

A Study of Universal Design and Web Accessibility of Websites with High Purpose Using of the Internet

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Abstract: As the Internet has become an essential tool in human life, a need for building accessible web pages is being emphasized. Universal design indicates implementation of products and services that are fair and easy to use, regardless of age or disability. Universal design emphasizing universality, thus, shares common goals with web accessibility, and web pages built with universal design can improve universality. In this paper, we evaluated web accessibility of domestic websites that are highly used in the purpose of using the Internet, identifying whether such pages adopt the principles of the universal design correctly. The results showed that web accessibility gets better each year but universal design principles are not observed in many pages.

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I. Introduction

Web accessibility indicates that people with disabilities are able to access the Web [1]. The Internet has been used as an essential tool in everyday life in modern society where various media are used to communicate [2]. In this context, there is a growing need for universal web accessibility without limitation and discrimination [3].

Universal design means 'products or environment design that can be used by almost everyone without special design or modification' [4]. Universal design considers various users such as the elderly and the disabled, and it naturally has the same purpose as web accessibility in terms of usability and convenience of ordinary people [5]. Web pages are composed of various factors such as contents, graphic images, colors, layouts, and backgrounds, and universality of web is more emphasized when universal design is applied [6][7].

The Korean government, in order to build websites with improved accessibility, has carried out several activities such as establishing the 'Anti-Discrimination against and Remedies for Persons with Disabilities Act' in 2007 and the 'Korean Web Contents Accessibility Guideline,' as well as performing 'Research of digital divide index and status.' As a result, accessibility has been improved. However, efforts of building Web applied of universal design, which is a concept including web accessibility, have mainly been conducted by researchers.

According to the 2016 Internet Usage Survey of the Ministry of Creation and Science of the Future, 99.2% of Korean households are using the Internet as of July 2016. The main reason of using the Internet was 'communication' (91.6%), followed by 'leisure activities' and 'collecting materials and information' (89.1%) [8]. Websites with high purpose of using the Internet are frequently used by anyone, and need to provide sufficient web accessibility in a way that users with disabilities can use them. This is why such sites should have better accessibility than those with low purpose of using. We evaluated the web accessibility of 22 domestic sites with high purpose of using the Internet, examining whether these sites implemented web pages with universal design. The results showed that overall web accessibility has been improved from 2012 to 2017 as of today. However, when compared to the overall accessibility, the accessibility of the sites with high purpose of using the Internet was rather low, and much of universal design has not been applied.

The composition of this paper is as follows. Section 2 includes the concept of universal design, relation of universal design and web accessibility, and literature review. Section 3 deals with web accessibility evaluation and universal design evaluation of domestic websites with high purpose of using the Internet, as well as the results. Section 4 describes the conclusion and further assignments.

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II. Related research

Sir Tim Berners-Lee, the founder of the Web, emphasized universality that anyone can approach, saying that the power of the Web lies in its universality. Universal Web design is to provide a universal web for everyone. Equitable approach as the purpose of web accessibility can be realized through the universal approach of universal design [2].

2.1. Universal Design

The concept of universal design is provided by the Center for Universal Design at NC State University in 1988. Universal design means ‘designing products or environments that are easy for everyone to use, regardless of age or ability,’ implementing fair and easy-to-use products and services for everyone regardless of their disability [10]. Universal design can be said to be an application of human-centered thinking to the field of design. When universal design is applied to a website, universality, one of the basic ideas of the Web, can be emphasized [6][7]. Table 1 shows the web accessibility guideline based on universal design concept by Seo Mira [11].

Table 1. Web Content Accessibility Guidelines application of the concept of universal design

Principles	Sub Items
1. Equitable Use	1-1. Replacement tool that considers the disabled 1-2. Consideration for elderly people 1-3. Consideration for the non-disabled
2. Flexibility in Use	2-1. Accessibility using diverse devices 2-2. Accessibility using diverse browsers 2-3. Facilitation of access to information
3. Simple and Intuitive Use	3-1. Layout 3-2. Brightness and contrast
4. Perceptible Information	4-1. Communicability of information 4-2. Logicality of document structure
5. Tolerance of Error	5-1. Prevention of error occurrence 5-2. Calling users’ attention to their error
6. Low Physical Effort	6-1. Clear labeling and easy access to information 6-2. Refrain from using an excessive number of frames 6-3. Easy access path
7. Size and Space for Approach and Use	7-1. Size of files

Although universal design has seven principles, there are no standards for applying universal design to web pages in Korea. In this paper, we evaluated universal design under the ‘web accessibility guideline based on universal design concept’ which was established in consideration of realistic conditions and web environment in Korea in order to apply universal design to the Web.

2.2. Web Accessibility

According to the Web Accessibility Initiative (WAI) of the World Wide Web Consortium (W3C), universal web design should allow those who have web accessibility disability to use the Web[9]. In modern society, the Web affects the overall human life, recognized as a necessary element for everyone. Thus, building accessibility-compliant web pages can serve as a significant factor of the Web in that everyone can access the information on the Web.

2.3. Relation of Universal Design and Web Accessibility

Universal design features three factors of functions, purposes, and aesthetics, but accessibility and usability have recently been given weight [2]. Universal design in web environment considers diverse users and usage environment, focusing on designs that satisfy the users with increased universality. The universal design web offers universal web for everyone; web accessibility can serve as a way to achieve these universal design goals [12].

2.4. Prior Research

Web accessibility has mainly been enhanced by the government, though the application of universal design in web environment, which is a more comprehensive concept, has been developed by researchers. There are some previous studies of applying universal design to the web environment.

Jang Youngbum in ‘Web Site Information Design and Design Process for Application of Universal Design and Compliance with Web Accessibility Guideline’ developed a web site design process in terms of universal design and web accessibility in order to focus on web universality [6].

Seo Mira in ‘Web Accessibility of Education Offices in Domestic Cities and Provinces from the Aspect of Universal Design’ investigated web accessibility of the Education Offices in domestic cities and provinces based on the UD-WCAG [11].

III. Universal Design and Web Accessibility of Websites with High Purpose of Using the Internet

In the ‘Internet Usage Survey’ in 2016, domestic Internet users responded that the purposes of using the Internet were ‘communication,’ ‘leisure activities,’ and ‘collecting materials and information.’ In this context, we evaluated the web accessibility of domestic websites with high purpose of using the internet and whether the sites were built by correct application of universal design.

3.1 Selected Sites

Among the top 100 sites based on the domestic online research site Rankey.com’s ranking in the second week of September, sites dealing with communication, leisure activities, collecting materials and information were selected for this study [13]. Web accessibility was evaluated with the automatic evaluation method by the K-WAH 4.0, a web accessibility evaluation tool provided by the Web Accessibility Institute [14]. Manual evaluation and various tools were used to evaluate universal design [15][16]. The category ‘communication’ included sites that provide SNS, chat, and Internet phone service; ‘Leisure activities’ sites provide Web radio, Web TV, and online game services; and the sites of ‘collecting data and information’ include portals and search sites.

Figure 1 below shows changes in HTML5 building rate for 100 domestic websites with a large number of users, provided by rankey.com. Of the 100 sites, four sites were not available and 96 sites were investigated. The building rate of HTML5 has been increasing since 2012. As of September 2017, 56 of the 96 sites were built in HTML5, representing 58% building rate.

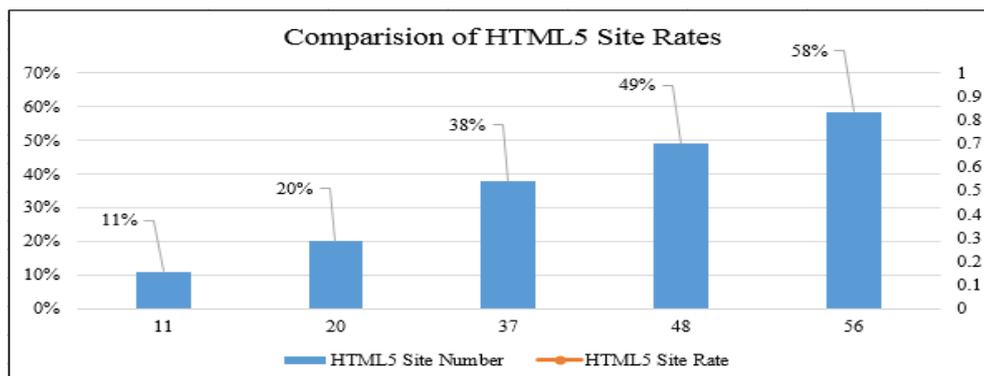


Fig. 1 Change of Korean websites’ HTML5 construction rate

Figure 2 is a graph in which the results of web accessibility evaluation for domestic websites with many users were compared from 2012 to 2017 as of today. The results of 2017 showed that items of ‘determining basic language’ and ‘prior notification of opening a new file’ were only slightly different from those with maximum values.

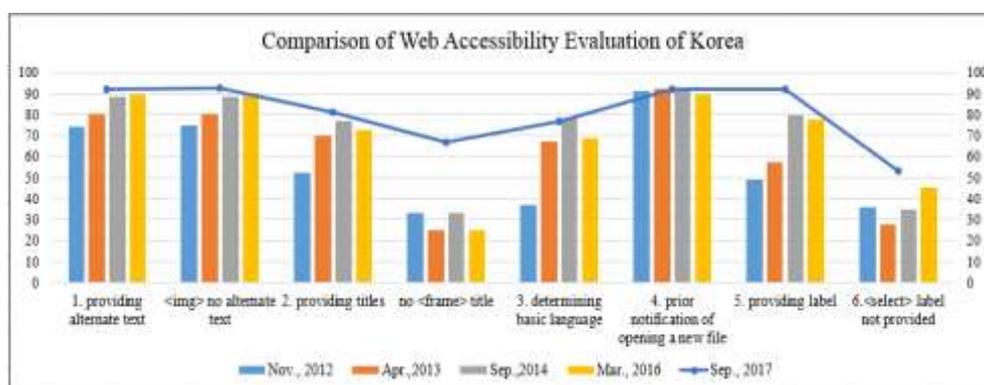


Fig. 2 Comparison of Web Accessibility of Korean Websites

Table 2 shows the results of web accessibility evaluation for 100 domestic websites with a large number of users from 2012 to 2017 (96 sites in 2017). The web accessibility has been improved due to the interest of the Korean government and various efforts for implementing web accessibility. The results of 2017 showed that six items were recorded highest in the evaluation, except for ‘determining basic language’ and ‘prior notification of opening a new file.’

Table 2. Web accessibility evaluation for 100 domestic websites with a large number of users

Items for Web AccessibilityAssessment	Korea				
	Nov., 2012	Apr., 2013	Sep., 2014	Mar., 2016	Sep., 2017
1.providingalternatetext	74.4	80.6	88.6	89.7	92.4
noalternatetext	74.8	80.6	88.7	90	92.8
2. providing titles	52.2	70	77.2	72.9	81.4
no <frame> title	33.3	25	33.3	25	66.7
3.determiningbasiclanguage	37	67.3	77.9	68.8	76.7
4.priornotificationofopening a new file	91.3	92.6	92.2	89.9	92.4
5. providing label	49.2	57.5	79.9	77.7	92.4
6.<select>labelnotprovided	35.9	27.6	34.7	45.2	53.3

3.2. Evaluation of Web Accessibility

Figure 3 is a graph in which the results of web accessibility evaluation were compared between 22 sites with high purpose of using the Internet and all the 96 sites. Among the six items for comparison, the evaluation results of the four items were lower than those of the 100 sites except for ‘title provision’ and ‘markup grammar’ items. In particular, ‘providing alternative text’ item, which may be most important in accessibility, was 81.8%, lower than the overall compliance rate of 92.4%.

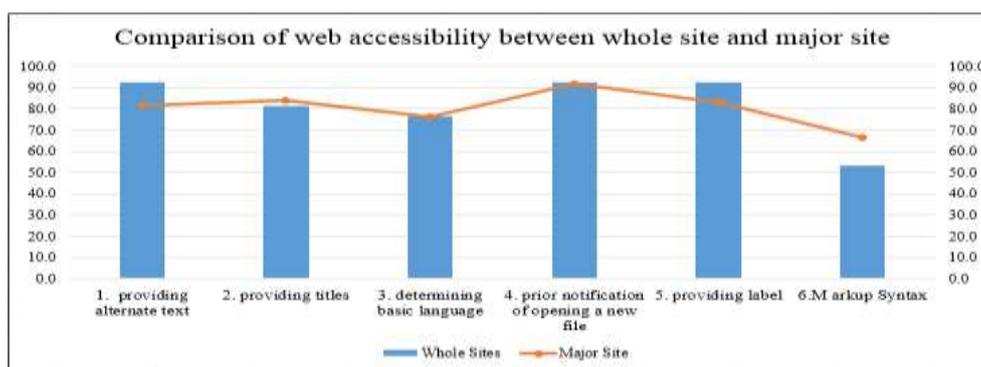


Fig. 3 Comparison of web accessibility between whole site and major site

In Table 3, the results of accessibility evaluation for each category were compared between all the 96 sites and those with high purpose of using. According to the table, the ‘providing alternative text’ item of the websites in the ‘community’ category was highest in the evaluation. The accessibility of websites in the ‘leisure activities’ category was lower than that of websites belonging to other categories in all of the items. In particular, the item of ‘providing alternative text’ was evaluated to be 75.2%, indicating that the disabled may experience inconvenience in use. Sites with high purpose of using the Internet may be more inconvenient in using than sites that are not frequently used, unless accessibility is provided. Considering the property, developers need to be interested in improving accessibility.

Table 3. Web accessibility evaluation websites with high purpose of using

Compliance Rate	Whole Sites	Target Site	Communi-cation	Leisure Activity	Information & Data
1.Provide alternate text	92.4	81.8	91.7	75.2	82.6
2.Provide titles	81.4	84.1	91.7	81.0	81.3
3.Definition of basic language	76.7	76.2	66.7	71.4	87.5
4.Priornotification of opening a new file	92.4	92.0	100.0	80.4	98.6
5. Provide label	92.4	83.3	87.5	66.7	100.0
6. Provide markup	53.3	66.7	50.0	57.1	87.5

3.3. Evaluation of Universal Design

Table 4 shows the results of evaluating the application of universal design by classifying 22 websites with high purpose of using into categories. Although universal design has seven principles, these principles cannot be applied to all objects; it is needed to modify the principles appropriately according to the object of

evaluation [17]. Seo Mira’s ‘web accessibility guideline based on universal design concept’ contains 7 main categories including sub-categories and items, based on the seven universal design principles. Among the many items of evaluation, however, items such as ‘Were the appearance and layout of contents configured in consideration of aesthetics?’ were excluded because such items were difficult to evaluate objectively and quite subjective. Consideration for the elderly or the non-disabled was also excluded.

Table 4 universal design evaluation of major web sites classified by category

	Communication	Leisure activity	Information Acquisition
1. Equitable Use: Replacement tool that considers the disabled			
01. Is provide alternate text for non-textual contents?			
Number of image/ Alternate text not provided (unit: number)	22.71/5.14	233.43/19.50	116.25/2.00
Alternate text provision rate (unit: %)	79.33	63.24	80.73
02. Is synchronized subtitle provided to multimedia contents?	Not applicable	1 not provided 6 not applicable	7 sites not applicable 1 site not provided
03. Does the text have a readable size?	All provide	All provide	All provide
04. Is it possible to zoom-in without using the browser function?	All provide	All provide	All provide
2. Flexibility in Use			
05. Are all function available only with keyboard?	All provide	All provide	All provide
06. Is it possible to input/transfer form only with keyboard?	All provide	All provide	All provide
07. Is easy and clear seeking structure provided?	4 sites proper 3 sites inappropriate	3 sites proper 4 sites inappropriate	7 sites proper 1 site inappropriate
3. Simple and Intuitive Use			
08. Is luminosity contrast foreground color and background color proper?	5 sites satisfy 2 sites partly dissatisfy	4 sites satisfy 3 sites partly dissatisfy	6 sites satisfy 1 site partly dissatisfy
4. Perceptible Information			
09. Did they use content with information as background image?	1 satisfy 6 sites partly provide	1 satisfy 6 partly provide	3 sites satisfy 5 sites partly provide
10. Is the alternate text of contents appropriate? (unit: sites)	proper: 3 partly inappropriate: 4	proper: 2 partly inappropriate: 5	proper: 5 partly inappropriate: 3
11. Does all web documents specify proper document type?	All provide	All provide	All provide
12. Does style language follow standard grammar?	average: 60.4 error average : 1 warning	average : 197.14 error average : 3.4 warning	average : 40.75 error average : 6.7 warning
13. Is basic language of document designated?	6 provide 1 not provided	All provide	All provide
14. Is style sheet used for lay-out design?	6 use 1 does not use	All provide	All provide
5. Tolerance of Error			
15. Do they provide summarized information of table?	1 site provide 1 site not provide	6 sites not applicable 1 sites not provide	7 sites not applicable 1 site provide
16. Do they provide page title?	All provide	6 sites provide 1 site not provide	All provide
6. Low Physical Effort			
17. Do they use frame?	All do not use	All do not use	All do not use

We selected items for universal design evaluation when they affected accessibility, could be evaluated by using manual methods, and could be evaluated by using tools for evaluating web pages. As shown in Table 4, the evaluation was conducted on 17 items.

The results of the universal design evaluation were different from those of the web accessibility evaluation. The rate of providing alternative text for images was much lower than the rate provided in the web accessibility evaluation. For use of keyboards, which was not an item in automatic evaluation for accessibility, all the websites provided content access, content input, and switching forms by using keyboards. However, when keyboards were used in the manual evaluation, there were errors such as ‘unconditionally opens submenu,’ ‘does not indicate functions being performed,’ ‘accesses login menu after most of the functions of the page are performed,’ ‘goes to menu after most of the functions of the page are performed,’ and ‘does not go in order of pages.’ When users with visual disturbance use web pages with these types of errors, they are not able to access a menu desired or can access the menu after accessing many unnecessary functions, having inconvenience in use.

In the case of providing alternate text, it is common to provide an alt attribute in background images or alt = "" for meaningful images. This is a problem that has been constantly raised in web accessibility and induces trouble for developers, but it is a property that should be provided correctly for accessibility.

For brightness contrast, 7 of the 22 sites were evaluated not to follow brightness contrast partially. In addition, there were many grammatical errors.

IV. Conclusion

In this paper, we evaluated whether websites with high purpose of using the Internet were built on the basis of web accessibility by classifying them into categories, while evaluating such web pages were applied of universal design in order to improve accessibility. The results showed that overall web accessibility has been improved every year, but the accessibility of websites with high purpose of using the Internet was lower than that of sites with many users and universal design for improving web accessibility was not applied in many parts.

Application of universal design is partially overlapped with web accessibility; some items are evaluated in the same way as web accessibility evaluation, and there are some extended items. Users with visual disturbance are hard to understand how a document is constructed or cannot switch between documents when functions such as 'providing alternative text,' 'providing basic language of document,' 'page title,' and 'accessing by keyboard only.' Thus, it is needed to provide such functions correctly, requiring efforts of working-level people such as developers and web designers. In some cases, it is hard to identify whether universal design was applied correctly to a web site built. This is why the government is needed to develop evaluation tools or guidelines for universal design.

This study may be limited in that only the items that can be objectively evaluated among the universal design evaluation items and that the guidelines for evaluation are not of national standards. Further studies are needed to develop methods and guidelines for automatic evaluation of universal design.

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