Development and Testing of a Thai Website Accessibility

Evaluation Tool

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| **Article Info** |  | **ABSTRACT** |
| ***Article history:***  Received Jun 12, 201x  Revised Aug 20, 201x  Accepted Aug 26, 201x |  | This research addresses the lack of a method to help with the evaluation of the accessibility of Thai websites and web applications by developing and evaluating an online tool WebThai2Access with developers, experts, and disabled users. The research was conducted by reviewing literature, and evaluations with 30 developers, 30 hearing impaired people, 30 visually impaired people, and 30 elderly people. The developers evaluated the websites whereas experimental tasks were given to each disabled group based on the problems they had accessing information on the web. The developers found WebThai2Access very usable. The result suggested that the 15 test criteria were reliable for evaluating websites. The average 95% upper and lower confidence limits of the developer scores were plus or minus 10% for both Pantip and YouTube websites and plus or minus 3% for the blind association website. The average 95% upper and lower confidence limits were plus or minus 0% for the visually impaired users, plus or minus 2% for the elderly users, and plus or minus 5% for the hearing impaired users. The results showed that WebThai2Access was very accessible and could be used reliably by developers and their evaluations predicted the accessibility of websites for disabled users reasonably well. |
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1. **INTRODUCTION**

The motivation for this research was the lack of a method to help users, managers and developers with the evaluation of the accessibility of Thai websites and web applications. The National Bureau of Statistics [1] estimated the total number of people with disabilities in Thailand in the year 2015 at about 1.7 million which is 2.61% of the total population. There were approximately 220,000 visually impaired persons accounting for 3% of the total disabled population. The department of Empowerment of Persons with Disabilities [2] stated that there were 196,272 hearing impaired people in Thailand. The number of elderly people is about 10 million, representing 15.38% of the total population. Wapattanawong and Prasatku [3] state that the number of elderly people in the future is likely to continue to increase 6% per year but during 2015 - 2020, the number of elderly people will increase by 7 %. A majority of these disabled and elderly people could benefit from accessible websites as a report estimated that 62% of people in the US of working age could benefit from accessible technologies [4] and disabilities increase with age. Research in 2006 reported that 97% of websites in Argentina, Australia, Brazil, Canada, Chile, China, France, Germany, India, Japan, Kenya, Mexico, Morocco, Russia, Singapore, South Africa, Spain, United Arab Emirates, United Kingdom and United States of America did not provide even minimum levels of accessibility [5] and while there are no published figures for Thai websites, it is very unlikely that they are more accessible as many of the countries tested have web accessibility legislation.

A benefit for making websites accessible to disabled people is that they are then also more likely to be usable on mobile devices [6]. At present, Thailand has regulations to support the development of accessible websites. The Ministry of Information Technology and Communication [7] has established a framework policy for information technology and communication of Thailand for the period 2011 – 2020. It mentioned that strategy 6 was to develop and apply ICT to reduce economic and social inequality by creating equality of opportunity to access public resources and services for all groups of people. It has prepared standards for government websites but the authors found no rigorous research study on how to apply a Thai web site development approach in practice and analyze the results. In addition, there is a lack of research on evaluating and developing of accessible websites in Thailand. There is only one site assessment tool which has been developed by a business unit, Thai Web Accessibility Team [8], but the evaluation data is not disclosed to the public.

Laaziri et. al. [9] proposed a model for assessing Accessibility, Usability, Emotionality, and Persuasivity but did not evaluate its use. Wahyuningrum and Mustofa [10] studied software quality measurement and identified the most widely used method was the empirical method involving users. Nayebpour and Rashid [11] investigated how service-oriented architecture might enable expert systems to respond to fast changing information.

Based on a review of the literature, the authors decided to develop criteria for evaluating access to information on Thai websites for disabled people including testing the use of such evaluation criteria with web developers, visually impaired, hearing impaired, and elderly people. Although the criteria developed is relevant to all disabilities and the developers evaluated the websites for all disabilities, the time and resources available for this research project allowed only 90 disabled participants to be used in the evaluation. Since 30 people can provide reasonable statistical evidence in an experiment, it was therefore decided to use 30 visually impaired people, 30 hearing impaired people and 30 elderly people. The selection of these three groups is a practical way to cope with the time and resource limitations as blindness requires visual information to be made accessible through speech alternatives and a website to be navigated using the keyboard, while deafness requires auditory information to made accessible through text alternatives and as people grow older the proportion of the population with a disability increases whether sensory, cognitive or physical.

Although disabilities is an umbrella term, covering impairments, activity limitations, and participation restrictions only certain disabilities are related to the accessibility of websites. For example, physical disabilities that only affect the ability of a person to use their legs will not restrict the ability of a person to use a website. Since a blind person cannot use a mouse but uses a keyboard, if a web site is accessible for a blind person it will also be accessible for a physically disabled person who cannot use a mouse but can use a keyboard. A website accessible for a physically disabled person who cannot use a mouse is however not always accessible for a blind person as they need all information provided in a non-visual form. The accessibility of a website does not depend on the particular type of keyboard a person uses and therefore although different users might use different sizes or designs of keyboard this study does not need to investigate different types of keyboard.

This article extensively expands on the brief information presented in the 2017 HCI International Conference poster extended abstract [12].

1. **DEFINITION OF TERMS**

1. Web2Access is an easy tool that the 2nd Author and his team had developed in the UK to help web developers in evaluating accessible websites.

2. Webthai2access.og was developed based on Web2Access but there are differences in criteria e.g. font, size, etc., as well as guidance in techniques because of language and culture differences.

1. **RESEARCH OBJECTIVE**

The objectives of this research are:

1. To develop a Thai Web Accessibility Assessment tool that helps developers to assess the accessibility of Thai websites.

2. To evaluate the use of this tool for assessing access to Thai websites for people with visual Impairment, hearing impairment or who are elderly.

The next section is a literature review, then the research methodology will be presented, followed by results, analysis and discussion. Finally, a conclusion, future work and recommendations will be presented.

1. **LITERATURE REVIEW**

Tim Berners-Lee, W3C Director and inventor of the World Wide Web stated “The power of the Web is in its universality, Access by everyone regardless of disability is an essential aspect” [13]. The Web was therefore invented to be used by everyone, irrespective of their ability, technology used or culture, and has the potential to remove barriers for people with disabilities, but only if websites are designed accessibly. Access to information through the Web is a basic human right [14]. Making the web accessible can help elderly people and those in less wealthy countries as well as people with disabilities in many aspects of their lives including education, employment, health care, and social lives. Accessible websites can provide social, technical, financial, and legal benefits for companies, government and education [15]. When web pages are not designed accessibly, many people cannot use the Web. For example, people who cannot use a mouse need keyboard access and people who are blind need alternative text for images and this affects many people as they get older. There are estimated to be about two million disabled people in Thailand, the majority in rural areas with 65 % unemployed and over 50 % working in agriculture and fishing and although there are anti-discrimination laws and guidance for disability development practice there are no specific laws or regulations for website accessibility. There has been a great deal of international research on the accessibility of websites resulting in the web accessibility guidelines [16] which have been adopted in some countries [17]. Research has shown that following these guidelines can also benefit non-disabled users [18]. Ahmi and Mohamad [19] evaluated 25 Malaysian ministry websites and found low compliance with web accessibility standards.

The Web Accessibility guidelines were originally developed for English and simply translating them does not necessarily address all the localisation issues of Thai Language and context. Web2Access [20] was developed with the view that a holistic approach is needed [21]. Although Web2Access was developed by web accessibility experts and has been used extensively in the UK over 10 years to evaluate many hundreds of websites by many developers and evaluators there has never been any experimental study to examine its ease of use or reliability.

1. **RESEARCH METHODOLOGY**

There is no official translation of the Web Accessibility Guidelines into Thai and no research into whether the guidelines require any localisation for the Thai language and culture. An interactive Thai website, WebThai2Access, was therefore developed to help manually test any Thai Website using a simplified checklist based on the more complex Web Content Accessibility Guidelines (WCAG 2.0). In addition, it explains the tools which can be used for the evaluation. It has been designed to be easier to use and score than the WCAG guidelines which have more than 60 tests most of which can only be carried out manually by someone with expert knowledge and experience as only a few of the tests can be carried out by automatic checkers. WebThai2Access has summarised and compressed the guidelines and tests into the following 15 criteria that can be followed by developers.

1. Accessible Login, Signup and Other Forms: covering all aspects of registering with a service or site, then returning to sign-in and finally to work with forms.

2. Image ALT Attribute: so that a screen reader user can hear about the image.

3. Link Target Definitions: which need to be understandable when used without a surrounding sentence or button.

4. Frame Titles and Layout: if the frames do not have a title the screen reader user may not know where they are in the page or which piece of content to read next.

5. Removal of Style sheet: as it is important to check how a site looks with and without style sheets.

6. Audio/Video Features: for those who have sensory disabilities such as deafness or a hearing additional text transcripts, captioning, and sign language can be very helpful.

7. Video/animations - audio descriptions: for those who have visual impairments offering alternatives for animations or videos where there are long scenes with no descriptive dialogue is essential.

8. Appropriate use of Tables: the order of content within the table and the use of row and column headers is important.

9. Tab Orderings Correct and Logical: when you cannot use the mouse the order in which the main navigational elements and links appear in a webpage is very important.

10. Page Functionality with Keyboard: after log-in (if log-in required by the page being evaluated).

11. Accessibility of Text Editors: many of the sites that allow users to contribute text, images and other multimedia also provide an editor that allows users to change the look and feel of their text as they would in a Word Processer application.

12. Appropriate Feedback with Forms: once a user has submitted text or an answer to a question or multiple choice items it is important that correct feedback is received to prevent confusion.

13. Contrast and Colour Check: for everyone to have an enjoyable experience when reading web sites content should have good levels of colour contrast and no distracting elements.

14. Page Integrity when zooming: allowing text and images to be enlarged through a zoom feature or text-resize.

15. Text size, style, blinking elements and Readability: avoiding items that flash or blink at a rate that can cause seizures and small text and serif fonts and complex language that can make text harder to read for some people.

The scoring has 4 levels corresponding to the WCAG 2.0 conformance levels, where 0% would be fail condition, 33% would be equivalent to an A, 67% would be equivalent to an AA, and 100% would be equivalent to AAA. The use of percentages has the advantage of allowing averaging compared to categories and understandability compared to level numbering (i.e. a level of 3 is meaningless without knowing the maximum is 4). There were 7 phases of the research. Phase 1 involved a literature review to identify where Thai accessibility guidelines differ from English guidelines and tools to evaluate Thai Websites. The results of this activity helped identify changes to web accessibility guidelines for Thai tools that could be used to evaluate Thai websites. In phase 2, an interview was conducted with 30 Thai developers, 10 people with hearing impairments, 10 people with visual impairments, and 10 elderly people in order to know the barriers to accessing Thai websites, including information about the websites that each group of users use in their daily life. In phase 3,extensive guidelines, tests, tools and documentation were developed and localized into Thai Language and Culture. An expert review was conducted and a validation study of the tests and guidelines and tools and documentation involving accessibility expertsto validate the Thai guidelines, tests and tools and documentation. In phase 4**,** based on the results of the expert validation and reviewWebThai2Access was built and tested. In phase 5, a user evaluation pilot study of WebThai2 Access was carried out and based on the results the experimental design was finalized and a user evaluation of WebThai2Access conducted with 30 developers and 30 visually impaired, 30 elderly and 30 hearing impaired users. In phase 6, the results were analysed for how well developers could evaluate Thai websites to predict how disabled users will use the websites. A case study was conducted for phase 7.

1. **EXPERIMENT DESIGN**

Three web accessibility experts followed instructions to evaluate the website http://www.tab.or.th by using a screen reader program such as NVDA, JAWS or Voiceover and also a speech Thai synthesizer program (Tatip) by inserting an outcome (%) which they believe to be appropriate in the ‘Evaluation’ box and in addition to this, answer all the questions in the ‘Technique’ box. An example for the 1st test is as follows: Test 1: Login, signup, and other forms accessible, such as contact us, feedback form, and help form. Check the process for the signup form, if there is access to the website or not, check how accessible the forms are, and if they can be accessed through the use of a keyboard and screen reader (NVDA, JAWS, and Voice Over) and check if the labelling has a meaningful name which can be understood by the users (W3C WCAG guidelines 1.1, 2.1, 2.4, 3.3 (https://www.w3.org/TR/WCAG20)). Target Audiences are those with blind and severe visual impairment Techniques are:

1. Check if it is possible to access any forms through the use of tab key and screen readers (NVDA, JAWS, Voiceover).
2. Once you have access to a form, check if the label is given a meaningful name by using WAVE look at “Features” and “Form Label”.
3. Check if it is possible to access the input aspect of the form through a logical order through the use of tab key and screen reader. If the inputted information is incorrect, such as type wrong password, then check to see if the screen reader reads the error message or not.
4. Check CAPTCHA (W3C WCAG 1.1.1) if there is an option to change the captcha i.e. the option to change from text to sound or from image to sound or text. Check if these are able to be changed through the use of keyboard or not and also check if the screen reader is able to read the changes.
5. Check if there are time limits (W3C WCAG 2.2.1) in the form.
6. Check sending the form whilst pressing the button to send the form, to see if the screen reader reads the send button.
7. Check if it possible to exit the form through the use of a keyboard and screen reader.

One of the 4 ratings explained earlier are possible:

0%: Unable to access the form and CAPTCHA through the use of keyboard and screen reader. Unable to access the form in time, and there is no label.

33%: Hard to access the CAPTCHA, the majority of the forms can be accessed by the use of a keyboard and the screen reader program can read the some of the form. There are a few labels used. The form has a time limit.

67%: The majority of the form can be accessed through the use of keyboard and screen reader, however there are some errors i.e. does not read the label or feedback and label identified by screen reader is not the same as displayed on the website. There is no time limit and there is an option for an alternative CAPTCHA.

100%: Forms can be accessed easily through the use of keyboard and screen reader, clear labels, no CAPTCHA, and there is no time limit.

The WebThai2Access website has tabs in the navigation linked to the following pages:

* products reviewed and approved by the system administrator
* list of disabilities with descriptions and associated tests
* list and short description of the 15 evaluation criteria, selecting each criteria displays a page with further details

They entered review information, reviewer’s name, email, platform and website. If the website that they want to evaluate is not already listed as having been reviewed they will be required to add website name, URL, and short description.

Six developers were asked to rate the usability and functionality of the WebThai2Access prototype at https://webthai2access.org using a 5 point Likert scale where 5 was the highest score and the average score was 4.7. The participants suggested having more text space by increasing the character limit to more than 255, having multiple text boxes corresponding to the techniques and changing the word “test” **(ทดสอบ)** to “testing” (**การทดสอบ**) in the disability tab since when translated into Thai it is confusing for the user. The WebThai2Access prototype was modified based on the evaluation results and feedback before conducting the experiment. Four groups of participants took part in the experiment. Each group spent about an hour to do the task apart from the hearing impairment group which spent only 20 minutes on the task as there were only three criteria that affected this group. The developers evaluated all 15 criteria while experimental tasks were given to each disabled group based on the problems they had accessing information on web. The experimental task of each group was as follows:

Table 1. Experimental tasks

|  |  |  |  |
| --- | --- | --- | --- |
| **Participants Group** | **www.pantip.com** | **www.youtube.com** | **www.tab.or.th** |
| 30 developers | all 15 criteria | all 15 criteria | all 15 criteria |
| 30 visually impaired people | criteria numbers 1-3 and 8-9 | criteria numbers 10 - 12 | criteria numbers 4-5 |
| 30 hearing impaired people | criteria numbers 1, 12 and 15 | - | - |
| 30 elderly people | criteria numbers 1, 3 and 12 - 15 | - | criteria 10 |

Table 1 shows that:

1. Thirty developers evaluated 3 websites: www.pantip.com, www.youtube.com, and www.tab.or.th on all 15 criteria.

2. Thirty visually impaired people evaluated 3 websites: criteria numbers 1-3 and 8-9 for www.pantip.com, criteria numbers 10 - 12 for www.youtube.com, and criteria numbers 4-5 for www.tab.or.th.

3. Thirty hearing impaired people evaluated www.pantip.com using criteria numbers 1, 12 and 15. There was no video or audio that may affect hearing on www.tab.or.th. and whether or not YouTube videos are accessible to hearing impaired people depends entirely on the person uploading the video and not the YouTube website accessibility.

4. Thirty elderly people evaluated websites using criteria numbers 1, 3 and 12 - 15 for www.pantip.com and 10 for www.youtube.com.

The results of the Thai web developers evaluations were compared with how well the Thai visually impaired, hearing impaired, and elderly people were able to carry out tasks related to their disabilities using the same three websites. This comparison of scores was used to determine how well developers’ evaluation scores using WebThai2Access predicts the accessibility of websites for disabled users (i.e. disabled people’s task scores).

1. **RESULTS, ANALYSIS, DISCUSSION**

The differences between U.K. and Thai criteria are font types and sizes: U.K uses Sans-serif size 10-12 px, while Thai uses serif size 14-16 px. Based on research [22] criteria 15’s text size, style, blinking elements, and readability, was changed from sans-serif fonts to serif and 14 - 16 px instead of 10 -12 px to suit Thai websites. The original English Web Accessibility Guidelines therefore required changing to reflect these differences.

Interview results showed that developers have little knowledge about Web Accessibility with no or little experience in using a screen reader so do not know how to use shortcut keys. Visually impaired people have a problem using CAPTCHA as a screen reader could not read the picture and there was no alternative audio. The screen reader could not access some pdf files with no alternate text to explain pictures as they only hear “graphic”. Many hearing impaired people have reading difficulties and so they found reading even plain text difficult and found it even more difficult to read text mixed between san serif and serif. There was not enough colour contrast between background and text. Therefore, they could not see it clearly. There is blinking information on some website which affect the readers. They found it difficult in filling information in the forms with no response feedback. Some websites provided very difficult content, so they needed sign language video or avatar to help. They did not know how to zoom in or zoom out text. Elderly people found it difficult to read less than 10 point text and poor colour contrast between background and text. They found it difficult in filling information in the forms with complex steps including signing up and signing. They do not know how to zoom in or zoom out text. The 30 developers who evaluated the accessibility of Webthai2access gave it an average score of 99%. Twelve criteria were rated 100% whereas criteria 8, 12, 15 were rated 98%, 95% and 99% respectively as shown in Table 2.

Table 2. Average scores of 30 developer participants rating on WebThai2Access

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Criteria** | **Mode** | **Average** | **sd** | **sd error** | | **Interval** | **Upper** | **Lower** |
| 1 | 1.00 | 1.00 | 0.00 | | 0.00 | 0.00 | 1.00 | 1.00 |
| 2 | 1.00 | 1.00 | 0.00 | | 0.00 | 0.00 | 1.00 | 1.00 |
| 3 | 1.00 | 1.00 | 0.00 | | 0.00 | 0.00 | 1.00 | 1.00 |
| 4 | 1.00 | 1.00 | 0.00 | | 0.00 | 0.00 | 1.00 | 1.00 |
| 5 | 1.00 | 1.00 | 0.00 | | 0.00 | 0.00 | 1.00 | 1.00 |
| 6 | 1.00 | 1.00 | 0.00 | | 0.00 | 0.00 | 1.00 | 1.00 |
| 7 | 1.00 | 1.00 | 0.00 | | 0.00 | 0.00 | 1.00 | 1.00 |
| 8 | 1.00 | 0.98 | 0.12 | | 0.02 | 0.04 | 1.02 | 0.93 |
| 9 | 1.00 | 1.00 | 0.00 | | 0.00 | 0.00 | 1.00 | 1.00 |
| 10 | 1.00 | 1.00 | 0.00 | | 0.00 | 0.00 | 1.00 | 1.00 |
| 11 | 1.00 | 1.00 | 0.00 | | 0.00 | 0.00 | 1.00 | 1.00 |
| 12 | 1.00 | 0.94 | 0.12 | | 0.02 | 0.04 | 0.99 | 0.90 |
| 13 | 1.00 | 1.00 | 0.00 | | 0.00 | 0.00 | 1.00 | 1.00 |
| 14 | 1.00 | 1.00 | 0.00 | | 0.00 | 0.00 | 1.00 | 1.00 |
| 15 | 1.00 | 0.99 | 0.06 | | 0.01 | 0.02 | 1.01 | 0.97 |

The 30 visually impaired users’ ages ranged from 13-23 with an average of 19. Nineteen were blind since birth and 7 became blind later on and 4 had severe visual impairment. Twenty-nine used Jaws and 1 used NVDA screen reader. Ten had 5 years screen reader experience and 20 had 1-2 years’ experience and all used the Windows operating system versions 7, 8 or 10. Eighteen used the Google Chrome browser, 9 used Internet Explorer and 3 used Firefox. All 30 hearing impaired users had been deaf since birth and were aged between 12 and 50 with an average age of 20. Twenty - five used a computer and 5 used mobile devices. The 30 elderly users’ ages ranged from 60 - 89, with an average age of 64.5. Twenty-four had 1-2 years’ experience using websites, 2 had 3 years’ experience while 4 had more than 3 years’ experience. Fourteen used a tablet, 7 used a smartphone and 9 used a computer. The 30 developers all had experience of HTML and developing websites and were trained to use a screen reader for the experiment and WebThai2Access.

From Tables 3 - 5, the analysis of the results suggested that using the test criteria was reliable for evaluating websites by developers as for the 15 criteria the average 95% upper and lower confidence limits of the developer scores were plus or minus 10% for both www.pantip.com and www.YouTube.com websites and plus or minus 3% for http://tabgroup.tab.or.th and they did not overlap the rating levels of 33% or 67%. This can be interpreted to mean that developers scored with low enough variability for agreement on rating levels using the following statistical analysis: standard error = standard deviation/sqrt 30; 95% confidence interval = 1.96\* standard error; upper limit = mean + confidence interval; lower limit = mean - confidence interval. If upper and lower limits do not overlap 0.33 (i.e.33%) or 0.67 (i.e. 67%) then we can say it is reliable. For example, YouTube criteria 1 lower limit is 0.74 which is > 0.67 therefore average of 0.83 can be treated as nearest to rating of 1 (100%).

Table 3**.** Developers’ rating scores on www.youtube.com

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Criteria** | **Experts’ rating** | **Mode** | **Average** | **SD** | **SD**  **error** | **Confidence interval** | **Upper limit** | **Lower limit** |
| 1 | 1.00 | 1.00 | 0.83 | 0.27 | 0.05 | 0.10 | 0.93 | 0.74 |
| 2 | 0.33 | 0.00 | 0.50 | 0.44 | 0.08 | 0.16 | 0.66 | 0.34 |
| 3 | 1.00 | 1.00 | 0.91 | 0.17 | 0.03 | 0.06 | 0.97 | 0.85 |
| 4 | 1.00 | 0.67 | 0.53 | 0.40 | 0.07 | 0.14 | 0.68 | 0.39 |
| 5 | 1.00 | 1.00 | 0.81 | 0.24 | 0.04 | 0.09 | 0.90 | 0.72 |
| 6 | 0.67 | 1.00 | 0.86 | 0.30 | 0.05 | 0.11 | 0.96 | 0.75 |
| 7 | 1.00 | 1.00 | 0.88 | 0.20 | 0.04 | 0.07 | 0.95 | 0.81 |
| 8 | 1.00 | 1.00 | 0.67 | 0.41 | 0.07 | 0.15 | 0.81 | 0.52 |
| 9 | 1.00 | 1.00 | 0.91 | 0.17 | 0.03 | 0.06 | 0.97 | 0.85 |
| 10 | 1.00 | 1.00 | 0.87 | 0.22 | 0.04 | 0.08 | 0.95 | 0.79 |
| 11 | 1.00 | 1.00 | 0.74 | 0.37 | 0.07 | 0.13 | 0.88 | 0.61 |
| 12 | 1.00 | 1.00 | 0.78 | 0.30 | 0.05 | 0.11 | 0.88 | 0.67 |
| 13 | 1.00 | 1.00 | 0.77 | 0.28 | 0.05 | 0.10 | 0.87 | 0.67 |
| 14 | 1.00 | 1.00 | 0.87 | 0.23 | 0.04 | 0.08 | 0.95 | 0.79 |
| 15 | 0.67 | 1.00 | 0.91 | 0.17 | 0.03 | 0.06 | 0.97 | 0.85 |

Table 4**.** Developers’ rating scores on www.pantip.com

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Criteria** | | **Experts’ rating** | | **Mode** | | **Average** | | **SD** | | **SD**  **error** | **confidence interval** | | **Upper limit** | **Lower limit** |
| 1 | 0.33 | | 1.00 | | 0.87 | | 0.23 | | 0.04 | | 0.08 | 0.95 | | 0.79 |
| 2 | 0.00 | | 0.67 | | 0.58 | | 0.36 | | 0.07 | | 0.13 | 0.71 | | 0.45 |
| 3 | 1.00 | | 1.00 | | 0.88 | | 0.19 | | 0.03 | | 0.07 | 0.94 | | 0.81 |
| 4 | 1.00 | | 1.00 | | 0.57 | | 0.47 | | 0.08 | | 0.17 | 0.73 | | 0.40 |
| 5 | 1.00 | | 1.00 | | 0.82 | | 0.29 | | 0.05 | | 0.10 | 0.93 | | 0.72 |
| 6 | 0.67 | | 0.67 | | 0.65 | | 0.34 | | 0.06 | | 0.12 | 0.77 | | 0.52 |
| 7 | 1.00 | | 1.00 | | 0.73 | | 0.30 | | 0.05 | | 0.11 | 0.84 | | 0.63 |
| 8 | 1.00 | | 1.00 | | 0.76 | | 0.34 | | 0.06 | | 0.12 | 0.88 | | 0.64 |
| 9 | 1.00 | | 1.00 | | 0.91 | | 0.15 | | 0.03 | | 0.05 | 0.97 | | 0.86 |
| 10 | 0.67 | | 1.00 | | 0.83 | | 0.26 | | 0.05 | | 0.09 | 0.93 | | 0.74 |
| 11 | 0.67 | | 1.00 | | 0.79 | | 0.30 | | 0.05 | | 0.11 | 0.89 | | 0.68 |
| 12 | 0.33 | | 1.00 | | 0.77 | | 0.29 | | 0.05 | | 0.10 | 0.87 | | 0.67 |
| 13 | 0.67 | | 0.67 | | 0.60 | | 0.30 | | 0.05 | | 0.11 | 0.71 | | 0.49 |
| 14 | 1.00 | | 1.00 | | 0.91 | | 0.15 | | 0.03 | | 0.05 | 0.97 | | 0.86 |
| 15 | 0.67 | | 1.00 | | 0.87 | | 0.21 | | 0.04 | | 0.07 | 0.94 | | 0.79 |

Table 5**.** Developers’ rating scores on www.tab.or.th

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Criteria** | **Experts’ rating** | **Mode** | **Average** | **SD** | **SD**  **error** | **Confidence interval** | **Upper**  **limit** | **Lower**  **limit** |
| 1 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 1.00 | 1.00 |
| 2 | 0.67 | 0.67 | 0.70 | 0.16 | 0.03 | 0.06 | 0.76 | 0.65 |
| 3 | 1.00 | 1.00 | 0.98 | 0.12 | 0.02 | 0.04 | 1.02 | 0.93 |
| 4 | 1.00 | 0.33 | 0.48 | 0.26 | 0.05 | 0.09 | 0.57 | 0.38 |
| 5 | 1.00 | 1.00 | 0.98 | 0.08 | 0.02 | 0.03 | 1.01 | 0.95 |
| 6 | 1.00 | 1.00 | 0.99 | 0.06 | 0.01 | 0.02 | 1.01 | 0.97 |
| 7 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 1.00 | 1.00 |
| 8 | 1.00 | 1.00 | 0.96 | 0.17 | 0.03 | 0.06 | 1.02 | 0.89 |
| 9 | 0.33 | 0.33 | 0.46 | 0.27 | 0.05 | 0.10 | 0.56 | 0.37 |
| 10 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 1.00 | 1.00 |
| 11 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 1.00 | 1.00 |
| 12 | 0.33 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 1.00 | 1.00 |
| 13 | 0.67 | 0.67 | 0.73 | 0.13 | 0.02 | 0.04 | 0.77 | 0.68 |
| 14 | 1.00 | 1.00 | 0.99 | 0.06 | 0.01 | 0.02 | 1.01 | 0.97 |
| 15 | 0.67 | 0.67 | 0.70 | 0.10 | 0.02 | 0.04 | 0.74 | 0.67 |

From Tables 6-8, using a similar analysis of the results for the disabled users suggested that using the test criteria was reliable for evaluating websites as for the 15 criteria the average 95% upper and lower confidence limits were plus or minus 0% for the visually impaired, plus or minus 2% for the elderly and plus or minus 5% for the hearing impaired and they did not overlap the rating levels of 33% or 67%.

Table 6 Elderly participants’ ratings

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Criteria** | **Mode** | **Average** | **SD** | | **SD**  **error** | **Confidence interval** | | **Upper**  **limit** | **Lower**  **limit** |
| 1 | 1 | 0.92 | 0.14 | 0.03 | | | 0.05 | 1.05 | 0.95 |
| 3 | 1 | 1.00 | 0.00 | 0.00 | | | 0.00 | 1.00 | 1.00 |
| 10 | 1 | 1.00 | 0.00 | 0.00 | | | 0.00 | 1.00 | 1.00 |
| 12 | 1 | 1.00 | 0.00 | 0.00 | | | 0.00 | 1.00 | 1.00 |
| 13 | 1 | 0.92 | 0.14 | 0.03 | | | 0.05 | 1.05 | 0.95 |
| 14 | 1 | 1.00 | 0.00 | 0.00 | | | 0.00 | 1.00 | 1.00 |
| 15 | 1 | 0.93 | 0.13 | 0.02 | | | 0.05 | 1.05 | 0.95 |

Table 7. Hearing impaired participants’ ratings

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Criteria** | **Mode** | **Average** | **SD** | **SD**  **error** | | **Confidence interval** | **Upper**  **limit** | **Lower**  **limit** |
| 1 | 1 | 0.99 | 0.06 | 0.01 | 0.02 | | 1.02 | 0.98 |
| 12 | 1 | 0.89 | 0.16 | 0.03 | 0.06 | | 1.06 | 0.94 |
| 15 | 1 | 0.85 | 0.17 | 0.03 | 0.06 | | 1.06 | 0.94 |

Table 8. Visually impaired participants’ ratings

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Criteria** | **Mode** | **Average** | **SD** | **SD**  **error** | **Confidence interval** | **Upper**  **limit** | | **Lower**  **limit** |
| 1 | 0.33 | 0.33 | 0.00 | 0.00 | 0.00 | | 0.33 | 0.33 |
| 2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 |
| 3 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | | 1.00 | 1.00 |
| 4 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | | 1.00 | 1.00 |
| 8 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | | 1.00 | 1.00 |
| 9 | 0.33 | 0.33 | 0.00 | 0.00 | 0.00 | | 0.33 | 0.33 |
| 10 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | | 1.00 | 1.00 |
| 11 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | | 1.00 | 1.00 |
| 12 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | | 1.00 | 1.00 |

Comparing the average scores of the developers and experts the average difference was 18% (ignoring difference direction) and 2% when the difference sign was considered. The mode ratings were the same for the developers and experts for 11 criteria on YouTube, 9 criteria on Pantip and 13 on tabgroup and for all websites for criteria 3, 5, 7, 8, 13, and 14. Comparing the scores of the 3 groups of 30 elderly, blind, and hearing impaired users with those of the developers showed that the average difference for the blind users was 26%, for the elderly was 17%, and for the hearing impaired was 8%, (ignoring the difference direction), and -1%, -17%, -7% when the difference sign was considered. The greatest difference between developers and blind users were 54%, 52%, -58% respectively for criteria 1, 2, (www.pantip.com) and 4 (http://tabgroup.tab.or.th). Looking at the mode values there was agreement between the developers and the blind users apart from criteria 1, 2, 4 where the mode ratings for blind users were 33%, 0%, 100% and for the developers were 100%, 67%, 33% respectively. The expert ratings were the same as the mode ratings by the blind users for all criteria suggesting that the experts were better that the developers at predicting how the blind users would perform. This might be because the developers were not experienced at using a screen reader.

The greatest difference between developers and elderly users were -23% and - 32% respectively for criteria 12, and 13 (www.pantip.com) and the only difference in the mode ratings were for criteria 13 where the elderly mode was 100% and the developer mode was 67%. The expert rating for criteria 13 was also 67% suggesting that the experts were not better than the developers at predicting how the elderly users would perform on criteria 13. The average differences between developers and the hearing impaired people were -12%, -12%, 2% for criteria 1, 12, 15 respectively and the mode ratings were the same, suggesting the developers predicted the hearing impaired people’s performance quite well.

1. **CASE STUDY**

To verify that WebThai2access could successfully be used by a developer to first identify and then correct problems in a website a case study was carried out in phase 7 involving a blind student and the developer at Suratthani Provincial Social Development and Human Security Office who used WordPress to create their website http://www.suratthani.m-society.go.th. The developer noted that there is some limitation of using Wordpress such as not being able to add code. The blind student used the website and identified problems they had with it and these problems were also identified by the developer using WebThai2Access. The developer then found solutions to the problems and the new version of the website was used by the blind student who verified that the identified problems had now been solved. Problems in accessing the website that had been identified and then solved were:

1. No Image ALT Attributes and Text Alternative for all images in the whole website. Therefore, a screen reader could not read them: improved by adding ALT Attributes and Text Alternative for all images

2. No Image ALT Attributes and Text Alternative for a map as it was placed in a frame and the URL of the map was copied from google map location therefore a screen reader couldn’t read it. Tried to add code <frame name = “name”> but it didn’t work because the codes were copied from the map, so when adding code, the picture of the map disappear: improved by adding alternative text for a map.

3. There is no caption in the video. No Image ALT Attributes and Text Alternative for a video and also the video was placed in a frame. The video was created in the center in Bangkok so the developer couldn’t add captions herself. The developer also didn’t know how to create captions so the researcher taught the developer how to add captions for future work. The researcher taught the developer how to add captions on to the video.

4. There is no explanation label in the “Other” field in the satisfaction form so a screen reader couldn’t read it: changes by adding an explanation label on “Other” field.

1. **CONCLUSION AND FUTURE WORK**

The results showed that WebThai2Access was very accessible and could be used reliably by developers and their evaluations predicted the accessibility of websites for disabled users reasonably well. The average rating of 4.7 out of 5 showed developers found WebThai2Access very usable. For the 15 criteria the average 95% upper and lower confidence limits of the developer scores were plus or minus 10% for both Pantip and YouTube websites and plus or minus 3% for blind association website and they did not overlap the tool rating levels which were 33% or 67%. The results for the disabled users suggested that using the test criteria were reliable for evaluating websites as for the 15 criteria the average 95% upper and lower confidence limits were plus or minus 0% for the visually impaired, plus or minus 2% for the elderly and plus or minus 5% for the hearing impaired and they did not overlap the rating levels of 33% or 67%. The case study verified that WebThai2access could successfully be used by a developer to first identify and then correct problems in a website. Future work will investigate how to even further improve the predictions of website issues and also develop criteria and techniques for evaluating accessibility on mobile devices.

1. **RECOMMENDATION**

Based on the results of this research it is recommended that all website developers in Thailand use WebThai2Access to evaluate the accessibility of their websites to improve their accessibility. WebThai2Acess can be used when designing and developing a new website and also for evaluating existing websites to make them more accessible.

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**REFERENCES**

1. National Bureau of Statistics. “Ministry of Education Announcement in defining the type and criteria of Educational disability 2009” 2014. Retrieved from http://www.nfepbr.org/pkp/attachments/article/121/2prb.pdf.
2. Department of Empowerment of Persons with Disabilities. “Elderly Act 2003” 2003. Retrieved from <http://wops.moph.go.th/ops/oic/data/20131007131133_1.pdf>
3. Wapattanawong, P., Prasatkul, P. “Thai population in the future” 2006. Retrieved from http://ipsr.mahidol.ac.th.
4. Microsoft ”Accessibility Research Study” 2003 Retrieved from <https://news.microsoft.com/2004/02/02/new-research-from-forrester-and-microsoft-shows-millions-of-aging-baby-boomers-can-benefit-from-accessible-technology/>
5. BBC. “Most websites failing disabled” 2006 Retrieved from <http://news.bbc.co.uk/1/hi/technology/6210068.stm>
6. Basekit “91% of SME websites are 'prehistoric' and not accessible via mobile according to BaseKit survey” 2014. Retrieved from <http://www.thedrum.com/news/2014/03/04/91-sme-websites-are-not-accessible-mobile-according-basekit-survey>
7. Ministry of Information Technology and Communication. “Framework Policy for Information Technology and Communication period, 2011 – 2563” 2011 Retrieved from http://www.thaiwebaccessibility.com/sites/default/files/content\_types/web\_content/ict2020\_book\_.pdf.
8. Thai Web Accessibility.” Website monitoring project that everyone has access to and Web Accessibility under Thai law” 2012. Retrieved from http://www.thaiwebaccessibility.com.
9. Laaziri K, M, Khoulji S, Larbi K M, Yamami A El “Enhanced model for ergonomic evaluation of information systems: application to scientific research information system” *Int. J. Electr. Comput. Eng*. Vol 9, No 1 pp 683-694 2019
10. Wahyuningrum T. and Mustofa K., “A Systematic Mapping Review of Software Quality Measurement: Research Trends, Model, and Method, *Int. J. Electr. Comput. Eng.*, vol. 7, no. 5, pp. 2847-2854, 2017.
11. Nayebpour A. and Rashid H. “Presenting Metrics for Evaluation of Expert Systems Based on Service Oriented Architecture” *Int. J. Electr. Comput. Eng.* , vol. 3, no. 5, pp. 688–695, 2013
12. Angkananon, K., Wald, M., & Ploadaksorn P. “Developing and Evaluating a Thai Website Accessibility Checker”. *In: Stephanidis C. (Eds) HCI International 2017 – Posters' Extended Abstracts. HCI 2017. Communications in Computer and Information Science*, vol 713 2017
13. Berners-Lee, T. W3C Accessibility (n.d.) Retrieved from <http://www.w3.org/standards/webdesign/accessibility>
14. United Nations “The Convention on the Rights of Persons with Disabilities (CRPD)” 2006. Retrieved from <https://www.un.org/development/desa/disabilities/convention-on-the-rights-of-persons-with-disabilities.html>.
15. Henry, S., & Arch, A. W “Developing a Web Accessibility Business Case for Your Organization” 2012. Retrieved from <http://www.w3.org/WAI/bcase/>
16. W3C “Web Content Accessibility Guidelines (WCAG) 2.1” 2018. Retrieved from <https://www.w3.org/TR/WCAG21/>
17. Rogers, M. “Government accessibility standards and WCAG 2” 2017 Retrieved from <https://www.powermapper.com/blog/government-accessibility-standards/>
18. Schmutz, S., Sonderegger, A., & Sauer, J. “Implementing Recommendations from Web Accessibility Guide-lines: A Comparative Study of Nondisabled Users and Users with Visual Impairments. Human Factors” *The Journal of the Human Factors and Ergonomics Society*. Volume 59(6), pp 956-972 2017
19. Ahmi, A., Mohamad, R. “Current state of web accessibility of Malaysian ministries websites”, *AIP Conference Proceedings.* Volume 1761, Issue 1. 2016 Retrieved from https://aip.scitation.org 10.1063/1.4960854
20. Wald, M., Draffan, E.A., Newman, R., Skuse, S., & Phethean C. Access Toolkit for Education. In: Computers Helping People with Special Needs. ICCHP 2012. Lecture Notes in Computer Science, vol 7382. 2012.
21. Sloan, D., Kelly, B. “Reflections on the Development of a Holistic Approach to Web Accessibility” *ADDW08 Conference* 2008 Retrieved from <http://opus.bath.ac.uk/12111>
22. Kamollimsakul, S., Petrie, H., & Power, C. “Web Accessibility for Older Readers: Effects of Font Type and Font Size on Skim Reading Webpages in Thai”. *In Computers Helping People with Special Needs. ICCHP 2014. Lecture Notes in Computer Science*, vol 8547 2014

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