

# Usability and Accessibility on the Internet: Effects of Accessible Web Design on Usability

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**Abstract.** Despite the overlapping scope and aims of web-usability and web-accessibility (such as problems in using the web and the barriers in accessing the web) there are only few studies which analyse the connections between the two areas. The present study investigates the relationship between web-accessibility and web-usability. To analyse this relationship we have designed an online test environment. We developed three complete internet presences (testportals), each one with a different level of accessibility. 131 test users were recruited viewed these three testportals and rated their usability. The instrument to evaluate usability was an especially modified and reduced version of the Web Usability Index (WUI) which was made available online in the form of a questionnaire. The central question this study sought to answer was: is there a difference in the usability ratings between websites with different levels of accessibility? The findings resulting from the central question were clear. The mean values show a significant difference in the usability ratings of the three portals. Other question our study sought to answer were the influences of the disability and the age factors. These influences are partly significant.

**Keywords:** Human Computer-Interaction, Usability, Accessibility, Age, Disabilities.

## 1 Introduction

New media is playing an increasingly significant role in the everyday life of users - also in the life of people with disabilities. Disabled users are a potentially discriminated group in processing information from the new media especially from the internet.

However, people with disabilities use the internet even more than people without disabilities. Adults with disabilities spend on average twice as much time online and are considerably more likely than adults without disabilities to report that the Internet has significantly improved the quality of their lives [1].

In fact, problems arise for a wide range of users. Many people suffer only from light impairments such as restricted eyesight. Moreover, older adults belong to a growing group of internet users.

Older users have decreased motor coordination so that it becomes difficult for them to move and click a mouse, scroll down a Web page, or click on standard-size links. Vision, cognition, and physical skills decline with advancing age [2].

Holzinger and Nischelwitzer categorise problems of the Elderly into Cognition, Motivation, Physical and Perception [3].

Studies from Chadwick-Dias, McNulty and Tullis about age and web-usability found that older users completed fewer tasks successfully and took longer for each task [4].

In 2003, the Austrian government published a report about people with disabilities. The report shows that 2.1m people (29.9 % of the Austrian population) have at least one physical impairment. With increasing age, the percentage of people with impairments rise rapidly [5].

Demographical, structural, and social trends tend towards more and more elderly people and single households [6].

The World Wide Web Consortium (W3C), as the central institution to create web standards and guidelines, has reacted to the problematic situation of people with disabilities with the Web Accessibility Initiative (WAI). In 1999 the WAI released the Web Content Accessibility Guidelines 1.0 (WCAG 1.0). These Guidelines are designed to increase the accessibility for disabled users. The checkpoint definitions in each guideline explain how the guideline applies in typical content development scenarios. Each checkpoint has a priority level (A, AA und AAA) based on the checkpoint's impact on accessibility [7].

On the other hand there has been a strong movement to improve usability in the internet for many years. Usability is a growing field which continues to become more and more important.

A usable system should be easy to learn, efficient to use, easy to remember, have a low error rate and achieve a high satisfaction among users [8].

There are several usability evaluation techniques. Holzinger divides them into inspection methods (without end users) and test methods (with end users) [9].

Despite the overlapping scope and aims of usability and accessibility (such as problems in using the web and the barriers in accessing the web) there are only few studies which analyse the connections between the two areas.

The relationship between areas of accessibility concerned with technical issues, and those concerned with usability is unclear. Little empirical data has been gathered to show that websites which achieve higher conformance to WCAG are also more usable for people with disabilities. Equally, only few studies have sought to establish the criteria for usability for people with disabilities [10].

Petrie and Kheir describe accessibility and usability problems as two overlapping sets, which would include three categories [10]:

- Problems that only affect disabled people; these can be termed “pure accessibility” problems;
- Problems that only affect non-disabled people; these can be termed “pure usability” problems;
- Problems that affect both disabled and nondisabled people; these can be termed “universal usability” problems.

The present study investigates the relationship between web-accessibility and web-usability. Findings which confirm a connection between the two areas could contribute to an increased implementation of the WAI guidelines and provide further arguments for improving accessibility.

## 2 Research Questions

Because of the theoretically reflections the central question this study sought to answer was:

**Question 1:** Is there a difference in the usability ratings between websites with different levels of accessibility?

Another question our study sought to answer was the influence of the disability factor. People with disabilities have often major problems using or accessing websites that do not give consideration to accessibility (like our **testportal1**). In this case the expected usability ratings are probably lower for people with disabilities. Contrary, websites that give much consideration to accessibility (like our **testportal3**) result probably in higher usability ratings of people with disabilities vs people without disabilities. In case websites give some consideration to accessibility (like our **testportal2**), we expect a similar level of usability ratings for people with and people without disabilities.

**Question 2:** Do people with disabilities and people without disabilities differ in their usability ratings for websites with different levels of accessibility.

Another question was the impact of age in the relationship between accessibility and usability. For older adults, accessible websites are probably more important than for younger adults. Websites that give consideration to accessibility are likely to result in higher usability ratings from older people compared to younger people and visa versa.

**Question 3:** Is there a correlation between age and usability ratings in websites with different levels of accessibility?

## 3 Design

To analyse the relationship between usability and accessibility we have designed an online test environment. We developed three complete internet presences (testportals), each one with a different level of accessibility. The content of these three portals was the same and the topic was “Events in Vienna”.

In the development of **testportal 1** no consideration was given to accessibility. Testportal 1 conform not to the W3C guidelines WCAG 1.0.

In the development of **testportal 2** some consideration was given to accessibility. These sites conform mostly to WCAG 1.0 level A.

**Testportal 3** was developed to achieve a higher level of accessibility. Testportal 3 conform mostly to WCAG 1.0 level AA.

131 test users were recruited, viewed these three testportals (each user viewed one portal) and rated their usability. Each participant was asked to attempt some tasks with the choosen website and after that to fill in an online questionair.

The instrument to evaluate usability was an especially modified and reduced version of the Web Usability Index (WUI) which was made available online in the form of a questionnaire. The main value of the WUI ist called the “overall usabilityindex”. This value shows the percentage of usability problems in a testpage. A higer value means more usability problems.

## 4 Results

### 4.1 Research Question 1

Is there a difference in the usability ratings between websites with different levels of accessibility?

**Hypothesis 1:** The usability ratings of not accessible websites (like testportal 1) are lower than the usability ratings of websites with a minimum level of accessibility - WCAG-A (like testportal 2).

**Table 1.** Significance level (Comparison testportal 1 and 2)

	Usabilityindex
Mann-Whitney-U	662,000
Wilcoxon-W	1223,000
Z	-2,634
asymptotic significance	,008
<i>Mean ranks: testportal 1: 52,47 (n=60), testportal 2: 37,06 (n=33).</i>	

There result is significant. There is a difference in usability ratings between testportal 1 (no accessibility) and testportal 2 (minimum accessibility). The mean ranks show that testportal 2 is more usable than testportal 1.

**Hypothesis 2:** The usability ratings of not accessible websites (like testportal 1) are lower than the usability ratings of websites with an extended level of accessibility - WCAG-AA (like testportal 3).

**Table 2.** Significance level (Comparison testportal 1 and 3)

	Usabilityindex
Mann-Whitney-U	466,000
Wilcoxon-W	1207,000
Z	-4,914
asymptotic significance	,000
<i>Mean ranks: testportal 1: 60,73 (n=60), testportal 3: 31,76 (n=38).</i>	

There result is significant. There is a difference in usability ratings between testportal 1 (no accessibility) and testportal 3 (extended accessibility). The mean ranks show that testportal 3 is more usable than testportal 1.

**Hypothesis 3:** The usability ratings of websites with a minimum level of accessibility - WCAG-A (like testportal 2) are lower than the usability ratings of websites with an extended level of accessibility - WCAG-AA (like testportal 3).

**Table 3.** Significance level (Comparison testportal 1 and 3)

	Usabilityindex
Mann-Whitney-U	407,000
Wilcoxon-W	1148,000
Z	-2,536
asymptotic significance	,011

*Mean ranks: testportal 2: 42,67 (n=33), testportal 3: 30,21 (n=38).*

There result is significant. Theres is a difference in usability ratings between testportal 2 (minimum accessibility) and testportal 3 (extended accessibility). The mean ranks show that testportal 3 is more usable than testportal 2.

**4.2 Research Question 2**

Do people with disabilities and people without disabilities differ in their usability ratings for websites with different levels of accessibility.

The number of the participants with disabilities in this study was low (n=22). Despite their low statistical relevance, the results of this question have been included.

**Hypothesis 4:** In websites where no consideration was given to accessibility (like testportal 1), the usability ratings of participants with disabilities are lower than the usability ratings of participants without disabilities.

**Table 4.** Significance level (Comparison disabled and not disabled / testportal 1)

	Usabilityindex
Mann-Whitney-U	202,000
Wilcoxon-W	1378,000
Z	-1,589
asymptotic significance	,112

*Mean ranks: disabled: 37,67 (n=12), not disabled: 28,71 (n=48)*

There result is not significant. No significant difference was found between the two groups (disabled and not disabled) in their usability ratings for testportal 1. It appears that factors of accessibility are of equally high relevance for all users. The expected effect is not seen here. Further research with more participants would be neccessary.

**Hypothesis 5:** In websites with minimum standards of accessibility (like testportal 2), there is no difference in the usability ratings of participants with disabilities and participants without disabilities.

There result is not significant. No significant difference was found between the two groups (disabled and not disabled) in their usability ratings for testportal 1. This result was expected theoretically but further research with more participants would be neccessary.

**Table 5.** Significance level (Comparison disabled and not disabled / testportal 2)

	Usabilityindex
Mann-Whitney-U	40,000
Wilcoxon-W	505,000
Z	-,313
asymptotic significance	,754
<i>Mean ranks: disabled: 18,67 (n=3), not disabled: 16,83 (n=30).</i>	

**Hypothesis 6:** In websites with extended standards of accessibility (like testportal 3), the usability ratings of participants with disabilities are higher than the usability ratings of participants without disabilities.

**Table 6.** Significance level (Comparison disabled and not disabled / testportal 3)

	Usabilityindex
Mann-Whitney-U	101,000
Wilcoxon-W	129,000
Z	-,282
asymptotic significance	,778
<i>Mean ranks: disabled: 18,43 (n=7), not disabled: 19,74 (n=31).</i>	

There result is not significant. No significant difference was found between the two groups (disabled and not disabled) in their usability ratings for testportal 3. Also in this case, it appears that factors of accessibility are of equally high relevance for all users. The expected effect is not seen here. Further research with more participants would be necessary.

### 4.3 Research Question 3

Is there a correlation between age and usability ratings in websites with different levels of accessibility?

**Hypothesis 7:** There is a correlation between age and usability ratings in websites where no consideration was given to accessibility (like testportal 1).

**Table 7.** Correlation: age – usabilityindex (testportal 1)

			age	Usabilityindex
Spearman-Rho	age	correlation coefficient	1,000	,385
		sig.	,	,002
		N	60	60
	Usability index	correlation coefficient	,385	1,000
		sig.	,002	,
		N	60	60

There result is significant. There is a significant correlation between age and usability ratings in testportal 1. The correlation coefficient is 0,385. This result was expected. Older adults have more problems, similar to people with disabilities, in using and accessing websites where no consideration was given to accessibility

**Hypothesis 8:** There is no correlation between age and usability ratings in websites with minimum standards of accessibility (like testportal 2).

**Table 8.** Correlation: age – usabilityindex (testportal 2)

			Usabilityindex	age
Spearman-Rho	Usabilityindex	correlation coefficient	1,000	,107
		sig	,	,555
		N	33	33
	age	correlation coefficient	,107	1,000
		sig	,555	,
		N	33	33

There result is not significant. There is no significant correlation between age and usability ratings in testportal 2. As expected, the effect of websites with minimum standards of accessibility on usability ratings in connection with age cannot be detected.

**Hypothesis 9:** There is a correlation between age and usability ratings in websites with extended standards of accessibility (like testportal 3).

**Table 9.** Correlation: age – usabilityindex (testportal 3)

			Usabilityindex	age
Spearman-Rho	Usability index	correlation coefficient	1,000	,027
		sig.	,	,874
		N	38	38
	age	correlation coefficient	,027	1,000
		sig.	,874	,
		N	38	38

There result is not significant. Testportal 3 demonstrates no significant correlation, but this correlation was theoretically expected. It seems that again accessibility is equally relevant for all users (including younger users), the expected effect is not seen here.

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