government agencies (Youngblood, 2014). However, surveys of the accessibility of the government websites indicate that severe web accessibility issues persist at the federal, state, county and municipal government level (Potter, 2002; West, 2008; Youngblood and Mackiewicz, 2012). This study seeks to provide a different angle to approach the accessibility issue of government online portals and offer a potential solution to incentivize governments to improve the accessibility of their online portals. Although a variety of explanations for the slow progress in the implementation of accessibility requirement exist (Berry, 1994; Velleman, Nahuis and van der Geest, 2017), one fact is often overlooked by accessibility scholars. According to the survey by the Pew Research Center (2017b), among the population with disabilities in the U.S., only 57% are Internet users. Another study (Rubaii-Barrett and Wise, 2008) indicates that only 30% of people with multiple disabilities are Internet users. Given that about 20% of Americans have some disabilities (CDC, 2015), it can be estimated that only 6% - 11% of the total population who have some disabilities are also Internet users. Since many individuals with disabilities are not even Internet users, it is questionable if the government, at least in the short run, has enough incentives to make website accessibility for the disabled a priority. Traditionally, website accessibility deals with the easiness for people with disabilities to browse websites (Harper and Yesilada, 2008). However, a growing number of

<sup>1</sup> E-government is the use of information and communication technologies to deliver government information and provide government services (Jeong, 2007). E-government portals refer to the websites through which the E-government services are delivered. In this study, E-government portals, E-government websites, government websites and government online portals are used interchangeably.

scholars (Shneiderman, 2000; Thatcher et al., 2003; Henry, 2004; Hendler, 2012) have argued that accessibility is closely related to website usability. The concept of usability has been widely used in website design by both the private and public sectors. As defined by the International Organization for Standardization (1998), usability is “the extent to which a product can be used by users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” (p. 56). Website usability is a critical factor in the success of any E-government project (Youngblood and Mackiewicz, 2012). In the U.S, Section 207 of E-government Act of 2002 stipulates the requirements for the availability, accessibility and usability of electronic government information (Seifert, 2008). Noticeably, usability and accessibility are treated as separate issues.

While web accessibility focuses on the web browsing experience of users with disabilities, usability deals with websites’ ease of use for all people with or without disabilities. The association between web accessibility and usability should be further examined and used as the basis for the solution to the lack of incentives to improve web design for people with disabilities: to push the implementation of a higher accessibility standard, government officials need to be convinced that improving website accessibility not only benefits people with disabilities but also other users. However, using the positive relationship between the two dimensions to promote accessible web design requires solid empirical evidence as the basis. Although many scholars have argued for the linkage between usability and accessibility (Shneiderman, 2000; Thatcher et al., 2003; Henry, 2004; Hendler, 2012), to the best of the author’s knowledge, very few studies have empirically examined the relationship between the two constructs with a representative national sample of E-government websites. By examining 342 U.S county government websites, this study seeks to fill this gap. The primary research question of the current study is: Do government websites with better accessibility also have better usability for general users? The structure of the study is as follows. In the next section, related studies on web accessibility and usability are reviewed, followed by the methodology section. The results of the analyses are reported in the fourth section. The last section provides a summary of the main findings and the discussion about the implications and limitation of the study.

## 2. Literature Review

### 2.1 Website Accessibility

According to W3C’s Web Accessibility Initiative, accessibility refers to that “websites, tools, and technologies are designed and developed so that people with disabilities can use them” (W3C, 2005). The idea of accessibility is deeply rooted in the initial purpose of the creation of the World Wide Web. In the statement of the World Wide Web Consortium, Tim Berners Lee claimed that “the web is fundamentally designed to work for all people, whatever their hardware, software, language, culture, location, or physical or mental ability.

When the Web meets this goal, it is accessible to people with a diverse range of hearing, movement, sight, and cognitive ability.” (W3C, *n.d.*). In the U.S. context, a number of legislation and regulations, such as Section 508 of the Rehabilitation Act Amendments, the Americans with Disabilities Act of 1990, and Section 225 of the Telecommunications Act of 1996, have articulated requirements for web accessibility at the federal government agencies (Loiacono, McCoy and Chin, 2005). Many state governments have also adopted or are in the process of adopting the standard used by the federal governments (Rubaii, Barrett and Wise, 2008).

International standards have also been involved to define and monitor the accessibility of government websites. Currently, the most commonly used international standards are WCAG 1.0 and 2.0 developed by the World Wide Web Consortium. In the United States, the U.S. Access Board has been revising the Section 508 standard to make it compatible with the latest WCAG requirement (U.S. Access Board, 2017). Although no legislation or regulations so far have mandated the implementation of WCAG 2.0 at the federal or local level, the standard developed by W3C is believed to the goal which governments at all levels aim to achieve in the future (Youngblood, 2014).

For many years, researchers have tracked the accessibility of E-government websites. In one of the first studies on the accessibility of the federal government websites, Stowers (2002) found that four years after 1998 amendment of the Rehabilitation Act Amendments, only 14% of the sites examined met the most basic accessibility standard as required by Section 508. Potter (2002) and Youngblood (2014) analyzed the same set of Alabama state government websites. The comparison reveals that, although twelve years had passed, the accessibility of the sites examined did not have significant improvement. Although the government sites are plagued by poor accessibility design, some studies have shown a more promising status of E-government

portals. Using an automated assessment tool, Hansan and Richards (2013) tracked the change in the accessibility of over 100 websites in the U.K and the U.S. over a 14-year period from 1999 to 2012. Their finding suggests that although severe accessibility issues remained in the government websites, the government website examined in general had higher accessibility score compared to other types of websites. Admittedly, the use of automated tools as the instrument cannot reveal the real experience of users. Nevertheless, their findings might suggest that government agencies, compared to the private sector, pay more attention to the accessibility of their websites.

The accessibility of E-government portals is crucial for the building of an inclusive community. As discussed in the introduction section, people with disabilities might only constitute a small proportion of the users of E-government portals. However, the underlying cause is often not that people with disabilities have no incentives to embrace the digital world but that many technologies fail to accommodate the special needs of this group of people (Cromby and Standen 1999; Heerink et al. 2010). Given that government services are monopolistic and often cannot be replaced by the private sector, people with disabilities could be severely disadvantaged by poor accessibility in the website design. Moreover, accessibility is not only relevant to how disabled people interact with E-government portals. As the study by Vicente and López (2010) shows, the unsatisfactory experience with Internet usage could further deteriorate the confidence of disabled users in their digital abilities. As a result, they become more anxious about new technologies and are less likely to adopt them.

## **2.2 Website Usability**

Compared to accessibility, the discussion on usability has a longer history, and the term has been used in a more general sense, i.e., it is not only applicable to people with disabilities but also those without (Yesilada et al., 2015). As the International Organization for Standardization (ISO, 1998) defines usability as “the extent to which a product can be used by users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” (p. 56). The concept of usability is widely used in the design of information systems. In general, a usable information system should have the capability of being understood, learned, operated, and attractive to the users (Fernandez, Insfran and Abrahão, 2011). Nielsen (1994) provided one of the most cited benchmarks of a system with good usability. According to Nielsen, a usable system, including an E-government portal, should be easy to use and remember, require minimal effort, contain few technical errors and help users achieve their goals (see Table 1 for the metrics proposed by Nielsen).

As E-government portals have become an important source of government information and platform to access public services, increasing attention has been given to the usability of government online portals. Following the ISO definition, Venkatesh, Hoehle and Aljafari (2014) explained E-government usability as “the extent to which a website can be used by citizens to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified E-government service context” (p. 670). Although website usability and accessibility are sometimes used interchangeably in the popular press, in this study, a strict adherence to the terms’ definitions is followed: accessibility deals with the ease of use of websites for people with disability, while usability focuses on whether the website can be easily used, regardless of the users’ physical and mental conditions and digital skills.

With the rapid development of E-government, many scholars have developed usability metrics for the assessment of E-government portals (Garcia, Maciel and Pinto, 2005; Huang and Brooks, 2011; Ansari et al., 2016). One of the most frequently cited frameworks for assessing the usability of E-government portals is proposed by Baker (2009). Six dimensions of government online portals are examined in Baker’s model, which include the information architecture, legitimacy of the information provided, the navigability of the website, the availability and usefulness of the online services, the accessibility of the portal and the availability of user help or assistance functionalities.

Based on Nielsen and Baker’s frameworks, many scholars have proposed more specific usability suggestions for government websites. For example, the website must provide access to critical information such as public notices and changes to local regulation (Baker, 2009). The site must have a clickable agency logo at the top, and the main navigational menu should appear at the top or left side (Cappel and Huang, 2007). Each navigational grouping should not have more than 10 items (Dewitt, 2010). To assess the usability of websites, most researchers rely on one or a combination of the three methods: user evaluation; manual inspection; web design checklist and automated tool evaluation (King and Youngblood, 2016).

The benefits of improving the usability of government websites are well studied and documented. Based on user evaluation, Huang and Benyoucef (2008) found a positive relationship between the perceived usability and the credibility of government websites. Moreover, the study by Teo, Srivastava and Jiang (2008) found that the impact of usability extends beyond users' perception of the credibility of the website. Their finding suggests that users who perceived the government online portal to be highly usable, defined as high technical reliability and ease of use, tended to have more trust in the government. Also, users who trust the government, in turn, usually use the online services more frequently (Tolbert and Mossberger, 2006). A website with good usability can also improve the image of a region. As Sicilia, Pérez and Heffernan (2008) said, "the website of a city represents a city's window into this connected, global and electronic world. It has become the first information source for most people and most companies interested in a particular city" (p. 6). Therefore, a well-designed, easy-to-use government website creates a positive first impression to potential investors, businesses and visitors (Youngblood and Mackiewicz, 2012).

Notwithstanding the evidence suggesting the benefits of improved website usability, studies have shown that many government agencies failed to pay enough attention to the usability of their websites. From 2002 to 2008, West (2002, 2006, 2008) conducted several rounds of assessment of more than 1,000 state and federal government websites. He found that, although the usability of the websites had been improving, there still existed severe usability issues that could negatively impact users' online experience. For instance, 64% of the websites used language that was well above the reading ability of average Americans, and 60% of the websites did not provide foreign language translation. Usability problems were also detected at the county (Youngblood and Youngblood, 2013) and municipal levels (Youngblood and Mackiewicz, 2012).

### 3. The Relationship between Web Accessibility and Usability

The difference between website accessibility and usability has been heavily discussed in policy and ICT studies. Traditionally, website accessibility has been researched as an issue pertaining to Internet users with various physical or cognitive disabilities (Harper and Yesilada, 2008). However, an increasing number of scholars have been arguing that improving website accessibility is not only beneficial to users with disabilities but also can improve the site's usability for users without disabilities (Henry, 2004; Web Accessibility Initiative, *u.d.*). For example, in *Constructing Accessibility Web Sites* (2003), Thatcher et al. described accessibility issues as a subset of usability issues and implied that improving the accessibility of a website could also lead to better usability. Some other scholars hold an even more radical position that there is little difference between website accessibility and usability and that no matter what it is called, it is about improving the usability for all users with or without disabilities (Shneiderman, 2000; Hendler, 2012).

Though many scholars argue that website accessibility and usability are highly related, the empirical evidence supporting this argument is rather limited. Leporini and Paternò (2008) conducted an experiment with 40 participants who are blind or with vision impairment. The result indicates that implementing a higher accessibility standard significantly improved the websites' usability for the 40 participants. In the study by Aizpurua, Harper and Vigo (2016), 11 legally blind individuals were asked to use four websites and then answered questions about the accessibility and usability of the websites. The feedback from the participants indicates that the accessibility issues pointed out by the participants were the same as 27 out of the 35 usability issues analyzed.

Curran, Walters and Robinson (2007) extended the focus from people with disabilities to older people in general. After a close examination of the accessibility guideline set by Web Accessibility Initiative, they concluded that most of the required designs aimed at improving the web accessibility for people with disabilities are also applicable to older adults. Another effort to extend the scope of website accessibility is made by Capra et al., (2012). The ethnographic research they conducted suggests that improving the accessibility of websites could also significantly improve the online experience for functionally illiterate individuals. However, the results of these studies are insufficient to answer the question whether improving website accessibility can also benefit more general users, since most elder people also suffer from some disabilities (U.S. Department of Health and Human Services, 2015), and few illiterate individuals are Internet users (Van Deursen and Dijk, 2016).

The experiment by Petrie and Kheir (2007) is one of the few studies which empirically analyze the relationship between web accessibility for people with disabilities and usability for general users. In their study, 6 blind

users and 6 sighted were asked to evaluate the quality of two websites. Their findings show that although the blind participants identified significantly more issues that impeded their online experience, the perceived severity of the commonly identified issues was not different between the two types of users. Using a similar method, Rømen and Svanæs (2012) compared the evaluation of two websites by people with visual, motion and cognitive disabilities and people without any disability. Among the 47 accessibility issues identified by users with disabilities, 32% were recognized by the users without disabilities as usability issues as well. These studies suggest that there might be some commonality between website accessibility and usability

Another empirical research by Mbipom and Harper (2011) focuses only on the general users without any disability. Based on an experiment with 32 general users, they found a positive correlation between being visually clean, a typical attribute of good usability, and web accessibility. This study provides some evidence to support that websites with higher accessibility might also have higher usability. Nevertheless, being visually clean is but one dimension of web usability. To solidly establish the positive correlation, more aspects of usability need to be analyzed as well.

There is little research which examines the relationship between website usability and accessibility with a large-scale sample. To the researcher's best knowledge, Yesilada et al's survey (2015) of 374 individuals from a variety of backgrounds such as academia, industry, user groups, NGOs, governments and business managers is the only available study of this type. The results suggest that the vast majority of the respondents believed that web usability and accessibility are highly related. Moreover, most of the respondents strongly disagree with the statement that improved website accessibility only caters to people with disabilities. However, this study provides, at best, only peripheral support for a positive correlation, since it only reveals what the relevant parties *believe* or *hope* rather than what the relationship between usability and accessibility *is*.

While many studies utilize the subjective evaluation technique in accessing website accessibility and usability, some other scholars resorted to automatic conformance checking tool and heuristic checklist as the instruments. For instance, Youngblood and Youngblood (2013) used a 14-item checklist to evaluate the usability of 38 portal websites of Alabama counties and WAVE, an automatic tool, to check the websites' conformance to W3C Priority Level One accessibility standard. In the study by King and Youngblood (2016), a 15-item heuristic was adopted to check the usability of 34 voting and election websites of Alabama counties, and a variety of automatic tools to evaluate the accessibility of the websites. Unfortunately, in these studies, the performance of the websites on accessibility and usability was not compared. Nonetheless, these studies established the feasibility of automated tools and manual inspection with the heuristic checklist as acceptable methods to access the quality of websites and therefore, lay a solid foundation for the empirical analysis of a large national sample of websites.

## **4. Methodology**

### **4.1 The Sample**

In order to obtain a representative sample of county government websites, a stratified random sampling technique was used. First, each U.S. state was assigned an ID number and categorized into one of the four groups: rural rich, rural poor, urban rich and urban pool. According to the U.S. Census Bureau (2016), on average, 80% of the American population live in urban areas. Therefore, states with higher than 80.7% of the population living in urban areas were classified as urban states. According to the latest data on resident income (Bureau of Economic Analysis, 2017), the average per capita personal income of Americans in 2016 was \$49,571. Thus, states with per capita personal income higher than the national average were defined as rich states. Using the average values as the cutoff in stratified sampling is acceptable when the variables follow the normal distribution. The distribution analysis shows that both the per capita income and the percentage of urban population are slightly skewed ( $\text{Skewness}_{\text{income}} = 1.15$ ,  $\text{Skewness}_{\text{urban population}} = -0.41$ ). Nevertheless, based on the 2 or -2 thresholds (Woodridge, 2016), it can be concluded that the distribution does not severely deviate from normality. Thus, using the average as the cutoff would lead to each state having a roughly equal chance of being selected.

To achieve a random selection of states, the ID number of each state was entered in the online random number generator, Random.Org. For each category, two random numbers were generated, and the corresponding states were selected. Then we collected data for the counties within each selected state. Table

1 summarizes the number of counties, per capita personal income and percentage of urban population of each selected state.

**Table1:** The Selected States

	Rich	Poor
Urban	Maryland (24, \$50,749, 87.2%) Washington (39, \$49,610, 84.1%)	Michigan (83, \$37,132, 80.2%) Nevada (17, \$41,024, 94.2%)
Rural	Pennsylvania (67, \$49,679, 78.7%) Wyoming (23, \$53,664, 64.8%)	Idaho (44, \$37,277, 70.6%) South Carolina (46, \$33,751, 66.3%)

In total, 343 counties were selected. Then 342 (one county did not have an online portal) county government centralized websites, the websites which do not represent a department but the county government as a whole, were accessed through Google Chrome browser on September 20, 2017. Admittedly, a thorough evaluation of the website accessibility would require an examination of the entire site. However, to make this study manageable, only the homepages of the websites were examined in this study. This is a common and generally acceptable practice adopted in many studies (Potter, 2002; Olalere and Lazar, 2011; Youngblood, 2014). Moreover, as the portal to the online services provided by the local government, the quality of the homepage usually indicates the quality of the entire page. Vigo et al. (2009) showed that the accessibility issues on the homepage are very likely to be present on other pages, and vice versa. Also, the homepage often serves as the landing page for users to access other content of the website. The accessibility of the homepage largely determines users' first impression of the entire web portal (Latif and Masrek, 2010). Therefore, the accessibility issues on the homepage should require more attention.

## 5. The Evaluation Instruments

**Website accessibility.** The accessibility of a website can be evaluated in many ways such as user evaluation, expert inspection and conformance testing (Brajnik, 2008). This study adopts the conformance testing strategy by utilizing an automatic testing tool. Compared to other types of testing, automatic testing tools have the advantages of providing standardized and easily replicable results.

Admittedly, automated evaluation tools cannot completely replace manual inspection, including expert evaluation and user evaluation, which is regarded as the best way to access the accessibility of websites (Youngblood and Mackiewicz, 2012). While the automated tool could indicate the existence of a problem, it cannot provide the critical insight on how severe the issue is. For example, the tool could indicate the absence of text alternatives to several pictures. However, without manual inspection, it is difficult to conclude whether or not the pictures themselves convey important information, making it inconclusive whether the lack of text alternatives is a serious issue. In fact, it is not uncommon that a mix of various methods, including manual inspection, automated tool evaluation and expert opinions are used to access website accessibility (Jaeger, 2006; Olalere and Lazar, 2011). However, automated tools do offer a unique advantage – the capability of examining a large number of websites to generate a snapshot of the accessibility issues (Youngblood and Youngblood, 2013). Also, although the automated tool might not be able to indicate the severity of the issue, it is very efficient in analyzing how many types of problems exist, and the frequency of each type of problems (Youngblood and Mackiewicz, 2012). Therefore, the accessibility score obtained using the FAE 2.0 tool should be better understood as an indicator for the scope rather than the severity of the accessibility issues on the examined websites.

The automatic conformance testing tool used in this study is the Functional Accessibility Evaluator 2.0 (FAE2.0) developed by the University of Illinois. Unlike many other automatic tools which only indicate the number of rules violations or general level of compliance, FAE2.0 generates a numeric score based on the website's conformance to the WCAG 2.0 standard. This feature makes FAE 2.0 an ideal tool for quantitative comparative analysis. For each webpage entered, FAE 2.0 evaluates it against all WCAG 2.0 level A and level AA rules and produces the following scores: P, the number of elements that pass the requirement; F, the number of requirement violation; MC, the number of elements that require manual evaluation. Then, an overall score [ $\text{Score} = P / (P+F+MC)$ ] ranging from 0 to 100 will be generated for the page. A page with score lower than 50 means the WCAG 2.0 standard is not implemented.

**Website usability.** Although website usability is a heavily studied concept, there is no consensus on how to measure it. Two of the most frequently used framework are Nielsen's (1994) 10-item metric and Baker's (2009) six-dimension model. The heuristic evaluation tool adopted in this study is mainly based on Baker's model since it is more recent and tailored to the case of E-government portals. Also, a greater number of studies exist which operationalize Baker's model so that a pool of assessment items for E-government portals is readily available. Verkijika and De Wet (2018) provided a detailed and operationalizable interpretation of Baker's model. Their interpretation of Baker's model formed the basis of the evaluation tool used in this study. Since Baker's model is based on the revision and modification of numerous previous works, including Nielsen's model, some evaluation items were developed based on Nielsen's 10-item metric, if they complement Baker's model. In addition, the *Research-Based Web Design & Usability Guidelines* (2003, thereafter referred to as the *Usability Guide*) issued by the U.S Department of Health and Human Services (DHH) was consulted, when Baker (2009) and Verkijika and De Wet's elaboration (2018) did not provide enough information on operationalization. The next part of this subsection introduces the details of each evaluation item in the assessment tool.

**Information architecture.** This dimension measures how well the website provides, organizes, classifies and presents information in an effective way. This dimension is often operationalized as the availability of information regarding the functions of the website and the departments within the government agency (Baker, 2009; Dan, Yahel and Nitzan, 2013) and the clear presentation of available information and services. Two variables, the availability of introduction of the website's purpose/functions and department information, are used to evaluate the availability of critical information. To measure whether the website presents the information in an effective way, the *Research-Based Web Design & Usability Guidelines* (2003, thereafter referred to as the *Usability Guide*) issued by the U.S Department of Health and Human Services was consulted. First, the webpage should not use horizontal scrolling, as it makes less convenient for people to see all the information. Second, all text links should be in different formats (colors, size, shade, etc.) from non-linkable texts, since the different format gives users a clear signal that there is more information available. Third, two conventional website design requirements, i.e., all texts should be left-aligned and no more than one contiguous line of all-cap texts, are included in the metric, since violation of these conventions impedes the readability of the texts.

One aspect of information architecture not included in Baker's model but emphasized by Nielsen (1994) is that the information should be presented in a way that the users feel they are respected and in control of their online experience. Two principles, which are adopted in the metric used by Huang and Brooks (2011) and Youngblood and Mackiewicz (2012), are particularly relevant for this concern. No audios or videos should automatically play, and splash pages should be avoided, since these designs intrude into users' activities and deprive them of the control of their online experience.

**Legitimacy.** A legitimate E-government website should be able to convince users that it is a trustworthy source of information, and their security and privacy are reasonably protected. Therefore, the website should include legitimacy features such as contact information, privacy/security statements and disclaimer statements.

**Online services.** This dimension evaluates the value of the website to users. A value website should not only provide information but also allow users to complete certain tasks. Baker (2009) further explained that a valuable website should provide interaction functions such as downloadable forms, online applications and interactive forms.

**User-help and feedback.** This dimension focuses on whether the website provides support and assistance to help users use the system. Roach and Cayer (2010) listed several critical assistive items that could streamline users' browsing experience, including internal search engines, different languages or translation services and contact us function. A different type of feedback is emphasized in Nielsen's model (1994): the website should inform the users of their status and progress. *The Usability Guide* recommends that websites use the site map for users to know which page they are browsing and hyperlinked texts change formats after being clicked.

**Navigation.** A website with good navigability allows users to easily explore the site towards specific pages or sections. Two recommended designs for navigational bars which are adopted in several prior studies (Cappel and Huang, 2007; Huang and Brooks, 2011; Youngblood and Mackiewicz, 2012) are included in the metric. First, the navigational menu should be placed on the top or the left side of the page. Second, there should be

no more than 10 items on the menu. Noticeably, the design of the navigational menu is not the only factor that impacts the navigability of a website. As E-government portals have provided an increasing amount of information and functions, the website can be inevitably complicated. Therefore, even a well-designed website can still confuse the users sometimes. As a remedy, the website should always offer users the option to go back to the homepage and start over (Department of Health and Human Services, 2003). *The Guideline* recommends that a website always have a “home” or “return” button or a prominent image, for example, the county logo, serving this function.

**Accessibility.** In accordance with the trend to consider accessibility in the context of usability, Baker (2009) included accessibility as an important factor which determines the usability of E-government portals. According to Baker, a website should be easy to use for a wide array of users, regardless of their digital skills or possible disabilities. Since this dimension matches exactly the definition of web accessibility, and this study treats accessibility and usability as closely related but different concepts, no items that evaluate the accessibility of websites are included in the metric for website usability.

Items selected for the heuristic evaluation instrument are summarized in Table 2. The checklist serves as a dichotomous testing tool. Each webpage was examined against all the 18 requirements. Each element of the webpages that passes the requirement was given 1 point. Thus, all the webpage examined had a usability score ranging from 0 to 18. A web page with a higher score is more usable than the one with a lower score. As an exploratory heuristic, this metric does not specify a threshold value for a *usable* webpage. Admittedly, this metric might not include all the relevant variables. Nevertheless, following the guideline of one of the most frequently used models for E-government accessibility evaluation, it should have covered the most important aspects of website accessibility.

Since some items in the list, such as the existence of information about the department and the availability of interactive functions, require subjective judgments, a research assistant coded 10% of the web pages independently. The results coded by the research assistant and the author were compared, and good intercoder reliability was established (Cohen’s Kappa = 0.81).

**Table 2:** Usability Evaluation Criteria

Dimension	Assessment Checklist
Information Architecture	The website should provide information regarding the functions of the online portal.
	The website should provide information about the structure/department of the government agency.
	No horizontal scrolling is used.
	All hyperlinked texts <sup>2</sup> are in different formats (colors, size, underlined, etc.) from non-linkable texts.
	All texts are left-aligned.
	No more than one contiguous line of all-cap texts
	No splash page <sup>3</sup> is used.
	No audios or videos play automatically when page loads.
Legitimacy	The website provides at least one of the three types of information: contact information, privacy statement or disclaimer statement <sup>4</sup> .
Online services	The website provides interaction functions such as downloadable forms, online applications, online renewal, interactive forms, online chatting, etc.
User help & feedback	The website has an internal search engine.
	The website has non-English versions or translation function.

<sup>2</sup> A hyperlinked text in an electronic document is a text element which links to information in a different location of the document. See the detailed definition at <https://www.webopedia.com/>.

<sup>3</sup> A splash page is a page automatically displayed before users can access the main content of the site. See the definition at <https://www.webopedia.com>

<sup>4</sup> A disclaimer statement is a legal notice about the key legal issues on the operation and use of the website. See the definition at <https://www.webopedia.com>

Dimension	Assessment Checklist
Navigation	The website has a site map
	Hyperlinked texts change formats after being clicked.
	There is a navigational menu.
	The navigational menu is placed on the top or left side of the page.
	There are no more than 10 items in the menu.
	The website has a "home" or "return" text or logo link.

A major limitation of the assessment instruments adopted in this study is that no users of the government websites participated in the evaluation process. Inviting users to assess the usability and accessibility of E-government websites is a common and recommended practice (Petrie and Kheir, 2007; Mbipom and Harper, 2011; Rømen and Svanæs, 2012) since the users are the ultimate stakeholders affected by the quality of the website. Their evaluations of the accessibility and usability of the online portals cannot be replaced by any automated tool assessment or heuristic checklist. However, to make user evaluation feasible, there must be a limited number of websites to be examined, as manifested in many studies (Leporini and Paternò, 2008; Aizpurua, Harper and Vigo, 2016). The number of websites that needed examination in this study makes user evaluation unmanageable. As an alternative, the users can be surveyed about their experience with the websites. However, the expansive sample used in this study covers 342 counties. Therefore, a roughly equal number of users from each of the counties must be surveyed, which is a daunting task. Based on these considerations, this study does not solicit subjective input from the users. When interpreting the accessibility and usability scores, readers should be aware that those scores only indicate the existing scope of the issues rather than the real online experience of users.

## 6. Data Analysis Methods

Since this study does not seek to establish a causal relationship from web accessibility to usability, correlation analysis was utilized as the main analysis method. To control for the effects of potential confounding variables, the coverage of broadband Internet, total population, percentage of population with high school or higher education, personal annual income and operating budget for each county were included as covariates. Table 3 summarizes the demographic and socioeconomic characteristics of the sampled counties and data sources.

**Table 3:** Profile of Selected Counties

	N	Mean	SD	Source
Broadband Coverage	342	0.69	0.31	National Broadband Map
Total Population	342	135022	269235	U.S. Census Bureau
% Population with at least high school education	342	0.81	0.07	U.S Census Bureau
Per Capita Personal Income	342	40678	12251	Bureau of Economic Analysis
County Operating Budget (\$mil)	281	168.97	641.87	County Websites/News Release

Values of all the demographic and socioeconomic covariates were obtained from the latest government dataset and are available for all the counties. The operating budget was obtained from the county government website or official news releases. In total, 281 county governments reported their annual budget on their websites. 207 counties have passed their budget for the 2016-2017 budget, 42 counties only had their proposed FY16-17 budget available, and 34 counties only published their FY15-16 budget. Three partial correlation analyses were conducted, the first one for all the 281 counties, the second for the counties which reported both estimated and adopted FY16-17 budget, and the third for the counties which only reported the adopted FY16-17 budget. As a complement, a one-way ANOVA test with Post Hoc analysis was also conducted on SPSS to investigate whether websites with higher accessibility scores are indeed better in terms of usability.

## 7. Analysis and Results

### 7.1 Website Accessibility and Usability

The average accessibility score of all the websites is 40.7 (SD = 12.5), with the lowest score being 13 and the highest score 62. Among all the 342 homepages examined, 30% of them (N = 100) achieved an FAE score of 50

or higher. In other words, most county government websites did not implement the WCAG2.0 standard. According to the benchmark provided by FAE 2.0, even the websites with the highest accessibility score only partially implemented the standard at best. Few studies exist which examine the website accessibility with a national sample of local government websites. Therefore, there is no benchmark to which the result of this study can be compared. Nevertheless, given that the United States Access Board has been recommending the adoption of WCAG 2.0 since 2011 (U.S. Access Board, 2011), the fact that only 30% of the websites at best partially confirmed to the standard is far from satisfactory.

The usability of the websites is presented in Table 4. The mean usability score is 14.4. Two websites satisfied all the 18 requirements. The lowest score for the 342 websites is 5. In general, the websites performed well in terms of the information architecture, with most of the rules violated by fewer than 10% of the websites. The most prominent issue is the failure to use different formats to indicate hyperlinked texts. Most of the websites succeeded in providing information that shows that website is a trustworthy, official source of information. Nevertheless, a considerable number of websites (N = 239) only did not provide any interactive function. Thus, the websites did not offer any government service other than information announcement.

**Table 4: Website Usability**

Usability Checklist	Websites Violating the Rules	Percentage
The website should provide information regarding the functions of the online portal.	12	3.5%
The website should provide information about the structure/department of the government agency.	0	0.0%
No horizontal scrolling is used.	0	0.0%
All hyperlinked texts are in different formats (colors, size, underlined, etc.) from non-linkable texts.	55	16.1%
All texts are left-aligned.	27	7.9%
No more than one contiguous line of all-cap texts	0	0.0%
No splash page is used.	5	1.5%
No audios or videos play automatically when page loads.	9	2.6%
The website provides at least one of the three types of information: contact information, privacy statement or disclaimer statement.	5	1.5%
The website provides interaction functions such as downloadable forms, online applications, online renewal, interactive forms, online chatting, etc.	103	30.1%
The website has an internal search engine.	89	26.0%
The website has non-English versions or translation function.	290	84.8%
The website has a site map	278	81.3%
Hyperlinked texts change formats after being clicked.	154	45.0%
There is a navigational menu.	6	1.8%
The navigational menu is placed on the top or left side of the page.	12	3.5%
There are no more than 10 items on the menu.	204	59.6%
The website has a "home" or "return" text or logo link.	76	22.2%
<b>Average Usability Score</b>	14.4	SD = 2.2

The lack of user help and feedback is the most severe issued discovered by the analysis.

Specifically, more than 80% of the websites only had English versions. Also, more than 80% of the websites did not use a site map, which is recommended to keep users informed of their status and progress (DHH, 2003).

Even though the change of formats after a hyperlink is clicked is a less prominent issue, there are still more than 50% of the websites violating this principle. Comparatively, the websites performed better in providing internal search engines, with the function built in 74% of the online portals examined. Two noticeable issues regarding the navigability emerged. First, about 60% of the websites placed too many items in the navigational

menu. Second, a considerable number of websites (N = 76, 22.2%) did not have any text or logo serving as the “home” or “return” button.

## 7.2 The Correlation Analysis

To test if website accessibility and usability are related, a series of correlation tests were conducted. First, the simple correlation between website accessibility and usability was tested. The result suggests a strong and positive correlation (Pearson’s  $r = 0.49$ ,  $p < 0.001$ ). However, according to prior studies, several factors, for instance, the financial resources available to the government, external pressure, and infrastructure availability (Berry, 1994; Velleman, Nahuis and van der Geest, 2017) could potentially influence the government’s adoption of innovation such as improving the accessibility and usability of its website. Therefore, to control for the potential effects of broadband availability, regional economic development, population and county budget on both the website usability and accessibility, partial correlation tests were conducted.

**Table 5: Partial Correlation**

All counties with reported budgets

	Usability Score	FAE Score
Usability Score	1	0.52**
FAE Score	0.52**	1

Counties with estimated and actual FY16-17 budgets

	Usability Score	FAE Score
Usability Score	1	0.41**
FAE Score	0.41**	1

Counties with actual FY16-17 budgets

	Usability Score	FAE Score
Usability Score	1	0.39**
FAE Score	0.39**	1

Partial correlation coefficients are reported. Covariates include broadband coverage, total population, % of population with high school or higher education, personal annual income and county budget. \*\*  $p < 0.01$

The results of the partial correlation tests are presented in Table 5. As the results show, after controlling for the potential confounding variables, the correlation between website accessibility and usability become smaller. Nevertheless, the two scores are still significantly and positively correlated. Since the current website accessibility and usability scores are most likely influenced by the most recent budget that was spent, the result of the analysis on counties which reported the adopted FY16-17 budget is used as the main indicator. Therefore, it is concluded that website accessibility is positively correlated with its usability (partial  $r = 0.39$ ,  $p < 0.01$ ).

## 8. One-Way ANOVA Test

As an alternative way to test the relationship between web accessibility and usability, a one-way ANOVA test with Bonferroni post hoc comparison was conducted. First, the 33 and 66 percentiles of the FAE score (33 and 48, respectively) were obtained through SPSS. Then, all the websites were categorized into one of the three groups: group 1 are the websites with accessibility score lower than 33; group 2 are the websites with FAE score between 33 and 48; group 3 are the websites with accessibility score above 48. Before running the ANOVA, a Levene test of homogeneity was conducted, and the test indicated that the data might have violated the homogeneity assumption of ANOVA. However, the number of observations for each group is relatively equal ( $N_1 = 116$ ,  $N_2 = 113$ ,  $N_3 = 113$ ), and the  $F_{\max}$  equals  $2.6^5$ . According to the 4-1 cell size ratio and  $F_{\max} < 10$  rules suggested by Tabachnick and Fidell (2001), the violation of homogeneity assumption should not be a concern in this case. The result of the one-way ANOVA test with the post-hoc analysis is reported in Table 6.

<sup>5</sup>  $F_{\max} = (\text{the largest within group SD})^2 / (\text{the smallest within group SD})^2$ . See Tabachnick and Fidell (2001) for details.

**Table 6:** One-Way ANOVA: Average Usability Score

	Group 1	Group 2	Group 3
Mean Usability Score	8.9 <sup>a</sup>	11.2 <sup>b</sup>	12.1 <sup>c</sup>
SD	1.5	1.1	1.1

$F(2, 339) = 55.3$ ,  $p < 0.01$ , partial  $\eta^2 = 0.288$ . Means with no superscript in common differ at  $p < 0.05$  using Bonferroni post hoc comparison.

This result provides another support for the positive relationship between website usability and accessibility. Specifically, the result shows that the accessibility and usability scores of county government websites are correspondent to each other. The websites with the highest FAE scores ( $M = 12.1$ ,  $SD = 1.1$ ) had significantly higher usability scores than both the ones with mediocre FAE scores ( $M = 11.2$ ,  $SD = 1.1$ ) and the ones with lowest FAE scores ( $M = 8.9$ ,  $SD = 1.5$ ). Meanwhile, the websites with mediocre accessibility scores had significantly higher usability scores than the websites with the lowest accessibility scores.

## 9. Conclusion and Discussion

As more government agencies in the U.S. have made an increasing number of essential public services and information online, the accessibility and usability of the government websites have become a critical issue.

There are abundant surveys on the accessibility and usability of government websites in the U.S. Nevertheless, most of the prior research focuses on only the government websites within one state (Potter, 2002; Youngblood, 2014) or one type of websites (Youngblood and Mackiewicz, 2012; West, 2008). Utilizing an automatic website accessibility checker and a usability checklist built upon previous research, this study analyzes the homepage of 342 county governments in eight states selected via a stratified random sampling process. The examination shows that the WCAG 2.0 accessibility standard was, at best, partially adopted in about one-third of the web pages examined. On the other hand, the result suggests that the web pages performed reasonably well in terms of usability. On average, they met 14 usability requirements out of the 18 specifications, though some usability issues such as the ease of use for to non-English speaking users, the overloaded navigational grouping, the indication of selected text links and the lack of interactive functions were not properly addressed.

Most of the prior studies which examine the accessibility of government web portals are based on the comparisons of the websites of the same agencies at different time periods (Potter, 2002; Henry, 2004; Youngblood, 2014). Admittedly, it is crucial for the local government officials to know if the website of their agencies has been improving. Nonetheless, it is also important for the local government to know the performance of their website relative to a national average. As one of the first studies which analyze a national sample of local government websites, the findings of this study, i.e., an average accessibility score of 41/100 and usability score of 14.4/18, can serve as a starting benchmark for future research on the accessibility and usability of the homepage of county government online portals possibly extend to the entire website. For local governments officials, the findings of this study can be used first to evaluate the quality of the homepage of the online portals, and then they can check whether the same issues exist in other pages as well.

Moreover, unlike most research on this topic, this study provides more than a survey of the accessibility and usability of E-government websites. Although many studies argue that website accessibility and usability are related concepts (Aizpurua, Harper and Vigo, 2016), there is a lack of concrete empirical evidence to support the argument. Using partial correlation and ANOVA tests, this study shows that the accessibility of a website, measured as the conformance to WCAG 2.0 requirement, could be positively correlated with the usability of the website. In general, the websites which had higher accessibility scores also had significantly higher usability scores. It is worth emphasizing that only the homepages of the websites were examined. Although it is not uncommon to evaluate the quality of homepage in lieu of the entire website in prior studies (Potter, 2002; Olalere and Lazar, 2011; Youngblood, 2014), without any doubt certain accessibility or usability issues might not be revealed by examining only one part of the website. Nevertheless, the homepage is usually the landing page for most visitors and largely determines people's first impressions of the entire online portal (Latif and Masrek, 2010), and thus, is of particular importance. Therefore, the finding of this study points out a possibility for future studies, which should extend the analysis to include the entire website.

The potential positive relationship between website accessibility and usability this study suggested has some important implications: improving website accessibility does not only benefit the individuals with disabilities but also general users without disabilities, since improving the accessibility produces a byproduct— higher usability. Based on the latest data on the U.S population and technology usage, 57% of the population with disabilities are Internet users, which constitute 11% of the total population. Therefore, although both the federal and local governments have invested many resources in making the E-government more accessible to people with disabilities, it is questionable if it is a high priority for many government agencies. This study, based on the evaluation of homepages of the websites, indicates a possibility that usability can be improved in the process of enhancing the accessibility of websites. The positive relationship is a preliminary finding which remains to be confirmed by future studies analyzing entire websites. Nevertheless, this finding suggests that government officials should reconsider what they can achieve by improving the accessibility of the E-government portals. In addition to benefiting people with disabilities, it could improve the online experience of all the users, with or without disabilities. Therefore, investment in accessible designs of government online portals is likely to have a higher return than what the government expects. For web accessibility advocates, the finding of this study suggests that it might be useful not to frame accessibility solely as an issue that impacts people with disabilities but also a design that enhances the online experience for all. This alternative narrative could be used to convince more stakeholders, including the government and the private sector, e.g., technology companies, that increasing investment in accessible design and adopting higher accessibility standards are in their own interest.

Although this study argues for the reframing of accessibility issues as something that could benefit non-disabled users, the intention is by no means to prioritize the online experience of users without disabilities over that of disabled users. At the heart of the research is how to make it more convenient for disabled users to enjoy the benefits of E-government and to enable the remaining population with disabilities who are not Internet users to use E-government. Focusing on the benefits of general users is a compromise for practical considerations. If the government as well as the private sector are convinced that improving website accessibility could also generate positive reaction from non-disabled users, which constitute the majority of Internet users, they will have more incentives to invest in accessible design. In this process, the E-government portal will become friendlier to disabled users, and there will be less barrier for the disabled non-adopters to using the services.

## **10. Limitations of the Study and Future Research**

All the conclusions and implications of this study should be considered in the context of its limitations. First of all, only the homepages of the websites were examined. Therefore, the accessibility and usability scores obtained might not be a perfect indicator of the websites' overall quality, and it might not be appropriate to generalize the relationship found in this study between the two scores to all the websites. Second, for feasibility consideration, this study adopted an automated tool and a heuristic checklist to evaluate the web pages. Although these instruments can effectively show the scope of the existing problems, it is inferior to user evaluation in its ability to indicate the severity of the issues. Therefore, more studies should be done examining the relationship between the usability and accessibility of county government websites using a mix of automated tool, manual inspection and user evaluation methods. Third, although the study uses partial correlation to control for the effect of some confounding variables, due to the lack of data, there still exist some confounding factors such as the quality of the government leadership and the actual Internet adoption rate, which are not included in the analysis. As a result, the magnitude of the correlation between the accessibility and usability scores could in fact be smaller. Last, there are many factors that can cause the failure to implement higher accessibility standard, and this study only focuses on one of the potential causes – the lack of strong incentives. However, even if the government is aware of the importance of the issue, it might still lack the capabilities or resources to implement the necessary change. Therefore, future studies should further explore why many government agencies fail to implement the higher accessibility standard.

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