RESEARCH ARTICLE

Website Accessibility Design Issues with Indian E-Government Sites

Surendranath Reddy S

Department of Computer Science & Engineering

JNTU Ananthapur, India

sr1surendranathreddy@gmail.com

Abstract— The paper attempts to provide the audience and web designers with a higher level of awareness about the level of accessibility problems within the e-government sector, specifically a sampling of sites of the Indian government. The research also show which guideline errors are the most prevalent among the sites and raises awareness about the issues of access in e-government. Most of the research work pertaining website accessibility evaluation is intended to benchmark the organizations, however this study plans to initiate learning for the selected Government Bodies (GB) to improve websites accessibility. The devised approach spans two phases and is tested in three government bodies of India. The websites evaluation is carried out according to the WCAG version 2.0 (level AA) by using various online tools - e.g. CCA (Colour Contrast Analyser), RIC (Readability Index Calculator), - and a test case to check that website is keyboard operable. Test results show that the selected websites failed to adhere to the WCAG 2.0.

Keywords— E-government, Websites Accessibility, Evaluation, India, WCAG2.0, www.pmindia.gov.in, www.narendramodi.in, www.india.gov.in

I. INTRODUCTION

This Website serves as an online tool to publicize the government information and services that are supposed to be accessible from everywhere and by everyone. Making a website that is 'accessible by everyone' is a hard nut to crack as all citizens are not equally capable i.e. citizens include people with several limitations and disabilities too and they must also be eligible to make use of website in a normal way. Extending the access to disabled people is an exigent job as disabilities constitutes hearing, visionary, speech, physical, neurological and mental disorders. Website accessibility refers 'to the extent to which maximum group of people can access the website'. Website accessibility is considered to be high if wide range of people could access the website and vice versa.Website accessibility is linked with the website design and emphasizing on website designs could enhance the website accessibility. Website design is made-up of various elements e.g. colors ratio, layout, browser independency, content (language), and support for assistive technology etc.

An estimate by W3C reports that 90% of the websites, available on World Wide Web, fail to provide access to disabled people while 70-98% websites all across the world have accessibility issues. The paper presents a method to evaluate the accessibility of Indian government websites using available online tools. The study

investigates the presence of inaccessibility issues in the government websites by making use of available online tools. The latest version of Web Content Accessibility Guidelines (WCAG 2.0) is used as a benchmark for this study and online tools are exploited to provide a comprehensive picture of the website accessibility analysis. The study attempts to initiate to follow W3C guidelines in the government bodies to improve web design.

II. WEB ACCESSIBILITY GUIDELINES

Various legislations and guidelines have been developed since the issue of website accessibility has grabbed Government's attention. Table 1 provides an overview of some of the legislations regarding web content accessibility. On 3rd of December 2012, the European commission adopted a proposal for a directive on the accessibility of the public sector bodies named as 'action 64'. The objective was to make sure that by the year 2015, all the public sector websites are fully accessible. In Germany, BITV 2 came into effect on the 22nd September 2011. According to BITV 2 all the websites under the federal government, both internet and intranet, must comply with the guidelines for improving website accessibility to public. 'Stanca Act' is legislated by Italian government and it explains that the government is responsible to protect the citizens' right to avail all services and information irrespective of any disability. This law addresses public administrations including those private agencies that are licensed to work for public. Dutch accessibility law has been in effect since 2006 and according to this law, new government websites must comply with these standards however existing websites were given time to adhere to these guidelines before 2011. On 7th December 2010, BSI (British Standard Institution) launched BS 8878 first British standard to define an approach for web accessibility and it is based on the principle that the web products must be accessible to all. In USA, section 508 is a federal procurement law that stresses on all the products and services by the federal government must be accessible by everyone including people with disabilities. Section 508 is under consideration and by the year 2014 it is expected to incorporate WCAG 2.0 level AA. Apart from these countries based legislation there is an independent body W3C (World Wide Web Consortium) they developed the international guidelines (WCAG) for web content accessibility, these guidelines are very extensive and two versions of them have been released so far. The country specific guidelines mentioned in table 1 are also based on these international guidelines so WCAG serve as a superset for regional legislations. These international guidelines (WCAG) are discussed in upcoming section and are used for this study.

TABLE I
LEGISLATIONS REGARDING WEB CONTENT ACCESSIBILITY

Law / Act	By	Based on (standard)
Action 64	European Union (EU)	WCAG 2.0
BITV 2	Germany	WCAG 2.0
Stanca Act	Italy	WCAG 1.0 (2)
Besluit Kwalitieit Rijksoverheidswesites	Netherlands	WCAG 1.0 (1)
Section 508	USA	WCAG 1.0 (1) + few Additions
BS 8878 (Equality act 2010)	UK	WCAG 1.0 (2) or WCAG 2.0 (AA)

A. Web Content Accessibility Guidelines (WCAG)

WAI (Web Accessibility Initiative) by World Wide Web Consortium (W3C) in May 1999 published set of guidelines addressing website accessibility under caption WCAG (Web Content Accessibility Guidelines). The Web Content Accessibility Guidelines (WCAG) document explains how to make Web content more accessible to people with disabilities. Web "content" generally stands for the information in any Web application that may be in form of any control i.e. text, forms, images, sounds etc. So far two versions of WCAG have been released as WCAG 1.0 and WCAG 2.0. The second version is the most recent one published in 2008. WCAG 1.0 has set of 14 guidelines that have checkpoints. The checkpoints are categorized into three levels of priority namely, priority 1, priority 2 and priority 3. Priority 1 is the most important, because it covers errors which are of most important to deal with. Rest two priorities come later. WCAG 2.0 comprises of 12 guidelines which are further organized into four principles e.g. perceivable, operable, understandable and robust. 12 guidelines are divided into 61 success criteria and each criterion is assigned a specific conformance level depending upon its importance e.g. A, AA, AAA shown in table 2.

TABLE II
WCAG 2.0 CONFORMANCE LEVELS

Standard	Conformance Level	Importance (61 Success criterion)
	A	A (priority 1) level contains 23 success criterion and they all must be fulfilled for a website to be accessible.
WCAG 2.0	AA	AA (Priority2) comprises of 13 success criterion and they should be fulfilled to improve website accessibility.
	AAA	A (Priority 3) comprise of 25 success criterion and they may be fulfilled as it would further enhance the accessibility but it is a challenge to conform to.

A website that conforms to all three levels is a big challenge therefore in all the tools and the legislated acts the highest suggested conformance level is AA. The "Conformance to a standard" means that web content satisfies the 'requirements' of that standard. The 'requirements' are the success criteria. To conform to WCAG 2.0, one need to satisfy the success criteria i.e. there is no content which violates the success criteria. Moreover when it is said that website conforms to level AA it means it has passed the success criterion for level A & level AA both, same way conforming to level AAA depicts that level A, level AA & level AAA all are satisfied. Most of the tools evaluate for WCAG 2.0 level AA which is the minimum requirement for a website to be accessible to most of the group of people. Table 3 provides an overview of what are these guidelines and how many success criterion(s) each of the guideline contains.

TABLE III
WCAG 2.0 GUIDELINES SPAN

Web Content Accessibility Guidelines (WCAG 2.0)		
Principles	Guidelines (12 in all)	Success Criterions (61)
Perceivable	1.1 Text Alternatives: Provide text alternatives for any non-text context 1.2 Time Based Media: Provide alternatives for time-based media 1.3 Adaptable: Create content that can be presented in different ways e.g. Simpler layout etc. 1.4 Distinguishable: Make it easier for user to see and hear (background and foreground)	1 criteria of Level A 9 criterions: 3 of level A, 2 of level AA, 4 of level AAA 3 criterions of level A 9 criterions: 2 of Level A, 3 of Level AA, 4 of Level AAA
Operable	2.1 Keyboard accessible: Make all functionality available from keyboard 2.2 Enough time: Provide users enough time to read and use content 2.3 Seizures: Do not design content to cause seizures 2.4 Navigable: Make ease for user to navigate the site	3 criterions: 2 of level A, 1 of Level AAA 5 criterions: 2 of level A, 3 of level AAA 2 criterions: 1 of level A, 1 of level AAA 10 criterions: 4 of level A, 3 of level AA, 3 of level AAA
Understandable	3.1 Readable: Make text content readable and understandable 3.2 predictable: Make web pages appear in predictable ways 3.3 input assistance: Help user avoid mistakes	6 criterions: 1 of level A, 1 of level AA, 4 of level AAA 5 criterions: 2 of level A, 2of level AA and 1 of level AAA 6 criterions: 2 of level A, 2 of level AA and 2 of level AAA
Robust	4.1 Compatible: Maximize compatibility with current and future user agents	2 criterions of level A

B. Website Accessibility Evaluation Tools

Various online tools are available to evaluate web content accessibility and some sites have listed them according to their specifications and benchmark they meet. Various tools are free to use and few of them have options to evaluate across multiple standards e.g. WCAG, section 508, and Stanca act. WCAG option is available in all tools because they are internationally recognized guidelines and all the other legislations (guidelines) are based on them. Two versions of WCAG have been released so far and as the second version is the latest one so most of the tools evaluate according to WCAG version 1.0, and few tools have option to evaluate accessibility adherence for WCAG 2.0.

TABLE IV
WEBSITE ACCESSIBILITY TOOLS

Tool	Available Testing options (Standards)
Total Validator	WCAG 1.0 Section 508
A-CHECKER	WCAG 1.0 **WCAG 2.0** Section 508 Stance Act BITV 2
WAVE	WCAG 1.0 Section 508
TAW	WCAG 1.0 **WCAG 2.0**
Accessibility Check	WCAG 1.0
WAEX	WCAG 1.0

Table 4 provides an overview of few online tools that could be exploited for websites accessibility evaluation, and it is shown that only two tools i.e. TAW and A-Checker have option for WCAG 2.0. TAW tool is available in English and Spanish interfaces and it generates the evaluation results in form of errors, warnings and 'not reviewed'. Not reviewed are the accessibility issues which TAW failed to analyze and they requiring human review. A-Checker generates a report with highlighting the error and its possible repair suggestion. As all tools have their own algorithms in which they are built so it is probable that one tool detect some errors while other (tool) detects some others. However all tools are likewise and easy to operate. For evaluation of any website, its URL is provided and the tool generates the website accessibility results. Apart from the tools mentioned in table 4, there are some other tools that evaluate across a single principle or a guideline e.g. Readability Index Calculator (RIC) evaluates the difficulty level of the website content (text) according to WCAG. As a government website is used and visited by all sorts of people and therefore the language used in website is of vital importance. This tool is available in different languages e.g. French, German and Dutch etc. It operates by copying the text from the website into the RIC interface and it generates the difficulty level of that text.
Color contrast analyzer (CCA) calculates the contrast ratio between the foreground and the background colors used in the website on the basis of Web Content Accessibility Guidelines as recommended by W3C. For a text to be visible and readable it must be in adequate contrast to its background e.g. white text on white background is not visible however black text on white background or vice versa is readable because of the high contrast ratio. WCAG has defined the minimum ratio required for both small and large texts i.e. for large text >=3:1 and for small text >=4.5:1. To calculate the contrast ratio, besides CCA there are many other tools available that could be exploited e.g. Access Color, Accessibility Color Wheel, and Color Laboratory etc.
Synopsis: This section showed that there are multiple tools available to evaluate the website accessibility across various standards and any single of them or some of them in combination could be exploited to highlight the maximum areas where improvement could enhance the website accessibility.

III.RESEARCH METHODS

The paper deals with evaluating the website accessibility for three governing bodies of India. The selection of the websites is made on the fact that these government bodies got their clients from all age groups and belong to different streams of public sector i.e. one is a medium sized, second is small sized, third is large sized. Here after websites of government bodies 1, 2, 3 will be mentioned as GB 1, GB 2, and GB 3 respectively. The whole process of websites accessibility evaluation is expected to be completed in the steps as follows.
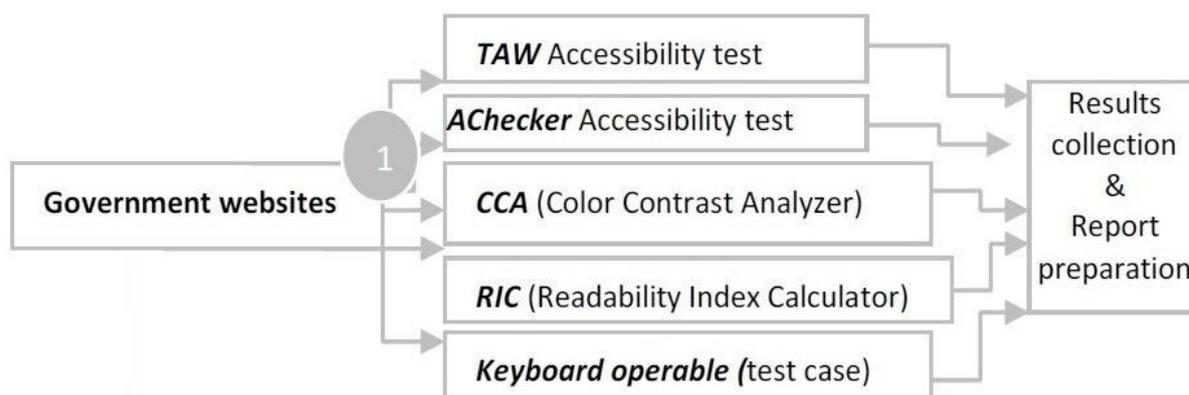
4

Fig. 1 Evaluation Process Flow

Propriety
- Findings don't violate any legal matters
- Findings are ethically sound
- Findings are easy to comprehend
- Findings does not address to conflict of interest of any one

Feasibility
- Findings are viable to implement

Accuracy
- Information in the findings is technically right
- Findings are valid to be conceded
- Findings are not biased

IV.RESULTS

The accessibility testing of all three websites are evaluated across TAW and AChecker. The testing generates the output in three categories i.e. errors, warnings and "couldn't reviewed". Errors are the "problematic areas (seriously) required to be fixed", warnings implies for "potential errors" they may lead to errors so it's better that they should also be addressed as well , however there are few criterions which the tools could not review and they require human review for testing, come under caption " could not reviewed". The summary of the results is shown in table 5. Table 5 depicts that according to WCAG 2.0, GB 1 website contains 86 problems, 185 warnings and 15 'could not reviewed' issues. GB 2 website has 25 problems, 248 warnings, and 17 'could not reviewed' issues. GB 3 website holds 6 problems, 223 warnings, and 17 'could not reviewed' issues.

TABLE 5
RESULTS GENERATED BY TESTING

Governing body(GB)	Tools used	Results		
		Problems X	Warnings !	Could not Reviewed ?
GB 1	TAW ACHECKER	25	248	17
GB 2		86	185	15
GB 3		6	223	17

Table 6 provides an expanded view of the errors and warnings, illustrating, in which WCAG principle each error or warning actually exists for all government bodies (GB). According to table 6, under 'perceivable' principle GB 1 contains 25 problems and 38 warnings, GB 2 has 46 errors and 41 warnings, and GB 3 engrosses 2 errors and 86 warnings. For principle 'operable' GB1 shows 5 errors and 7 warnings, GB 2 shows 35 errors and 80 warnings and GB 3 contains 4 errors and 36 warnings.

For third principle 'understandable' GB 1 holds 1 error and 6 warnings, GB 2 has 2 error and 6 warnings, and GB 3 contains 0 error and 6 warnings. Under last principle 'robust' GB 1 has 13 errors and 197 warnings, GB 2 contains 3 problems 58 warnings, and GB 3 contains 0 error and 95 warnings.

TABLE VI
EXPANSION OF ERRORS & WARNINGS

GB	Perceivable	Testing analysis Operable	(WCAG 2.0) Understandable	Robust
GB 1	6 (**X**) 38 (**!**)	5 (**X**) 7 (**!**)	1 (**X**) 6 (**!**)	13(**X**) 197 (**!**)
GB 2	46 (**X**) 41 (**!**)	35 (**X**) 80 (**!**)	2 (**X**) 6 (**!**)	3 (**X**) 58 (**!**)
GB3	2 (**X**) 86 (**!**)	4 (**X**) 36 (**!**)	0 (**X**) 6 (**!**)	0 (**X**) 95 (**!**)

There are some success criterions in WCAG 2.0 that require human review e.g. guidelines relating to color contrast, readability, support for assistive technology. It is better to deal them separately in accordance with the guidelines. All three websites are tested for the use of sufficient color contrast ratio in the website in line with the standard set by WCAG 2.0. Table 7 shows the results generated by CCA (Color Contrast Analyzer) for all three government websites. GB 1 and GB 2 failed to hold minimum contrast ratio standard by WCAG. GB 3 cleared the test with high contrast ratio of 10:1, the high the contrast ratio the more visible is the text.

TABLE VII
RESULTS OF CCA

GB	Tool	Standard ratio (WCAG)	Ratio used in the website	Remarks (Fail/Pass)
GB 1	**Color**	For small text> 4.5:1	1.9:1	X
GB 2	**contrast**	For large text >3:1	2.3:1	X
GB 3	**analyzer (CCA)**		10:1	√

To check the difficulty level of the content used in the selected government websites, RIC (Readability Index Calculator) is used. Text from all three websites is pasted into the interface of the RIC and it operates by revealing the difficulty level of the language used in these websites. Besides English language, RIC tool supports Dutch language text. Table 8 shows the results with revealing the difficulty level of the language used in the selected websites e.g. according to the legend of RIC GB 1 contains fairly difficult content, GB 2 holds content that is normal and the content of GB 3 according to RIC is difficult to comprehend.

TABLE VIII
RESULTS OF RIC

GB	Tool	Index calculated	Remarks
GB 1	**Readability**	50	Fairly difficult
GB 2	**index**	65	Normal
GB 3	**calculator** (RIC)	31	Difficult

Legend

90-100 Very Easy
80-90 Easy
70-80 Fairly Easy
60-70 Normal
50-60 Fairly Difficult
30-50 Difficult
0-30 Very Difficult

There are two success criterions regarding keyboard accessibility in "operable" principle of WCAG 2.0. According to WCAG the website must be fully operable using keyboard only and there must be no keyboard trap. To check the website accessibility through keyboard, a simple test case is conducted. In the test case, all three websites are traversed with only keyboard and 200 operations are performed, the results are notified.

6

TABLE IX
TEST CASE FOR KEYBOARD OPERABILITY

GB	Number of keyboard hits	Accomplished (success rate)	Remarks
GB 1	200	99%	Keyboard operable, no trap
GB 2	300	100%	Keyboard operable, no trap
GB 3	200	100%	Keyboard operable, no trap

V. DISCUSSION AND ANALYSIS

This section introduces the existing issues in each website along with their relevance to accessibility. Table 10 Shows the error types of GB1, two types of errors exist and each error has two instances making 4 errors in total.

TABLE X
TYPES OF ERRORS FOR GB 1

Conformance level(PL)	Error type	Instances	Intent
A	Consecutive text and images link to same resource	2	The objective is to avoid unnecessary duplication due to presence of adjacent text and iconic versions of a link.
AA	Use of absolute font sizes	2	The objective of this technique is to identify and specify the font size of text proportionally so that user could efficiently scale the content.

According to WCAG 2.0, if consecutive links leads to same resource file, they should be grouped; this rule is violated in GB1 design as the same links are not grouped. And the second error is regarding the usage of absolute units for font sizes which should not be done because else wise it does not allow users to scale (big or small) the content effectively. On the other hand in GB 2 website accessibility test highlighted 11 errors in all. There are four types of errors but their multiple instances make 11 errors in total. Table 11 provides a list of these four errors and their occurrences (instances) in GB 2 website design.

TABLE XI
TYPES OF ERRORS OCCUR IN GB 2

GB 2 Level	Error type	Instances	Intent
A	Images without "alt" attribute	1	"The intent of this success criterion is to make information conveyed by non-text content accessible through the use of a text alternative".
A	Form controls without label	4	"If non-text content is a control or accepts user input, it should have a name or label that describes its purpose".
AA	Use of absolute font sizes	2	"The objective of this technique is to identify and specify the font size of text proportionally so that user could efficiently scale the content".
A	Empty links (navigation)	4	"Whenever possible, provide link text that identifies the purpose of the link without needing additional context".

According to WCAG all the images, that convey meaning and provide understanding of the content, must be provided with a short 'alt' attribute. This enhances the website interactivity as alt attribute is displayed when the element cannot be rendered normally. The second error is the 'presence of form controls without associated labels', according to WCAG use 'label' elements or 'title' to label the form control. When there is no text on the screen that could be identified as label or in case where it is confusing to display label, user agent (software that works on user behalf) can speak the title attribute.

7

The third error is same as identified in GB 1 for using absolute font sizes and the forth error is the presence of empty links in the website. According to WCAG a link should never be empty, it should always contain text else it could cause confusion for keyboard or screen reader users. Table 12 provides an overview of the errors occur in GB 3 website. Six types of errors with multiple instances are identified, 3 errors are same as highlighted in GB 1 and GB 2. According to WCAG the headings in the webpage must be defined in different level headers e.g. h1, h2 etc. Using headings merely confuse users, who rely on them for navigation or for those using assistive technologies and in GB

3 website none heading level is defined. The second error emphasizes to follow a standard method for the form submission, according to WCAG a form must have a submit button as it is an appropriate control for causing change of context. Third error indicates the absence of well-formedness of the webpage it implies that web content must be robust enough to be interpreted by user agents and assistive technologies.

TABLE XII
TYPES OF ERRORS OCCUR IN GB 3

Priority level(PL)	Error type	Instances	Intent
A	Consecutive text and images link to same resource	2	The objective is to avoid unnecessary duplication due to presence of adjacent text and iconic versions of a link.
A	None h1 element in the document	2	The intent is to organize the content
A	Use of absolute font sizes	20	The objective of this technique is to identify and specify the font size of text proportionally so that user could efficiently scale the content.
A	Empty links (navigation)	2	"Whenever possible, provide link text that identifies the purpose of the link without needing additional context".
A	Form with no standard submission method	1	The objective of this guideline is to allow user to explicitly request changes of context.
A	Web page is not well formed	1	Content must be capable of interpreted by variety of user agents including assistive technologies.

Apart from the accessibility testing tools, three independent tools e.g. CCA, RIC and a test case was conducted mentioned in section 5. Table 13 provides the summary of the results for all three government bodies.

TABLE XIII
WEBSITE ACCESSIBILITY TESTS SUMMARY

Benchmark	Testing issues	Tools	Results		
			GB 1	GB 2	GB 3
WCAG 2.0	Perceivable		X	X	X
	operable	TAW	√	X	√
	understandable	AChecker	√	√	√
	robust		√	√	√
	Color contrast	CCA	X	X	√
	Readability	RIC	X	√	X
	Keyboard trap	Test case	√	√	√

Table 13 shows that only GB 3 cleared color contrast test while other both websites failed the test as the contrast ratio for the colors used in background and foreground (of the websites) is not high enough to make it readable for everyone e.g. light background color with light foreground color. GB3 passed this test as the contrast ratio between the used colors is very high making text readable e.g. light background with dark foreground text color or dark background with light foreground text color. Readability test was only passed by GB2 that contains text which is normal to understand while other two websites content is difficult to comprehend as identified by the tool. After performing series of tests for the selected government bodies, it is observed that all three government bodies don't fully adhere to the international standards of web content accessibility guidelines set by W3C. GB1 and GB 2 both cleared 4 tests out of total 7 while GB 3 could only clear 2 tests.

VI.CONCLUSION

The work reveals that all three websites still require considerable efforts in their designs to make them fully accessible. Most of the related literature is missing this part and is restrained to only testing results and benchmarking the government bodies. The reports generated by the tools helps to identify the errors and facilitate to fix them. Every accessibility evaluation tool operates on its algorithm which differs from the other tool and hence each tool has its own limitations depending on the algorithm used. It is therefore better to use combination of tools to identify maximum accessibility issues. In this paper, results are obtained by using combination of tools. Hence the results show that the tested government websites are not keeping up to the guidelines set by W3C. This study assists and emphasizes to adhere to the guidelines set by W3C.

VII.   APPENDIX

GB 1 – Government body 1 – Prime Minister of India website – www.pmindia.gov.in
GB 2 – Government body 2 – Prime Minister of India website – www.narendramodi.in
GB 3 – Government body 3 – National portal of India – www.india.gov.in

REFERENCES

[1]X. Zeng, "Evaluation and Enhancement of Web Content Accessibility for Persons with Disabilities", *Doctoral Dissertation*, Graduate Faculty of School of Health and Rehabilitation on Science in partial fulfillment of the requirements for the degree of Doctor of Philosophy, University of Pittsburg, 2004, http://etd.library.pitt.edu/ETD/available/etd-04192004-155229/unrestricted/XiaomingZeng_April2004 .pdf
[2]C. Boldyreff, "Determination and Evaluation of Web Accessibility", Paper presented at the Eleventh IEEE International Workshops on Enabling Technologies: Infrastructure for Collaborative Enterprises (WETICE'02), Pittsburgh, PA, USA, 2002
[3]J. Lazar, A.D. Sponaugle, and K.D. Greenidge,"Improving web accessibility: a study of webmaster perceptions", Computers in Human Behavior, 20(2), 2004, pp.269-288.
[4]W3C, Web Content Accessibility Guidelines 2.0, (2008), http://www.w3.org/TR/WCAG/
[5]Nomensa, "BS8878 Web Accessibility Code of Practice", Nomensa Blog. 2010, December 10 http://www.nomensa.com/blog/2010/bs8878-webaccessibility-code-of-practice/
[6] S. McCoy, and E.T. Loiacono, "Website accessibility: a cross-sector comparison", Universal access in the information society, 4(4), 2006, pp.393-399
[7] M. Q. Patton, "Utilization-focus evaluation", 3rd edition, Thousand Oaks, CA: Sage. 1997.