Usability and Accessibility Comparison of Governmental, Organizational, Educational and Commercial Aging/Health-Related Web Sites

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Abstract:

This study is aimed at answering whether aging/health-related web sites of different domain extensions (i.e. .com, .edu, .gov and .org) differ in their accessibility and usability, and whether these two measures are correlated. The usability and accessibility of governmental, organizational, educational and commercial aging/health-related web sites were compared using two automatic evaluation tools: Bobby and LIFT. The governmental web site group has the highest compliance with Web site Content Accessibility Guide although only 52% got an approved status. The accessibility approval was found to correlate significantly with overall usability ratings for all groups, except the commercial web site group.

Keywords: Automatic Usability Evaluation, Aging, World Wide Web, LIFT, BOBBY, Accessibility

1 Introduction

1.1 Health Information on the Internet

The growth of the Internet has brought about a substantial increase in the amount of information readily available to the public. One of the most largely accessed areas on the Internet is the health and medical area, which was accessed by approximately 54 percent of Internet users according to a January 1999 poll (Weber, 1999) across the adults life span. In 1998, 22 millions individuals reported surfing the Web for medical information, with the number estimated to have reached 30 million by 2000 (Elliott & Elliott, 2000).

The medical community is slowly, but cautiously, accepting the Internet as a factor in patient care and doctor-patient relationships, although critics reported that the use of Internet by hospital systems and physicians groups today is still limited to posting billboards (Cochrane, 1999) or as a marketing tool (Weber, 1999). Extensive literature starts to develop on the phenomenon of web-based health Information Retrieval. However, the medical community is generally more concerned with information quality and clinical outcomes arising from usage, rather than focusing on issues of design for accessibility, usability and accommodation (Chi-Lum, 1999, Dakins, 1999).

The philosophy of putting emphasis on the accuracy of the information is understandable given the consequences of inaccurate, incomplete or misused health-related information (Ling, 1999). However, without a focused effort on improving accessibility and usability, high quality information will not necessarily be accessible and clinical outcomes may not be achievable. The accessibility problem of health information on the Internet is so severe that in a survey to the Northeast chapter of the American Medical Association, only 14% of the physicians said that they would recommend the Internet as a medical information resource for patients (Eder & Darter, 1998).

Research reviewing medical and health related web sites has found various accessibility and usability problems. Some examples are the following: while those sites are attractive, they only function as yellow pages (Cochrane, 1999); it is difficult to find specific information and it contains content of varying quality (Hersh, 1999); there is a potential for serious abuse and conflict of interest because of the profit acquired from selling an advertiser's products (Bloom & Iannacone, 1999). The danger of these facts is that while for most topics of searched information, failing to find the proper information on the Internet in a timely manner might not bring severe consequences, in the health and medical areas, there

might be serious consequences involved. Therefore, it is crucial to make certain that health and medical information are structured in a way that enables even novice users and users with special needs (such as older users or users with disability) to find the information easily and in a timely manner.

1.2 Web Health Information's Uses by the Elderly

A significant increase of older population has led to various studies investigating the age effect in utilizing the Web as information resources. Forecasts projected that by the year 2030 people aged 65+ will represent 22% of the people living in the US (U.S. Census Bureau, 2000). Although an age bias against older adults using computer technology still exists, more older adults are beginning to incorporate the Web as part of their life, currently representing 13% of the online users (Cury, 2001). In a study asking older users of the main use of the Web, one of the top three answers is to get information about health and medical conditions (White, et al, 1999; Cochrane, 1999).

Older adults have some disadvantages in fully utilizing the Internet as their information resources. That is, older people had more trouble finding information in a Web site than younger people (Mead, et al, 1997). Very little research, however, focused on ensuring the accessibility and usability of Web health information for the elderly. Therefore, this study aims to evaluate the usability and accessibility aspects of the web sites that might be of interest to older computer users.

1.3 Usability and Accessibility Mandates, Guidelines and Tools

There are some encouraging signs that the accessibility of the Internet is taken into account by mainstream society (Newell & Gregor, 1997). Accessibility for information on the Web has been well regulated in the U.S. Some legal mandates regarding accessibility are Section 255 of the Telecommunications Act 1996 (http://www.fcc.gov/cib/dro/section255.html), which regulates the accessibility of Internet Telephony, and Section 508 of the Rehabilitation Act Amendments of 1998 (http://www.ed.gov/offices/OSERS/ RSA/RehabAct.html), which requires that when Federal departments or agencies develop, procure, maintain, or use electronic and information technology, they shall ensure that the technology is accessible to people with disabilities, unless an undue burden would be imposed on the department or agency.

Various institutions also compiled accessibility guidelines for information on the Web. Those resources are well documented and available for public viewing on the Internet. Some examples of those guidelines are:

- W3C Web Content Accessibility Guidelines (WCAG) (http://www.w3.org/TR/WAI-WEBCONTENT)
- WAI Quick Tips Reference Card (http://www.w3.org/WAI/References/QuickTips)
- Penn State University's Center for Academic Computing Web Accessibility Check-List (http://www.psu.edu/dept/cac/training/outlines/accessibility/check.html)
- Public Service Commission of Canada: Designing Universal Web Pages (http://www.psc-cfp.gc.ca/eepmp-pmpee/access/welcome1.htm)
- Captioning and Audio Description on the Web - The National Center for Accessible Media (http://www.wgbh.org/pages/ncam).

In addition to guidelines, various businesses and organizations have provided (commercial) validation and transformation tools to aid web site's accessibility. Most of them have (limited) free services for public uses. Some of those tools are:

- Bill Loughbourgh's WAI Checkpoint Checker (http://rdf.pair.com/checker.htm)
- VisCheck's Online Color-blindness simulator (http://www.vischeck.com/index.shtml)
- NCAM's Media Access Generator (http://www.wgbh.org/wgbh/pages/ncam/webaccess/magindex.html)
- UsableNet.Com's LIFT Validation Service (http://www.usablenet.com/index.htm)
- The WAI's HTML Table Linearizer (http://www.w3.org/WAI/Resources/Tablin)
- WAVE - PIATs web page accessibility evaluation assistant (http://www.temple.edu/inst_disabilities/piat/wave)
- FITAI Web page Accessibility Verification Tool (http://w3.gsa.gov/web/m/cita.nsf/YourPage32?OpenForm)
- Bobby (http://www.cast.org/bobby)
- W3C WAI Content Accessibility Checking Service (http://www.w3.org/2000/07/eval43)

- TIDY (http://www.w3.org/People/Raggett/tidy)

Sullivan and Matson (2000) compared 50 most popular web sites in terms of their usability and content accessibility and found a marginal correlation (ρ=0.23) between manually analyzed content accessibility in conformance to the Priority 1 of the WCAG and overall automated usability testing result provided by LIFT (http://www.usablenet.com/index.htm). The present study extends Sullivan and Mason's study in two ways: by automating the content accessibility testing using Bobby (http://www.cast.org/bobby), which performs the test based on all Priorities, and by performing group comparisons of commercial, educational, governmental and organizational web site groups in terms of their usability and content accessibility. This study aims to answer three research questions:

1. Do aging/health-related web sites of different natures (i.e. commercial, educational, governmental and organizational) differ in their accessibility and usability?
2. Is the result of accessibility evaluation of a particular group of web sites related to the result of its usability evaluation?
3. Do aging/health-related web sites of different natures (i.e. commercial, educational, governmental and organizational) differ significantly in page loading time and page size ?

The three automatic evaluation tools used in this study and their evaluation criteria are:

A. UsableNet.Com's LIFT Validation Service

The tested page (including its frames, if any) is evaluated against the following criteria:

1. Portable colors for backgrounds, foregrounds, links and specific FONT elements
2. New and visited links should be different and possibly the conventional ones
3. No BLINK, MARQUEE, SPACER elements should be used
4. Headings should be used to split page text (if significant text is present)
5. NOFRAMES should accompany frames and be meaningful
6. IFRAME is not portable, so far
7. Browser-compatible specification of frame borders should be used
8. Page downloading should not exceed 20s on medium speed internet connections
9. Images should have proper ALT strings
10. IMG should specify size of image
11. Images should not be embedded within links labels
12. The page should contain a description and a set of keywords
13. The page title should be short and meaningful
14. Email addresses should be explicit
15. External links contained in the page should be valid
16. The page should not contain invisible elements
17. Compliance with the HTML 4.0 standard

LIFT provides a report of the number of catastrophic errors (errors that disable users to complete tasks), major errors (errors that cause users to face major impediments), minor errors (errors that are really a nuisance for users) and cosmetic errors (low priority materials). In addition, as a general rating, LIFT assigns a rating of excellent, good, fair or poor.

B. Bobby (http://www.cast.org/bobby/AboutBobby313.cfm)

Bobby recommends effective Web page authoring for special Web browsers (e.g. one which reads text out loud using a speech synthesizer for blind users). Bobby divides the accessibility errors into 4 sections to be tested:

1. *Priority 1 Errors* are problems that seriously affect the page's usability by people with disabilities, in accordance with Priority 1 of WCAG. A Bobby Approved rating can only be granted to a site with no Priority 1 errors. Bobby Approved status is equivalent to Conformance Level A for the WCAG.
2. *Priority 2 Errors* are secondary access problems. If all items in this section including relevant User Checks passed the test, it meets Conformance Level AA for the WCAG.
3. *Priority 3 Errors* are third-tier access problems. If all items in this section including relevant User Checks passed the test, it meets Conformance Level AAA for the WCAG.
4. *The Browser Compatibility Errors* are HTML elements and element attributes that are used on the page which are not valid for particular browsers. These elements do not necessarily cause

accessibility problems, but users should be aware that the page may not be rendered as expected which may impact usability and accessibility.

As a general rating, Bobby gives the rating with the picture of "Bobby-hats". Hats with wheelchairs indicate Priority 1 accessibility errors that are automatically detectable. A question mark identifies a possible Priority 1 error that cannot be fully automatically checked, indicating that the user will need to address that question manually.

C. NetMechanic (http://www.netmechanic.com/)

NetMechanic provides automatic tools that provide

1. Link Check: a check whether the web links printed in the examined page are active
2. HTML Check and Repair: the validation of the HTML syntax based on the W3C guidelines
3. Browser Compatibility: a check of the compatibility with frequently used browsers (e.g. Netscape or Internet Explorer)
4. Page Loading Time Check: the measure of the loading time at different connection speeds, the size of the page and the images and finally the number of images in the examined page.
5. Spell Check: a check of grammatical errors.

Apart from the above tests, NetMechanic also provides recommendations for corrections of the errors. In this experiment NetMechanic was solely used as an automatic tool to measure the page loading time.

2 Methodology

2.1 Data Collection Method

Because of the importance of facilitating usability and content accessibility of web sites for older computer users, the web sites were collected using keyword search of “aging” from http://www.google.com search engine (all of them containing information about health). The web site’s domain name extension (.com, .edu, .gov and .org) was used as a filter.

The analyzed web sites for each extension were limited to the sites listed in the first three pages (30 sites) of the google’s search result because the majority of web users are not expected to go beyond 3 pages when looking for information (Zaphiris, 2000). After removing subsections of the same web sites and dead links, the numbers of analyzed sites for each extension ranged from 20-25.

2.2 Analysis

To answer the aforementioned three research questions, several statistical analysis techniques are employed. For the first research question, the means and standard deviations of the four domain name extension groups were compared for significant differences using Analysis of Variance (ANOVA). For the second question, two analyses were performed. First, to investigate whether, in general, the accessibility and usability are related, bivariate correlation for all analyzed web sites was calculated. Second, to investigate whether in a particular group of domain names (i.e. .com, .edu, .gov and .org), the accessibility and usability are related, the bivariate correlation of web sites within a group was observed. Finally for the last question, the means and standard deviations for page loading time, page size, images size and number of images of the four domain name extension groups were compared for significant differences using Analysis of Variance (ANOVA).

3 Results and Discussions

Table 1 lists the mean and standard deviation of the usability and accessibility ratings for each group of web sites. Bobby's approval rating is converted into a binary variable with '0' representing 'Not Approved' and '1' representing 'Approved' status. The Usability rating is also converted into an ordinal scale with '1' representing 'Fair', '2' 'Good', and '3' 'Excellent'.

From Table 1 it is apparent that governmental sites are in general the best in terms of accessibility and usability ratings compared to web sites of different extensions. The reason might be related to more strict enforcement by governmental agencies of the Section 508 of the Telecommunications Act to ensure that web sites maintained by the Federal governments are accessible

and usable by most people (see Section 1.3 above). However, although the governmental sites are superior to other domain types, only half of the tested web sites (52%) was approved by Bobby.

Table 1 also shows high browser compatibility errors in all groups. One possible reason is that web site designers tend to rely on web design tools that are compatible with only one particular type of browser.

Table 1: Descriptive statistics of web site domain names

		Accessibility (Bobby)					Usability (LIFT)			
Type		Bobby's Approval	Priority 1	Priority 2	Priority 3	Browser Compatibility	Usability Rating	Catastrophic	Major	Minor
.com	Mean	**0.13**	**1.30**	**3.39**	**1.96**	**13.13**	**1.70**	**0.09**	**2.43**	**2.91**
(N=23)	*S.D.*	*0.34*	*0.93*	*1.23*	*0.21*	*9.48*	*0.63*	*0.29*	*1.50*	*1.88*
.edu	Mean	**0.25**	**0.95**	**2.20**	**1.60**	**7.75**	**1.80**	**0.00**	**1.95**	**3.25**
(N=20)	*S.D.*	*0.44*	*0.69*	*1.24*	*0.68*	*7.66*	*0.70*	*0.00*	*1.23*	*2.75*
.gov	Mean	**0.52**	**0.57**	**2.67**	**1.71**	**6.81**	**2.00**	**0.00**	**1.43**	**3.33**
(N=21)	*S.D.*	*0.51*	*0.75*	*0.66*	*0.56*	*4.32*	*0.63*	*0.00*	*1.12*	*1.49*
.org	Mean	**0.24**	**0.92**	**2.80**	**1.92**	**9.16**	**1.68**	**0.04**	**2.04**	**3.64**
(N=25)	*S.D.*	*0.44*	*0.64*	*1.22*	*0.40*	*4.79*	*0.56*	*0.20*	*1.40*	*2.63*
Total	Mean	**0.28**	**0.94**	**2.79**	**1.81**	**9.31**	**1.79**	**0.03**	**1.98**	**3.29**
(N=89)	*S.D.*	*0.45*	*0.79*	*1.18*	*0.50*	*7.18*	*0.63*	*0.18*	*1.36*	*2.23*

Figures 1 and 2 depicts the means of each web site groups in terms of overall accessibility (Bobby's approval) and overall usability rating.

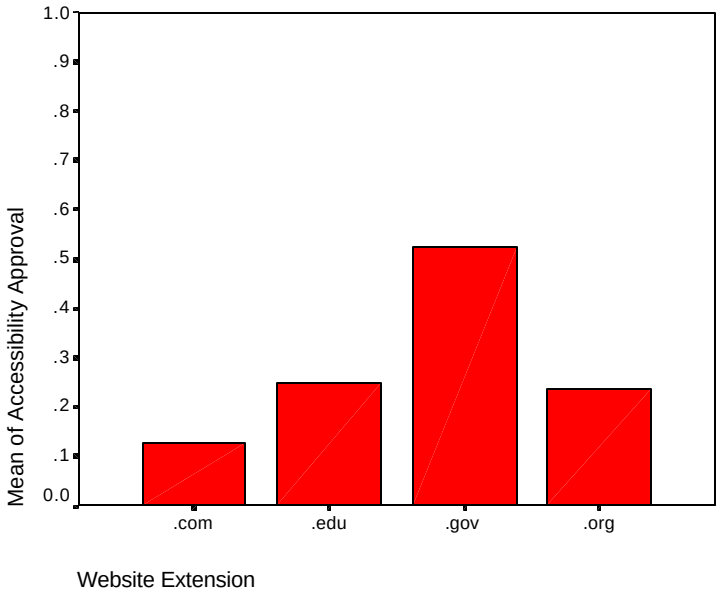

Figure 1: The means of Bobby's Accessibility Approval by web site extension types

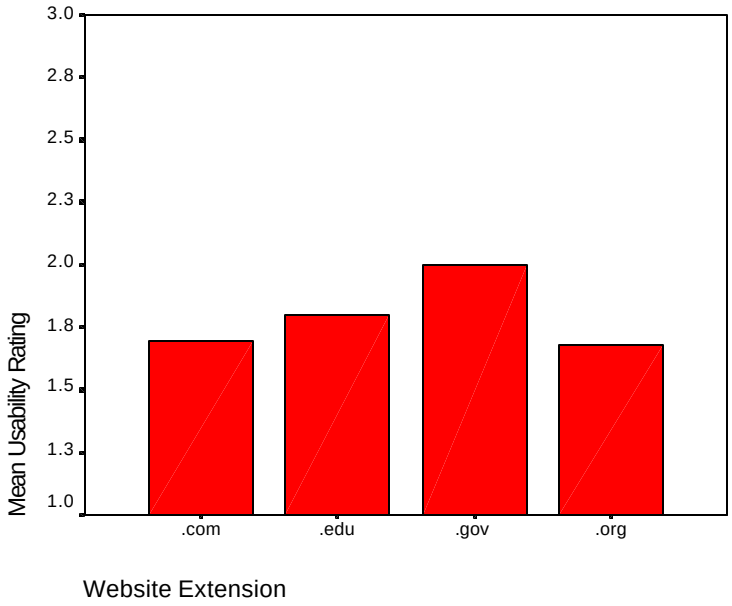

Figure 2: The means of LIFT's Usability Rating by web site extension types

The ANOVA follow-up analysis shows that the mean's differences between those groups of web sites are significant at $p<0.05$ for Bobby's approval ($F_{(3,85)}= 3.193$, $p=0.028$), Priority 1 errors ($F_{(3,85)}= 3.435$, $p=0.021$), Priority 2 errors ($F_{(3,85)}= 4.117$, $p=0.009$) and Browser compatibility errors ($F_{(3,85)}= 3.643$, $p=0.016$). On the other hand, all of the usability measures' group differences (LIFT) are not significant at $p<0.05$. Therefore, as measured by the automated evaluation tools used in the present study, the answer of the first research question is that web sites of different extensions differ significantly in their accessibility but not in their usability.

To answer the second research question, bivariate correlation of different usability and accessibility measures were observed. Observing all web sites (with all extensions), the accessibility approval correlates significantly with the overall usability rating ($\rho=0.531$, $p<0.01$). However, observing bivariate correlation of those measures within the same group, while the educational, governmental and organizational sites' usability and accessibility measures still correlate significantly, in the commercial group, that is not the case. LIFT's evaluation consists of two parts: accessibility issues and usability issues unrelated to accessibility. Since the commercial web site group is relatively high in usability rating yet low in accessibility approval, one can conclude that commercial sites perform high in usability issues unrelated to accessibility. In other words, commercial sites are user-friendly for people with no disability.

Research (e.g. Hamilton, 1997) showed that the fastest way to guarantee your web visitors never return is to serve up big, slow-to-download pages. According to the GVU 7th WWW User survey hosted by the GVU Center, Georgia Institute of Technology (GVU, 1997), speed is the number one complaint of Web users. To be specific, 76.55% of users that participated in the online survey stated that slow web site were a major obstacle in their online experiences.

Since page loading time is considered a major obstacle in web usage, this study used an automatic Web evaluation tool, NetMechanic, to identify any differences (if any) among the four domain extension groups examined in this study. To achieve this aim, the page loading time when the page is accessed with a 28.8 k connection speed were recorded. The choice of this specific connection speed is based on the report by the GVU WWW User Survey (GVU, 1997) which shows that more than 70% of the internet users log on at 28.8K or less. The results of the page loading speed of the examined domain extension groups are shown in Figure 3. The total size of the images in the examined pages is depicted in Figure 4. The total size of the page including graphics is pictured in Figure 5.

The ANOVA follow-up analysis shows that the mean's differences between those groups of web sites are significant at $p<0.05$ for the page loading time ($F_{(3,79)}= 3.124$, $p=0.031$), the total page size ($F_{(3,79)}= 3.140$, $p=0.030$) and for the total graphic size ($F_{(3,79)}= 3.226$, $p=0.027$). On the other hand, no significant difference (at $p<0.05$) was found in terms of the number of graphics per page used.

Flanders (1999) recommends that the goal of every web page designer should be to create a site between 34.4Kb and 47.8Kb. From Figure 5 we can see that only the governmental (mean page size of 37.7Kb) and the educational (mean page size of 45.1Kb) groups managed to fall in this range. On the other hand the organizational (mean page size of 74.2Kb) and the commercial (mean page size of 56.2Kb) groups fall well above the recommended page sizes.

Nielsen (1996) reports that users are more likely to lose interest in a site if the download time exceeds 10 seconds. Another study (Selvidge, 1999) found that users were frustrated by 30 and 60 second delays in page loading time, but would tolerate delays of 20 seconds. From Figure 3 we can see that for all groups of sites examined, the average load time is in the neighborhood of 15-23 seconds, well above the 10 seconds recommended by Nielsen (1996) but close to the tolerated 20 seconds recommended by Selvidge (1999). Governmental websites examined had the smallest page loading time (12.47 seconds), on the other hand organizational websites ranked worst in terms of page loading time (22.69 seconds) with educational (15.29 seconds) and commercial (19.63 seconds) groups coming second and third respectively.

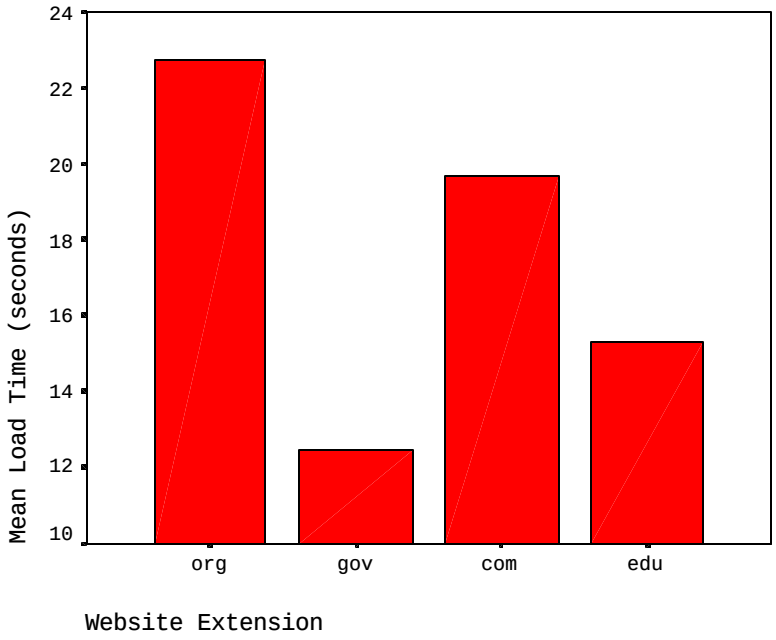

Figure 3: The means of load time by web site extension types

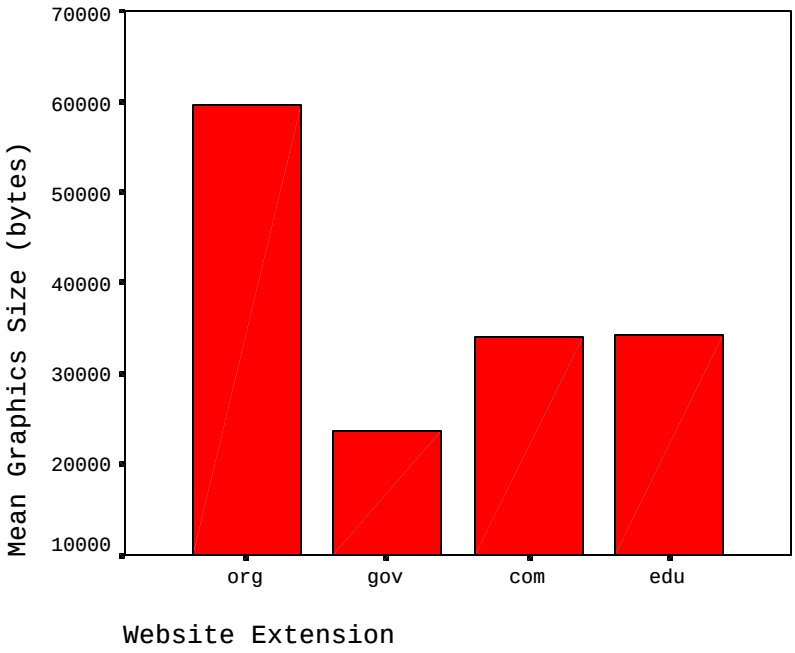

Figure 4: The means of graphic sizes by web site extension types

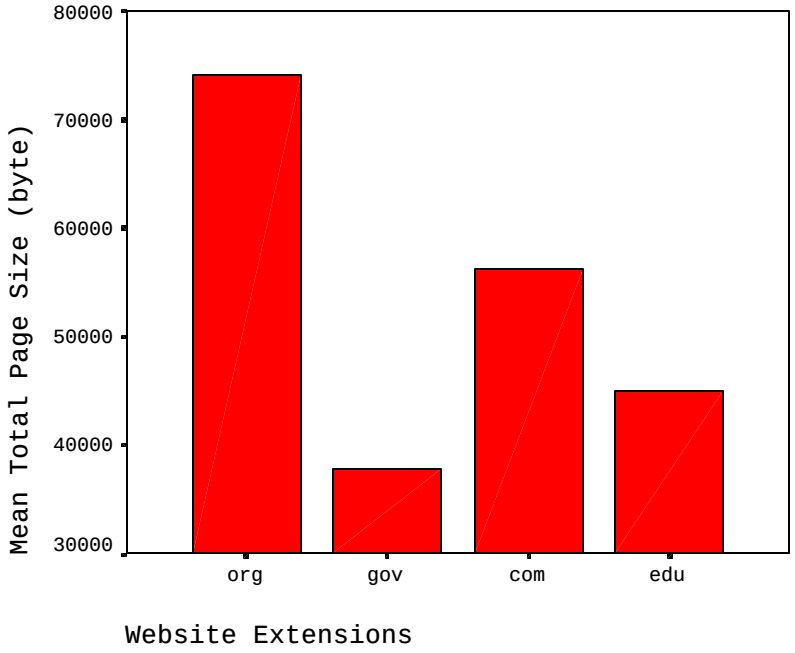

Figure 5: The means of total page sizes by web site extension types

4 Conclusions and Further Studies

This study aimed to answer three research questions:

1. Do aging/health-related web sites of different natures (i.e. commercial, educational, governmental and organizational) differ in their accessibility and usability?

2. Is the result of accessibility evaluation of a particular group of web sites related to the result of its usability evaluation?
3. Do aging/health-related web sites of different natures (i.e. commercial, educational, governmental and organizational) differ significantly in page loading time and page size ?

The analysis revealed that the governmental web site group has the highest compliance with Web site Content Accessibility Guide (WCAG) although only 52% got an approved status. The accessibility approval was found to correlate significantly with overall usability ratings for all groups, except the commercial web site group.

The governmental website group also has the smallest page loading time compared to the other three groups and it follows the recommended web page size.

The present study brings about several implications for the practitioners. First, because some web sites' accessibility and usability measures are not predictive of each other, it opens a door into exploring the possibility of developing an integrated automated accessibility and usability evaluation tool. Second, the finding that most web sites did not receive the approved status from Bobby could be used to motivate web site designers to improve the accessibility and usability of web sites. The study also recognize that web site designers need to comply with the recommended page loading time and page size in order to ensure good usability and accessibility ratings.

Further research could be conducted in several areas. First, in this study, only simple correlation and ANOVA were employed. Advanced statistical analysis such as structural equation modeling would be fruitful to explore the underlying relationship between different measures of usability and accessibility evaluation. Second, in the present study, the topic of interest is aging/health-related web sites. However, the methodology used in this paper could be applied in any area of interest (e.g. entertainment, e-commerce or, services).

Some limitations of using automatic evaluation tools need to be recognized:

1. There are important elements (such as the web navigation structure, the information's layout, the value of information, or various aesthetic aspects) which are not evaluated by the automatic tools.
2. The meaning/significance/appearance of graphics is not evaluated, only the inclusion of ALT tags are taken into consideration by Bobby and LIFT and only the number (higher number of graphics correlates to lower rating) of graphics is considered in LIFT.
3. Text-only web sites will get high ranking with both tools regardless of the quality of information or the readability of the fonts.

These limitations might imply that, although automatic evaluation tools provide a quick reference of the web site's accessibility and usability, formal usability evaluation involving user testing combined with a series of other non-empirical methods (such as cognitive walkthroughs or GOMS) still hold a major importance in the thoroughness of web site evaluation.

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