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Factors that affect visually impaired users' acceptance of audio and music websites

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Abstract

The number of users with visual impairments is on the rise. Companies have an opportunity to increase their reach and revenue by ensuring their websites are accessible to these users. Developing websites around the needs of those with visual impairments is especially critical as the affluent Baby Boomer generation ages and is faced with a multitude of vision problems. Despite this fast growing, web-reliant population, little work has been done to develop a behavioral model that addresses its needs. Grounded in accessibility and acceptance theories, this research proposes a model that predicts Web usage behavior of blind and low-vision users. Our results show that one of the most widely used acceptance models does not predict the adoption behavior of visually impaired users as effectively as a modified model that includes information accessibility. Those with visual impairments decide to revisit a website based, in part, on its accessibility as well as its ease of use and usefulness. These results suggest that traditional acceptance models may predict the behavior of users with visual impairments better when reliability and convenience of access to Information are also considered.

Keywords: Accessibility; Usability; Blind users; Technology acceptance

1. Introduction

The Internet has become a popular means by which to work, shop, play, and communicate. One area of growth is the online audio book and music industry. More and more people are buying music and other audio products online instead of through traditional formats, such as in-store sales (eMarketer, 2008). With the digitalization of multimedia and the success of iPods and MP3 devices, audio and music sites are becoming hot spots of activity. The availability of online audio and music sources and their growing success raises a question about the accessibility of these sites to blind and low-vision users who want to download music and other audio products. Previous research has shown that businesses often ignore website accessibility (Loiacono, 2004; Loiacono et al., 2009) to their own detriment since people with disabilities control over $175 billion in disposable income (United States Department of Education, 2004). Inaccessible websites may push away people without disabilities as well. Over 75% of those without a disability believe that companies should make their products and services accessible to those with disabilities, even it if means incurring additional costs (United States Department of Education, 2004). So, the question then becomes ***how does information accessibility online affect visually impaired users' use of a website***?

Accessibility will be discussed in greater detail below, but overall accessible websites are those that give users equal opportunity to "perceive, understand, navigate and interact with" (W3C, 2008) the information they contain. The Internet relies heavily on text and image content as a primary way of retrieving and delivering information. This graphic user interface (GUI) method of providing access to the Web, however, is not suited for a large segment of the user population. People with sensory disabilities have been isolated from the Internet because many websites are not designed to fit their needs. Assistive technologies, such as screen readers and text magnification, can be helpful to them, but, as Loiacono (2004) has reported, most websites do not support these technologies and, hence, remain inaccessible.

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(For a more extensive discussion of website accessibility standards, see Appendix A.)

According to the US Census Bureau (2007), approximately 13 million US citizens (4% of the US population) and 180 million people worldwide (World Health Organization, 2007) have some sort of a sensory disability. This population becomes even larger when we include people with a reduced sense of visual depth perception. Vision loss is a major public health issue and will demand even more attention as Baby Boomers, who comprise a large portion of the population, continue to age. According to the Lighthouse National Survey on Vision Loss (2011), 16.5 million people over the age of 45 have some kind of impaired vision. In 2010, when the last Baby Boomers turned 45, the figure grew to 20 million as older people lost their vision and required corrective lenses. As the population of people with visual impairments increases, the need to meet their accessibility needs for online resources also increases. Often times the Web serves as a means of breaking the social isolation felt by those with visual impairments. They are freed from physical constraints that may hinder them from making purchases, gaining information, or communicating with others.

While a number of powerful theoretical models have been developed to help make online resources more user friendly, little attention has been given to the specific needs of users with visual impairments. This research takes a basic step towards understanding factors that may help predict web usage behavior of this population. In particular, we examine *how accessibility may affect visually impaired users' use of a website*.[1] To investigate this phenomenon, a theoretically based model was developed to predict accessibility's impact on adoption behavior. The proposed model was tested using measures to evaluate the usage and accessibility of online audio book and music stores by the blind and visually impaired community. After discussions with members of this community via popular online message boards, phone conversations, and emails, we selected a popular online music and audio book store, Amazon.com, as a primary site for this study. The popularity and growth of this site is confirmed by recent reports. Amazon.com has invested more than $300 million in technology and content to build a digital-download business (Schonfeld, 2006). With millions of users visiting Amazon.com daily, it is fast becoming the largest promoter of digital downloads.

In what follows, we discuss background information and review the literature related to this topic before presenting our research model and the study's methodology. We then present and discuss our results, highlighting key contributions of this research.

2. Background

Audio and music recordings made to play on mobile devices, such as iPods and MP3 players, have become a ubiquitous part of our society and appear to be valuable resources to those with visual impairments. The Internet currently provides more multimedia than at its inception, yet it employs mainly visual means of delivering information to users. That is why, of all disability communities that use the Internet, people with visual disabilities have the most limited accessibility to it (Miyashita et al., 2007). The population of blind and visually impaired Internet users is growing rapidly. According to the American Foundation for the Blind, a conservative estimate of American computer users with visual impairments is 1.5 million. Of this 1.5 million (aged 15 and older), 979,000 use computers regularly (Gerber and Kirchner, 2001).

2.1. Visual disabilities

The most common types of visual impairment include myopia (nearsightedness), hyperopia (farsightedness), astigmatism, low vision, and total blindness (Paciello, 2000). Those with myopia, hyperopia, and astigmatism are often able to use corrective lenses to improve their vision. Low vision refers to chronic visual impairment that cannot be improved with corrective lenses or medical/surgical treatment. Over 135 million people worldwide (World Health Organization, 2007) and 3.5 million people in the US (Massof, 2006) have low vision, which ranges from mild to severe. Color blindness is a type of low vision that impairs one's ability to recognize certain pairs of colors. Roughly one in every 20 people has some kind of color vision disability (Cassin and Solomon, 1990). Finally, total blindness refers to complete lack of sight or no light perception. From a legal perspective, however, those whose vision cannot be improved to better than 20/200, and those who have 20° or less of their visual field remaining are considered legally blind (Paciello, 2000).

2.2. Accessibility technologies for blind and low-vision users

Numerous applications are available to enable and improve the computer use and Internet experience of people with visual impairments. These technologies can be divided into two groups: those that assist with input and those that assist with output. The most popular technology for input is speech recognition. It combines a piece of software and an input device (microphone or headset), allowing the user to speak commands that the software translates into system actions. This technology can also be used as a Dictaphone to create new text.

Output devices that assist those with visual impairments include: (1) screen magnifiers, (2) Braille displays, and (3) screen readers. Screen magnifiers refer to pieces of software that "zoom in" on the computer screen to provide larger text and images. Most GUI operating systems (OS) nowadays have an embedded screen magnifier that can enlarge selected areas. Braille displays are pieces of hardware that use pop-up pins to display Braille symbols that are usually 20–80 characters long. Screen reader software packages use

[1]Here, we use the expression *website use* interchangeably with *website acceptance*, or *website adoption*.

a synthetic voice to read text and computer commands aloud to the user. Earl and Leventhal (2000) have reported that JAWS® is one of the most widely used screen readers for Windows (Fig. 1).

2.3. Internet barriers faced by people with disabilities

Poorly designed websites create barriers for visually impaired visitors, similar to the way inadequately designed buildings prevent some physically disabled visitors from entering. Web developers often do not realize how simple features built into a webpage's source code can greatly assist those who cannot see a computer monitor. High speed Internet is becoming more widespread in the US and around the world, and the higher bandwidth is enabling Web designers to deliver more multimedia content. In turn, the line between software applications and webpages is becoming ambiguous. Some websites combine text, graphics, Flash animation, and video. Rendering these websites accessible to the visually impaired requires that every component be coded in a way that allows assistive technologies to access content. For example, Flash animation or online video should have captions that can be read to users via screen readers if the user chooses this option.

3. Literature review

In the previous section, we discussed barriers faced by visually impaired users when viewing online resources. Although these barriers are likely to affect how visually impaired users react to online resources, Information System (IS) user behavior models rarely take visual impairment into consideration. To determine which existing theories would be best for our investigation, we examined videotapes of several accessibility experiments conducted at a usability lab for a leading financial corporation. In these experiments, visually impaired users completed tasks that required them to navigate through several different websites. The users' behavior suggested that Davis's (1989) widely used Technology Acceptance Model (TAM) might be a good choice for our research. TAM suggests that people are likely to use a website if they find it easy to use and useful. TAM's prediction seemed to fit the behavior of the visually impaired users we observed in the videotapes. Though TAM has been successful in predicting user adoption behavior generally, it has not been used to examine the behavior of users with visual impairments, however. In fact, the acceptance literature suggests that TAM may need tailoring for populations with specific needs (Djamasbi et al., 2009; Hu et al., 1999). In predicting the acceptance behavior of more specific populations—healthcare professionals, for example—it may be important to examine how ease of use and usefulness affect user attitude (Djamasbi et al., 2009; Hu et al., 1999).

Some studies have shown that including relevant population-specific factors, in addition to those already in TAM, can provide a better explanation of acceptance behavior (Djamasbi et al., 2009; Holden and Karsh, 2010; Hu et al., 1999; Pare et al., 2006). The video recordings of visually impaired users that we watched suggested that including accessibility factors in TAM is likely to improve its explanatory power for this population. For example, the recordings showed that the reliability of access to information (or consistent quality of access) was an issue. On several occasions, users were unable to move to the next page because the designated buttons were not made accessible (were not "tagged" properly) for screen readers. Thus, while users were aware of a next page (and of its availability to non-visually impaired users), they were unable to access it. Additionally, the videos showed that access to information often was inconvenient because getting to it required many additional steps for the visually impaired users; again this happened because Web components were not properly labeled for the screen reader. Thus, the video recordings suggested that constructs that capture the level at which access to information on a site is reliable and convenient, in addition to TAM constructs, may be particularly helpful in understanding the Web experiences of visually impaired users because these factors are likely to affect the ease of site navigation.

Culnan's (1984) well-established behavioral theory takes these additional constructs into account. We adopted those constructs, specifically, users' perceptions of reliability and convenience of access to information, when developing our

Fig. 1. Example of screen reader.

own model of how visually impaired users' perceptions of a website's accessibility might affect their use of it. Both TAM and the variables introduced by Culnan have been independently validated on users without visual disabilities; however, rarely have they been used together and/or included in studies involving visually impaired users.

In what follows, we briefly review relevant literature on technology acceptance and on the accessibility variables that were used to develop the proposed model in this study.

3.1. Technology acceptance model

TAM (Fig. 2) was derived from the Theory of Reasoned Action (1979) to investigate individuals' adoption of a technology (Davis, 1989; Davis and Kottemann, 1995; Morris and Dillon, 1997; Szajna, 1996; Venkatesh, 1999; Venkatesh and Davis, 2000; Venkatesh et al., 2003). TAM posits that the major factors that influence user acceptance are perceived usefulness and perceived ease of use of the technology. *Perceived usefulness* is the degree to which a person believes that his or her performance will be enhanced by the use of a technology (Davis, 1989). A significant part of the TAM research suggests that perceived usefulness has a strong influence on user usage behavior (Davis, 1989). *Perceived ease of use* refers to the extent to which one thinks that the system will be free from effort (Davis, 1989). Though both factors correlate significantly with actual usage of the technology, perceived ease of use affects intention to use a technology directly as well as indirectly (via perceived usefulness). This implies that increasing users' perceived ease of use may increase their acceptance of the technology. The indirect relationship can be explained in that the easier a technology is to use, the more useful it can be. TAM has demonstrated that the direct relationship between perceived ease of use and behavioral intention to use is most relevant, while the indirect relationship via perceived usefulness is less important to technology users.

TAM has been validated and has been used to test users' acceptance of Web-based systems under a multitude of conditions: general Web usage (Agarwal and Karahanna, 2000; Riemenschneider et al., 2003); online shopping (Devaraj et al., 2002; Lin and Lu, 2000); online learning (Cheung et al., 2002) and others (King and He, 2006). Years of testing have proven it to be a "powerful and robust predictive model of a person's willingness to accept and use a technology" (King and He, 2006, p. 751). Although Davis (1989) originally considered the inclusion of antecedents to components of TAM, he concluded that the antecedents were fully mediated by perceived ease of use and perceived usefulness. More recent research, however, has shown that antecedents to components of TAM are relevant and enhance its predictability and practicality (Davis and Yi, 2011; Anderson et al., 2011; Venkatesh, 1999; Venkatesh and Davis, 2000). In other words, incorporating these antecedents into TAM allows those examining technology acceptance behavior to develop more actionable strategies for improving IS usage. Like others, we chose TAM as a foundation on which to build a better model, in our case, for our own investigation of the impact of accessibility on the acceptance behavior of visually impaired users.

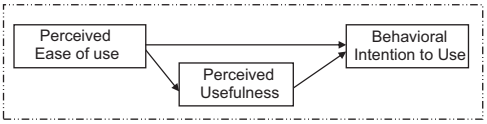

Fig. 2. Technology acceptance model, Davis (1989).

3.2. Accessibility variables: convenience and reliability

Culnan's (1984) work, grounded in organizational communication literature, suggests that the degree to which a user believes that an online resource is accessible to him or her has a significant impact on the user's acceptance of that resource. According to this conceptualization, accessibility of an online resource consists of two independent dimensions: physical accessibility and information accessibility. Physical accessibility refers to the extent to which a device is physically available to the user. For example, to access websites, users need to have an electronic device such as a computer or a cell phone. Information accessibility refers to the extent to which a user can employ a system to reach information. In regard to websites, users would need to be able to employ whatever delivery system is in place, i.e., to see and click links that lead to a site's information, to read printed information, or to hear audio files on the site.

According to Culnan, information accessibility can be divided into three perceptual sub-dimensions: convenience, reliability, and ease of use. *Perceived convenience* pertains to the degree to which a user perceives a system to provide unobstructed and convenient access to the desired information. *Perceived reliability* refers to the degree to which a system is thought to be consistent in providing dependable, failure free, and reliable access to information. Finally, *perceived ease of use* refers to the extent to which a person finds the system easy to use. It also includes perceptions of friendliness, flexibility, and forgiveness when a user makes a mistake, such as clicking an incorrect link.

A number of studies support Culnan's work by demonstrating that accessibility can affect user behavior. For example, information accessibility has been found to affect email use (Karahanna and Limayem, 2000) as well as use of virtual learning communities (Teo et al., 2003). Yuan et al. (2011) showed that access to online resources plays a significant role in knowledge workers' decisions to retrieve needed information. Ilie et al. (2009) showed that both information accessibility and physical accessibility of online resources affect physicians' decisions to use electronic medical health records. Physical accessibility was also found to affect adoption and use of an electronic messaging system (Rice and Shook, 1988). Karahanna and

Straub (1998) found that physical accessibility affects this technology's use through its influence on ease of use.

4. Research model

Although TAM has been validated in many different studies (Davis, 1989; Davis and Kottemann, 1995; Morris and Dillon, 1997; Szajna, 1996; Venkatesh, 1999; Venkatesh and Davis, 2000; Venkatesh et al., 2003), it has not been tested for visually impaired users. Similarly, while Culnan's (1984) accessibility variables have been shown to affect users' perception of usefulness and/or ease of use (Karahanna and Limayem, 2000; Teo et al., 2003), they have not been tested for this population either. TAM and accessibility variables are relevant, however. When site information is not easily retrieved by screen readers, visually impaired users may have to exert more effort to use the website; this may affect their willingness to use the technology. In this section, we argue that together TAM and information accessibility variables (Culnan, 1984) can provide a more comprehensive picture of acceptance behavior for visually impaired users.

Culnan (1984) suggested that usage behavior is affected by the degree to which users perceive a device is available to them (physical access) as well as the degree to which they believe the desired information on that device is accessible to them (information accessibility). Because access to computers and the Internet is so prevalent today (i.e., people have the ability to physically get to a computer and use it to access the Internet), we focused on the information accessibility construct which looks at the ability to access information once a user is on the Internet. Prior research suggests that the sub-dimensions of information accessibility can impact TAM constructs differently. In particular, in their study of email usage, Karahanna and Limayem (2000) showed that users' perceptions about reliability of their access to information acted as an antecedent to their perception of email's usefulness. Their perception of the convenience of information accessibility had no significant effect on how useful they perceived email to be. These results suggest that including the information accessibility sub-dimensions as independent constructs in our model is likely to provide a more nuanced explanation of user behavior.

In the following section, we present hypotheses that informed our proposed model. We then explain how we tested our model via a laboratory experiment, which was setup to provide a uniform and concrete experience in which to collect data from users, rather than a structure in which to manipulate any study variables. The goal is to see if the modified TAM model lends understanding to usage behavior for people with visual impairments.

5. Hypotheses

Traditional acceptance models have shown that, all else being equal, the easier a system is to interact with, the less effort it will take to use (Davis, 1989). This seems especially relevant to those with visual impairments because webpages tend to be more graphic-intensive and often are geared toward sighted people (Everard and Galletta, 2005–2006; Jones, 2004; Loiacono and McCoy, 2004). Designs that do not include the needs of visually impaired users can make access to certain information for these users inconvenient by requiring them to take many additional steps. As we mentioned earlier, our videotaped usability sessions showed that improper labeling of certain buttons prohibited visually impaired users from going to the next page by clicking on those buttons. While some technically savvy users were able to get there by using the search feature, this required additional steps (typing in the search feature and clicking on several results until the proper page was found).

A website's lack of adherence to accessibility standards can affect the user's perception of reliability of information access on a website as well. Similarly to the above example on inconvenience, many webpages provide a summary or a headline followed by a "click here" or "read more" link. Access to information on such pages can be problematic if the headlines and their corresponding "read me" links are not properly labeled. Under these conditions, visually impaired users who utilized screen readers had difficulty orienting themselves. The incorrect tagging gave inconsistent access to information; if there were only one headline, the users were able to follow the link, but when there were multiple headlines, they could not discriminate between the links. This gave them the impression that the access to the information on the website was not reliable.

Poor designs, such as those explained above, make access to certain information more error prone for those who use screen readers. This, in turn, can affect a user's perception of how easy a webpage is to use and how useful it is overall. Thus, when a user perceives that access to information on a webpage is inconvenient and/or unreliable, it is likely that the user will find it hard to use the webpage and in turn less useful as well. In other words, perceived convenience and/or reliability of access to information are likely to affect the perceived ease of use and perceived usefulness constructs in TAM. Because prior research provides evidence that perceived reliability and convenience are independent construct and may not *both* affect TAM constructs in the same way (Karahanna and Limayem, 2000), we tested the effect of these two sub-dimensions of information accessibility on perceived ease of use and perceived use separately:

H1a. Perceived convenience will have a significant impact on perceived ease of use.

H1b. Perceived convenience will have a significant impact on perceived usefulness.

H2a. Perceived reliability will have a significant impact on perceived ease of use.

H2b. Perceived reliability will have a significant impact on perceived usefulness.

Lack of adherence to certain accessibility standards can seriously affect access to information for a visually impaired

user. When a screen reader is unable to read parts or all of a page, a user who cannot see the page is likely to perceive that access to information on the page is inconvenient. In order to get around such a problem, these users often must take additional steps that are not required by sighted users. Even worse, inadequate tagging of web components denies access to those components and renders the website an unreliable source of information because it does not provide dependable access to all of its components. Providing information is a major function of websites; thus, it is reasonable to argue that perceived convenience and perceived reliability of the system that provides accessibility to website information are likely to have a direct impact on a person's behavioral intention to use the site, especially when it comes to those with visual impairments. Hence, we hypothesized that perceived convenience and perceived reliability (sub-dimensions of information accessibility) are also likely to have a direct effect on the acceptance behavior of visually impaired users.

H3. Perceived convenience will have a significant impact on behavioral intention to use.

H4. Perceived reliability will have a significant impact on behavioral intention to use.

TAM is an intuitive model that predicts people will use a system if they find it easy to use and useful. This model has been verified through numerous studies of different technologies (including websites) (Benamati et al., 2000; Davis and Kottemann, 1995; Karahanna and Limayem, 2000; King and He, 2006; Morris and Dillion, 1997; Venkatesh, 1999). Although this model has not been tested with visually impaired users, we expected that this intuitive model would also hold for this population. While visually impaired users have needs other than those of sighted users, they too are likely to accept a website only if they find it easy to use and useful. Thus, similar to other usage studies using TAM, we predicted that all TAM relationships would hold for the visually impaired population as well (Fig. 3).

H5. Perceived ease of use will have a significant impact on perceived usefulness.

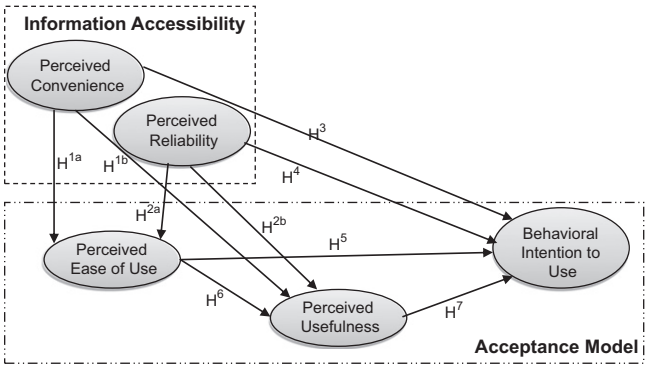

Fig. 3. Research model with hypotheses.

H6. Perceived ease of use will have a significant impact on behavioral intention to use.

H7. Perceived usefulness will have a significant impact on behavioral intention to use.

6. Methodology

In this section, we describe the study's participants, their assigned task, and the procedures for data collection and analysis.

6.1. Participants

Subjects were recruited via online forums, mailing lists, and bulletin boards for blind and low-vision users. Requests for participation were also emailed to a number of blind Web users who had heard about the study from friends.

All subjects were experienced Internet users who volunteered to participate. A total of 59 subjects participated, which is sufficient for use of Partial Least Squares (PLS) analysis (Chin and Newsted, 1999; Vinzi et al., 2010). Of the 59 subjects studied, 18 were female. Their ages ranged from 19 to 58, with a mean age of 35.76 years. Participants had a range of visual impairments, including low vision and various levels of blindness (Table 1). Of this population, 95% were using the Internet on a daily basis, and 97% said they had a medium-to-high level of experience using computers. 100% stated that they used the Internet for email and/or instant messaging as well as for browsing. Approximately 80% of the subjects had purchased items online previously. 40 of the subjects reported using screen readers, such as JAWS or VoiceOver, and 39 indicated using corrective lenses.

6.2. Procedure

After agreeing to participate, subjects were directed to the experiment website where they first completed a consent form. After completing the form, they were given instructions on how to proceed with the experiment. The entire experiment was estimated to take no longer than half an hour and consisted of the following steps: (1) providing demographic information, (2) performing the first experimental task at the first website visited, (3) completing the experimental survey

Table 1
Number of participants with specific visual impairments.

	No. of participants
Nearsighted	16
Farsighted	5
Astigmatism	4
Low vision	9
Partially blind	11
Completely blind	14
Color blind	0

Note. Subject in this study were solicited from online resources for blind and low vision users.

for the first website visited, (4) performing the second experimental task at the second website visited, and (5) completing the experimental survey for the second website visited. The survey measured the variables of interest: users' perceptions of accessibility and their degree of technology acceptance. Participants were presented with questions and a dropdown menu of response options. From our previous interaction with visually impaired users, we determined that dropdowns were the easiest presentation format. They allowed screen readers to convey the survey in an understandable manner to those who were completely blind as well as to those with less severe visual impairment. After completing the surveys, the respondents were presented with a thank you message and were reminded that they were entered to win a $100 Visa gift card.

6.3. Task

Each subject was required to visit Amazon.com and performed a task that required them to look up the title of the fifth song on a specified album. In other words, participants found the title of the fifth song for the album "Come Away with Me" by Nora Jones or find the title of the fifth song for the album "It's Time" by Michael Buble. The task appeared on a separate page that provided the instructions for completing the task as well as the link to Amazon.com. The participants were instructed to (1) go to the designated website by clicking on the link to find the fifth title of the specified album, (2) after completing the task, come back to the task page by pressing ALT and F4 if a PC user and CMD and W if a Mac user, (3) enter their answer in the specified textbox on the task page, and (4) submit the answer after entering it in the textbox by pressing the Submit button on the page. After pressing Submit, the participants were directed to a page that contained the TAM and accessibility surveys. After completing the surveys, participants were required to click Submit to move to the next step. Clicking Submit redirected the participants to the task page that provided the instructions for the second task. This arrangement ensured that the questionnaires were presented to users after each task.

Despite the above arrangement, it was possible for some participants to type the answer in the textbox without referring to the designated webpage. Our data showed that this probably did not happen, however. All participants clicked on the link that redirected them to the designated website (Amazon). Second, the average task completion time was about 4 min, with the standard deviation of 24 s. These data suggest that the questionnaires were probably completed after the task was completed.

6.4. Measurements

The survey questions (see Appendix B) were adopted from scales that have been used and validated in previous accessibility (Culnan, 1984) and technology acceptance (Davis, 1989) studies. Culnan (1984) provides a robust tool for measuring a user's perception of information accessibility. Similarly, TAM (Davis, 1989) offers a powerful and efficient tool for capturing user acceptance behavior. Some studies have applied these measures successfully in investigations of e-commerce (Djamasbi et al., 2006), but so far, neither of the scales has been used to assess the accessibility of online audio and music stores for visually impaired users.

7. Results

Table 2 contains the descriptive statistics for the variables used in this study. All 59 subjects responded to each variable. The standard deviations appear to be low, less than the mean average, indicating that the responses are close to the mean and are thus within an acceptable range. Construct validity and reliability were determined through several analyses. First, in order to ensure the items measuring each construct were properly related, composite reliabilities were calculated for each construct (Ringle et al., 2005). Table 3 shows all constructs exhibited good reliability. Each construct's reliability measure was well above the acceptable 0.70 cutoff point (Nunnally, 1978; Nunnally and Bernstein, 1994).

The data was analyzed using the Partial Least Squares (PLS) method with bootstrapping, since it is a SEM technique which is better suited for use in theory development than its SEM counterparts. (Chin et al., 1996, 2003; Gefen and Straub, 2005). Convergent and discriminant validities were evaluated as in (Gefen et al., 2000), using: (1) factor item loadings and (2) average variance extracted (AVE). Convergent validity is revealed by the loading of all variables on their designated (theoretical) factor at a significance level of $p < 0.001$. Some items (PEU3, PCON2, PREL1, and BIU3) did not load clearly on their theoretical factors and so were removed. As Table 4 shows, the remaining variables loaded as expected on their theoretically designated construct.

In addition, the AVE for each construct (Table 3) was at least 0.809 or higher, well above the 0.50 recommended threshold (Fornell and Larcker, 1981). In terms of

Table 2
Item descriptive statistics.

	N	Minimum	Maximum	Mean	Std. deviation
PU1	59	2	7	5.97	1.26
PU2	59	1	7	5.42	1.71
PU3	59	1	7	5.73	1.61
PEU1	59	1	7	5.51	1.64
PEU2	59	2	7	5.76	1.78
PEU4	59	1	7	5.75	1.52
BIU1	59	1	7	5.88	1.60
BIU2	59	1	7	5.47	1.95
PCON1	59	1	7	5.00	1.63
PCON3	59	1	7	5.17	1.68
PCON4	59	1	7	5.05	1.73
PREL2	59	2	7	5.64	1.27
PREL3	59	1	7	5.20	1.62
PREL4	59	1	7	5.66	1.47

Table 3
Construct discriminant & convergent validity.

	CR	AVE	PCON	PEU	BIU	PREL	PU
Perceived convenience	0.930	0.815	**0.903**				
Perceived ease of use	0.927	0.809	0.687	**0.900**			
Intention to use	0.895	0.810	0.639	0.706	**0.900**		
Perceived reliability	0.941	0.843	0.761	0.630	0.666	**0.898**	
Perceived usefulness	0.928	0.811	0.664	0.761	0.732	0.731	**0.900**

Note. CR = Composite Reliability. AVE = Average Variance Extracted. Squared AVEs are indicated on diagonal in bold.

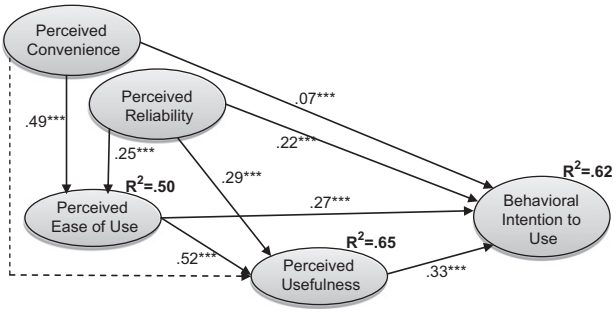

Fig. 4. Research model results. *Note*: $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$. Dotted line indicates a non-significant path.

Table 4
Item cross loadings.

	CON	EOU	INTENT	REL	USE
BIU1	0.534	0.704	**0.910**	0.491	0.717
BIU2	0.620	0.561	**0.890**	0.662	0.595
PEU1h	0.668	**0.933**	0.708	0.622	0.785
PEU2	0.627	**0.910**	0.643	0.638	0.765
PEU4	0.546	**0.854**	0.530	0.393	0.440
PCON1	**0.930**	0.636	0.577	0.772	0.655
PCON3	**0.902**	0.561	0.584	0.656	0.601
PCON4	**0.875**	0.662	0.569	0.704	0.539
PREL2	0.659	0.580	0.602	**0.919**	0.607
PREL3	0.747	0.521	0.433	**0.870**	0.590
PREL4	0.625	0.585	0.631	**0.923**	0.686
PU1	0.575	0.690	0.714	0.603	**0.908**
PU2	0.694	0.729	0.688	0.660	**0.941**
PU3	0.514	0.634	0.565	0.599	0.**849**

All are significant at level $p < 0.001$.

discriminant validity (see Table 4), all items loaded strongly on their designated theoretical construct and were at least 0.10 (an order of magnitude) higher than any cross loading (Gefen and Straub, 2005). Further, the squared roots of the AVE (diagonal elements in Table 3) have loadings of 0.898–0.903, which are higher than the cross loadings between constructs (Gefen et al., 2000). This analysis further supports discriminant validity. A final test was conducted to ensure there was no issue with multi-collinearity. The variance inflation factors (VIFs) were calculated and indicated no collinearity problems. All VIFs were less than 6, substantially lower than the recommended cutoff of 10 (Neter, 1989; Petter et al., 2007).

Once we established that the reliabilities and validities of the constructs were supported, we tested our proposed model (Fig. 4) using PLS through the SmartPLS package (Ringle et al., 2005). The results support the hypotheses and clarify the relationship between certain variables.

The first set of hypotheses (H1a and b) posited that a positive relationship would exist between the perceived convenience of a website and its perceived ease of use as well as its perceived usefulness. Similarly, the second set of hypotheses (H2a and b) speculated that the perceived reliability of access to a website would positively influence its perceived ease of use and perceived usefulness. Though H1a was supported (path coefficient of 0.49 ($p < 0.001$)) and perceived convenience does impact perceived ease of use, H1b was not supported. Perceived convenience does not appear to affect a person's evaluation of a website's ease of use. On-the-other-hand, both H2a and b were supported. Perceived reliability does impact perceived ease of use with a highly significant path coefficient of 0.25 ($p < 0.001$). Similarly, perceived reliability impacted perceived usefulness. The path coefficient was 0.29 and was highly significant at $p < 0.001$ as well.

In addition to their impact on perceived ease of use, perceived convenience and reliability were predicted to directly affect a visually impaired person's intention to use a website. Specifically, the third hypothesis (H3) predicted that the perception of convenience would directly impact intention to use. The fourth hypothesis (H4), anticipated that perceived reliability would directly affect a visually impaired person's behavioral intention to use a website directly. Perceived convenience did directly impact participants' intention to use a website directly (H3, path coefficient of 0.07, $p < 0.001$). Additionally, our analysis supported a direct relationship between perceived reliability and a visually impaired person's behavioral intention to use a website (H4, path coefficient of 0.22, $p < 0.001$).

Our data supported the three hypotheses related to TAM. The fifth hypothesis (H5) predicted that perceived ease of use would impact perceived usefulness. This was supported with a highly significant path coefficient of 0.52 ($p < 0.001$). Further, the sixth hypothesis (H6) suggested that perceived ease of use would have a direct impact on a visually impaired person's behavioral intention to use a website. This was confirmed with a strongly significant path coefficient of 0.27 ($p < 0.001$). Lastly, hypothesis seven (H7) postulated that perceived usefulness would have an impact on a visually impaired person's intention to use a site. This was indeed supported with a path coefficient of 0.33 ($p < 0.05$). This is consistent with previous research which has shown that perceived ease of use can have a direct effect on intention to use a system, while also having an indirect one. Perceived ease of use can affect behavioral intention indirectly through its impact on perceived usefulness. Fig. 4 depicts the research model tested and reports the statistical results.

We ran additional analyses with the data, focusing on the TAM and the accessibility variables individually. We found that our proposed model was more explanatory of a visually impaired user's behavioral intention to use an audio or music website. Although the entire TAM was supported, its overall R^2 was 0.59. This R^2 is less than the proposed model's: 0.62. Our results showed that the perceived reliability and perceived ease of use had a significant impact on a visually impaired person's intention to use a website, but our data did not support a significant link between perceived convenience and intention to use a website. The R^2 for the accessibility variable alone was 0.49. This indicates the importance of including the accessibility variable in TAM. The combined results show that the proposed model appears to capture a greater amount of variance as compared to TAM or the accessibility variables alone.

7.1. Additional exploratory analysis

Although the main focus of this research was to develop a model to help explain visually impaired persons' behavioral intentions to use websites, we conducted additional exploratory analyses to provide more insight into our results. First, we tested our proposed model (using PLS) on those with a higher degree of visual impairment (i.e. partially and completely blind users) separately from the rest of the visually impaired users in our study. Our analysis revealed that the link between perceived ease of use and behavioral intention to use was different between the two groups. The link was significant for users with a lower degree of visual disability (low vision), but not significant for those with a higher degree of visual disability (blind). These results together suggest that the level of visual impairment may indeed affect acceptance behavior and that future studies are warranted to examine this possibility.

In addition, we conducted an analysis to see whether there were any differences between the acceptance behavior of visually impaired and sighted users. We collected information from an additional 22 users who were sighted. We used SmartPLS to run our analysis, which revealed that estimates of our proposed model were supported for the sighted as well as the visually impaired users in our study. This analysis also revealed that the proposed model was supported with an overall model R^2 of 0.66 for sighted users. This exploratory investigation suggests that our proposed model also may lead to a deeper understanding of sighted users' acceptance behaviors. Further research is warranted.

8. Discussion

The results of our analysis show that all of the hypotheses were supported except one. Hypothesis 3 asserted that perceived convenience would have a significant impact on a visually impaired person's intention to use the website. Contrary to our expectations, the results did not show a significant path between perceived convenience and intention to use for visually impaired users. Perceived convenience, according to our results, affected intention to use only indirectly, through its effects on perceived ease of use.

Several findings are worth further discussion. First, the results show that the proposed model has a strong explanatory power ($R^2=0.62$). Second, the analysis shows that the explanatory power of the proposed model ($R^2=0.62$) was greater than that of the TAM ($R^2=0.59$) or of the accessibility variable ($R^2=0.49$) separately. Third, the proposed model provides a more nuanced explanation of acceptance behavior because it considers more factors than those included in either the TAM or the accessibility variables alone. Thus, the proposed model more fully explains the acceptance behavior of people with visual impairments. As the results indicate, perceived reliability has a significant and direct impact on the user's intention to use a website. Further, perceived convenience and reliability have a significant impact on perceived ease of use of a website as well ($R^2=0.50$), indicating a partial direct effect on acceptance as well as an indirect effect through perceived ease of use. This shows that visually impaired users' intention to use a website depends on (1) their perceiving it as accessible (i.e., perceiving it as providing reliable access to information), (2) their perceiving it as easy to use (i.e., easy to learn and navigate), and (3) their perceiving it as useful. In other words, visually impaired users, similar to sighted users, evaluate an IS based on its perceived ease of use and perceived usefulness. Additionally, however, information accessibility (i.e., reliability of access to information) plays a particularly important role in a visually impaired user's evaluation and decision to use a site.

Our exploratory results show that information accessibility was also an important factor for the acceptance behavior of those users who did not have visual impairments. The exploratory results provide further support for studies that include information accessibility as a potential factor in the acceptance behavior of users without disabilities (e.g., Karahanna and Limayem (2000)), but these results also offer additional insight. The exploratory analysis suggests that accessibility may affect the acceptance behavior of users with visual impairments differently than those users without visual impairments. Specifically, our analysis showed that perceived convenience affected acceptance behavior of visually impaired users only indirectly. But for those without visual impairments, the impact of perceived convenience on acceptance was both direct and indirect. Additional research is required.

Previous research has shown that professionals benefit from an acceptance model that is tailored to their specific needs (Yi et al., 2006; Djamasbi et al., 2009; Hu et al., 1999). Just as this previous research has called for some modification of TAM for specific populations, such as healthcare professionals, the current research suggests that TAM may need modification to include factors relevant to visually impaired users. The strong explanatory power of our proposed model suggests that acceptance behavior of people with visual impairments may be explained more fully by including factors that are currently not captured by TAM.

Additionally, our exploratory analysis showed some differences in construct relationships between users with and without visual impairment, highlighting the need for a model that might predict the acceptance behavior of visually impaired users specifically. Given that acceptance models, including TAM, have not been tested with this particular population (Djamasbi et al., 2006), our study has important implications. First, as explained above, the results indicate that traditional models of acceptance may need to be modified for visually impaired users. We found that information accessibility (through perceived convenience and reliability) has a direct impact in predicting user acceptance behavior, along with perceived ease of use and perceived usefulness. Second, our exploratory analysis showed that perceived convenience and reliability may also affect the acceptance behavior of users without visual impairments. These results provide further support for including information accessibility dimensions within the traditional TAM to better explain the behavior of users without visual disability (Zimmer et al., 2008). For example, as in studies of email use (Karahanna and Limayem, 2000) or webpage use (Zimmer et al., 2008), factoring in information accessibility can lend additional insight into a user's decision to use an IS.

In addition to making theoretical contributions, our results have several important practical implications. The results may be particularly important to those companies that target Baby Boomers and older generations is that aging is one of the major causes of visual impairment. The results show that paying careful attention to accessibility standards that assure convenient and reliable access to information is likely to increase the number of visually impaired users who revisit a company's site, affecting the return on the company's IT investment.

The results also show that designers benefit from including visually impaired users in their tests. As the results indicated, the impact of information accessibility on acceptance behavior was different between those with and without visual impairments in our study. Designers can include simple modifications, such as adding correct tagging to improve the user experience for those with visual impairments, while maintaining the site's performance for sighted people. Through early accessibility tests, designers can assess the effectiveness of their improvements (e.g., proper tagging) for visually impaired users.

Further, by helping those with disabilities access websites, companies can better serve their sighted customers as well. One such example is by providing an alternative, non-Flash site for users with screen readers. The multimedia nature of Flash (combining text, audio, video, and graphics) offers a potentially richer way for sighted and hearing users to experience a website, but it also makes access difficult for those who require the use of screen readers. The bandwidth-intensive content contained in Flash has caused sighted users to encounter long delays when accessing Flash-enabled sites on their mobile devices. Thus, by providing alternative, non-Flash sites, both sighted and visually impaired users will benefit. This is likely to result in an increase perception of the site's reliability and ease of use.

9. Limitations and future research

As with any experiment, it is difficult to assess the generalizability of the results beyond the context studied. Future research should test the extent to which our results generalize to broader contexts (employing different web genres, tasks, etc.).

In this research, we tested our model with users from a large cross section of visual disability groups. More in-depth studies focusing on specific visual impairments and/or examining differences in acceptance behavior between users in different visual disability groups may be helpful as well. For example, examining possible differences between the acceptance behavior of blind users and those with low vision (or those who are color blind) is likely to refine our results. In doing so, we might understand more about the special concerns of visually impaired users and what can be done to enhance their website use in particular.

In this study we did not examine the impact of the physical dimension of accessibility to information. The availability of different assistive technologies (e.g., brail vs. screen reader) or lack of them, may affect acceptance behavior of visually impaired users. Thus, future studies may compare model results based on use of different assistive technologies.

Moreover, future research can test the proposed model with users who possess disabilities that are not visually related. Such studies could expand the generalizability of our findings or reveal its limitations. For example, those with cognitive impairments may value different aspects of information accessibility when evaluating an audio site.

While all participants in our study completed the same tasks, they were allowed to use different assistive technologies. This may have caused the task to be easier for some of the participants than others. We did not control to see how challenging the participants perceived the task to be. Thus, future research is needed to test whether the perception of task difficulty can affect the study results.

Our data showed that the majority of our participants (97%) were able to complete the tasks in our study. It is likely, however, that failure to complete tasks can affect acceptance behavior. Thus, future studies can be designed in a way to test this relationship.

Adam and Kreps (2006) have argued that, in addressing problems with web access, web designers "would benefit from a critical approach…married to continuing efforts in the technicalities of Web standardization….[This] means having disabled people completely involved in the design and testing of websites and the development of Web accessibility standards" (Adam and Kreps, 2006, p. 215). (Adam et al., 2004) suggested that Internet research has failed to adequately address disabilities across cyberculture studies. As with gender, which has only recently been seen as a "social category" in IS, disability has not been considered as a social category (Adam, 1998). Thus, to truly understand visually impaired users and

their website needs, future studies will need to include these groups in the development and testing of sites, not after the fact, but as they are being created. Research into how such users can be integrated into the design and development of websites is a critical area for future work.

10. Conclusions

The contribution of this research is two-fold. First, it is one of only a few, if any, studies that framed the investigation of technology acceptance for people with disabilities within the context of a theoretical model. By applying such a model to the accessibility literature, we were better able to understand access issues for visually impaired users. Second, we have developed a model that examines the impact of accessibility in the context of a technology acceptance model, thus providing a deeper understanding of how visually impaired users accept or reject a technology. Our research provides one of the first theoretical, conceptual models on accessibility and is one of only a few studies to examine technology acceptance while considering the needs of the visually impaired. Third, given the high level of disposable income ($175 billion) of those with disabilities, industries will find it to their fiscal advantage to develop sites that consider the needs of those with visual impairments. This is especially critical as the affluent Baby Boomer generation ages and is faced with a multitude of vision problems. They are likely to need (and thus demand) additional measures to ensure their access to websites.

Appendix A. Web accessibility standards

The ***World Wide Web Consortium*** (*W3C*) is the main international standards organization for the World Wide Web. It was founded in 1994 to improve the World Wide Web by publishing Web standards and guidelines called the W3C Recommendations (W3C, 2008). It is responsible for the development of uniform protocols to assure the interoperability of the Web. The consortium consists of member organizations that maintain full-time staff for the purpose of working together in the development of standards for the World Wide Web. As of December 2006, the W3C had 429 members and was open for new organizations to join. Other W3C activities include education and outreach, software development, and discussions about the Web. The Consortium is administered by the MIT Computer Science and Artificial Intelligence Laboratory (CSAIL) in the US, the European Research Consortium for Informatics and Mathematics (ERCIM) (in Sophia Antipolis, France), and Keio University (in Japan). There are also offices in 15 regions around the world (W3C, 2008).

The W3C started the ***Web Accessibility Initiative*** (*WAI*) as an effort to improve the accessibility of the Web for people with physical disabilities who require special devices and software to access the Web. The WAI has developed a number of guidelines that can help to make Websites more accessible. Further, it ensures that the current core technologies of the Internet support accessibility, designs evaluation and repair tools for accessibility and coordinates the research and development the efforts on accessibility for the Web (Web Accessibility Initiative, 2007).

Of the guidelines the WAI developed, the ***Web Content Accessibility Guidelines*** (*WCAG*) are generally accepted as the classic guidelines for creating websites which are accessible to all. The guidelines are organized in a checklist/checkpoint format. The checkpoints are prioritized based on three levels (Website Content Accessibility Guidelines, 2007). According to the document, there are several priority levels. Priority 1: A Web content developer *must* satisfy this checkpoint. Otherwise, one or more groups will find it impossible to access information in the document. Thus, satisfying this checkpoint is a basic requirement for some groups to be able to use Web documents. Priority 2: A Web content developer *should* satisfy this checkpoint. Otherwise, one or more groups will find it difficult to access information in the document. Thus, satisfying this checkpoint will remove significant barriers to accessing Web documents. Priority 3: A Web content developer *may* address this checkpoint. Otherwise, one or more groups will find it somewhat difficult to access information in the document. Thus, satisfying this checkpoint will improve access to Web documents. (A complete set of the new guidelines can be found at: http://www.w3.org/TR/WCAG20/).

The ***Americans with Disabilities Act*** (*ADA*) is a wide ranging piece of legislation which was devised to make the American society more accessible to people with disabilities. It expanded the Rehabilitation Act regulations of 1973 to include all public and commercial facilities regardless of whether they receive federal funding. It applies to many types of public places: restaurants, retailers, movie theaters and health care institutions. Its homepage http://www.ada.gov provides links to technical materials, publications, and proposed changes to ADA regulations. Some of the proposed regulations are associated with Web accessibility. The laws for many of the new services and goods websites are unclear, as the entities do not have a physical location for their customers. For those, the ADA website provides an online course for businesses entitled, "Reaching out to Customers with Disabilities".

One of the most recent and widely applied regulations that directly addresses the need for accessibility over the Internet is ***Section 508***. It refers to Section 508 of the US Rehabilitation Act amended by Congress in 1998. It requires that individuals with disabilities, who are members of the public seeking information or services from a federal agency, have access to and use of information and data that is comparable to that provided to members of the public who do not have disabilities unless an undue burden would be imposed on the agency (Section 508, 2007). It also requires that when Federal agencies "develop, procure, maintain or use electronic and information technology" they must ensure that this technology allows federal employees and members of the public with disabilities to have access to and use of information.

Section 508 does not generally apply to private sector businesses and their websites. In contrast, companies in the UK have an obligation on all websites offered to the public: they must be accessible and usable by disabled people. Other countries follow the UK approach. In August of 2006, the United Nations published a draft International Convention on the Rights of Persons with Disabilities. It addresses Web accessibility among other issues. Section 508 standards tend to define the minimum level of Web accessibility, while the WCAG represent higher level of accessibility. Overall, the WCAG is more detailed (restrictive) in terms of describing specific guidelines. Unlike Section 508, WCAG Version 2.0 provides guidelines focused not only on HTML but also on other Web technologies. Section 508 lacks regulations on dynamic content, auditory descriptions, language selection. On the other hand, the WCAG does not include specific guidelines for timed responses and the ability to skip navigation. The new regulations have drawn national and international attention because of their implications on every retailer, business and organization that maintains an online presence http://www.jimthatcher.com/sidebyside.htm/.

Though many laws exist to govern the access to information and technology by those with disabilities, several ***lawsuits*** have been filed to test ambiguities in these laws. In April of 2000, for example the National Federation for the Blind (NFB) filed an Americans with Disabilities Act (ADA) lawsuit against the Connecticut Attorney General's Office. The Internal Revenue Service (IRS) official website provided links to four inaccessible online tax filing services (Intuit, HDVest, H&R Block, and CioCia). The four tax filing services agreed to make their websites accessible in time for the next year's tax season. In a more recent case filed in 2006, the NFB is sued Target.com, alleging that the department store discriminates against the visually impaired by violating state and federal laws that protect the disabled. All these instances and more indicate that the ADA, Section 508 and the WCAG are not just guidelines that can be overlooked, but are strong legislative tools to protect the interest of a large segment of the nation.

Appendix B. Survey questions (construct labels added here)

For each of the following questions please indicate your opinion about this online store

Usefulness (PU)
1. I find the iTunes store to be useful.
2. Using the iTunes store enhances my effectiveness in finding information.
3. I find the information in the iTunes store interesting to me.

Ease of use (PEU)
4. My interaction with the iTunes store was clear and understandable.
5. I find the iTunes store to be easy to use.
6. Interacting with the iTunes store did not require a lot of my mental effort.
7. I find it easy to get the iTunes store to do what I want it to do.

Behavioral intent to use (BIU)
8. Previously, I have visited the iTunes store.
9. I intend to use the iTunes store.
10. I predict that I would use the iTunes store in the next 6 months.

This online store is:

Convenience (IACON)
15. Close/Remote
16. Convenient/Inconvenient
17. Nearby/Distant
18. Unobstructed/Obstructed

Reliability (IAREL)
19. Certain/uncertain
20. Dependable/undependable
21. Failure-Free/failure-Prone
22. Reliable/unreliable

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