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# Blindness and Online Interaction: Beyond Design Standards

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**Abstract**

The use of internet and other communication technologies has become predominantly common in the life of normal sighted users. In order to have a fair level of equality in the society, blind people must also be able to use these facilities with equal ease and effectiveness. Recent studies showed that the usage and acceptance rate of online applications among the blind community is not up to the expectations. The aim of this article is to investigate the accessibility issues faced by blind people during online interaction like eGovernment portals. Results showed that a WCAG compliant eGovernment website failed to satisfy the requirements of a sample of blind users. This article is part of on-going research aimed to uncover accessibility problems that could be faced by blinds during online interaction and are not addressed in accessibility standards. It attempts to understand cognition and perception thoughts of a blind user while interacting with a web-based environment.

**Keywords**: Blindness, Web Accessibility, WCAG

## 1. Introduction

The eGovernment endeavour of serving its citizens, partners, and government employees is critically dependent on the accessibility and usability of its integral websites to the intended target users. It is believed that utilizing information and communication technology (ICT) tools will help improving the delivery of government services. The Governments worldwide have adopted the ICT means to deliver information and services to their citizens via eGovernment portals. Thus it is of extreme importance that these eGovernment portals are tailored to suit the needs and requirements of citizens from all groups to assure its success and effectiveness. The efficiency and effectiveness of web based interaction for blind is still a critical issue while developing an eGovernment system. A common and important group of any community is those who suffer from blindness. According to a report published by World Health Organization (WHO) in 2009, there exist more than 314 million blind or visually impaired people around the world; 39 million of them are totally blind (Visual impairment and blindness, 2012). Considering the increased population of blind people, a high degree of web accessibility is undoubtedly an important criterion to successfully implement an eGovernment system.

The term blindness is the condition of lacking visual perception due to physiological or neurological factors. In medical terms vision is a result of light beams hitting the eye retina and gets transmitted to the human's brain. Thus blindness happens either when an insufficient amount of light hits or fails to hit the retina, or when the details from retina failed to reach the brain correctly. According to World Health Organization (WHO), blindness in the normal eye with the normal symptoms; can be defined as a visual keenness of less than 3/60 (20/200, 0.05), whereas vision impairment is measured from less than 6/18 (20/50, 0.3). The degree of blindness is the extent of this lack of visual perception. Whilst blindness includes different levels of vision ability, it can be broadly subdivided into four 11 categories of impairment namely partially sighted, low vision, legally blind, and totally blind. Based on a report published by World Health Organization (WHO) in 2009, there exist more than 314 M. blind and visually impaired persons around the world (Visual impairment and blindness, 2012).

### 1.1 Blindness and Online Interaction

The process of web-based interaction for blind people is entirely different from that of sighted users (AlJarallah, Chen, & AlShathry, 2013). The interaction with online resources for blind people is a listening activity. They need a specific strategy and assistive devices to access online information. Blind people predominantly depends on special computer software tools, known as assistive technologies, like online screen-readers, text to speech tools, or text based web pages to read web contents and to interact with computers properly. Assistive technologies use add-on assistive software to transparently provide an existing system with specialized input and output capabilities. Blind people use assistive technology and haptic devices that incorporate some specialist software and/ or hardware which help these users overcome their disability. Screen readers are specially designed software applications that identify, interpret and announce the text content of a web page in the form of sound or a Braille output device.

These methods of non-visual interaction have a major disadvantage of giving serial access to information unlike the instant access from normal visual interaction. Thus blind people would take longer to interpret the contents on a web page. It is this nature of non-visual interaction, employing a distinct information access mechanism which makes the accessibility and usability a distinct feature for blind people in web interaction.

A very common perception of adapting a design to suit the requirements of disabled users is the concept of enabling such a group of computer users to utilise assistive technology to compensate their inability of accessing website content. But very unfortunately that is not completely true for blind users. Blind users face increased level of difficulties because of inadequate access and poor accessibility of the available resources (Al-Khouri, 2011) (Yu, 2004). The root cause of this increased level of difficulties for blind users is the fact that recent advancements have made web pages an inherently complex resource conveying multiple informational content and inter-relationships among them. The efficiency and effectiveness of web based interaction for blind is indeed a critical issue while developing an eGovernment system (Collinge, 2003) (Carter, 2008). The prime reason for the increased level of difficulties specifically for blind users is that a web page is an inherently complex resource since it simultaneously conveys multiple informational details and relations among these details, with links to other pages, advertisements, etc. (Jokela, 2000). Moreover, modern web based applications tend to use excessive visual content for instance pictures, graphics or tables in order to make it more attractive. For normal sighted users it is very easy to locate the core information on complex web page but blind users have to verify all the information on a webpage in order to identify the required and/or relevant information. Thus it is of extreme importance that eGovernment websites are tailored to suit the needs and requirements of people from all groups. The blind people must also be able to use the information and services with an equal degree of ease and comfort as compared to the normal sighted users (Abdelbaset Rabaiah, 2009). The existing literature does identify the lack of accessibility levels required in a non-visual online interaction (Rutter et al., 2006) (Loiacono& McCoy, 2004). However, it does not point out the diversity and types of problems faced by blind people. The main focus of this research is towards those who are completely blind and who rely on screen reader to access web contents.

### 1.2 Design Aesthetics and accessibility

Accessibility and usability sound similar and coherent, but are clearly two distinct concepts. Accessibility is to measure whether the information or resource can be accessed by the whole targeted population, and usability is the degree of ease to which an information or resource could be used. In the context of eGovernment system, web accessibility and usability are the two most crucial requirements for its successful implementation (Blakemor, 2006) ( Michailidou et al.,2008).

Accessibility refers to access by all individuals, regardless of technological or physical discrimination. The Web Accessibility Initiative (WAI) has described the term "Web Accessibility" as "people with disabilities can use, in terms of being able to perceive, understand, navigate and interact, with the Web" (Rutter et al., 2006). Accessibility for web based interaction with blind users refers to making the content perceivable, operable, understandable, robust and easy to navigate and interact with. It is treated as a technical construct that allows the use of assistive technologies such as screen readers etc., in order to give necessary access to interface elements of a system. A good degree of perceivability in web-based interaction can be achieved by making alternatives such as providing text captions for images and audio, adaptability of webpage layout, and suitable colour contrast (Katz-Haas, 1998) (Rutter et al., 2006). The web based interaction can be made more efficient by taking into account issues like keyboard use, colour contrast, timing required for input and more importantly navigability feature through the website. This is particularly important for blind users in order to make their experience more productive and satisfactory. The content on a modern website is often arranged with a high degree of complexity and use of visual effects. Thus it is of paramount importance that the content on a website is clear and easily understandable. This can be achieved by addressing issues such as readability, predictability, and input assistance for the required information (Tractinsky, 2004). The interaction between a person and the system is affected by several key considerations such as the ease of learning, ease of memorization, error tapping and efficiency of use. Usability for web based interaction with blind users is not just limited to getting the information on the webpage, but also the blind users should be able to use all other features and functions such as links, buttons and form controls.

A system that is not accessible to users is certainly not usable too; however a well-designed accessible system also does not guarantee usability. The problem of inaccessibility would prevent access to features and functionality of a web based application. However usability would hinder the use of these features and functionality. In order to give better understanding of concepts of accessibility and usability, the fable is described in the next paragraph.

### 1.3 Web Accessibility Guidelines

Just like other internet based applications, eGovernment services being available round the clock, 7 days a week would provide its citizens, businesses and partner greater degree of flexibility to process their applications or transactions outside normal office hours. In order to successfully accomplish the set goals, a high degree of web accessibility and usability is of paramount importance (The Office of Government Commerce, 2003). Numerous guidelines have been formulated by the growing community of website accessibility experts and a brief subset of these is currently in common use (Al-Badi, 2003 ) (Boldyreff,2002). The extensive literature review clearly outlines that the present system of web based interaction for eGovernment websites does not conform to the accessibility and usability requirements of blind users (Loiacono & McCoy, 2004). A report published in 2004 points out that 80% of the web sites do not meet the basic accessibility and usability requirements (Loiacono & McCoy, 2004) (Wang et al. 2010). Jakob Nielsen who is a leading web usability consultant in Denmark, stated that the web usability is defined by five quality components that are learnability, efficiency, memorability, errors and satisfaction (Nielsen, 2000). Learnability in web based interaction refers to how easily the users can carry out basic tasks for the first time. Efficiency relates to how quickly and effectively can the tasks be performed (Theofanos, 2003).

The Web Content Accessibility Guidelines (WCAG) documents present standards in order to make the web content accessible and usable for the blind people. The guidelines are primarily laid out for web content developers, web authoring tool developers, page authors, site designers and others who need a technical standard for web accessibility. The design principles and standards were established in 1999 by the World Wide Web Consortium (W3C) through the development of Web Accessibility Initiative (WAI) (Gerber, 2001). The W3C is a well-known international organisation that develops and enforces defined standards to ensure the compatibility and continuous growth of the Web. W3C is a huge consortium of web users and stakeholders in the industry and public organisations in many web related fields. One important role of W3C is to publish "recommendations" which are adopted as a standard in the industry. W3C was founded by Tim Berners-Lee at MIT and currently headed by him (Blas et al., 2004). The consortium consists of member organizations which recruit dedicated full-time staff for the goal of developing and improving web standards.

The W3C is administered by the Massachusetts Institute of Technology and the Computer Science and Artificial Intelligence Laboratory in the USA, the European Research Consortium for Informatics and Mathematics (ERCIM) in France, and lastly Keio University in Japan. The W3C has presences in sixteen regions around the world to promote the W3C web standard for local communities. They also welcome voluntarily contribution in W3C development activities. Most of newly improved or created standardization work is carried out by external experts in W3C's international community group. From a blind user’s perspective, one of the design principle followed by W3C is "Web for All". The design principle illustrates one of W3C's primary goals to make the benefits of web services accessible by all people regardless of many factors like: available infrastructure capabilities, language, cultural and geographical location, physical or cognitive ability levels. An updated version WCAG 2.0 came in December 2008, as a result of recommendations of WCAG 1.0, which acted as the main guidance for web developers and designers on Web accessibility and usability (Babu et al., 2010). The WCAG recommendations have also been incorporated by several other governments into obligatory requirements on web evaluation and accessibility (Leuthold S., 2008).

## 2. Accessibility Evaluation

As was sated in the introduction section, the aim of this article is to explore the problems and difficulties that cause users dissatisfaction and are not addressed in the international accessibility standards like WCAG guidelines. Therefore, it is important to construct a rigorous evaluation process to determine whether WCAG compliant eGovernment website satisfies the requirements of blind people.

### 2.1 Self-Content Analysis

The first stage of evaluation was to do a self-content analysis of the portal using automated accessibility checkers. There exist numerous tools to evaluate whether or not a website or eGovernment portal adheres to the web accessibility guidelines provided by WCAG. These tools provide helpful feedback to web designers about a website and can also assist them in the repair and enhancement process. The reason for this stage is to reveal any nonconformity of the website to the WCAG standards that may cause dissatisfaction among blind users. Web accessibility evaluation tools are specialised software programs that evaluate whether or not a web site meets the web accessibility guidelines provided by WCAG or any other accessibility standard. These tools are very helpful when used throughout the process of website design, implementation, and maintenance. Web accessibility tools can be used for many purposes depending on the expertise of the users and the types of criteria they want to evaluate their website against. These tools could be of significant help in assisting web designers and developers to prevent accessibility barriers, repair the encountered barriers, and to improve the overall quality of the website or eGovernment portal.

Three widely accepted tools were chosen to perform the automated accessibility checking to the eGovernment portal: Cynthiasays, WAVE and AChcker. Cynthia Says is a free Web accessibility testing tool for validating Web content developed by HiSoftware to evaluate the online content against WCAG accessibility standards. The HiSoftware Cynthia Says accessibility checker is among the recommended portals by World Wide Web Consortium (W3C). The homepage of Cynthia Says is shown in Figure 1

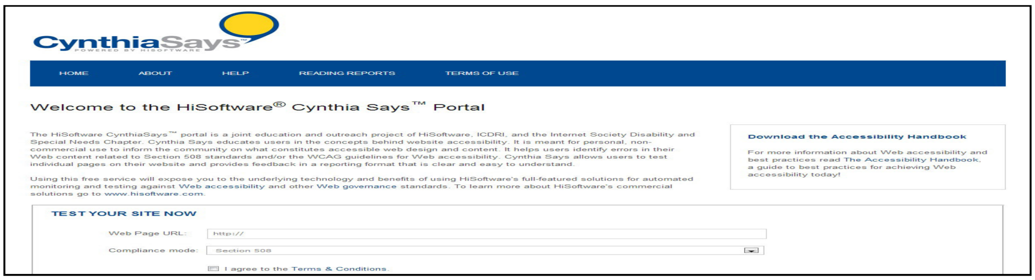


**Figure1: Cynthia Says accessibility checker**

W3C is an international community that integrates and develops open standards, protocols and guidelines for websites aimed to achieve highest standards of accessibility and usability. Two more checkers were used to evaluate eGovernment website from all accessibility perspectives.

The other automated accessibility checker used was WAVE (Figure 2). WAVE is a product of WEBAIM.org and it checks websites for their browser compatibility, broken links, and accessibility and for web standards validation. It has a separate accessibility checker and validator compatible with the WCAG guidelines and with section 508 of the Rehabilitation Act. It also covers all the three priority standards of WCAG namely Priority A, Priority AA, Priority AAA.


**Figure 2: WAVE accessibility checker**

The last automated accessibility checker used is named AChecker (Figure 3). It divides the non-conformities and non-compliances issues of a website into separate subheadings (AChecker). This checker was developed in Canada and is especially useful for HTML and CSS validation.

 

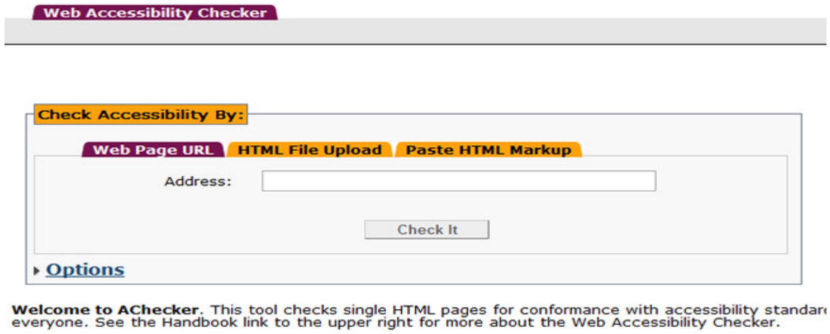


**Figure 3: AChecker accessibility tool**

Three web pages of the eGovernment portal were selected to get examined by the accessibility checkers for their compliance to WCAG standards. These three web pages will also be used in the following experiment.

Upon our self-checking of the three selected web pages it seems that the Saudi eGovernment portal is well technically designed with care attention to compliance to WCAG standards. The three accessibility checkers were applied into the selected three webpages covered in the study. Given the richness of content and features of each page, every checker generated a long report which shows the result of the analysis. Reports were reviewed and summarized in tabular format for better visibility (Table 1).

**Table 1: Result of automatic accessibility checkers**

| | Cynthia | | | | AChecker' | | | | WAVE | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | AA | AAA | Total | A | AA | AAA | Total | A | AA | AAA | Total |
| **Page 1** | 0 | 1 | 2 | 3 | 0 | 0 | 1 | 1 | 0 | 2 | 1 | 3 |
| **Page 2** | 1 | 1 | 2 | 4 | 1 | 2 | 4 | 7 | 0 | 2 | 1 | 3 |
| **Page 3** | 0 | 1 | 1 | 2 | 2 | 2 | 1 | 5 | 0 | 1 | 1 | 2 |

As can be seen from Table, all the three examined web pages presented few number of accessibility issues using the three checkers. The total number of accessibility problems ranges from 3 issues in page 1 to 5 issues in pages 3. The maximum number of major (A-level) problems was discovered in page 3 by AChecker, while the remaining problems (AA, AAA) are just alerts or minor layout-related issues. The 3 (A-level) problems discovered by AChecker in the two webpages were that related to java script implemented in the website, whereas the only (A-level) problem found by Cynthia in webpage was the absence of a frame title. The overall accessibility of the three pages is high given the low number of accessibility problems discovered by the three checkers. The most important thing is that none of the discovered problem has direct relation with the tasks list that blind users are asked to do in the experimental exercises. Most importantly, the tools focus on making the content of the website distinguishable, i.e. blind users should be able to read and hear the content including a clear separation from foreground to background, which is the case in the current eGovernment portal.

### 2.2 Experimental Exercise with blind users

The main focus of this evaluation stage is to closely observe a group of blind users in the online environment, which is in our case Saudi eGovernment portal. The purpose of this observation is to evaluate the accessibility requirements of the website from the blind users' point of view. It is expected that the result will show good level of satisfaction based on the outcome of the previous evaluation step which demonstrated high level of conformance to the WCAG standards. The exercise was conducted to deeply explore the various aspects of accessibility and usability problems faced by blind people. As already stated in the beginning of this article, the eGovernment website of Saudi Arabia was selected as a case study for this research; however, the approach followed in this research is applicable to any type of Online interaction..

Figures 4 and 5 show the home page of eGovernment website of Saudi Arabia in Arabic and English languages respectively.


**Figure 4: Home page of eGovernment website of Saudi Arabia**


**Figure 5: English version: home page of eGovernment website of Saudi Arabia**

The version under study is the Arabic version considering that Arabic is the official language in the country.

### 2.2.1Participants Allocation

The term "population" refers to the group of people to whom the findings and results of this survey could be applicable and extendable. The biggest challenge in conducting the exercise was to select a group of individuals that could represent the view of the whole population of blind people in the Kingdom of Saudi Arabia. Another challenge was to separate those who were born blind, and those who acquire blindness later on in their lives. Thus a comprehensive sampling technique is used for selecting a set of individuals from the population. The selection had to be done in such a way that it covers people from all possible backgrounds with respects to their level of education, IT literacy, professionalism, age group etc. The aim of using a sampling method is to select a group of people from the whole population of blind people so that their view can represent the issue of accessibility and usability problem of the whole society. The use of an optimum sampling method that models the whole group of blind people and gives minimum sampling variation is very important. Stratified sampling is among the most common statistical methods of sampling from a population (Berg & Lune, 2004). It is a well-known fact that the sub-populations within an overall population of blind people vary widely depending on their knowledge and exposure to web based and IT resources. The whole process of allocating participants was done under the guidance, supervision and support from 'Prevention of Blindness Union (PB Union)' and 'Arab Gulf Program for Development' (AGFUND).

In this study the total population has been divided into 10 subgroups or 'strata' in such a way that each 'stratum' is mutually exclusive. Every element in the population of blind users is assigned to only one stratum and no population element has been excluded. The basis of subdivision of elements into 'strata' is their level of exposure, competency to use web based resources and IT literacy. A total of thirty individuals were selected based on the sampling technique from different educational, social and professional backgrounds. The subdivision of applicants for the exercise was done under the subheadings shown in Table 2.

**Table 1: Participants Subgroups**

1) Student
2) Professional
3) Professional retired ( > 60 years old)
4) Others, Proficient IT literate users
5) Others, Men aged under 25 ( < 25)
6) Others, Men aged 25 to 50 ( 25 - 50)
7) Others, Men aged over 50 ( > 50)
8) Others, Women aged under 25 ( < 25)
9) Others, Women aged 25 to 50 (25 - 50)
10) Others, Women aged over 50 ( >50)

The division is done in such a way that blind users under category 1 and category 2 have a minimum of three years of internet experience and an adequate level of IT literacy. This kind of division allows us to make a functional differentiation among various categories of blind people. However, it is to be noted that the number of blind people falling under these categories would show a high degree of non-linearity. The main purpose of doing such a functional division is to minimize sampling errors pertaining to different functionality requirements. Thus the survey would result in getting results from a wide variety of functional groups. My contribution was to select applicants according to the sampling technique in such a manner that represents the majority of the blind population.

During the participant allocation process, there was a concern regarding the age of blindness for all participates and how this factor would affect the way they use eGovernment services. There are basically two kinds of people who make up the blind: those who were born blind, and those who acquire blindness later on in their lives due to illness or age factors. In our study, there were 2 in the professional retired group who developed complete blindness due to diabetic retinopathy. However, both never used the eGovernment service prior to their blindness. However, their performance will be carefully noticed to make sure that their distinctive case of blindness will not affect the credibility of the research.

### 2.2.3 Experiment procedure

The process of user testing was conducted individually for all users. Prevention of Blindness Union has several branches in Saudi Arabia, where the exercise was conducted. A total of 30 interviewees were requested to participate in the experimental exercise. 12 out of 30 (40%) interviewees were based in Riyadh, 15 interviewees which accounted for 50% were based in Dubai and the remaining 3 (10%) were based in Jeddah. The exercise was conducted at the date and time convenient to the interviewee and in presence of a representative from Prevention of Blindness Union.

The participants were briefed with an explanation about the study before the commencement of the evaluation process with the procedures to be used. They were also introduced to the WCAG 2.0 guidelines and given some examples of accessibility problems. Participants were assured that the evaluation was of the website and not of their ability to use the web. The experimental exercise was duly explained to each and every individual. The exercise included undertaking various tasks on the eGovernment portal and was carefully observed to better understand the accessibility and usability problems. The tasks for the exercise were selected keeping in mind the most repetitive and commonly used by web users.

A standard office based PC with high speed internet connection was provided to the users. The experiment was conducted using Supernova Arabic screen reader developed by Nattiq Technologies installed in a WINDOWS 7 machine with Internet Explorer 10 as a web browser. Due considerations were also given to ensure that the environment and facilities were adequate and comfortable for the interviewees. Throughout the exercise, the researcher recorded the time and efforts that participants spent to complete each task. The researcher also rated the degree of difficulty whenever faced by participants working to complete a task. The researcher's rating was not disclosed to the participants at the time of entry. At the end of exercise, the users were interviewed personally and asked to fill a feedback form. The feedback exercise was aimed to accurately examine their experiences as well as the time taken in every task. The results were compiled and analysed to point out the major challenges faced by blind users during web interaction. There were no time constraints on the interviewees for completing the tasks. However, the time taken by each individual interviewee was noted by the researcher. This factor has been accounted for in one of the post exercise question asking whether the user felt the time spent was worth for the information and facility obtained from the website and would he/ she like to use the service again. It was not reasonable to time bound the experimental exercise because all the blind users would take different amount of time in completing the assigned tasks, primarily dependent on their level of IT literacy and web based experience. Blind users, who fall into the category of professional men or women between 25-50 years old, would take far less time in completing the tasks of experimental exercise as compared to an individual with very little or no experience of using web based system or faces the problem of limited level of IT literacy.

#### 2.2.4 Tasks lists

The exercise given to the people consisted of a pre-user testing session questionnaire followed by 13 online tasks and lastly a feedback interview. The pre-user testing session questionnaire was designed to ascertain the academic background and level of IT literacy of interviewee. This questionnaire had an important role to play in analysing results obtained from the experimental exercise. The online tasks given to applicants to be conducted on the eGovernment portal are shown in Table 3:

**Table 2: Tasks Lists**

1) Find a health facility by distance. Ministry of Health (Ministry of health)
2) Find a private medical facility. Ministry of Health (Ministry of health)
3) Inquiry about social security status. Ministry of Social Affairs (Ministry of Social Affairs, 2011)
4) Search the form for filling up “Subscription and Registration in Social Insurance” [“Government services” - “Government forms”] or “Car Registration Form”
5) “Inquiry and updating of family member medical records, appointments, details and mobile numbers” – “Health and Environment”
6) “Renewal of medical certificate” – “Health and Environment”
7) Check the current Government policy
8) "Projects and Initiatives" - "National Plans and Initiatives" - find info about "The Eighth Development Plan 1425/26 – 1429/30 AH 2005 – 2009 AD"
9) The Internet Awareness Project “SALEEM”
10) Check latest IT events
11) Register on the website. Log in and comment on a BLOG of your interest.
12) Search for Government jobs
13) Participate in polls
14) Give feedback of the website

The interviewees weren’t constrained by time and neither were they provided any kind of assistance during the experimental exercise. However, the interviewees were briefed that they should try to do as many activities as possible. They were also briefed that they could go back to the home page if they are lost, or they could choose to leave a particular task if it was taking much longer than expected. During the experimental exercise, the researcher role is to observe the user and the progress made throughout the exercise very carefully. For this aspect, five performance indicators were identified (Table 4) so as to draw a measurable conclusion on the level of accessibility problems faced by the participants. Such performance indicators include: time taken, ease of use, number of trials for every task. The value of these performance indicators was carefully taken for each task, to record the so as to be able to assess the overall performance.

**Table 4: Performance Indicators**

- How much time did this task consume? __ minutes __ seconds
- Did the interviewee found it difficult to locate the correct page?
  [ ] Yes [ ] Little [ ] No
- Did the interviewee perform the task without any problem?
  [ ] Yes [ ] Little [ ] No
- Did the interviewee found it easy to use write his or her feedback on the website?
  [ ] Yes [ ] Little [ ] No
- Was the feedback entered by the interviewee free of any error?
  [ ] Yes [ ] Little [ ] No   Comments: _________

The questions on time taken, ease of locating the correct webpage, problems faced by the interviewee associated with the task, general comments and rating of overall performance were common to all the tasks. Each point allows for maximum value of 2 for answer [Yes] down to value of 0 for [No]. This value is given based on the researcher close observation to the interviewees' physical and psychological reactions in the test. The time taken to perform a task was not considered as a major performance indicator of the task difficulty. This is due to the fact that participants would take different amount of time to perform the tasks depending on their relative subgroup. The researcher assumed, based on self-assessment , an average time of 5 minutes for every task is very enough for a blind user. Accordingly, a value of 2 is given when the interviewee performed the task in less than the average time and a value of 1 is given when he/she performs the task in more than the average time. A maximum time limit for every task is determined at 10 minutes before the task is considered incomplete and a value of 0 is given accordingly.

### 2.2.5 Result of Practical Experiment

The numerical representation is illustrated on the basis of our performance indicator listed used in the experiment. For each performance indicator, the result of every user performing the 14 tasks is coded following our (2, 1, 0) scale, and then the average performance result for every task is calculated. This average value for every single task will be used as a metric to assess any future improvement for this task or for the online environment this tasks is incubated in.

**Table 5: Participants results against the 1st performance indicator**

| P1 | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | T10 | T11 | T12 | T13 | T14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| U1 | 2 | 0 | 2 | 1 | 0 | 2 | 0 | 1 | 2 | 0 | 1 | 1 | 1 | 2 |
| U2 | 0 | 2 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 2 | 2 | 0 | 0 | 0 |
| U3 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 2 | 0 | 1 | 0 | 0 | 2 | 0 |
| U4 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 2 | 0 | 1 | 0 | 1 | 1 |
| U5 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 2 |
| U6 | 1 | 1 | 2 | 0 | 1 | 2 | 0 | 2 | 2 | 0 | 1 | 1 | 0 | 1 |
| U7 | 0 | 1 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| U8 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| U9 | 0 | 1 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 |
| U10 | 2 | 0 | 2 | 0 | 0 | 0 | 2 | 1 | 2 | 0 | 0 | 0 | 1 | 1 |
| U11 | 2 | 0 | 1 | 0 | 2 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| U12 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| U13 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 2 | 1 | 0 | 0 | 0 |
| U14 | 1 | 0 | 2 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 2 | 1 | 2 |
| U15 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 2 | 1 | 0 | 0 | 1 | 1 |
| U16 | 2 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 |
| U17 | 1 | 2 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 2 | 2 | 1 | 0 |
| U18 | 1 | 0 | 1 | 1 | 0 | 2 | 1 | 2 | 1 | 0 | 1 | 0 | 0 | 1 |
| U19 | 1 | 2 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 2 | 0 | 2 |
| U20 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 2 | 1 | 0 | 0 | 2 | 1 |
| U21 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 2 |
| U22 | 0 | 2 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 2 | 0 | 1 | 1 |
| U23 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 2 | 0 | 2 | 1 | 0 | 0 | 0 |
| U24 | 1 | 1 | 2 | 0 | 1 | 2 | 0 | 0 | 2 | 0 | 1 | 2 | 0 | 1 |
| U25 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 2 | 1 |
| U26 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| U27 | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 2 | 1 | 1 | 0 | 1 | 1 | 2 |
| U28 | 2 | 2 | 2 | 1 | 0 | 2 | 2 | 2 | 0 | 0 | 2 | 2 | 0 | 2 |
| U29 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| U30 | 0 | 1 | 0 | 2 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
| Average | .66 | .73 | .73 | .63 | .46 | .83 | .63 | .83 | .73 | .53 | .76 | .7 | .6 | .9 |

## Table 6: Participants results against the 2nd performance indicator

| P2 | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | T10 | T11 | T12 | T13 | T14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| U1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| U2 | 1 | 1 | 1 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| U3 | 0 | 1 | 0 | 2 | 0 | 0 | 1 | 2 | 0 | 1 | 0 | 0 | 1 | 1 |
| U4 | 1 | 1 | 1 | 0 | 2 | 1 | 0 | 1 | 2 | 1 | 1 | 2 | 0 | 1 |
| U5 | 0 | 1 | 0 | 1 | 1 | 0 | 2 | 1 | 1 | 2 | 1 | 0 | 1 | 0 |
| U6 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 2 |
| U7 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| U8 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| U9 | 0 | 1 | 1 | 1 | 0 | 2 | 0 | 0 | 1 | 1 | 2 | 1 | 1 | 1 |
| U10 | 2 | 0 | 1 | 1 | 1 | 0 | 2 | 1 | 2 | 0 | 0 | 1 | 1 | 0 |
| U11 | 0 | 1 | 2 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 2 | 0 | 1 | 2 |
| U12 | 1 | 0 | 1 | 1 | 0 | 2 | 0 | 1 | 0 | 0 | 1 | 2 | 0 | 0 |
| U13 | 2 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 1 |
| U14 | 1 | 1 | 2 | 0 | 1 | 2 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 2 |
| U15 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 |
| U16 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 0 | 1 | 2 | 1 | 0 |
| U17 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 |
| U18 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| U19 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| U20 | 1 | 1 | 0 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 0 | 1 | 0 | 2 |
| U21 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| U22 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| U23 | 0 | 0 | 0 | 1 | 0 | 1 | 2 | 0 | 1 | 2 | 1 | 0 | 1 | 0 |
| U24 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 2 | 0 | 1 |
| U25 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 |
| U26 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 1 | 1 |
| U27 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 2 | 1 | 0 | 0 | 1 | 1 | 2 |
| U28 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 2 | 0 | 1 |
| U29 | 1 | 0 | 2 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| U30 | 0 | 1 | 0 | 1 | 0 | 1 | 2 | 0 | 0 | 2 | 1 | 0 | 2 | 1 |
| Average | .73 | .63 | .66 | .73 | .5 | .73 | .76 | .76 | .66 | .66 | .66 | .8 | .63 | .83 |

## Table 7: Participants results against the 3rd performance indicator

| P3 | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | T10 | T11 | T12 | T13 | T14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| U1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 12 | 1 | 0 | 0 | 1 | 0 | 1 |
| U2 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 2 | 1 | 1 | 0 |
| U3 | 0 | 1 | 1 | 2 | 1 | 0 | 1 | 0 | 2 | 1 | 1 | 0 | 1 | 0 |
| U4 | 1 | 0 | 2 | 0 | 1 | 0 | 0 | 2 | 1 | 1 | 1 | 1 | 0 | 1 |
| U5 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| U6 | 1 | 1 | 1 | 1 | 1 | 2 | 0 | 2 | 1 | 0 | 1 | 2 | 0 | 1 |
| U7 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| U8 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 2 | 0 | 1 | 1 | 0 | 1 |
| U9 | 0 | 1 | 1 | 1 | 0 | 2 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 |
| U10 | 1 | 0 | 2 | 0 | 1 | 0 | 1 | 2 | 0 | 0 | 1 | 2 | 0 | 1 |
| U11 | 2 | 1 | 0 | 0 | 2 | 0 | 0 | 1 | 2 | 1 | 1 | 0 | 1 | 2 |
| U12 | 0 | 0 | 2 | 1 | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 0 |
| U13 | 1 | 2 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 1 | 0 | 2 | 1 |
| U14 | 0 | 1 | 0 | 0 | 1 | 2 | 1 | 0 | 2 | 1 | 1 | 1 | 0 | 1 |
| U15 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| U16 | 2 | 1 | 1 | 1 | 2 | 1 | 0 | 2 | 1 | 0 | 1 | 1 | 1 | 1 |
| U17 | 1 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| U18 | 0 | 0 | 1 | 0 | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| U19 | 1 | 1 | 1 | 1 | 2 | 2 | 0 | 0 | 2 | 1 | 1 | 1 | 0 | 1 |
| U20 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| U21 | 2 | 0 | 2 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 2 | 0 | 1 |
| U22 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 2 | 0 | 1 | 0 |
| U23 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 2 | 1 | 1 | 0 | 1 |
| U24 | 1 | 2 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 0 | 0 | 0 | 1 | 1 |
| U25 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 |
| U26 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| U27 | 2 | 0 | 2 | 1 | 0 | 0 | 0 | 1 | 1 | 2 | 0 | 2 | 1 | 1 |
| U28 | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 0 | 2 | 0 | 1 | 0 |
| U29 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| U30 | 1 | 1 | 2 | 1 | 0 | 1 | 2 | 0 | 0 | 2 | 2 | 1 | 1 | 0 |
| Average | .7 | .86 | .9 | .63 | .76 | .8 | .8 | .8 | .7 | .73 | .73 | .73 | .63 | .63 |

### Table 8: Participants results against the 4th performance indicator

| P4 | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | T10 | T11 | T12 | T13 | T14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| U1 | 1 | 0 | 2 | 0 | 1 | 2 | 0 | 2 | 2 | 0 | 0 | 1 | 1 | 2 |
| U2 | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 1 | 0 | 1 |
| U3 | 1 | 0 | 0 | 2 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| U4 | 2 | 0 | 1 | 0 | 1 | 1 | 1 | 2 | 1 | 0 | 2 | 2 | 1 | 2 |
| U5 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 |
| U6 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 2 | 1 | 1 | 2 | 1 | 1 | 0 |
| U7 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| U8 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| U9 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 2 | 1 |
| U10 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 2 | 1 | 0 | 0 |
| U11 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 2 | 0 | 1 | 0 | 1 | 2 |
| U12 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 2 | 0 | 0 |
| U13 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 1 |
| U14 | 2 | 0 | 2 | 0 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 0 | 2 |
| U15 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| U16 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 2 | 1 | 2 |
| U17 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 0 |
| U18 | 0 | 0 | 1 | 1 | 0 | 1 | 2 | 2 | 1 | 1 | 0 | 1 | 1 | 0 |
| U19 | 0 | 0 | 2 | 1 | 1 | 0 | 1 | 1 | 2 | 0 | 1 | 1 | 0 | 1 |
| U20 | 1 | 0 | 1 | 1 | 1 | 2 | 1 | 1 | 0 | 2 | 1 | 1 | 1 | 1 |
| U21 | 1 | 2 | 1 | 0 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 |
| U22 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| U23 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 2 | 1 | 0 | 0 | 1 | 0 | 1 |
| U24 | 1 | 0 | 2 | 1 | 2 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
| U25 | 2 | 1 | 0 | 1 | 1 | 0 | 2 | 0 | 0 | 2 | 1 | 1 | 1 | 0 |
| U26 | 0 | 2 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 2 |
| U27 | 1 | 0 | 0 | 1 | 1 | 2 | 0 | 1 | 0 | 0 | 1 | 2 | 0 | 0 |
| U28 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| U29 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| U30 | 0 | 2 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 2 | 1 | 0 | 2 | 1 |
| Average | .76 | .7 | .76 | .66 | .76 | .66 | .73 | .76 | .83 | .63 | .73 | .8 | .66 | .86 |

### Table 9: Participants results against the 5th performance indicator

| P5 | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | T10 | T11 | T12 | T13 | T14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| U1 | 1 | 0 | 1 | 1 | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 2 |
| U2 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 2 | 0 | 2 | 0 | 1 |
| U3 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |
| U4 | 2 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 2 | 0 | 1 | 2 | 0 | 1 |
| U5 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 2 | 1 | 0 | 1 | 0 |
| U6 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| U7 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 |
| U8 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| U9 | 2 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 2 | 1 |
| U10 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 2 | 0 | 0 |
| U11 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 2 | 0 | 1 | 1 | 1 | 2 |
| U12 | 1 | 2 | 2 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 |
| U13 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 |
| U14 | 2 | 2 | 2 | 0 | 0 | 2 | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |
| U15 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 1 | 0 |
| U16 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 2 | 1 | 0 | 1 | 2 | 1 | 2 |
| U17 | 1 | 1 | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |
| U18 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| U19 | 2 | 0 | 1 | 1 | 1 | 2 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| U20 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 2 | 0 | 0 | 1 | 0 |
| U21 | 0 | 2 | 1 | 0 | 2 | 0 | 1 | 1 | 2 | 0 | 1 | 2 | 0 | 2 |
| U22 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |
| U23 | 1 | 1 | 0 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 1 | 2 | 0 | 1 |
| U24 | 0 | 0 | 2 | 0 | 1 | 2 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 1 |
| U25 | 0 | 0 | 1 | 2 | 1 | 0 | 2 | 0 | 0 | 2 | 1 | 0 | 2 | 0 |
| U26 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 |
| U27 | 2 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 2 |
| U28 | 0 | 2 | 1 | 2 | 2 | 2 | 0 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| U29 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| U30 | 0 | 1 | 0 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 1 | 1 |
| Average | .63 | .63 | .76 | .66 | .73 | .66 | .76 | .7 | .7 | .66 | .73 | .73 | .6 | .83 |

As it can be seen from the illustrated results (Table 5 to Table 9), most of the tasks have low average value compared to the optimal average value of 2. Some of the tasks got considerably lower average values than other tasks in all of the 5 performance indicators like task 1, task 5 and task 13. It was also noted that in these tasks the participants was required to navigate to the bottom of the web page to perform the task. Moreover, in these tasks, along with other tasks which have similar low average values, participants tended to reset their screen readers repeatedly. Some other tasks like task 7, task 8, task 9 and task 14, achieved better average values in all of the 5 performance indicators. Three of these tasks were close to the top right corner of the webpage where the screen reader usually starts narrating the website content. Some tasks, on the other hand, which required the user to navigate to the bottom of the webpage, had better performance than tasks on the middle of the website. This could be attributed to the fact that such tasks performed after a precedent task located relatively on top of it. The close sequence of two tasks justifies the difference of results between the two and eliminates any ambiguity. The average value for the task of searching for a job, for example, was satisfactorily completed by more number of interviewees as compared to other tasks. This task is located just below the main headings of the home page. However, all values shown in these tables does not lead to any conclusion as to whether the eGovernment portal is inaccessible or not, It needs to be used as an indicator and as a baseline to evaluate any suggested improvement. On other hand, most of the participants found it difficult to complete the tasks and took quite long time. Also most of the interviewees were not able to locate the desired web page and web links because of navigational issues. It was noticed that most of users prefer to go back to the top of the page whenever they were asked to perform a new task. This was a major contributing factor to increased time taken and inability to complete the task. Each task was individually rated by the researcher for overall performance of the interviewee.

Based on foregoing, it can be concluded that the problem of accessibility faced by blind users is less dependent on the exact task to be performed and more on the layout of the website

**2.2.6 Post Test Evaluation**

The experimental exercise was followed by a candidate feedback questionnaire, which was designed to better understand the user's experience while using the eGovernment website. The tasks on experimental exercise resembled very closely what a blind user would normally do on a regular basis. Thus it has been assumed that if the website was developed keeping in mind the basic requirements of blind people, the experimental exercise must give satisfactory results for the sample of interviewees selected, irrespective of their IT literacy. The questions were verbally asked from the author to each individual candidate to avoid communication gap, and allow free flow of thoughts about the web based experience. The interviewees were requested to comment on the questions of feedback form and the answers were noted in the forms by the researcher. The summary of results obtained from candidate feedback questionnaire is shown in Figure 6.

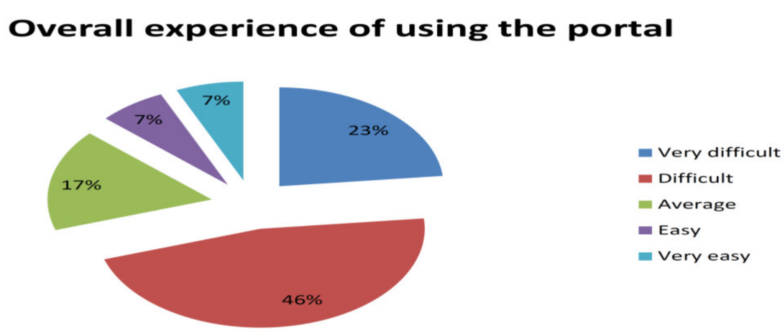


**Figure 6: Overall Experience of Using the Portal.**

## 3. Discussion

A critical analysis of our experimental exercise indicates that blind people faced several challenges related to web accessibility and usability. These challenges are clearly reflected in the excessive time taken to perform the tasks, repetition of tasks, unable to locate the desired we blink or hyperlinks etc. These challenges are logical in the case of poorly designed website or with low level compliance to the WCAG standards; however, with nearly level AAA compliant website this issue is totally excluded. Moreover, the selected sample of participants represents the blind population with all factors like age, computer literacy etc., are taken into account. During our close observation to the blind user while performing the given tasks, we noticed that the user faced difficulty going backward and forward from/to the current location of the cursor. The user tends to point the cursor again and again to the beginning of the website to resume the screen reader. The arguments for this behaviour are that similar to what we experience in our life, when we get lost in a new city we consult a map for getting the right orientation. This map will be used as mental model which guides us to traverse through our surrounding attributes (buildings, street etc.). This mental model is also applicable and used implicitly during the online interaction experience. For normal sighted users, the surroundings mental model of the website can easily be built through the visual contact with website pages and links. However, in the case of blind users, this mental map is not existed and hence they face great challenges in navigation efficiently through the website space. The website for blind users represents a very wide space with richness in attributes (links, images, tabs etc.) without having any idea about the possible paths between these attributes.

## 4. Conclusion

The most appealing and important issue to be considered by web designers is to ensure that the web based experience results in an output as a service or information, which is worth the time and efforts spent by the blind people. The aim of having a successful implementation of eService or online application cannot be fulfilled until and unless it provides an effective and efficient way to blind people in utilizing them. The aim of this article is to evaluate the unknown and hidden accessibility and design issues faced by blind users while using online applications like the e-Government services. Findings of this research showed that conformance to WCAG guidelines may not be the success factor for blind users' acceptance to online applications. Although the selected eGovernment portal conforms to all major WCAG requirements and satisfies other technical standards, it failed to satisfy the requirements of blind people which leaded to user dissatisfaction. It showed that web designers assume that blind user is ordinary users who deal with the computer in non-visual contact without carefully considering other aspects like their cognitive load and their complex problem solving process. Future research would include deep analysis to the navigation issues faced by blind users in our experiment. A detailed review to the cognitive and physiological behaviour theories so as to come up with set of guidelines to improve web accessibility.

## References

Visual impairment and blindness (2012, June). Retrieved January 2013, from World Health Organization: http://www.who.int/mediacentre/factsheets/fs282/en/

AlJarallah, K., Chen, R. C., & AlShathry, O. (2013). Cognitive-based approach for assessing accessibility of e-government websites. In Universal Access in Human-Computer Interaction. User and Context Diversity (pp. 547-554). Springer Berlin Heidelberg.

AlJarallah, K. (2013). Cognitive User-centred Design Approach to Improve Accessibility for Blind People during Online Interaction.

Al-Khouri, A. M. (2011). An innovative approach for e-Govenment transformation. International Journal of Managing Value and Supply Chains (IJMVSC), Vol. 2, No 1.

Abdelbaset Rabaiah, E. V. (2009). A Strategic Framework of e-Government: Generic and Best

Practice.

Jokela, T. (2000). Usability capability models—review and analysis. In People and Computers XIV—Usability or Else! (pp. 163-181). Springer London.

Rabaiah, A., &Vandijck, E. (2011). A strategic framework of e-government: Generic and best practice. Leading Issues in e-Government Research, Academic Publishing International Ltd, 1-32

Rutter, R., Lauke, P. H., Waddell, C., Thatcher, J., Henry, S. L., Lawson, B.,& Urban, M. (2006). Web accessibility: Web standards and regulatory compliance. Apress.

Loiacono, E., & McCoy, S. (2004). Web Site Accessibility: an Online Sector Analysis. Information Technology and People, 87–101.

Katz-Haas, R. (1998). Ten guidelines for user-centered web design. Usability Interface, 5(1), 12-13.

Tractinsky, N., Katz, A. S., &Ikar, D. (2000). What is beautiful is usable.Interacting with computers, 13(2), 127-145.

The Office of Government Commerce. (2003). Measuring the expected benefits of E-Government

Al-Badi, A. a. (2003 ). Towards a Comprehensive Usability Framework for Global Websites.International Business Information Management Conference. Cairo.

Jakob, N. (2000). Designing Web Usability. Indianapolis: New Riders.

Theofanos, M. F. (2003). Bridging the gap: between accessibility and usability. Interactions, 36-51.

Gerber, E., & Kirchner, C. (2001). Who's Surfing? Internet Access and Computer Use by Visually Impaired Youths and Adults. Journal of Visual Impairment & Blindness, 95(3), 176-81.

Di Blas, N., Paolini, P., & Speroni, M. (2004, June). Usable accessibility" to the Web for blind users. In Proceedings of 8th ERCIM Workshop: User Interfaces for All, Vienna.

Babu, R., Singh, R., & Ganesh, J. (2010).Understanding blind users' Web accessibility and usability problems. AIS Transactions on Human-Computer Interaction, 2(3), 73-94.

Leuthold S., B. A. (2008). Beyond web content accessibility guidelines: Design of enhanced text user interfaces for blind internet users. Elsevier International Journal of Human-Computer Studies, Vol. 66, No. 4 (April 2008) 257-270.

Berg, B. L., & Lune, H. (2004). Qualitative research methods for the social sciences (Vol. 5). Boston: Pearson.

Blakemor, M. (2006). e-Government strategy across Europe - a bricolage responding to societal challenge.

Collinge, A. (2003). How and Where is Local e-Government Delivering Value to the Citizens? SOCITIM and I&DeA.

Carter, F. B. (2008). Trust and risk in e-government adoption. The Journal of Strategic Information Systems, 165–176.

Boldyreff, C. (2002). Determination and Evaluation of Web Accessibility. IEEE International Workshops on Enabling Technologies: Infrastructure for Collaborative Enterprises (WETICE'02). Pittsburgh, PA, USA

Michailidou, E., Harper, S., & Bechhofer, S. (2008, September). Visual complexity and aesthetic perception of web pages. In Proceedings of the 26th annual ACM international conference on Design of communication (pp. 215-224). ACM.

Wang, Y., Hernandez, M., & Minor, M. (2010). Web aesthetics effects on perceived online service quality and satisfaction in an e-tail environment: The moderating role of purchase task. Journal of Business Research, 935–942.