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Evaluation of Universal Design of ICT
in Emergency Management websites: An
Earthquake Scenario of Nepal

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Universal Design of ICT in Emergency Management

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Preface

This study is about the website evaluation of earthquake related emergency management. This research study aims to investigate the accessibility and usability issues and barriers that a user may face while accessing the earthquake related emergency management website. The research has been undertaken as the requirement for the partial fulfilment of master's degree of Computer Science under the faculty of Technology Arts and Design at the Oslo Metropolitan University. The main motivation and inspiration about writing this Master's Thesis was the article about "Universal Design of Information Sharing Tools" and "Usability, content and connection" by (Jaziar, Gjørseter, & Chen, 2017) and (Youngblood & Youngblood, 2017) respectively. While writing the thesis, I have learnt about the importance of websites accessibility and usability in context of Universal Design of ICT. I was also able to explore possible solution to make a website more accessible and usable by everyone.

I am heartily thankful to the Department of Computer Science, Oslo Metropolitan University, Norway for providing me with an opportunity to undertake the master's level thesis. I would like to thank my supervisor, **Terje Gjørseter** for the patient guidance, encouragement and advice that he has provided me throughout my time as his student. It has been an honour to be his student and beneficiary as a master's student.

I would also like to thank my beloved friends who were pursuing their Masters in Universal Design of ICT in Oslo Met University who agreed to participate on user testing of the website. I would like to provide my sincere gratitude to all the visually impaired students from Nepal who also participated for the user testing of the websites. Their enthusiasm has helped to provide a shape to my research study and helped to provide an appropriate result to the study.

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Abstract

This research study is about an investigation on the accessibility and usability issues that people of Nepal have faced while using earthquake-related emergency management websites in the context of Universal Design. There are few previous research studies done in the past to explore the accessibility and usability issues on emergency management websites, but it was not enough. Four earthquake-related emergency management websites were selected for the evaluation process. Firstly, two automated accessibility evaluation tools i.e. WAVE and SortSite has been used to determine the accessibility level among all the four websites, if they meet the Web Content Accessibility Guidelines (WCAG) 2.1 or not. After the evaluation from the automated tools, an empirical experiment was performed among the 16 participants including visually impaired as well as non-disabled participants. To measure the performance, System Usability Scale (SUS) was used to measure usability scale among all the four websites. Similarly, the open-ended question was asked to find out related accessibility issues and participant's opinion (post accessibility and usability questionnaire) were used. Data collected from the participants were analysed with a mixed-method approach where quantitative data were analysed followed by qualitative data. From the analysis, participants found NSC and EMSC websites were usable and accessible to some extent among the four emergency management websites. However, the participants suggested web developers and designers should follow WCAG 2.1 guidelines as well as Universal Design and its principles to make the website more usable and accessible. They also suggested adding the additional features in the website that is necessary during an earthquake situation to keep themselves prepared. The findings of the study may also be useful to investigate the subject matter to future researchers.

Keywords: Nepal Earthquake, Emergency Management, Universal Design, Accessibility, Usability.

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1. Introduction

Human-Computer Interaction is the study of how users interact with the computers and to what extent computers are or are not been able to develop for the successful interaction with the human (Rouse, 2005). HCI aims to understand how people are using technology and how technological solutions can be made more usable for people. HCI brings knowledge from various aspects such as computer science, design, psychology, and other behavioural sciences. HCI plays a vital role in emergency management as well. People may face all kind of emergency environmental hazardous situation such as an earthquake, flood, hurricane, typhoon, tsunami, and so on. During this situation, the role of information technology is a vital one. Information technology can be helpful in such a situation to gather, access, process, and communicate the information. This will increase the user's situational awareness, to improve user's instant decision making. Besides, they can be used to train the users in such emergency for proper evacuation and preparedness (Klann, Malizia, Chittaro, Cuevas, & Levialdi, 2008). But designing of the interface that can be usable by everyone including vulnerable groups is a challenging task. The principle of Universal Design and accessibility standard guidelines should be implemented to make any system or interface that can be usable by everyone in an emergency.

Emergency situations may occur at any time and circumstances. Implementation of disaster prevention activities may lead to control over disasters and emergencies. Activities may contain both pre and post-disaster activities such as early warning systems. But the government of any country, they are likely to focus on post-disaster actions like evacuation and relief. The contribution of government to their citizens on pre-disaster procedures like early warning systems will save lives and livelihood.

Emergency management is a discipline of avoiding risk and dealing with the catastrophic consequences for communities, regions or entire countries (UASEM, 2015). It is the process of mitigating, preparing, response, and recovery for an emergency. It also involves plans, activities, strategies, arrangements which are needed during an emergency or in disaster events.

Talking about a disaster event, such as an earthquake, Nepal was hit by a devastating 7.8 magnitude of an earthquake on 25th April 2015. The epicentre of the earthquake struck on the Lamjung district of Nepal which is located 81 km North-West of the capital city of Kathmandu. The Lamjung district and Kathmandu were the major districts that were severely affected. In that disaster, more than 8500 people lost their lives and over 18,500 people were injured. Out of all the injured numbers of people, approximately 6% suffered spinal cord injuries, 2% had amputations, 4% had traumatic brain injuries

and the majority of the injuries i.e. 70% were fractured (Sheppard & Landry, 2015). Initial day after the earthquake, the Nepalese government soon announced the state of emergency and called for an international aid that provided life-saving medical care, food, water, and emergency shelter. A flash appeal with \$415 million was called up to respond, recovery, and rehabilitation to most urgent humanitarian needs for the next three months (Appeal, 2015). We can observe that the role of rehabilitation is increasing in numbers for the recovery and response phase in a disaster situation. But the measures of preparedness during and before the disaster are almost lacking behind. According to (Becker, Paton, Johnston, Ronan, & McClure, 2017) disaster experience leads to influence the preparedness among the people. For example, when people experience a deadly disaster event then they will be searching to find out the possible preparedness measures to keep them safe during a disaster situation. The same situation happened with the people of Nepal as well. After the devastating earthquake, preparedness measures and tips were provided to people by the various non-profit organizations.

Knowledge of preparedness measures and tips is not enough. The citizens of a country should be aware of implementation about the role of Universal Design, ICT (Information Communication Technology) tools and its application for emergency management as well.

In Nepal, 50% of the people in the country use a smartphone (NepaliTelecom, 2017) . They are likely to use the internet as well. On the other hand, the internet is changing the nature of society since the industrial revolution (Aggarwal & Bento, 2002). Similarly, the use of internet is increasing in almost all the developed as well as in developing countries. The awareness about disaster preparedness and mitigation can be provided to the people by using the internet and user-specific designed websites (Izadkhah & Hosseini, 2004). However, the content of the website is only useful if it is designed accessible and usable by everyone following Universal Design and its principle.

The World Wide Web (WWW) has become the source of information to people all over the world. In a disaster situation as well, the web is becoming increasingly vital. Most of the people are willing to get the information through the web during a disaster to keep themselves safe. In this diverse world, many people may access the information about what they need, whereas for others it presents a barrier to access the offered information via web. So, it is important to ensure that disaster management or emergency management websites should be accessible for everyone including people with disabilities.

Until now, the research field on Universal Design in emergency management has been primarily focused on the physical environment, building and escape routes. But the research and development on the Universal Design of ICT in Emergency Management will provide a greater impact to save

people's lives in a disaster situation. However, the research indicates that the focus on Universal Design of ICT tools and platforms regarding emergency management has not been seen strong enough (Jaziar, Gjørseter, & Chen, 2017).

1.1. Universal design in Web Application

The term Universal Design in web application refers to the design of a website in such a way that it can be usable by everyone, such as the design of user-friendly websites as well as compatible with assistive technology. The Universal Design concept first emerged from North Carolina State University in 1997 where the team led by Ronald Mace defined Universal Design as “the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design”. They have provided 7 principles of Universal Design which are as follow:

- a. Equitable use.
- b. Flexibility in use.
- c. Simple and Intuitive use.
- d. Perceptible Information.
- e. Tolerance for error.
- f. Low physical effort.
- g. Size and Space for Approach and use (Rossetti, 2006).

1.2. Website Accessibility

Web accessibility means that the website, tools and technologies are designed in such a way that people with disabilities can use them (W3C, 2019). Web accessibility also helps users to perceive, understand, navigate, interact with the web and contribute to the web. (W3C, 2019) elaborates the website's accessibility requirements that include screen reader, screen magnifiers and voice recognition as a form of assistive technology that guides people with disabilities to perceive the web content. The crucial role of fulfilling those web accessibility requirements is web developers and designers. Web developers and designers should follow WCAG2.1 accessibility guidelines and Universal design principles to make web content more accessible and usable. However, the level of accessibility is low on the website although various tool has been developed to help increase the accessibility of the websites (Lazar, Dudley-Sponaugle, & Greenidge, 2004).

1.3. Website Usability

Web Usability refers to the measure of effectiveness, efficiency and satisfaction where users can achieve their goal on a website. Website usability is also referred as ease of use of the website to the users to access various features available on the websites. Five components were used, keeping the users in mind for the website usability and defined usability (Nielsen, 2012), which are:

- a. Learnability
- b. Efficiency
- c. Memorability
- d. Errors and
- e. Satisfactions

This research study is focused on the evaluation of earthquake-related emergency management websites. The evaluation process investigated accessibility and usability issues and barriers that the users (people of Nepal) may have faced while accessing earthquake -related emergency management websites during an earthquake situation in Nepal.

In this study, four earthquake related emergency management website were selected in total. Two automated accessibility evaluation tools against Web Content Accessibility Guidelines (WCAG) 2.1 have been used to evaluate the accessibility level of earthquake related emergency management websites. Similarly, a mixed-method approach for the data analysis has been used to analyse the data collected from the real experiment. In all the websites, six pages were evaluated by assuming these pages might be important for the users during an earthquake situation for preparedness. The pages that were evaluated are as follows: Homepage, Earthquake Information Page, Felt Earthquake Page, Preparedness tips page, Reminder Alert page, Contact Information Page. This study also addresses the common accessibility and usability issues screen reader users as well as non-disabled users encountered. Also, subjective performance, as well as subjective opinions of the participants, were used for analysing the results and drawing conclusions to the study.

1.4. Problem Statement

Nepal is one of the most disaster-prone countries in the world that lacks resilience and means to respond to disasters (Tuladhar, Yatabe, Dahal, & Bhandary, 2015). Nepal is a country that has a long history of destructive earthquakes. Earthquakes of various magnitude have occurred almost every year that results in huge damage and casualties affecting both the non-disabled and people with disabilities (NSET, 2012). There are various factors influencing damage and casualties. Among them, poor emergency management system, poor physical network design, internet and ineffective network management around the nation, restricts people to access the emergency information. Besides that, in Nepal, websites, their outdated content, and inaccessibility have led people with disabilities and non-disabled people to perceive less amount of information during an emergency resulting in situational disability.

Situational disability issue is one of the less explored areas concerning the Universal Design of ICT for emergency management (Gjørseter, Radianti, & Chen, Understanding Situational Disabilities and Situational Awareness in Disasters, 2019). Situational disability consists of disabilities involving restriction of physical tolerance as well as restrictions relating to tolerance of environmental influences (ILO, 1984). For example, a person in an earthquake when the ground is shaking, may not be able to type the mobile phone virtual keyboard. What if a person cannot access the small home button on the website during the shaky ground? If a system is inaccessible, it could be the worst-case that denies some users to retrieve the life-saving information during an emergency. As a result, people who are not able to access the information from a website or a mobile application may be the victim of situational disability in an emergency.

Similarly, websites are the key element to disseminate valuable emergency information to different populations (Kapucu, Wang, & E, 2008). Providing information is not enough, the websites today should be designed in such a way that it can be accessible publicly and should meet the accessibility standards, usable, interactive and promote transparency of operation.

Web accessibility is the process of designing the websites, tools and technologies in such a way that people with disabilities can use them (W3C, Accessibility Fundamentals, 2019). Specifically, users can perceive, navigate, understand and interact with the web and its content. However, many of the websites are designed inaccessible that restrict people with disabilities to perceive the information. For example, a user who is blind and depends upon Assistive Technologies (AT's) will find major difficulties in accessing the information that results in poor perceiving of information during an emergency. Likewise, WCAG 2.1 and section 508 guidelines are the examples that are globally accepted guidelines to make the web content accessible and universally designed.

In response to the problem, this study will discover the existing barriers and issues that the people of Nepal have faced in the context of preparedness during an earthquake while accessing the various emergency websites and their contents by accessing and evaluating the accessibility approach.

1.5. Research purpose and question

The main objective of this research is to investigate, evaluate and analyse the accessibility issues and barriers that users are facing while using earthquake-related emergency management websites mainly in developing countries like Nepal. Accessible websites and interfaces help diverse users to interact with the system. When the website is designed accessible, everyone can use them in most situations. In an emergency as well, accessible web design helps people with various disabilities to pursue the information wisely and helps them to be prepared during a disaster situation. In contrast, the concept of accessibility and Universal design is not well adapted in most of the developing countries. Nepal being one of the developing countries is lagging the problem of accessibility and Universal Design. The main problem with the country not implementing Universal Design, accessibility and ICT tools is due to the lack of knowledge among the developers, unstable political situation, limited resources, lack of education and awareness, and due to economic instability, illiteracy, and ignorance.

To accomplish the aim of the research, various approaches are performed. For example, two automated tools, WAVE web accessibility evaluation tools and SortSite tools are used to evaluate the disaster management websites whether the web content meets the WCAG 2.1 guidelines or not. Moreover, semi-structured and online interviews have been carried out within 16 users including sighted users and blind users. Also, pilot testing was carried out to test the user experience concerning usability and accessibility of the websites.

Similarly, to examine the problem that lies in the application of Universal Design and ICT tools in emerging countries during the emergency like an earthquake in Nepal and finding the user issues and barriers while accessing the web contents, the following research questions have been presented:

1. To what extent do the emergency management websites related to earthquake meet universal design and accessibility criteria following WCAG 2.1 guidelines?
 - a. in Nepal
 - b. Elsewhere
2. Which type of accessibility and usability barriers were faced by the people of Nepal while using earthquake-related emergency management websites
 - a. for preparedness

b. during an earthquake?

2. Literature Review

This chapter aims to present a critical review of the literature on the accessibility and usability issues that a user (non-disabled and visually impaired) may face while using emergency management websites. Relevant studies are reviewed that particularly emphasizes the findings and methodological issues.

The web is an essential communication tool. It is essential to ensure that the websites should be fully accessible to persons with disability to enable full integration to the society. On that note, the United Nations Convention on the Rights of People with Disabilities came into force for Nepal on May 7, 2008. Likewise, in 2013, the Nepal council of minister approved a set of directives and guidelines on accessibility called "*Accessible Physical Structure and Communication Service directive for People with Disabilities, 2069 BS*". The directive aims to provide arrangements making information and communication accessible to people with disabilities (Shrestha, 2017). The guidelines and directive were approved, the implementation of accessible websites among the developers is still lacking behind.

Despite several new policies to promote disability rights, the government of Nepal still lacks to promote and implement the law and policy regarding Universal design. Nepal being a developing country is listed among the prone country for an earthquake where Universal design plays an important role. In this kind of disaster situation, everyone including people with disabilities can be the victim and will be searching for the preparedness measures. Appropriate development and implementation of ICT technologies can minimize disaster risk and crisis communication regarding the needs of people with disabilities (Bennett, Phillips, & Davis, 2017). The Universal Design provides a useful framework considering the design of emergency management systems (Paupini & Giannoumis, 2019). The design of the framework may provide a basis for identifying and removing accessibility and usability issues in emergency situations.

Situational Disability is an another type of disability that everyone may face during a disaster situation (Gjørseter, Radianti, & Chen, 2018). The author also discussed that the situational disability issue is one of the less explored areas concerning the Universal Design of ICT for emergency management. The author adopted a scenario-based analysis with simplified personas to identify situational disabilities among the stakeholders in a disaster situation. From the analysis, they have found that situational disabilities possess a loss of situational awareness among the general public including vulnerable groups such as elderly and people with disabilities and first responders. The author concluded that the Universal Design of ICT tools for emergency management plays a vital role

to make the tools usable for a broader range of groups as well as to those who are affected by situational disabilities.

Talking about Universal design, accessibility and usability, this research aims to evaluate earthquake-related emergency management websites to investigate the accessibility and usability issues and barriers faced by (visually impaired and non-disabled) while using the earthquake-related emergency management website. The research also aims to identify the main cause of challenges faced and to explore the possible potential solutions in making accessibility, usability and inclusive earthquake-related emergency management websites for everyone.

Several websites were evaluated using automated evaluation tools (Al-radaideh, Nuser , & Wahbeh, 2011), (Kaur, Kaur, & Kaur, 2016), (Yakup, 2016). They addressed that the automation evaluation tools provided the comparative importance of website assessment criteria based on usability and accessibility of the website. In contrast to that, data examined from automated tools is a bit like being a detective at a crime scene (Sagar, Gupta, & Sangaiah, 2018). So, a little evidence is not enough to understand the whole picture. Thus, an automated tool in website evaluation just notifies us about the conformance level or the violation of the WCAG guidelines. The involvement of end-users for evaluation provides comprehensive results. Likewise, a fully integrated approach is the most relevant and appropriate method for accessibility testing that includes, automated evaluation tools, manual testing and user testing (Lang, 2003). A similar type of conclusion has been made by (Harper & Yesilada, 2008). The authors stated that the best and optimum results can be achieved with a combination of various approaches of web accessibility evaluation.

Accessibility and usability in a web possess a high impact on both people with disabilities and non-disabled users. The blind users often experience frustration while interacting with the web (Lazer , Allen, Kleinman, & Malarkey, 2007). The authors listed the top causes of frustration such as a) confusion caused by the page layout and screen reader feedback; b) conflict between screen reader and application; c) forms that are poorly designed, unlabeled and inaccessible; d) absence of alternative text in the pictures e) problem with the ambiguous links, inaccessible PDFs and screen reader malfunctions. To solve these kinds of problems, a developer should follow Web content Accessibility Guidelines 2.1 (WCAG 2.1). There are few professionals, who follow these guidelines, but even the guideline has been followed, people with disabilities still encounter the problems. The work of (Power, Freire, Petrie, & Swallow, 2012), it was found, 50.4% of the problems encountered by the users were covered by WCAG2.0 in which 16.7% of the websites implemented the technique recommended by WCAG2.0. But the techniques did not solve the problem. The authors also found out that few of the professionals are implementing the techniques recommended by WCAG. Even

when the guidelines were followed there is a little indication that the people with disabilities will encounter some problems while using the web.

Similarly, web accessibility and usability are two distinct factors but hold similar concepts, which can be only differed by the fact that accessibility focuses on users with impairments (Schmutz, Sonderegger, & Sauer, 2017). Accessibility issues are the subset of usability issues, in which usability issues affect everyone whereas accessibility issues affect people with impairments (Thatcher, et al., 2003). The study of (Schmutz, Sonderegger, & Sauer, 2017), showed that the positive effect of accessibility on performance and subjective evaluations were similar for both non-disabled users and with the visual impairment users.

Usability evaluation alone cannot answer whether software or a product is accessible to all kinds of users (Tanaka, Bim, & Rocha, 2005),. So, an accessibility evaluation is also necessary that can say little about software usability. Thus, usability and accessibility have some points in common. Automatic accessibility evaluation tools and user testing are performed to ensure the level of accessibility and usability barriers that were encountered by both non-disabled and visually impaired users. But the studies that focus on accessible website evaluation for emergency management are rare.

The primary research on Universal Design in Emergency Management until now focuses on the physical environment, buildings and escape routes. A community engagement through ICT supported tools was proposed to improve resilience (Stough & Kang, 2015),. According to (Stough & Kang, 2015), "Accessibility" in terms of disaster context not only includes physical access to emergency evacuation vehicles and shelters but also access to emergency communications and disaster resources. Similarly, the term "Inclusive" in the disaster context suggests conveying the ideas that people and societies should accommodate the needs of people with disabilities.

A test was conducted based on WCAG 2.0 to examine a sample of pages from information-sharing tools via Automated accessibility evaluation tool (Jaziar, Gjørseter, & Chen, 2017). From the results, it has been found that none of the information-sharing tools was universally designed and accessible to all users.

Similarly, a user testing was performed because user testing is more effective for assessing accessibility (Wentz, et al., 2014). The testing involves people with disabilities by providing various tasks to complete. The author evaluates 26 emergency alert sign-ups in three cities of the United States of America. The author also points out that the sign-up process for emergency-related information is inaccessible. The tasks consist of series of steps focusing on the inspection of sign-up pages that consists of form description, field, buttons, labels, required field notification, CAPTCHA,

progress indicator and alternative means to register for the alert service. From the inspection and user testing; authors found that, out of 26 sign up pages, 21 sign up pages have one or more accessibility issues and violations. Somehow, a similar type of issues will be investigated in my research.

Likewise, Emergency Management Agencies (EMAs) websites were evaluated in Alabama USA that operates for federal, state and local levels (Youngblood & Youngblood, 2017). They evaluated nine elements from the website that can be essential for effective communication during a disaster situation. Notification or alert information, contact information, updating of the website, emergency preparedness information was some of the elements out of nine elements. After the evaluation, none of the websites met all of the nine content standards as well as the accessibility standards. The study found out the homepage of LEMAs websites fails to provide ALT attributes on the link and images that were presented on the website. Similarly, the author also concluded that the websites should be made more usable on mobile devices. Mobile devices are widely used that can play a primary tool to bridge the digital divide; particularly for lower-income populations are the ones at more risk in an emergency. The author also added that mobile readiness is essential in emergency for preparedness because, in that situation, users may not be able to access the internet through computers or laptops.

To better understand the status of research in Universal Design of ICT for emergency management, a systematic literature review was conducted where they reviewed 33 papers in depth that was published in last 10 years (Gjørseter, Radianti, & Chen, 2018). After the systematic review and comparing with the papers that were not relevant in the study, they were able to identify the key gaps associated with Universal Design, accessibility and emergency management. Some of the gaps that were identified are mentioned below:

- a. *“Most of the work on ICT tools and platforms for Emergency Management does not take into account Universal Design nor accessibility.”*
- b. *“Good efforts towards accessible tools and platforms exist, but most of them are on the conceptual or at best on the prototype level.”*
- c. *“Awareness about people with disabilities is increasing in Emergency Management, but the concerns are still more commonly focused towards non-ICT issues.”*
- d. *“Awareness about how Universal Design can benefit all users, not only the disabled, was rarely found.”*

- e. *“Research on the use of assistive technology by older adults during disasters is a neglected issue.”*
- f. *“Accessibility is used for example in a context of “accessible emergency communication systems” or web that accessible from different devices. It is also used the accessibility in terms of people that have no access to internet in the disaster and reveal the fact the less educated people have less access to internet.”*
- g. *“In use of social network in emergency situations, age gap was identified as significantly more severe than the disability gap.”*

The social media mash-up during the disaster situation for people with disabilities were highlighted by (Kent & Ellis , 2015),. Although, we have seen social media is becoming an important tool during a disaster situation. But the author discussed the social media mash-up as communication channels are not always accessible to people with disabilities. The study also unveils that Twitter, MySpace, Facebook are inaccessible to people with disabilities. While lacking the inaccessibility and universal design principles, social media are continuously recommended as alternative tools. The author also extended the definition of disability to include digital disability in terms of communication and the internet. The digital disability may impact a person’s ability to survive or to evacuate in an emergency. So, with the accessible development of web content it became possible for the software developers to render information in a combination of synthetic or natural speech in Braille, and visually, with the styling of the presentation to include speech and non-speech cues. By doing this, the information will be accessible to some extent for the people with disabilities (Häkkinen & Sullivan, 2007).

All in all, there have been several efforts made with the research regarding accessibility and usability issues that were encountered by the users while using emergency management websites. The practical implementation of these notions is not been embraced in current disaster management practices. From the above literatures, it can be concluded that universal design, usability and accessibility are still lacking at the practical level.

3. Methodology

3.1. Introduction

Chapter 3 explains the procedures and methods that are used in this study to determine the features of web accessibility in websites during disaster preparedness. It also determines the accessibility and usability barriers that the users are facing while accessing the websites in a disaster situation for preparedness.

3.2. Research Design

A mixed-method approach is presented in this research. This approach is useful to know the best about both quantitative and qualitative approaches. Basically, in this approach, a researcher explores what variables to study and develop a detailed view of those variables with a large sample of individuals. By doing this, a researcher may first survey with many participants and then follow up with a few of them to know their specific language and voices about the topic. As a result, the benefit of collecting both open-ended qualitative data and closed-ended quantitative data provides the best understanding of a research problem (Creswell J. W., 2003).

Within mixed method approach, sequential mixed-method approach is used. In sequential mixed method approach, quantitative method will be carried out first, analyse the results in which qualitative study depends on the quantitative results. The reason behind choosing the mixed method approach is that the results from the quantitative data can be explained further with the qualitative data (Creswell J. W., Research Design, 2014).

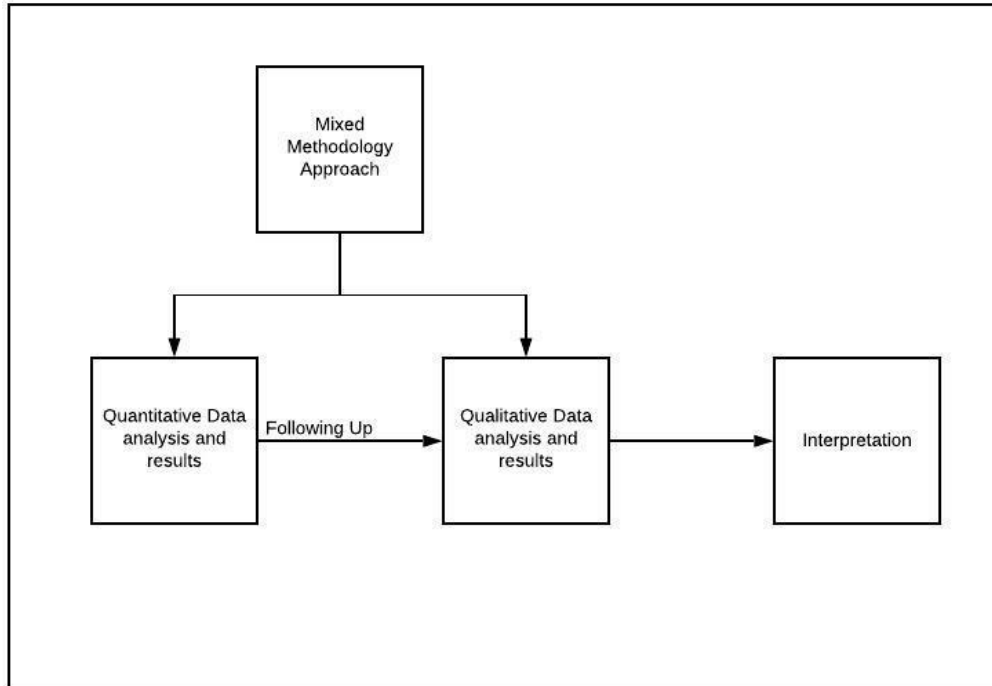


Figure 3.2-3-1 Experimental Study

3.3. Selection of websites

Four websites were chosen for the critical evaluation and assessment of web accessibility and usability of the sites. Out of four websites, two of them are the national websites from Nepal and two of the websites is a global website. The selection of the website is given below:

- a. European-Mediterranean Seismological Centre (EMSC) - European-Mediterranean Seismological Centre.
- b. National Seismological Centre (NSC) - National Seismological Centre.
- c. NSET - National Society for Earthquake Technology
- d. PDC - Pacific Disaster Centre

The two national websites from Nepal were chosen because these two websites are the only available websites in Nepal from which users residing in Nepal can access the information regarding earthquakes. Similarly, two of the global websites have been chosen to compare the accessibility and usability features from both Nepalese websites.

3.4. Target Pages to be evaluated

During the evaluation of the websites, a researcher should aim for the target pages that needed to be evaluated. The target pages out of all the four emergency management websites are given below.

- a. Homepage.
- b. Earthquake Information Page.
- c. Preparedness tips page
- d. Reminder Alert page.
- e. Contact Information Page.

3.5. Research Participants

One of the main tasks in the research is to identify the research participants. After analysing problems of the study, research questions, theoretical perspective, the decision regarding the selection of participants is taken (Sargeant, 2012).

In this research, we invited Ten Non-Disabled participants and Six completely blind participants to evaluate the accessibility and usability of the emergency management websites. The non-disabled participants that we selected were the students of Oslo Metropolitan University who were pursuing their Masters in Universal Design of ICT. Similarly, completely blind participants that were selected were students and graduates who are experienced in using the Screen Reader tool. The process of data collection was begun from the 6th of January to 31st of January.

The recruitment of completely blind participants follows the Snowball Method of selecting participants. For instance, one participant contacted other participants and so on.

3.6. The process of evaluating website

The Process of evaluating was divided into various stages which are defined in the figure below. Firstly, all the four-emergency management websites were analysed with the help of automated accessibility evaluation tools that are WAVE and Sortsite.

Secondly, participants were recruited for the user testing process for all the four emergency management websites. Participants were given the usability and accessibility task to perform on the

websites. Likewise, usability surveys, usability questionnaires, accessibility questionnaires and post web accessibility questionnaires were provided to the participants. All the questionnaires were designed in the Google Forms for the feedback and data collection purpose.

Lastly, after the completion of evaluation process and data were collected, mixed-method approach was implemented for the analysis, results and recommendation purpose.

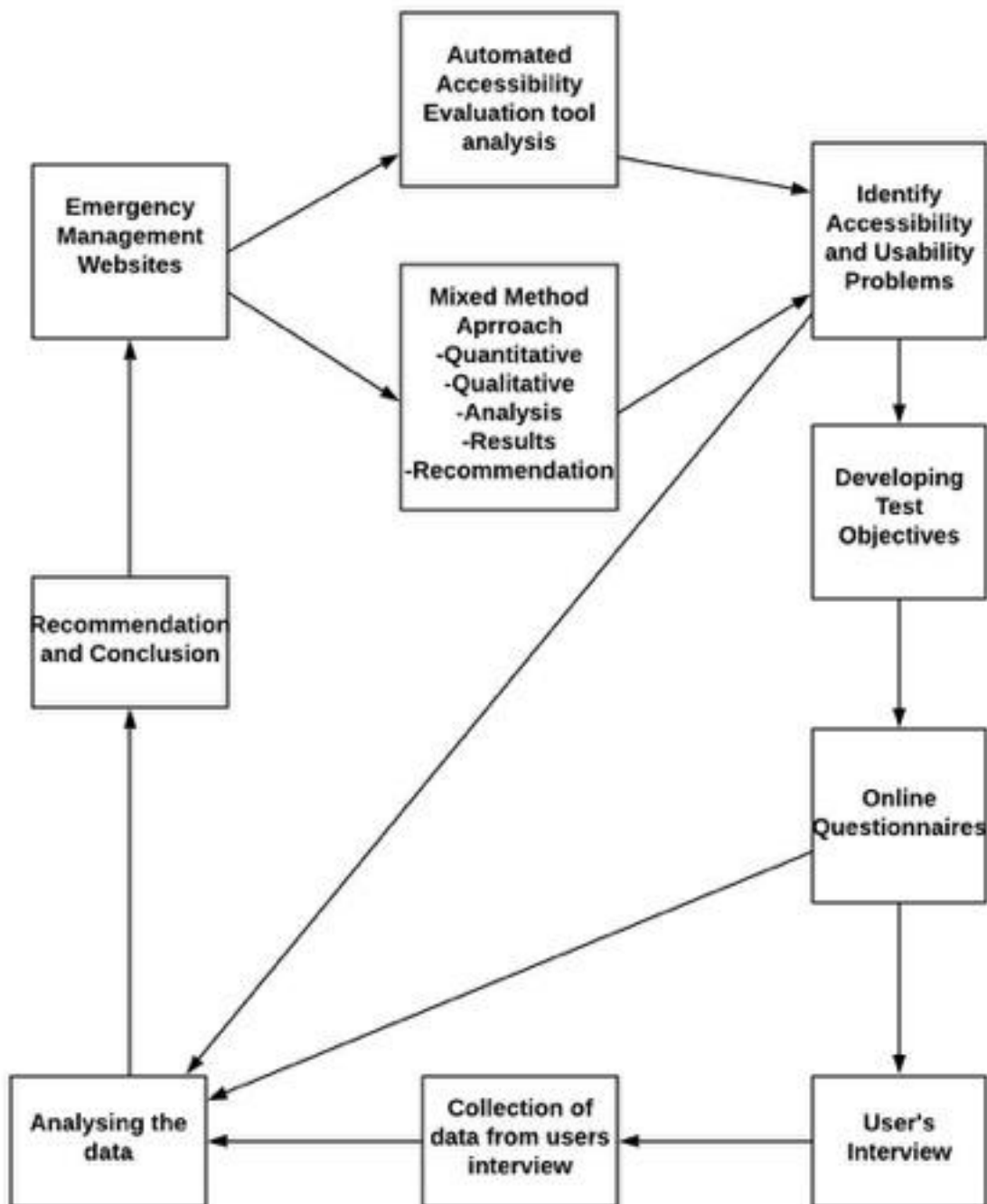


Figure 3.6-1 Evaluation Process

3.7. Data Collection Tools

To collect the data, user testing, and automated accessibility evaluation tools were used to evaluate the emergency management web page's accessibility and usability.

3.7.1. Automated accessibility evaluation tools

In this paper, we have selected two types of automated evaluation tools to determine if the accessibility and usability of the emergency website meet WCAG 2.1 accessibility guidelines and compare each other. Similarly, Automated evaluation tools are important to check only the minimal accessibility level of the website and relying on automated tools alone has negative effects as automated tools cannot fully check the accessibility of the web pages. For instance, an automated tool can check if the image contains the ALT tag, but it cannot verify if the ALT text is useful and correct (Kurt, 2011). So, further user testing is also done in this research to support further issues on accessibility and usability on web pages.

We have chosen two types of automating accessibility evaluation tools i.e. WAVE and SortSite to compare the results with each other to provide the answer for research question 1.

Below is the procedure that I performed while using the automated tools:

- a. Select an automated tool i.e. WAVE and SortSite.
- b. Enter the URL of the webpage in URL toolbar.
- c. Click on the check button to know whether the webpage meets WCAG 2.1 guidelines.
- d. Gathering the encountered results.

3.7.2. Semi-Structured Interview

In this research, face to face interviews and observation is conducted to determine the various accessibility and usability barriers and evaluation that the users are facing while using emergency management websites. Interviews with potential subjects can be an important tool for ensuring that an individual is appropriate for your study (Lazar, Feng, & Hochheiser, 2010). As participants provide you the direct feedback and depth understanding which is fundamental to HCI research. So, a semi-structured interview is performed by asking open-ended questions to discuss the further findings of the study.

3.7.3. Online Interview

An online interview was conducted among the visually impaired participants through Skype in Nepal. With the help of the screen sharing feature of Skype, an online interview was conducted to evaluate the accessibility and usability of emergency websites.

3.7.4. Online Questionnaire

Comparing data collection through the traditional paper-and-pencil methods, conducting the online survey is an alternative way of collecting data (Lefever, Dal , & Matthíasdóttir, 2007).The author also suggested that web surveys have the potential and used globally to collect a large amount of data efficiently and effectively within short frames of time.

After the accessibility and usability tasks were performed by the users, online questionnaires are given to the participants. The online questionnaires were created by using google form. Email ID of the participants was asked to send the forms.

3.7.5. Identifying the purpose of Questionnaire

It is necessary to identify the purpose of the questionnaire before designing it. It should be designed in such a way that it should provide a useful response to your research. So, a series of evaluation questionnaire was developed that will look for the views of the participants (both non-disabled and visually impaired) on the website's content, design, level of accessibility and usability among all of the four emergency management websites. The main aim of the questionnaires was as follows:

- a. Identifying potential users who use the websites.
- b. Strength and weakness of the websites in the context of usability, accessibility, content and design.
- c. Opinions for future improvement.

3.7.6. Questionnaire Design

- a. Firstly, our questionnaire started with the demographic questionnaire of the participants that includes, age, gender, education qualifications, employment status, disability, experience on Screen Reader tools considering visually impaired participants.
- b. Secondly, a series of the task was given.

- c. Finally, after the task was performed, the questionnaire was divided into four categories based on user experience, level of accessibility, and usability:
 - a) Usability survey.
 - b) Usability questionnaire.
 - c) Accessibility questionnaire.
 - d) Post accessibility questionnaire was provided.

3.7.7. Usability Testing

Usability testing often refers to the process of determining and evaluating the product or service by testing it with representative users (Usability.gov, 2019). While testing the usability of any websites, participants will try to complete the task assigned to them and observers will listen, watch and take notes. The main goal of usability testing is to identify the usability problems, collect qualitative and quantitative data and determines the satisfaction of participants towards the product. There are various benefits of conducting usability testing of websites. Some of the benefits of conducting usability testing are listed below:

- a. It helps to understand if the participants have completed the specified tasks successfully.
- b. It also helps to find out the time consumed by the participants to complete specific tasks.
- c. Figure outs how satisfied are the participants with the website.
- d. It helps to identify the changes and updates that are required to meet user's satisfaction.
- e. And helps to analyse the performance to see if it meets your usability objectives or not.

3.7.8. Division of websites

As observed during the pilot study with the non-disabled users, they took around 1.5 hours to 2 hours to complete the task. Although, the websites were not divided into the non-disabled users.

Considering a longer time taken by the non-disabled users, while interviewing visually impaired users, four of the websites were divided among the three participants, two websites to each. By doing this, the amount of time that will be taken will be reduced and the amount of stress that they will face will be reduced as well.

3.7.9. Data management and analysis

In this research, the assessment method has been used and discussed to measure the usability and accessibility of all the four websites.

3.7.9.1. System Usability Scale (SUS):

According to (Usability.gov, 2019), System Usability Scale (SUS) is a reliable tool for measuring usability. It was originally developed by John Brooke in 1986 that allows you to evaluate a wide variety of a product and services, hardware and software, mobile devices, websites and applications. Similarly, System Usability Scale (SUS) consists of the 10-item questionnaire that includes five responses for respondents according to the range of satisfaction i.e. from strongly agree to strongly disagree.

In this research as well, the sighted participants, as well as participants who are blind, will be asked to surf the emergency management websites with the help of a screen reader. They will be asked to score 10 items of the questionnaire that consists of five responses from strongly agree to strongly disagree. The 10 items of the questionnaire proposed by (Brooke, 1996) are as follows:

- a. "I think I would like to use this system frequently."
- b. "I found the system unnecessarily complex."
- c. "I thought the system was easy to use."
- d. "I think that I would need the support of a technical person to be able to use this system."
- e. "I found the various function in this system were well integrated."
- f. "I thought there was too much inconsistency in this system."
- g. "I would imagine that most people would learn to use this system very quickly."
- h. "I found the
- i. system very cumbersome to use."
- j. "I felt very confident using the system."
- k. "I needed to learn a lot of things before I could get going with this system."

Based on the above 10 items of questionnaire, participants will be asked to use the five responses ranging from strongly agree to strongly disagree.

Strongly agree				Strongly disagree
1	2	3	4	5
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Table 3.8.1-3-1 Response scale format of System Usability Scale (SUS)

3.7.9.2. Scoring and Interpreting System Usability Score (SUS)

(Sauro, 2016) defines the procedure for measuring System Usability Scale (SUS) from the collected results as:

- a. “For odd items: subtract one from the user response.”
- b. “For even-numbered items: subtract the user responses from 5.”
- c. “This scales all values from 0 to 4 (with four being the most positive response).”
- d. “Add up the converted responses for each user and multiply that total by 2.5. This converts the range of possible values from 0 to 100 instead of 0 to 40.”

3.8. Ethical Consideration

Ethical consideration is a critical part of this research study. Ethics are the norms that distinguish between right and wrong. They also help to distinguish between acceptable and unacceptable variables and behaviours. Ethical behaviour is also an important factor in a research study as it encourages the importance of the environment of trust, accountability and mutual respect among the researchers. It is important while collecting the data from various participants that is data sharing, copyright guidelines, confidentiality, destroying the data and electronics file at the end of the project, recording of audio and video of the participants and identity of the participants

Similarly, any studies including the implication of human sample will usually have ethical involvement. It is important to establish trust with the research participants that can be achieved by ensuring confidentiality to all the participants and carefully examining the research process, its goals and objectives, how the data are presented without influencing responses.

In this study, 10 non-disabled and 6 visually impaired participants were recruited. Both group of participants were provided with the consent forms (see Appendix A). During the user testing, a

consent form was provided along with the other questionnaire via online. For the visually impaired participants, consent forms were dictated first and suggested them to read with the help of screen reader and written consent form was collected. Likewise, non-disabled participants were also given a consent form and written consent form were collected.

3.9. Pilot Study

A pilot testing in research is a process of testing a small scale of methods and procedures that can be used on a larger scale if the pilot testing demonstrates that the method and procedure can work (Last, 2001). The pilot study helps to evaluate the feasibility of the process that is important to the main study (Lehana, et al., 2010). With the help of pilot testing, it helps the researcher to find out errors and modifications that need to be carried out in their main study. There are various reasons to conduct pilot testing. Some of them are highlighted below.

- a. Recruitment rates/ refusal rates
- b. Failures/success rates
- c. Understanding of study questionnaires
- d. Length of time to fill out the study forms
- e. Determining process time, etc.

In this study, Pilot study of the research, including accessibility and usability testing of the four emergency management websites was conducted among the participants for the initial data collection. The detailed information about the study was provided to the participants for their consent to take part in the consent form. The data collection process, aims, and objectives of the research study were informed to the participants. The participants were informed that they could withdraw their participation at any time without asking any questions during the interview process. Moreover, it was also informed that the data that are collected will be anonymized by replacing the participant's name with the code numbers such as Participant 1 and Participant 2 in the order of the initial interview. There will not be any kind of audio or video recording of the participants.

4. Findings and Results

This section elaborates on the findings of the research by using automated accessibility evaluation tools and user testing.

4.1. Automated Accessibility Evaluation Tools

There are various accessibility evaluation tools available online to check the accessibility of websites. These tools automatically evaluate websites. The automated accessibility evaluation tools that were used in the research are WAVE and SortSite.

a. Comparison of tools

Wave helps to evaluate the accessibility of the websites and their content. To evaluate the webpage by using WAVE, simply enter the URL of a webpage and press the submit button for the evaluation process. The results given by WAVE are presented with the embedded icons and indicators to present some of the information about accessibility on the webpage. Wave evaluates only a single page of a website at a time. The options like HTML validator and CSS validator are not presented in WAVE.

SortSite is a one-click website testing tool. In this evaluation tool as well, simply enter the URL of a webpage and press the submit button for evaluation process. The main advantage of this evaluation tool is that it analyses entire website on one click and each page is checked against more than 1200 standards-based checkpoints. The "SortSite" test checks accessibility, broken links, compatibility, search engine optimization, privacy, web standards and other usability issues.

4.2. Results from Automated Accessibility Evaluation Tools

WAVE

The WAVE accessibility evaluation tool was run on MACOS version 10.14.6 and Chrome version 77 to check the accessibility issues on the above presented four emergency management websites. Table 1, 2, 3 and 4 provide the detailed problems detected by WAVE for the home page, Hazards (earthquake) alert information page, Warning alert information page, information submission page. The below table also provides the violation of the WCAG 2.1 accessibility guidelines detected by WAVE.

1) Homepage

Websites	Perceivable	Operable	Understandable	Robust
NSET	1.1.1, 1.3.1	2.2.2, 2.4.4,	3.3.2	
NSC	1.1.1, 1.3.1	2.2.2, 2.4.4, 2.4.6	3.3.2	
EMSC	1.1.1, 1.3.1	2.4.4, 2.4.6	3.3.2	
PDC	1.1.1	2.4.4		

Table 4.2-4-1WCAG 2.1 Errors for homepage (WAVE)

The table above shows the violation of success criteria on homepage of all the four emergency management websites that were detected by the WAVE accessibility evaluation tool. The failure of success criteria 1.1.1 Non text content (Level A) and 2.4.4 Link purpose (In Context) (Level A) was detected on all the four websites that means images and images within a link do not contains alternative text. If an image that contains no texts or image that does not contain alternative text, a screen reader has no content to present to the users who are blind. Likewise, on homepage of EMSC has a form that does not contain a corresponding label violating success criteria 1.3.1 Info and Relationships (Level A). Following that, NSET, National Seismological Centre and EMSC violate success criteria 2.4.6 Headings and Labels (Level AA) and 3.3.2 Labels or Instructions (Level A). It also affects the users using a screen reader as screen reader won't be able to detect the content or label presented in the form and headings.

Similarly, success criteria guidelines 2.2.2 Pause, stop, Hide (Level A) need to be fixed on NSET and National Seismological Centre as both of the website contains marquee element. As a result, marquee element may distract and create confusion for the users using screen readers while scrolling the content of the website.

Below is the screenshot of the wave report for homepage of all of the websites that were evaluated.



Figure 4.2-4-1 WAVE report for NSET homepage

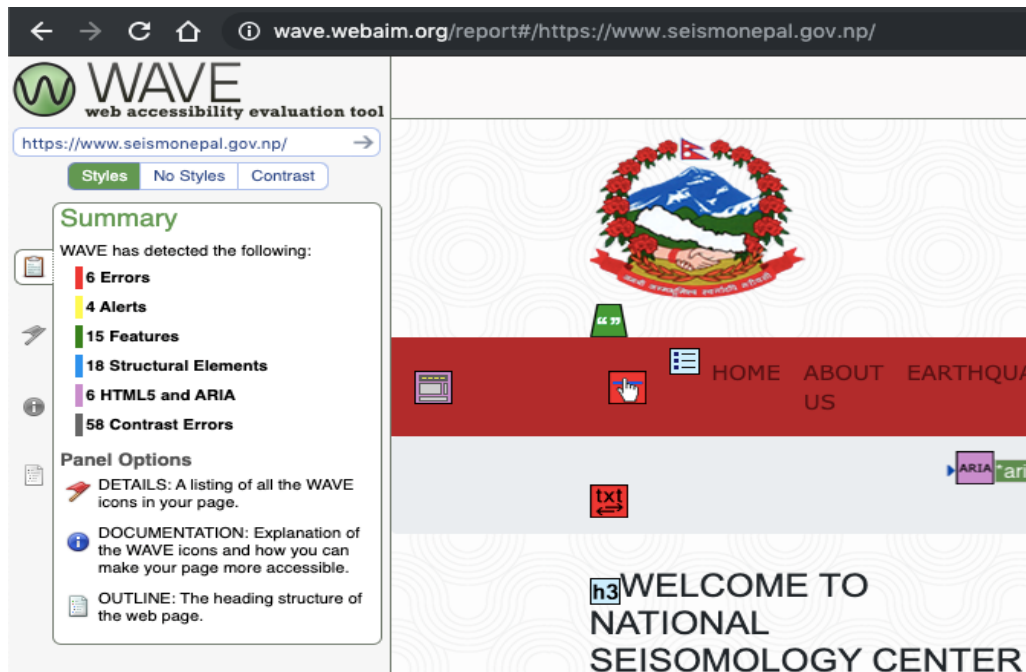


Figure 4.2-4-2 WAVE report for NSC homepage

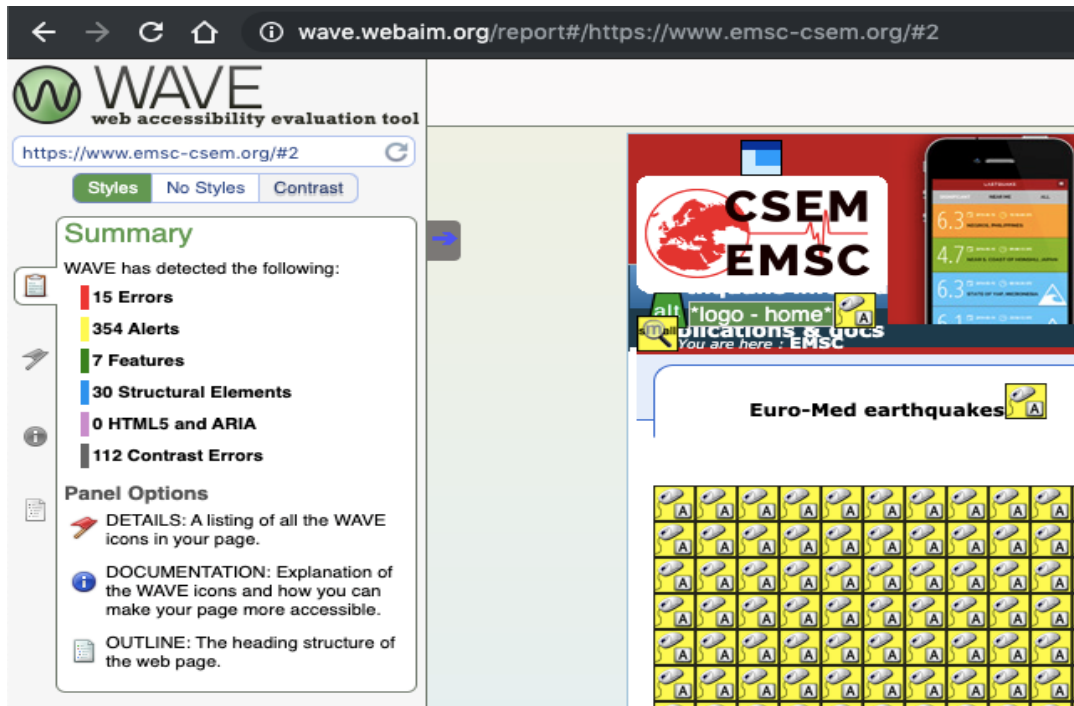


Figure 4.2-4-3 WAVE report for EMSC homepage



Figure 4.2-4-4 WAVE report for PDC homepage

2) Earthquake Alert Information Page

Websites	Perceivable	Operable	Understandable	Robust
NSET	1.1.1	2.4.4		
NSC	1.1.1, 1.3.1	2.2.2, 2.4.4, 2.4.6	3.3.2	
EMSC	1.1.1, 1.3.1	2.4.4, 2.4.6	3.3.2	
PDC	1.3.1	2.4.1, 2.4.6		

Table 4.2-4-2 Errors for Hazards (earthquake) alert information page (WAVE)

Table 6 shows errors detected by WAVE accessibility evaluation tool if the users want to access the hazards such as earthquake related information from the websites. During the evaluation, WAVE was able to detect similar errors which were in homepage.

- a. All the websites except PDC, couldn't meet the success criteria guidelines 1.1.1 Non text content (Level A).
- b. PDC, National Seismological Centre, and EMSC couldn't meet the success criteria guidelines 1.3.1 Info and Relationships (Level A) in which labels weren't provided in form control.
- c. Likewise, 2.4.4 Link Purpose (In content) (Level A) needs to be fixed in all the three websites except PDC.
- d. Heading and labels need to be fixed for the form control on three of the websites i.e. National Seismological Centre, EMSC and PDC that violating success criteria 2.4.6 Headings and Labels (Level AA). Similarly, Wave also discovered violation of 3.3.2 Labels or Instructions (Level A) that needs to be fixed.
- e. An empty heading was detected Pacific Disaster Center's website violating success criteria 2.4.1 Bypass Blocks (Level A) that results in presence of no information on the heading and may introduce confusion to the screen reader users.

3. Preparedness or Warning Alert Page

Websites	Perceivable	Operable	Understandable	Robust
NSET		2.4.4, 2.4.2, 2.4.1		
NSC	1.1.1, 1.3.1	2.2.2, 2.4.4, 2.4.6	3.3.2	
EMSC	1.1.1, 1.3.1	2.4.4, 2.4.6	3.3.2	
PDC	1.3.1	2.4.1, 2.4.6, 2.4.4		

Table 4.2-4-3 Errors for Preparedness or Warning alert information page (WAVE)

In the above table, WAVE accessibility evaluation tool discovered various errors on the preparedness or warning alert information page in all the four websites. In an emergency, such as, in an earthquake, everyone will be willing to be well prepared and get warning alert. In this scenario, the websites must be able to provide these features to users with disabilities and without disabilities. So, during the evaluation, we found that three of the websites except PDC had the same problem with the images that do not contain alternative texts that leads the users with the screen readers to face problems while accessing the relevant information. Similarly,

- a. 3 of the websites except NSET couldn't meet the success criteria 1.3.1 Info and Relationships (Level A). However, NSET doesn't consist of any kind of form for the warning alert but consists of preparedness tips. Also 2.4.4 Link Purpose (In Context) (Level A) needs to be fixed in all the four websites.
- b. An empty heading was detected Pacific Disaster Center's website violating success criteria 2.4.1 Bypass Blocks (Level A) that results in presence of no information on the heading and may introduce confusion to the screen reader users.
- c. Success criteria 2.4.2 Page Titled (Level A) needs to be fixed in NSET as it contains the title where description is missing.

- d. Similarly, success criteria violating 2.4.6 Headings and Labels (Level AA) and 3.3.2 Labels or Instructions (Level A) were found in both the National Seismological Centre and EMSC websites that is needed to be fixed.

4. Contact Page

Websites	Perceivable	Operable	Understandable	Robust
NSET	1.1.1, 1.3.1	2.4.1, 2.4.2, 2.4.4	3.3.2	
NSC	1.1.1, 1.3.1	2.2.2, 2.4.4, 2.4.6	3.3.2	
EMSC	1.1.1, 1.3.1	2.4.4, 2.4.6	3.3.2	
PDC	1.1.1, 1.3.1	2.4.6, 2.4.4	3.3.2	

Table 4.2-4-4 Errors for Information submission page (WAVE)

It is always necessary to evaluate accessibility issues on the information submission page because accessible forms are easier to use by everyone including people with disabilities. In this research as well, with the help of WAVE accessibility evaluation tool, we have evaluated information submission page of all the four websites. As information submission page consists of a form where users can fill-up the form. A form in any website needs to be accessible with a correct label, legends, field set, and placeholders. A screen reader should be able to navigate each section of the form so that diverse users can access the form. In the case of emergency management websites as well, information submission page is an important part from which users can submit their information regarding emergency issues to get warning alert and to make prepared themselves during a disaster. While evaluating we found,

- a. Issues on success criteria 1.1.1 Non Text Content (Level A), 1.3.1 Info and Relationships (Level A), 2.4.4 Link Purpose (In Context) (Level A), 2.4.6 Headings and Labels (Level AA) and 3.3.4 Labels or Instructions (Level A) in all of the four websites that is need to be fixed.

Moreover, Alerts were also detected by WAVE in all the four websites violating different success criteria guidelines. Out of all the alerts in four websites, similar types of success criteria guidelines were violated and need to be fixed such as first-level heading, heading skipped, suspicious link and redundant links. These alerts can be considered as a likely problem that is needed to be fixed.

The WAVE accessibility evaluation tool also represents various features which are not an issue. Besides, the number of structural elements and HTML and ARIA were reported which are not serious issues and can be considered as a positive outcome. WAVE accessibility evaluation tool detected several contrast errors on all the four emergency management websites. When there is not enough contrast between text and the background colour of the websites, it will be an important issue for the users who have certain vision problems that might create the problem while reading the text.

SortSite

SortSite is a web crawler that evaluates the websites quality issues on errors, accessibility, compatibility, search, standards and usability. In order to evaluate the websites, 30 days trail version of SortSite tool was downloaded on MAC OS. SortSite is widely used in more than 50 countries with the consisting of larger organizations. Over 30% of the Fortune 100 use this product such as Disney, Sony, AT&T, NASA, UNICEF and so on.

In this research as well, SortSite was used to evaluate Home page, Hazards (earthquake) alert information page, Preparedness or warning alert information page, Information submission page for all of the four emergency management websites i.e. National Society for Earthquake Technology (NSET), National Seismological Centre, European-Mediterranean Seismological Centre (EMSC), and Pacific Disaster Centre (PDC).

1. National Society for Earthquake Technology (NSET):

1) Homepage (<http://www.nset.org.np/nset2012/>):

The homepage of NSET was evaluated by using SortSite evaluation tool. During the evaluation, SortSite displayed various levels of issues following WCAG 2.1 on web pages. For example, level A explains that pages with level A issues are unusable for some people, Level AA explains that pages with Level AA issues are very difficult to use and level AAA explains that pages with level AAA issues

can be difficult to use. So, when the homepage of NSET was evaluated, SortSite discovered 14 issues in level A, 4 issues on level AA and 3 issues on level AAA.

Level A issues

14 issues in level A was discovered out of them, issues with screen readers are listed below:

- a. Missing ALT text: Alternative text should be provided on the webpage containing an image file.
- b. Missing TH elements: Without a proper tabular structure, a screen reader may find complex to read the layout of the table or data of the table.
- c. Missing ALT text in Link: Link which were used on the webpage should contain the text for the link purpose so that screen reader can describe the content or purpose of link to the screen reader users.
- d. Missing LABEL on form control: A form on a webpage should contain the label for each field to be read by the screen reader.
- e. Markup errors: It may cause screen readers to miss content.

Level AA issues

Sortsite also reported 4 issues on Level AA issues which are listed below:

- a. Color contrast issues: Without enough color contrast, people with visual impairment may find difficulties to access the page with poor background and foreground color.
- b. Empty Headings: A heading containing image should be defined with an alternative text so that screen reader can describe the heading for the screen reader users.

Level AAA issues

SortSite reported 3 issues on Level AAA which are listed below:

- a. "Avoid specifying a new window as the target of a link with target=_blank." This issue is a critical issue for screen reader users. As per SortSite suggestion, some screen readers and mobile devices provide very little indication about opening a new tab or window. In that case, insert a warning into the link text as "opens in a new window".
- b. "Link uses general text like 'Click Here' which doesn't explain link purpose." This is also one of the critical issues for the users using screen reader. Inserting a link text or adding an arial-label that provides link purpose will help screen reader to read concisely.

14 issues on 1 pages

▶ ● All <code>onmouseout</code> handlers should have an equivalent <code>onblur</code> handler.	WCAG 2.1 A F54 Section 508 (2017) A F54	1 pages
▶ ● All <code>onmouseover</code> handlers should have an equivalent <code>onfocus</code> handler.	WCAG 2.1 A F54 Section 508 (2017) A F54	1 pages
▶ ● Each <code>a</code> element must contain text or an <code>img</code> with an <code>alt</code> attribute.	WCAG 2.1 A F89 Section 508 (2017) A F89	1 pages
▶ ● Identify row and column headers in data tables using <code>th</code> elements, and mark layout tables with <code>role=presentation</code> .	WCAG 2.1 A F91 Section 508 (2017) A F91	1 pages
▶ ● Link uses general text like 'Click Here' with no surrounding text explaining link purpose.	WCAG 2.1 A F63 Section 508 (2017) A F63	1 pages
▶ ● Removing the underline from links makes it hard for color-blind users to see them.	WCAG 2.1 A F73 Section 508 (2017) A F73	1 pages
▶ ● This form control has no <code>label</code> and no programmatically determined name.	WCAG 2.1 A F68 Section 508 (2017) A F68	1 pages
▶ ● This page has duplicate IDs which cause problems in screen readers.	WCAG 2.1 A F77 Section 508 (2017) A F77	1 pages
▶ ● This page has markup errors, causing screen readers to miss content.	WCAG 2.1 A F70 Section 508 (2017) A F70	1 pages
▶ ● <code>alt</code> text should not be an image file name.	WCAG 2.1 A F30 Section 508 (2017) A F30	1 pages
▶ ● <code>alt</code> text should not contain placeholders like 'picture' or 'spacer'.	WCAG 2.1 A F30 Section 508 (2017) A F30	1 pages
▶ ● <code>area</code> elements must have an <code>alt</code> attribute.	WCAG 2.1 A F65 Section 508 (2017) A F65	1 pages
▶ ● <code>iframe</code> and <code>frame</code> elements must have <code>title</code> attributes.	WCAG 2.1 A 2.4.1 Section 508 (2017) A 2.4.1	1 pages
▶ ● <code>img</code> elements must have an <code>alt</code> attribute.	WCAG 2.1 A F65	1 pages

Figure 4.2-4-5 Level A issues on homepage of NSET (SortSite)

Level AA

4 issues on 1 pages

▶ ● Ensure that text and background colors have enough contrast.	WCAG 2.1 AA 1.4.3 Section 508 (2017) AA 1.4.3	1 pages
▶ ● Headings should not be empty.	WCAG 2.1 AA G130 Section 508 (2017) AA G130	1 pages
▶ ● If you set any of the colors on the <code>body</code> or <code>a</code> elements you must set all of them.	WCAG 2.1 AA F24 Section 508 (2017) AA F24	1 pages
▶ ● The CSS outline or border style on this element makes it difficult or impossible to see the dotted link focus outline.	WCAG 2.1 AA F78 Section 508 (2017) AA F78	1 pages
▶ Expand all 18 issues		

Figure 4.2-4-6 Level AA issues on homepage of NSET (SortSite)

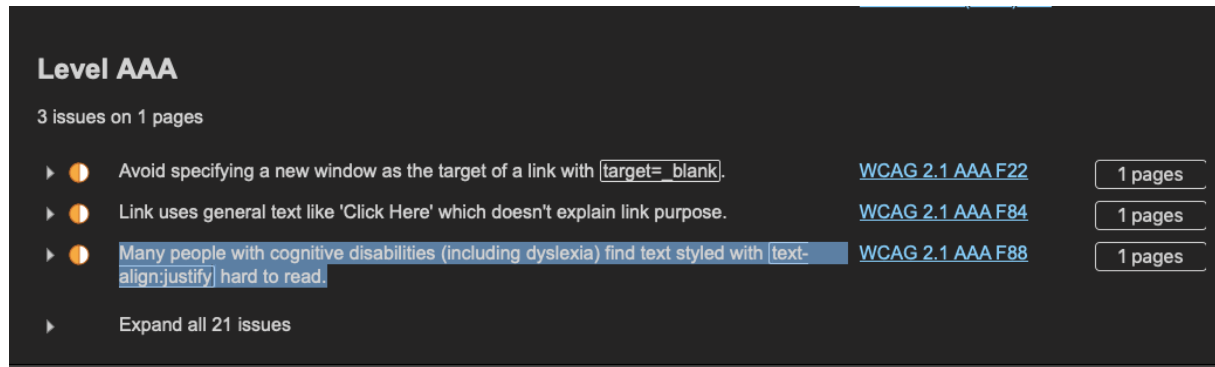


Figure 4.2-4-7 Level AAA issues on homepage of NSET (SortSite)

2) NSET earthquake information page (<http://www.nset.org.np/nset2012>)

NSET's earthquake information page was evaluated by using SortSite. During the evaluation, SortSite reported 9 issues on Level A, 3 issues of Level AA and 3 issues of Level AAA. The issues were almost similar to the issues which we have found on the homepage of NSET. The issues such as alternative text missing on the image and image links were common which were a critical issue for the users using screen reader. The results reported by SortSite on level AA and level AAA were also like the results that we got in the homepage of NSET. Likewise, other similar issues that were found after evaluation are listed below.

- a. Missing TH elements
- b. Mark-up errors: Missing end tags may lead screen reader to miss the important content.
- c. ALT text should not be an image file name: ALT text should be changed to the description of the image so that screen reader describes the image.
- d. ALT text should not contain placeholders like 'picture' or 'spacer': Images of texts should use the text and for the other images description of the image should be used.
- e. iframe and frame elements must have title attributes; As per the SortSite suggested, missing title may result in some screen reader to read out the frame filename, which is usually meaningless.

3) NSET Preparedness or Warning alert information page

NSET does not contain a warning alert page but does consist of the page with preparedness tips during an earthquake. So, we evaluated the preparedness page. During the evaluation, SortSite

reported 9 issues on Level A, 3 issues on Level AA and 2 issues on Level AAA. Out of the 9 issues on Level A “Document title must not be blank” was the new issue that was found on this page. On this issue, SortSite suggested that before producing any PDF document or the documents that are produced from office, the title should be filled in the document properties before saving as a PDF. So, other 9 issues on Level A, 3 issues on Level AA and 2 issues on Level AAA are similar issues that we found on homepage and earthquake alert pages of NSET.

Likewise, SortSite also discovered similar usability issues on both Priority 2 and Priority 3. There were no usability issues found on Priority 1. Below is the Sortsite report for NSET preparedness or warning alert information page.

4) NSET information submission page

The Information submission page of NSET was evaluated by using SortSite evaluation tool. Sortsite reported 12 issues on Level A, 3 issues on Level AA and 2 issues on Level AAA. Out of the 12, issues almost the issues were like the issues that we found while evaluating the other 3 pages of NSET. The unlikely issues that were encountered in information page are listed below:

- a. Form Label is blank: It is a critical issue because a form control label should not be blank. There should be a label describing form labels so that screen reader can describes the form control.

2. National Seismological Center

1) Homepage

Homepage of National Seismological Center was evaluated by using SortSite. During the evaluation, 11 issues on Level A, 1 issue on Level AA and 2 issues on Level AAA WCAG guidelines were detected. SortSite accessibility evaluation was able to report almost similar type of issues that were encountered in the homepage of NSET. Among the issues on Level A marquee text is very hard to read for low vision users and empty button element and has no programmatically determined name were the new issues detected on the homepage of National Seismological Center. The marquee element which is present in this page makes very hard for the users using screen reader during scrolling. Replacing the static element like span may solve the problem.

Similarly, 1 issue on Level AA was the similar issue that was found on the homepage of NSET. 2 issues on Level AAA was found in which one was similar issue that was encountered in homepage of NSET and color contrast issue ensuring that the text and background colors should have 7:1 contrast ratio was the new issue that was detected in this page. Sortsite suggested that some users will find

difficulties to read light grey text on a white text background or dark grey text on black background and white text on a red background. So, text and background should have a 7:1 contrast ratio.

2) National Seismological Center earthquake information page

After evaluating the earthquake information page of National Seismological Center, SorSite was able to report 9 issues on Level A, 1 issue on Level AA and 2 issues on Level AAA WCAG 2.1 guidelines respectively. The similar issues such as missing ALT attribute, no label on the form, marquee element, empty buttons were encountered which was already explained previously on NSET web pages.

3) National Seismological Center Warning Alert Page.

The warning alert page of National Seismological Center encountered 10 issues on Level A, 1 issue on Level A and 2 issues on Level AAA was discovered by SortSite respectively. Similar issues were detected compared to other pages of National Seismological Center. Below is the report generated by SortSite.

SortSite also reported 4 issues on Priority 2 consisting of omitting image width and height, labels missing on form, issue on background and recommendation of text links rather than image links were reported. Similarly, 1 issue on Priority 3 was reported like the earthquake information page of National Seismological Center.

4) Information Submission Page

On the evaluation of Information Submission Page of National Seismological Center 10 issues on Level A, 1 issue on Level AA and 2 issues on Level AAA were reported by SortSite. All the 10 issues were similar issues that were explained previously that consists of missing A element, ALT attribute, no labels on the input field of the form, marquee element and so on.

3. European-Mediterranean Seismological Centre (EMSC)

1) Homepage

We evaluated home page of the EMSC by using SortSite. After the evaluation, Sortsite was able to report the various issues on all the levels consisting Level A, Level AA and Level AAA WECAG 2.1 guidelines.

- a. Level A – 12 issues.
- b. Level AA – 2 issues.
- c. Level AAA – 3 issues.

Out of the 12 issues on Level A, most of the issues are like which we encountered on the homepage of the other 2 websites that we evaluated. Below are the new issues that were encountered on the home page of the EMSC.

- a. Missing keyboard onkeypress handler: An equivalent keyboard event handler should be added because some of the users are unable to use the mouse and use the keyboard to navigate.
- b. Markup Error: As per SortSite suggested mark-up errors like missing end tags may result in screen reader users to miss some important content on the website.
- c. Use of nested tables: In this kind of issue modifying the inner tables presenting the same data will solve the problem with nested tables.

Two issues were reported by Sortsite on Level AA WCAG 2.1 guidelines which are similar issues that was previously encountered on homepage of other 2 websites. Similarly, 3 issues on Level AAA were reported by SortSite which were also like Level AAA issues that were found on pages of NSET and National Seismological Center.

2) EMSC Earthquake Information Page.

The Earthquake information page of EMSC was evaluated by using SortSite. SortSite discovered 10 issues on Level A, 1 issue on Level AA and 1 issue on Level AAA WCAG2.1 guideline. All the 10 issues on Level A, 1 issue on Level AA and 1 issue on Level AAA were similar as we found on homepage of EMSC.

3) EMSC warning alert page.

During the evaluation of EMSC warning alert page, we were able to find the following issues:

- a. Level A – 9 issues
- b. Level AA – 2 issues
- c. Level AAA – 1 issue

Level A issues such as A element must contain text or an image with ALT attribute, LABEL missing on form control, ALT text missing on an image, mark-up errors, use of nested tables and unstructured tables were reported by SortSite on the warning alert information page.

The Warning alert page of EMSC contains a form to provide an alert notification to the users via email. The form consists same label in one legend. So, when a form contains items with same label,

screen reader will find difficulties to tell them apart. As per SortSite suggested, “Adding a fieldset with a legend differentiates the controls, because the legend text is announced along with the label text”. The above issues were found In Level AA issues of EMSC warning alert information page.

4) EMSC Information Submission Page

Information Submission Page mainly consists of form. When evaluated, SortSite was able to report 9 issues on Level A, 1 issue on Level AA and 2 issues on Level AAA WCAG 2.1 guidelines.

Issues on Level A such as missing labels on form control, markup errors on page, use of nested tables, image without ALT attributes etc were reported by SortSite. Similar issues on Level AA and Level AAA such as background issues, issues on text align which were found on homepage of EMSC were found on information submission page as well.

4. Pacific Disaster Centre (PDC)

1) Homepage

We evaluated homepage of Pacific Disaster Centre by using SortSite. SortSite was able to detect several issued on Level A, Level AA and Level AAA respectively.

Level A

SortSite was able to report 9 issues on Level A WCAG 2.1 guidelines such as, use of duplicate ID, use of links with no surrounding texts, stray end tag, unclosed element, using same ALT text on adjacent images and frames element missing title attributes.

Level AA and AAA

SortSite discovered issues on color contrast on text and background in Level A WCAG 2.1 guidelines. Likewise, displaying new windows without warning, color contrast ratio, links without link purpose were detected by SortSite on Level AAA issues.

2) PDC Earthquake information page

Pacific Disaster Centre’s earthquake information page was evaluated by using SortSite accessibility evaluation page in which Sortsite reported several issues where all the issues were similar to the issues which we found on homepage of Pacific Disaster Centre. The issues that were reported by Sortsite are as follows:

- a. Level A – 9 Issues
- b. Level AA – 2 Issues

- c. Level AAA – 2 issues

3) Warning alert page

After the evaluation of PDC's warning alert page, Sortsite reported 4 issues on Level A, 1 issue on Level AA and 2 issues on Level AAA respectively. Out of 4 issues on Level A, SortSite reported some missing IDs on the page in which the aria-describedby attribute must point to IDs of element in same document. The other 3 issues found on Level A were similar issues that were found on other pages of PDC. Likewise, Level AA and Level AAA consists of similar issues that we detected on other pages of PDC.

4) PDC Information Submission Page

Pacific Disaster Centre's Information Submission Page was evaluated by using SortSite. SortSite discovered 4 issues on Level A, 1 issue on Level AA and 1 issue on Level AAA respectively.

Level A

SortSite reported 4 issues on Level A WCAG2.1 guideline such as,

- a. Form LABEL element is blank: The screen reader users will find it difficult to navigate if the label in form is blank. So, adding the label on associated control helps screen reader users to navigate properly.
- b. "LABEL elements should be attached to the controls they label." As per SortSite suggested, "Add a FOR attribute set to the ID of the associated control."

Level AA and Level AAA

Similar issues on Level AA and Level AAA were discovered by SortSite as compared to other pages of PDC which has been explained before.

4.3. Pilot Study Results

Before starting the final experiment with the selected participants, in this research, pilot testing was conducted among the two participants. The participants were pursuing their master's degree at Oslo Metropolitan University. The main objective of the pilot study was to identify the possible biases of the study before conducting a real experiment to collect the data.

Pilot study was conducted to measure the accessibility and usability features for all of the four emergency management websites. Accessibility and usability tasks were given to the participants with study form. The main objective of performing these tasks was to find out if the emergency management websites are accessible and usable enough or not for the users to be well prepared during an earthquake situation. After the completion of the series of tasks that were given to the participants, the following results were collected, and possible changes were done for the real experiment.

- a. Participants took a longer time than expected while performing the tasks. This issue was encountered because of the confusion in the questionnaires. Another reason was they need to go through four of the websites. To solve this issue, first, training and briefing will be given before the real experiment and questionnaires will be modified for a quick understanding among the participants.

The results from the pilot testing, it can be concluded that the main study is feasible by changing some of the protocol during data collection in real experiment.

4.4. Automated Evaluation Tool Analysis

WAVE and SortSite are the two automated accessibility evaluation tools that were used in this research to evaluate four of the emergency management websites. After results were generated (see Appendix D) by evaluating four of the websites, analysing those results is necessary. The results from evaluation conducted by the automated accessibility evaluation tools will be compared with the results obtained from experimental study. Below table shows the total accessibility issues generated by removing the false and duplicate errors and presenting percentage issues of each tool.

Automated Tools	WAVE (Errors)	SortSite (Errors)
Mean	26.5	13.37
Standard Deviation (SD)	19.30	3.61

Table 4-5 Overall analysis of Automated evaluation tools

The table above shows the results obtained from WAVE and SortSite on four earthquake related emergency websites (see Appendix D). Errors are the combination of critical errors and alerts generated by the WAVE. In case of SortSite, errors were calculated with the issues that were shown on Level A, AA and AAA. The average total errors generated by WAVE (*Mean=26.5, SD=13.37*) which is relatively higher than that of SortSite (*Mean=13.37, SD=3.61*). The total error generated by WAVE was more severe, which is need to me minimize to achieve successful accessibility.

4.5. Quantitative data analysis

This section illustrates the quantitative data analysis from the collected data using System Usability Scale (SUS).

After the observation of the above data, it can be concluded that the mean score of 56.25 lies below the average of 68. This means that the website falls on Grade D i.e. Poor in terms of usability under SUS interpretation guidelines which is highlighted below.

SUS Score	Grade	Adjective Rating
>80.3	A	Excellent
68-80.3	B	Good
68	C	Okay
51-68	D	Poor
<51	F	Awful

Table 4-6 Usability Grade description for NSET (Non-disabled users)

Visually Impaired Participants

Usability survey for NSET was conducted among the Three participants who were in Nepal. Two of the participants were pursuing their bachelor's degree and one them was bachelor's graduated. The data were collected, findings and results are as follows:

Participants	SUS Raw Score	SUS Final Score
001	8	20
002	8	20
003	16	40
Mean		26.66
Median		20
Mode		20
Standard Deviation (SD)		11.55

Table 4-7 A statistical analysis of SUS score for NSET (Visually Impaired users).

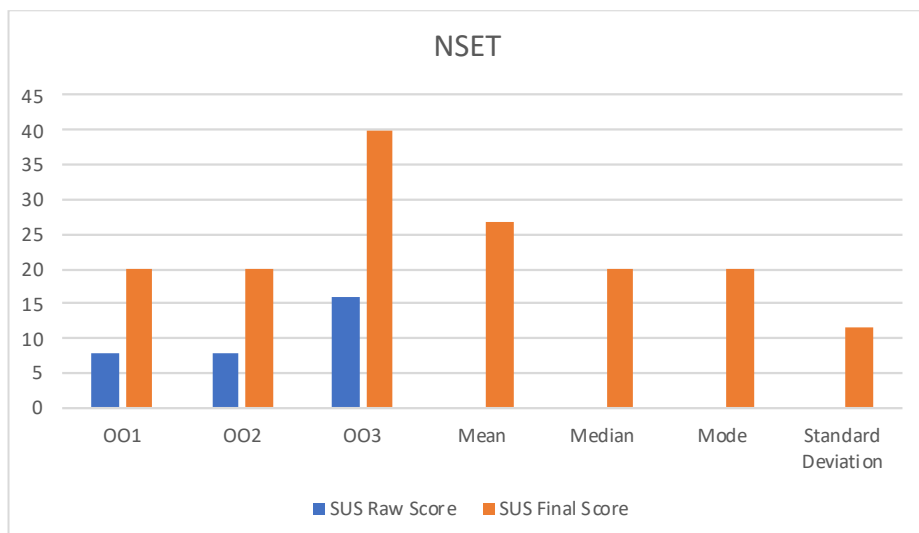


Figure 4-8 A histogram representation of SUS score for NSET (Visually Impaired users).

The above table and histogram present SUS Raw score, SUS final score, Mean, Median, Mode and Standard deviation from the usability testing of NSET for visually impaired participants. The average (Mean) score is 26.66 with the Median of 20 and mode of 20 ranging from 0 to 100. Likewise, the standard deviation of the data is 11.55. As we can observe from the data that mode is 20, re-occurrence of the data has been discovered.

We can observe that the mean score is 26.66 which lies below the average of 68. This means that the website falls on usability grade F i.e. Awful in terms of usability, when navigated with screen reader and interpreted as Awful under the SUS interpretation guidelines which is highlighted below.

SUS Score	Grade	Adjective Rating
>80.3	A	Excellent
68-80.3	B	Good
68	C	Okay
51-68	D	Poor
<51	F	Awful

Table 4-8 Usability Grade description for NSET (Visually impaired users)

4.5.1. Usability survey analysis of National Seismological Center (NSC)

Usability survey for National Seismological Center (NSC) was conducted among the non-disabled and visually impaired users.

Non-disabled Participants

Usability Survey was conducted among the same Ten participants with the help of the google forms through email. The findings and results are as follows:

Participants	SUS Raw Score	Sus Final Score
001	37	92.5
002	33	82.5
003	30	75
004	29	72.5
005	27	67.5
006	33	82.5
007	36	90
008	38	95
009	35	87.5
010	36	90
Mean		83.5
Median		85
Mode		82.5
Standard Deviation (SD)		9.22

Table 4-9 A statistical analysis of SUS score for NSC (Non-Disabled users).

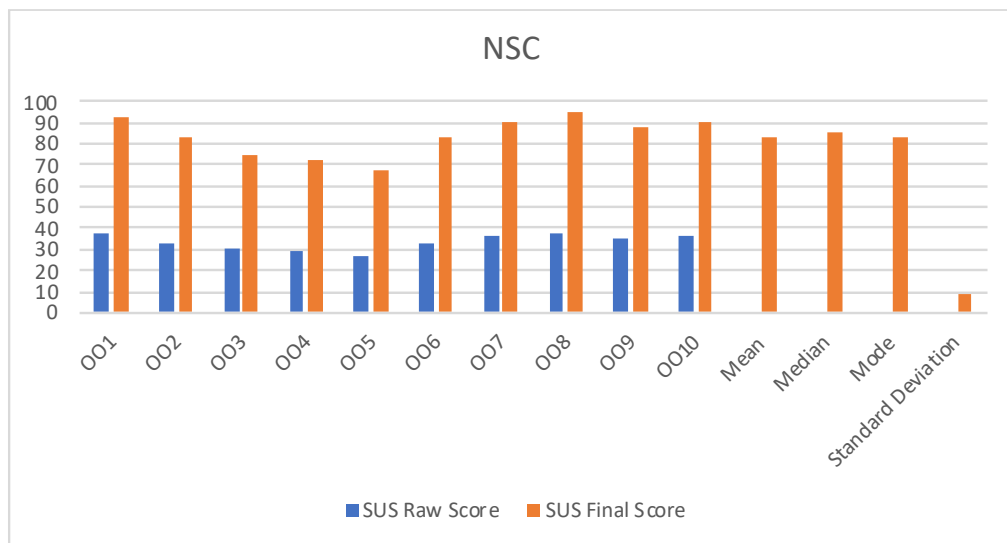


Figure 4-9 A histogram representation of SUS score for NSC (Non-Disabled users).

The above table represents SUS Raw score, SUS final score, Mean, Median, Mode and Standard deviation from the usability testing of National Seismological Center (NSC). The average (Mean) score is 83.5 with the Median of 85 and mode of 82.5 ranging from 0 to 100. Likewise, the standard deviation of the data is 9.22. As we can observe from the data that mode is 82.5, re-occurrence of the data has been discovered.

After the observation of the above data, it can be said that the mean score of 83.5 lies above the average of 68. This means that the website falls on Grade A i.e. Excellent in terms of usability under SUS interpretation guidelines which is highlighted below.

SUS Score	Grade	Adjective Rating
>80.3	A	Excellent
68-80.3	B	Good
68	C	Okay
51-68	D	Poor
<51	F	Awful

Table 4-10 Usability Grade description for NSC (Non-Disabled users)

Visually Impaired Participants

Usability survey for National Seismological Center (NSC) was also conducted among the Three participants who were in Nepal. All the Three participants were pursuing their bachelor’s degree. The data were collected, findings and results are as follows:

Participants	SUS Raw Score	SUS Final Score
001	29	72.5
002	33	82.5
003	32	80
Mean		78.34
Median		80
Mode		N/A
Standard Deviation (SD)		5.21

Table 4-11 A statistical analysis of SUS score for NSC (Visually Impaired users).

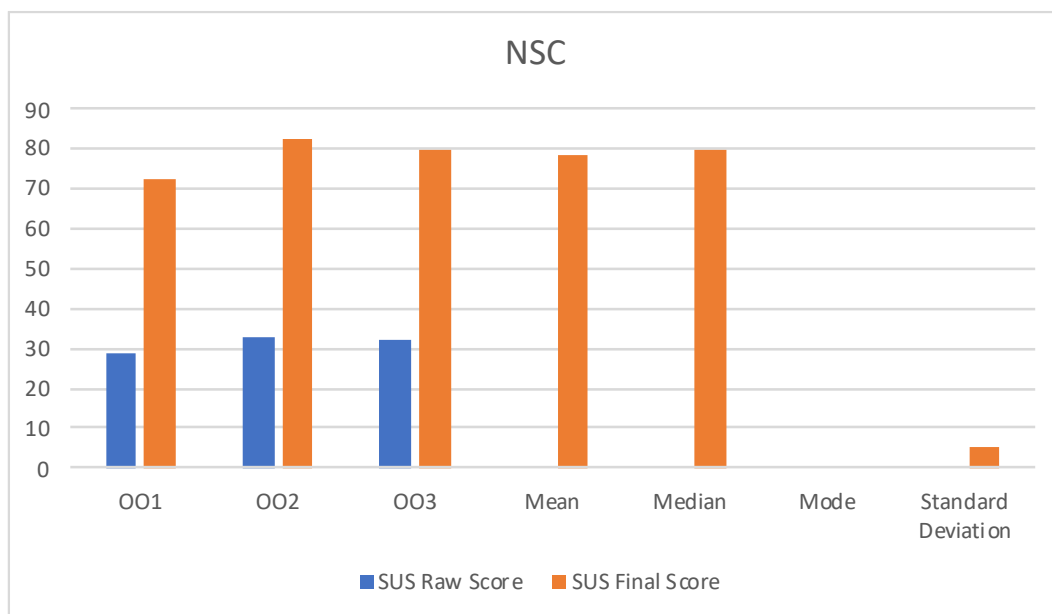


Figure 4-10 A histogram representation of SUS score for NSC (Visually Impaired users).

The above table and histogram present SUS Raw score, SUS final score, Mean, Median, Mode and Standard deviation from the usability testing via Screen Reader tool of National Seismological Center (NSC) for visually impaired participants. The average (Mean) score is 78.34 with the Median of 80 ranging from 0 to 100. Likewise, the standard deviation of the data is 5.21

We can observe that the mean score is 78.34 which lies above the average of 68. This means that the website falls on usability grade B, when navigated with screen reader and interpreted as Good in terms of usability under the SUS interpretation guidelines which is highlighted below.

SUS Score	Grade	Adjective Rating
>80.3	A	Excellent
68-80.3	B	Good
68	C	Okay
51-68	D	Poor
<51	F	Awful

Table 4-12 Usability Grade description for NSC (Visually impaired users)

4.5.2. Usability survey analysis of European-Mediterranean Seismological Centre (EMSC)

Usability survey for European Mediterranean Seismological Centre (EMSC) was conducted among the non-disabled and visually impaired users respectively.

Non-Disabled Participants

Participants	SUS Raw Score	Sus Final Score
001	29	72.5
002	28	70
003	29	72.5
004	30	75
005	20	50
006	26	65
007	32	80
008	29	72.5
009	25	62.5
010	28	70
Mean		69
Median		71.25
Mode		72.5
Standard Deviation (SD)		8.27

Table 4-13 A statistical analysis of SUS score for EMSC (Non-Disabled users).

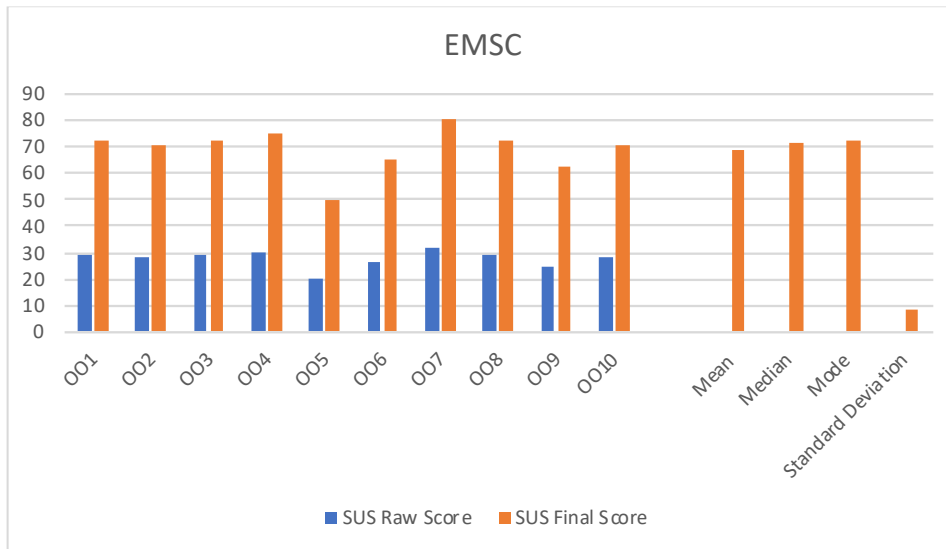


Figure 4-11 A histogram representation of SUS score for EMSC (Non-Disabled users).

The above table represents SUS Raw score, SUS final score, Mean, Median, Mode and Standard deviation from the usability testing of European-Mediterranean Seismological Centre (NSC). The average (Mean) score is 69 with the Median of 71.25 and mode of 72.5 ranging from 0 to 100. Likewise, the standard deviation of the data is 8,27. As we can observe from the data that mode is 72.5, re-occurrence of the data has been discovered.

After the observation of the above data, it can be said that the mean score of 69 lies above the average of 68. This means that the website falls on Grade B i.e. Good in terms of usability under SUS interpretation guidelines which is highlighted below.

SUS Score	Grade	Adjective Rating
>80.3	A	Excellent
68-80.3	B	Good
68	C	Okay
51-68	D	Poor
<51	F	Awful

Table 4-14 Usability Grade description for EMSC (Non-Disabled users)

Visually Impaired Participants

Usability survey for European-Mediterranean Seismological Centre (EMSC) was also conducted among the Three participants who were in Nepal. Among the Three participants, two of them were pursuing their bachelor’s degree and One of them was bachelor’s graduated. The data were collected, findings and results are as follows:

Participants	SUS Raw Score	SUS Final Score
001	26	65
002	31	77.5
003	28	70
Mean		70.84
Median		70
Mode		N/A
Standard Deviation (SD)		6.30

Table 4-15 A statistical analysis of SUS score for EMSC (Visually Impaired users).

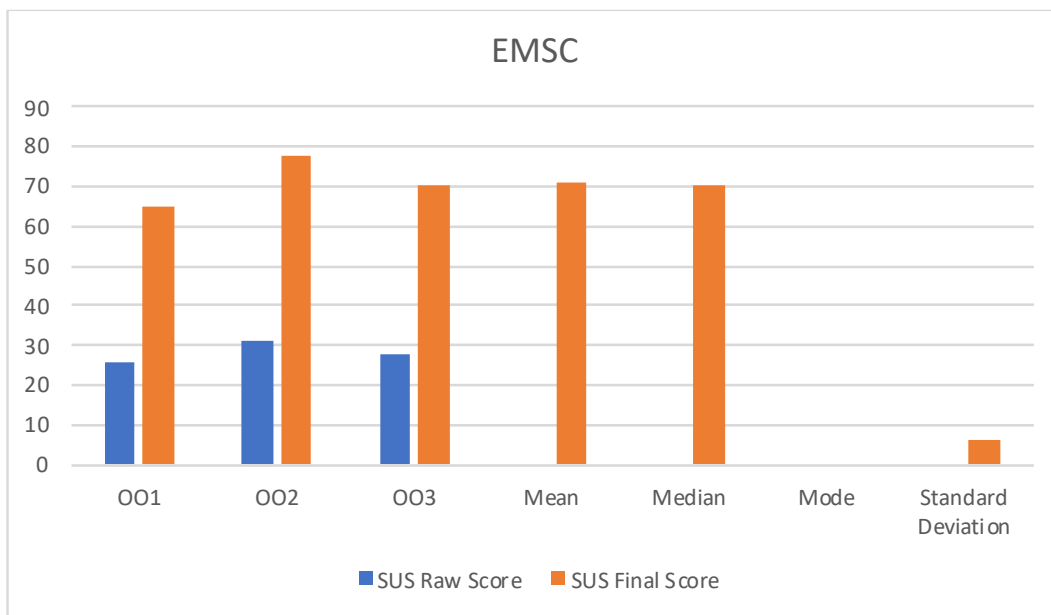


Figure 4-12 A histogram representation of SUS score for EMSC (Visually Impaired users).

The above table and histogram present SUS Raw score, SUS final score, Mean, Median, Mode and Standard deviation from the usability testing via Screen Reader tool of European-Mediterranean Seismological Centre for visually impaired participants. The average (Mean) score is 70.84 with the Median of 70 ranging from 0 to 100. Likewise, the standard deviation of the data is 6.30.

We can observe that the mean score is 70.84 which lies above the average of 68. This means that the website falls on usability grade B, when navigated with screen reader and interpreted as Good in terms of usability under the SUS interpretation guidelines which is highlighted below.

SUS Score	Grade	Adjective Rating
>80.3	A	Excellent
68-80.3	B	Good
68	C	Okay
51-68	D	Poor
<51	F	Awful

Table 4-19 Usability Grade description for EMSC (Visually Impaired users)

4.5.3. Usability survey analysis of Pacific Disaster Centre (PDC)

Usability survey for Pacific Disaster Centre (PDC) was conducted among the non-disabled and visually impaired users respectively.

Non-Disabled Participants

Participants	SUS Raw Score	Sus Final Score
001	29	72.5
002	15	37.5
003	31	77.5
004	36	90
005	12	30
006	30	75
007	09	22.50
008	18	45
009	18	45
010	17	42.5
Mean		53.75
Median		45
Mode		45
Standard Deviation (SD)		23.01

Table 4-17 A statistical analysis of SUS score for PDC (Non-Disabled users).

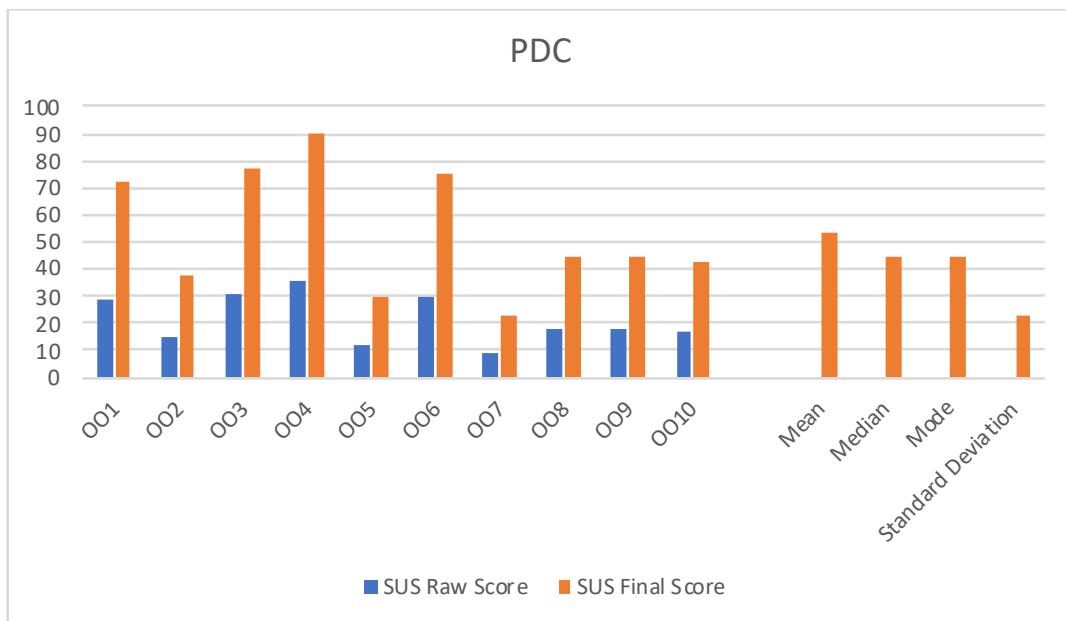


Figure 4-13 A histogram representation of SUS score for PDC (Non-Disabled users).

The above table represents SUS Raw score, SUS final score, Mean, Median, Mode and Standard deviation from the usability testing of Pacific Disaster Centre (PDC). The average (Mean) score is 53.75 with the Median of 45 and mode of 45 ranging from 0 to 100. Likewise, the standard deviation of the data is 23.01. As we can observe from the data that mode is 45, re-occurrence of the data has been discovered.

SUS Score	Grade	Adjective Rating
>80.3	A	Excellent
68-80.3	B	Good
68	C	Okay
51-68	D	Poor
<51	F	Awful

Table 4-18 Usability Grade description for PDC (Non-Disabled users)

After the observation of the above data, it can be concluded that the mean score of 53.75 lies below the average of 68. This means that the website falls on Grade D i.e. Poor in terms of usability under SUS interpretation guidelines.

Visually Impaired Participants

Usability survey for Pacific Disaster Centre (PDC) was also conducted among the Three participants who were in Nepal. All the Three participants were pursuing their bachelor's degree. The data were collected, findings and results are as follows:

Participants	SUS Raw Score	SUS Final Score
001	10	25
002	09	22..5
003	12	30
Mean		25.84
Median		25
Mode		N/A
Standard Deviation (SD)		3.81

Table 4-19 A statistical analysis of SUS score for PDC (Visually Impaired users)

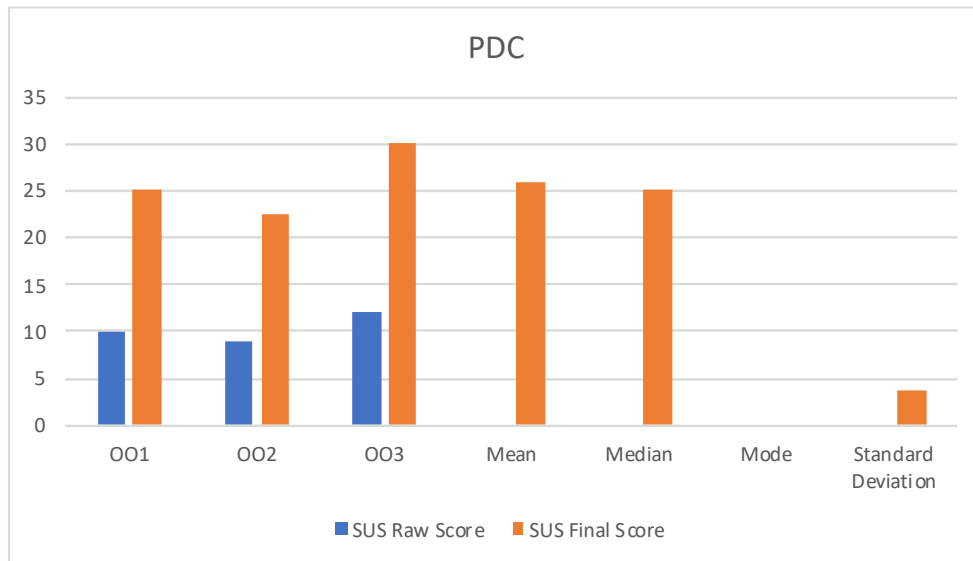


Figure 4-14 A histogram representation of SUS score for PDC (Visually Impaired users).

The above table and histogram present SUS Raw score, SUS final score, Mean, Median, Mode and Standard deviation from the usability testing via Screen Reader tool of Pacific Disaster Centre (PDC) for visually impaired participants. The average (Mean) score is 25.84 with the Median of 25 ranging from 0 to 100. Likewise, the standard deviation of the data is 3.81.

We can observe that the mean score is 25.84 which lies below the average of 68. This means that the website falls on usability grade F, when navigated with screen reader and interpreted as Awful in terms of usability under the SUS interpretation guidelines which is highlighted below.

SUS Score	Grade	Adjective Rating
>80.3	A	Excellent
68-80.3	B	Good
68	C	Okay

51-68	D	Poor
<51	F	Awful

Table 4-20 Usability Grade description for PDC (Visually Impaired users)

4.5.4. Comparing Average SUS scoring of websites

After the data has been analyzed separately for each of the websites consisting the data from both non-disabled and visually impaired participants, we thought that comparing those data is necessary.

Non-Disabled Participants

Websites	Mean
NSET	52.5
NSC	83.5
EMSC	69
PDC	53.75

Table 4-21 Overall mean data

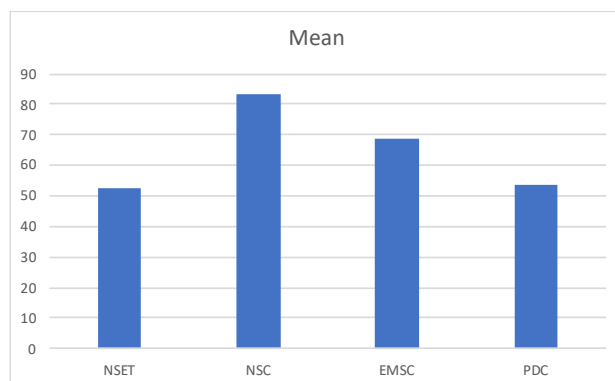


Figure 4-15 Overall mean Data

From the table and figure above, we can find that National Seismological Center (NSC) was considered as the most usable website in terms of user experience among all of the four websites. The mean of NSC was 83.5 which lies above the average value of SUS score i.e 68 and falls under Grade A in terms of usability that is considered as excellent.

European-Mediterranean Seismological Centre (EMSC) got the decent SUS average score which is 69 that lies above the average value of SUS score 68, that falls under Grade B and considered as Good in terms usability under SUS interpretation guidelines.

Likewise, the average score for National Society for Earthquake Technology (NSET) and Pacific Disaster Centre (PDC) was 52.5 and 53.75 respectively. The mean score for both the websites were poor that lies below the average value of 68 and considered as Poor with Grade D. As a result, these

two websites were not so usable in context of non-disabled users in case of emergency situation like earthquake.

Website	SUS Score	Grade	Adjective Rating
NSET	51-68	D	Poor
NSC	>80.3	A	Excellent
EMSC	68-80.3	B	Good
PDC	51-68	D	Poor

Table 4-22 Overall SUS interpretation guidelines

Visually Impaired Participants

Website	Mean
NSET	26.67
NSC	78.34
EMSC	70.84
PDC	25.84

Table 4-23 Overall mean data

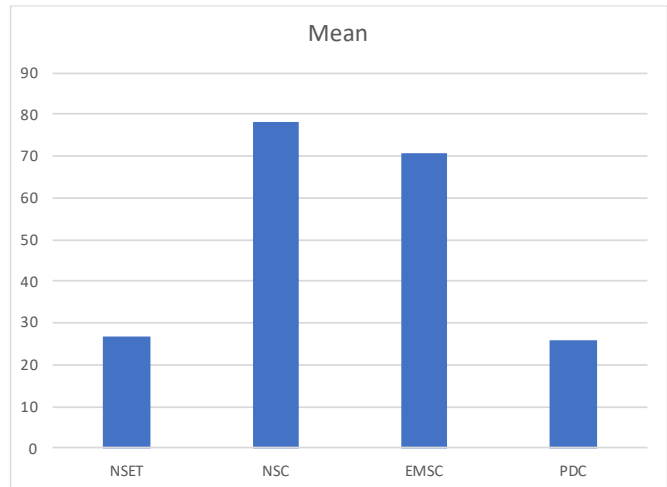


Figure 4-16 Overall mean Data

The above table and figure describe the mean SUS score generated from Visually impaired participants. We can observe that National Seismological Center (NSC) has the highest mean of SUS score that is 78.34 followed by European-Mediterranean Seismological Centre (EMSC), when navigated with Screen Reader tool by visually impaired participants. These both websites lie above the average SUS score of 68, which means these websites are usable and falls under the Grade B, considered as Good in terms of usability under SUS interpretation guidelines.

Similarly, we can also determine that National Society for Earthquake Technology (NSET) and Pacific Disaster Centre (PDC) has the minimum mean of SUS score that is 26.67 and 25.84 respectively, when navigated by screen reader tool. Both of the websites lie below the average SUS score of 68, that means these websites are minimally usable and falls under grade F, considered as Awful in terms of SUS interpretation guidelines.

Website	SUS Score	Grade	Adjective Rating
NSET	<51	F	Awful
NSC	68-80.3	A	Good

EMSC	68-80.3	B	Good
PDC	<51	F	Awful

Table 4-24 Overall SUS interpretation guidelines

4.5.5. Comparing Adjective ratings of the websites

Website	SUS Score	Grade	Adjective Rating
NSET	52.5	D	Poor
NSC	>80.3	A	Excellent
EMSC	68-80.3	B	Good
PDC	53.75	D	Poor

Table 4-25 Chart Presenting rating of the websites (Non-Disabled Participants)

Website	SUS Score	Grade	Adjective Rating
NSET	<51	F	Awful
NSC	68-80.3	B	Good
EMSC	68-80.3	B	Good
PDC	<51	F	Awful

Table 4-26 Chart Presenting rating of the websites (Visually Impaired Participants)

The above two table represents the adjective ratings of all the websites generated according to the data provided by both non-disabled and visually impaired participants. The table consists of SUS

Score, Grades and adjective rating of individual websites. From the above table it can be observed that NSET scored D grade with the adjective rating as 'poor', according to the non-disabled participants in terms of usability of the website. Similarly, NSET also scored grade F with the adjective rating of 'awful', according to the visually impaired participants. The same results can be observed on the PDC's website. As a result, it can be said that the website which are not usable by the non-disabled users cannot be usable to visually impaired users as well.

Likewise, we can also observe from the above table that non-disabled participants found the NSC as 'excellent' in terms of usability as well as the visually impaired participants found it 'good' in terms of usability. The same kind of result can be observed on EMSC as well. As a result, it can be said that, the websites which are usable by the non-disabled users can be usable by the visually impaired users.

4.6. Experimental Study analysis of Usability Questionnaire

Usability questionnaire was the another set of questionnaires after the completion of usability survey. Usability questionnaire was provided to both non-disabled as well as visually impaired participants. It consists of two questionnaires with the multiple checkbox option regarding how usable participant have found during the task for websites.

4.6.1. Non-Disabled participants

The participants were asked two questions regarding usability of the website after performing usability task and survey. The questionnaire consists of “Are resource provide through website based on user’s infromation?” and “Is the website easy to use?”. The findings and results are as follows.

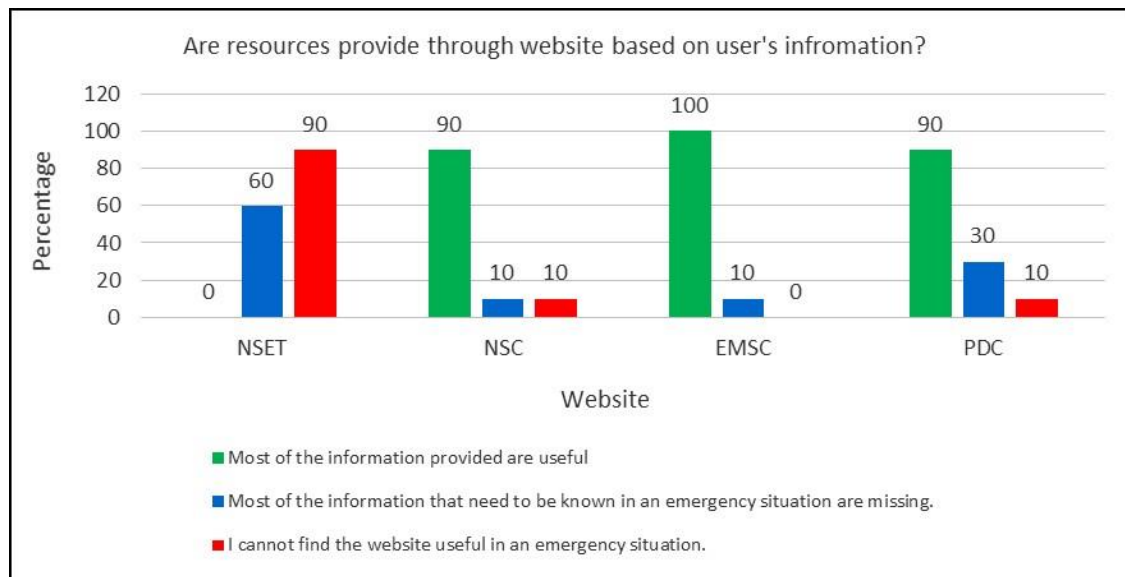


Figure 4-17 Overall results of resources provided on the websites based on user’s information

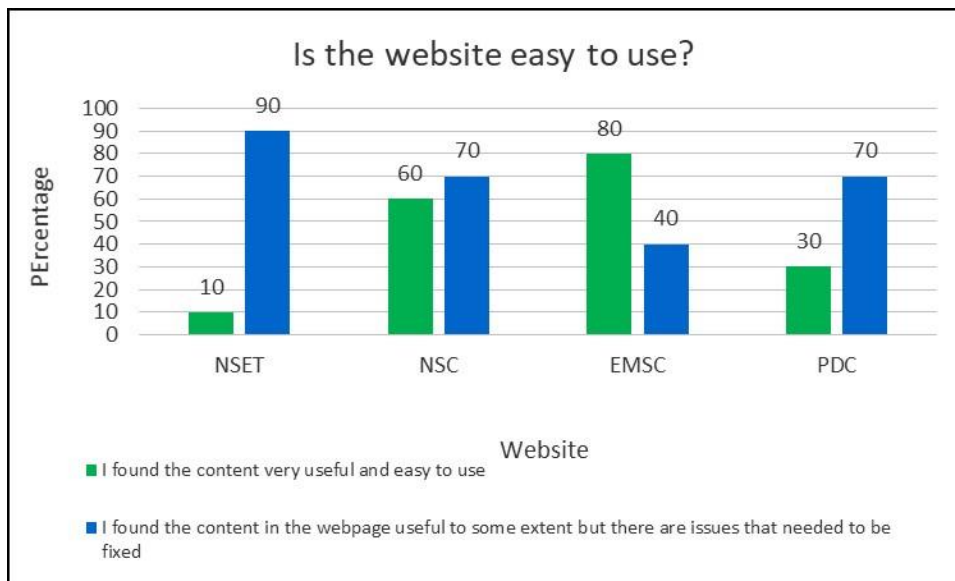


Figure 4-18 Overall result for ease of use of the websites

National Society for Earthquake Technology (NSET)

From the above figure, it is obvious that, website scored poorly for the statement “most of the information provided are useful”. Likewise, 60% of the participants found the information that needs to be known in emergency are missing in the NSET’s website. Similarly, 90% of the participants cannot find the website useful in an emergency. As from the statistics, it is found that, website is poorly usable in terms of user’s experience during an emergency like an earthquake.

Talking about the ease of use of the NSET’s website, 90% of the participant found that the webpage is useful to some extent but there are issues that needed to be fixed. Having said that, 10% of the participant found the website easy to use and very useful.

National Seismological Centre (NSC)

From the above results, 90 % of the participants found that, information provided on the website are useful and 10% found information that needs to be known are missing and website is not useful in emergency situation respectively. The statistics shows that the website provides useful information during the emergency situation like earthquake.

Universal Design of ICT in Emergency Management

Although, 90% of the participant found website provides useful information in an emergency situation, 70% found there are some issues in the websites that need to be fixed. Similarly, 60% of them also found the content very useful and easy to use.

European-Mediterranean Seismological Centre (EMSC)

The above results show that, 100% of the participants found that the information provided in the website are useful. 10% of them think that some of the information that needs to be known in an emergency is missing.

Similarly, 80% of the participants have found the website's content useful and easy to use. Where, 40% of them also think that there are some issues in the website that needs to be fixed in context of usability.

Pacific Disaster Centre (PDC)

In the given above results, 90 % of the participants found the information provided on the website are useful in an emergency situation. 30% of them also found that, some of the information that needs to be known in an emergency situation is missing. Likewise, 10% of the participant found the website is not useful in an emergency situation.

Regarding the resources provided by the website, 90% found it very useful but 70% of them found that the issues exists in the website and need to be fixed. Only 30% of the participants discovered the website is useful and easy to use.

4.6.2. Visually Impaired participants

During the interview, same sets of usability questionnaire were asked to visually impaired users. The findings and results are based on the navigation of screen reader tool from the visually impaired participants:

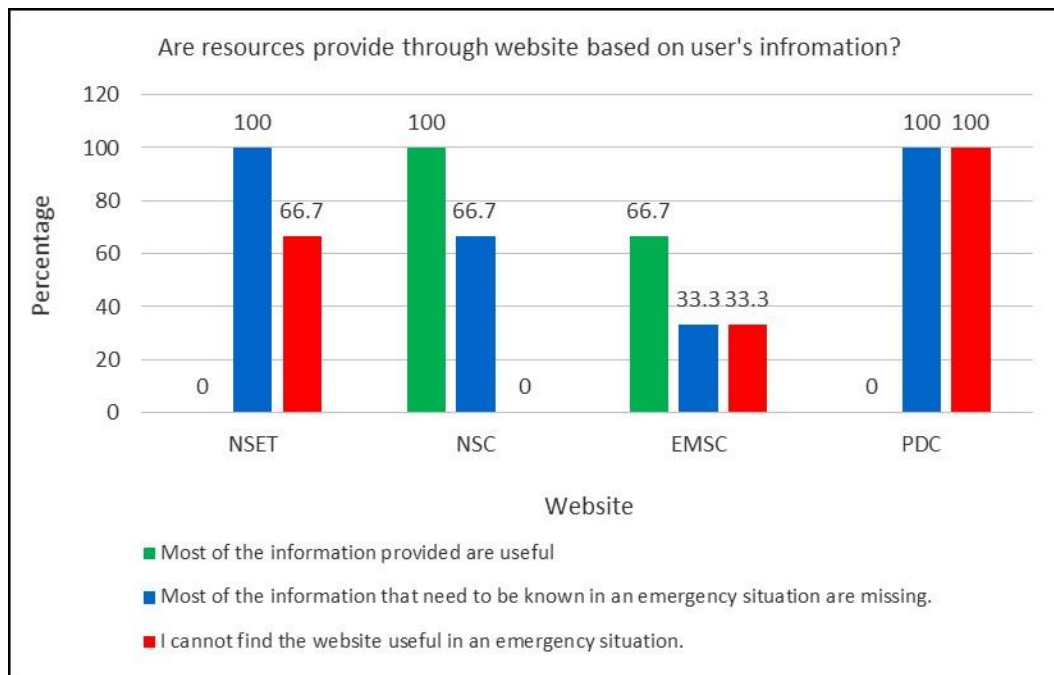


Figure 4-19 Overall results of resources provided on the websites based on user's information

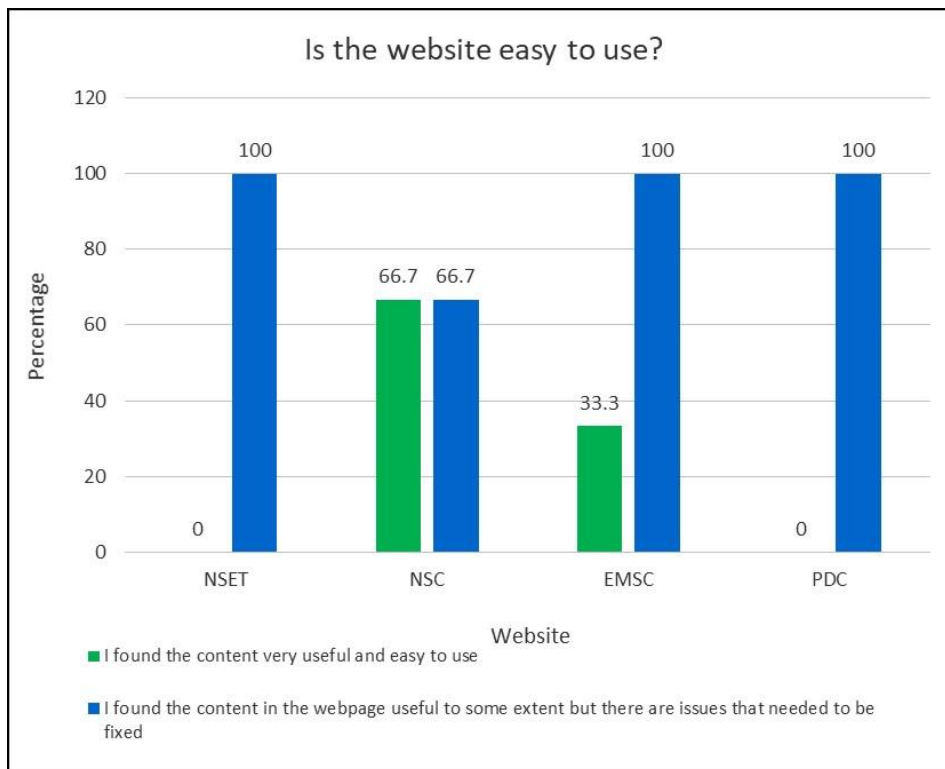


Figure 4-20 Overall result for ease of use of the websites

National Society for Earthquake Technology (NSET)

In the figure above, nobody found the information provided by website are useful. Among the participants, 100% found that the information that needs to be known during an emergency situation are missing and 66.7% cannot find the website useful in an emergency situation like earthquake.

In case of website easy to use, nobody found the website’s content useful and easy use. 100% of the participant thought the content in the webpage are useful to some extent but there are issues that needs to be fixed.

National Seismological Center (NSC)

In the results above, everyone found the information provided by the website is very useful. Among the participants 66.7% also thought that some of the features that website should provide are missing during and emergency situation.

Similarly, 66.7% of the participants found the website useful and easy to use and same number of participants also thought that the website has some issues regarding the features that needs to be added and fixed.

European-Mediterranean Seismological Centre (EMSC)

In the given figure above, 66.7% found that the information provided in the website during an emergency situation are useful. Likewise, 33.3% of the participants thought that the information that needs to be known during an emergency situation are missing and same number of participants thought that they cannot find the website is useful in an emergency situation.

When we asked about if the website is easy to use, 100% of the participants thought that website is useful to some extent but there are issues that needs to be fixed in an emergency situation. Similarly, 33.33% of the participants also found website useful and easy to use.

Pacific Disaster Centre (PDC)

The results above discovers that nobody found the website provides useful information during an emergency situation. All the participants found that, most of the information that needs to be known during an emergency situation are missing and same number of participants thought that they cannot find the website is useful in an emergency situation.

When asked about if the website is easy to use, 100% of participants thought that content of the website is useful to some extent but there are issues that needs to be fixed. None of the participants found the website easy to use while navigating with the screen reader tool.

4.7. Experimental study analysis of Accessibility Questionnaire

During the interview, accessibility questionnaire was provided to the participants after the completion of usability survey and usability questionnaire. Accessibility questionnaire consists of eleven questions including Yes/No and multiple-choice questions for both non-disabled and visually impaired participants. The questionnaire for non-disabled participants are designed to understand how accessible the emergency websites in terms of forms are, search tool, website load speed, links, style, texts and so on. Likewise, accessibility questionnaire for visually impaired participants are designed on the basis of the navigation of Screen reader. The questions about title, heading, search option, Alt Tags, forms, etc of the webpages were asked with the use of screen reader tool.

4.7.1. Non-Disabled Participants

Q1: Is the website easy for the normal users?

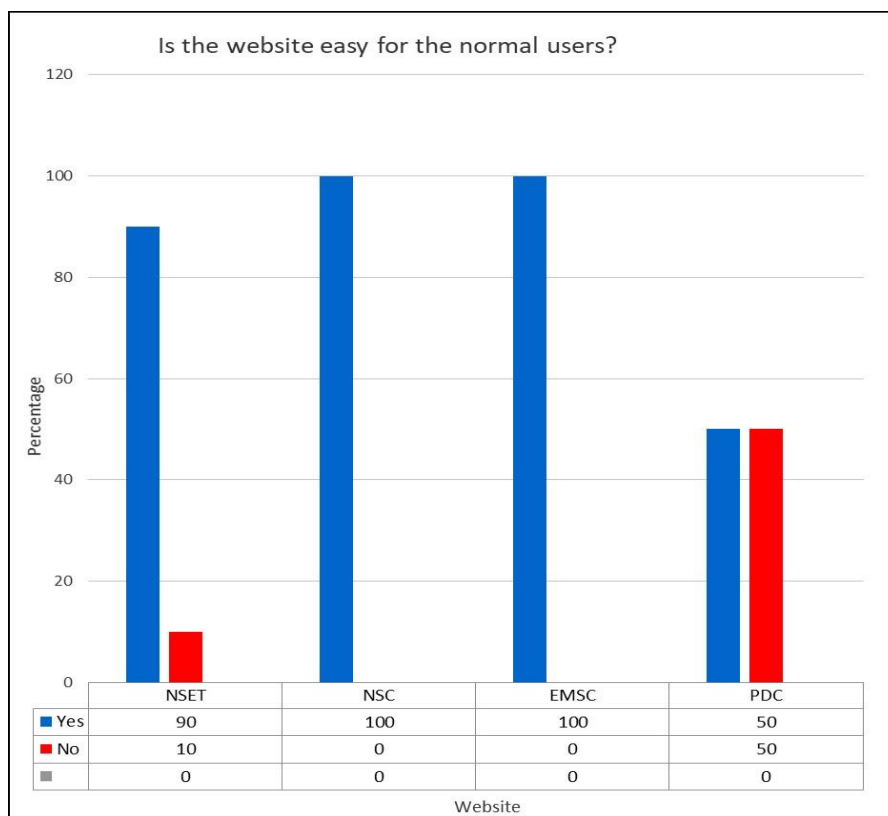


Figure 4-21 Results showing website easy to use for normal user.

From the figure above, 90% of the participants found NSET’s website easy to use while 10% did not find easy to use. All the participants found NSC and EMSC easy to use while 50% of the participants found PDC difficult to use and 50% found easy to use respectively.

Q2: Is the website load speed reasonable?

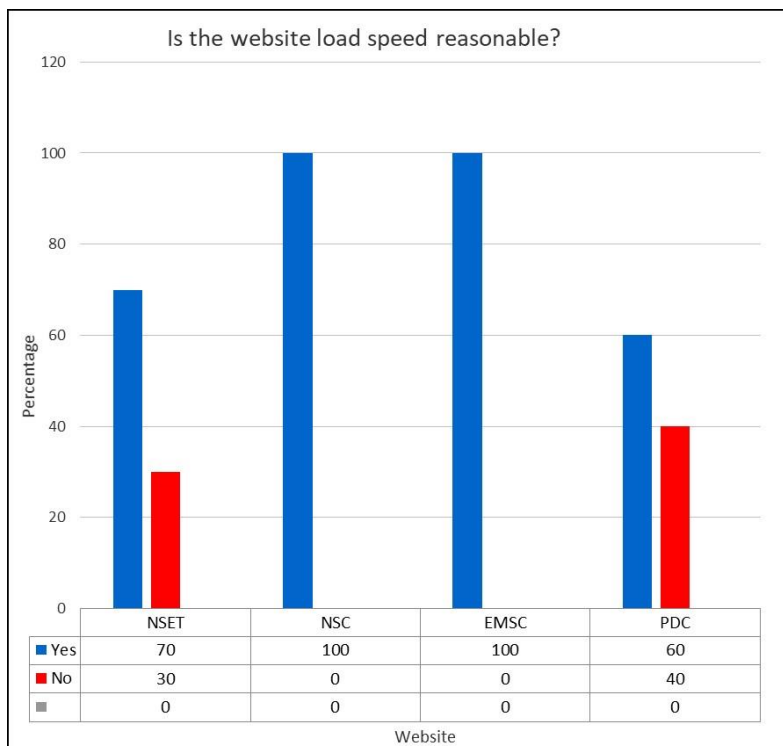


Figure 4-22 Results presenting website load speed statistics

When asked about the website load speed on the browser for NSET, 70% of the participant found the load speed reasonable while 30% of the participants had trouble loading the website. Likewise, 100% participant found the website load speed reasonable for both NSC and EMSC respectively. Similarly, 60% of the participants discovered website speed load reasonable while 40% had problem with the loading of Pacific Disaster Centre website.

Q3: Does the site works in different browsers such as (Firefox, Safari, IR and Chrome)?

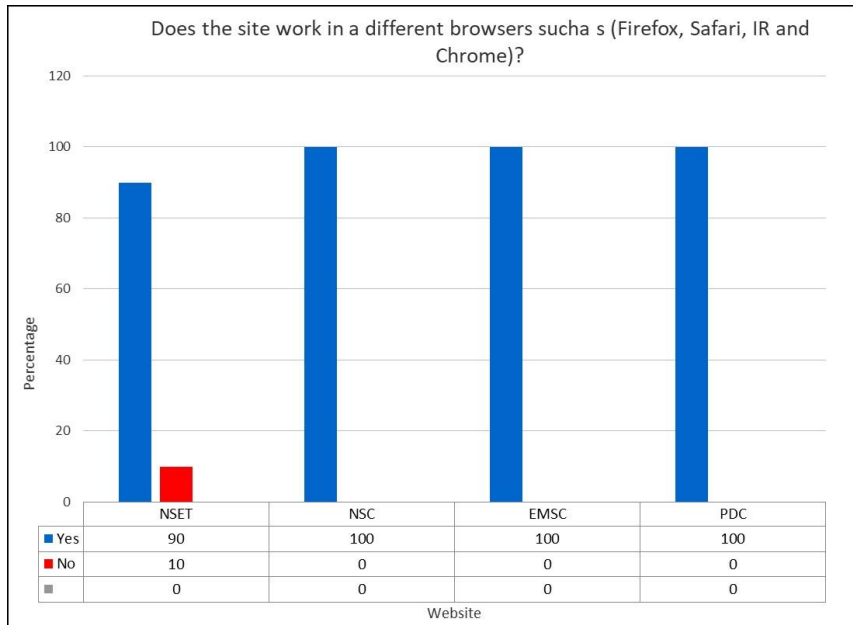


Figure 4-23 Results of websites working in different browsers.

From the figure above, all the participants found that NSC, EMSC and PDC worked well in every browser. But 10% of the participants had problem with NSET’s webpage running in some of the browsers.

Q4: Is there a visual appeal in the website?

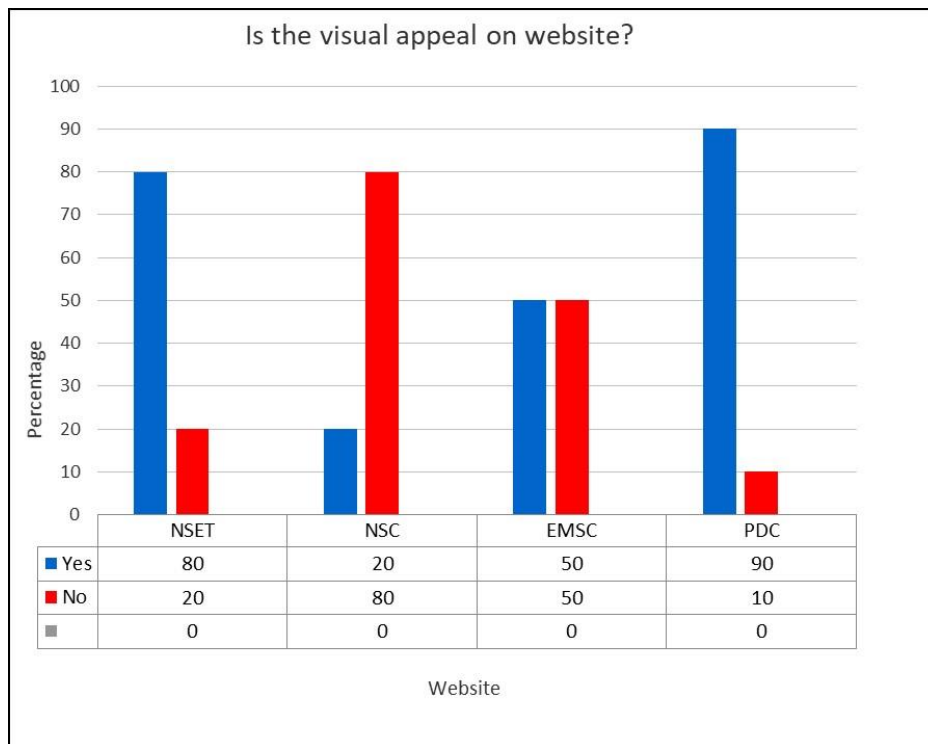


Figure 4-24 Results of visual appeals on the websites

Visual appeal in the websites are important factor. Visual appeal of the website is its color, shape, pictures, fonts, white space and so on. A web designer should be careful while inserting the visual appeals. Attractive visual appeal may help people to perceive quickly but creating many visualizing elements such as picture, videos overlapped in a text creates problem to the users while using the website.

From the figure above, 80% of the participants discovered visual appeal in the NSET’s website where 20% of the participants did not faced the problem of visual appeal. Likewise, 20% of the participant found that there is a visual appeal on NSC’s websites where 80% did not discovered any visual appeals on the NSC’s website.

50% of the participants discovered visual appeal on the EMSC’s website where only 10% discovered visual appeal on PDC’s website.

Q5: Does style (text-to-background contrast, font size, etc) meets the desired styles in the website?

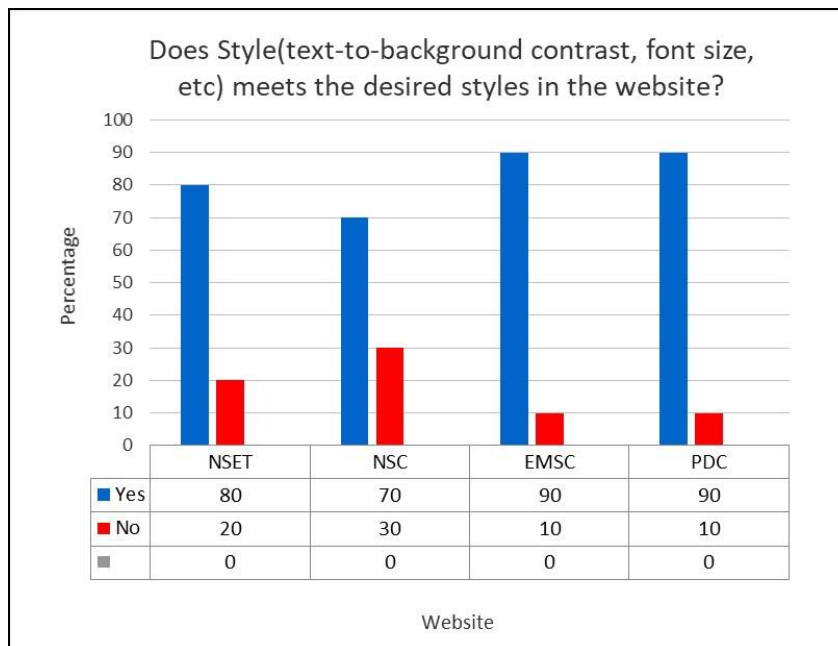


Figure 4-25 Results presenting the desired styles on the websites

Text-to-background, font size is the essential parts of the website. While designing the website, its font size, text and background contrast should be designed properly. These features will help the people with color blindness can perceive the information properly.

From the figure above, 80% of the participants found the styles in NSC’s website meet the desired styles of the websites but 20% found the difficulties with the text-to-background contrast and font size in the website.

70% of the participants discovered that NSC’s website meet desired style but 30% of the participants found the difficulties with the text-to-background contrast and font size in the website.

Similarly, 90% of the participant found EMSC and PDC’s websites are okay with the desired style but 10% of the participants discovered the difficulties with the text-to-background contrast and font size in both websites respectively.

Q6: Is text simple, clear and concise?

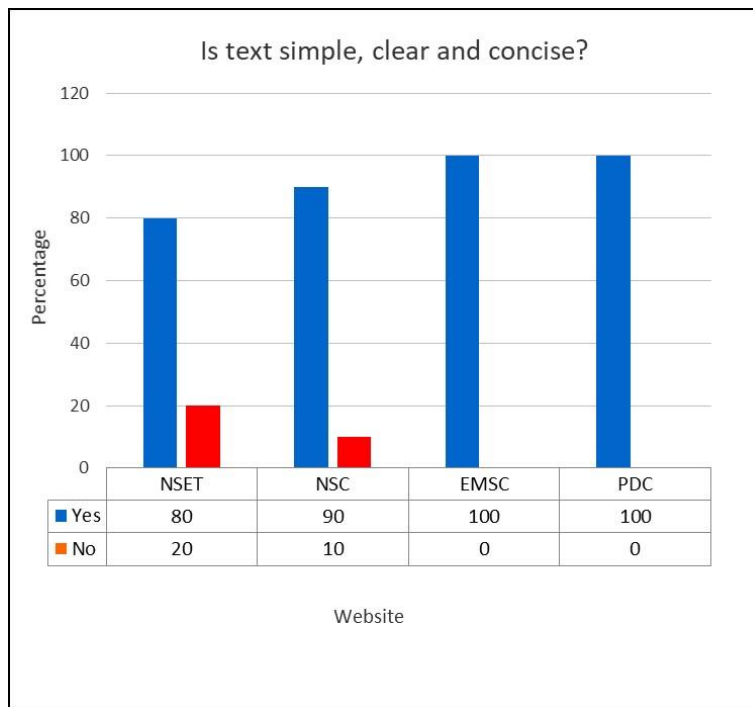


Figure 4-26 Results for simple, clear and concise text in the websites

A website should be designed in such a way that it should be able to communicate effectively with the users or visitors. By providing the texts with simple, clear and concise manner, a user can perceive the information quickly and effectively.

The above figure discovers that the 80% of the participants found the website has simple, clear and concise texts defining the website content but 20% thought that texts in the website are unclear. Likewise, all the participants found that there is a simple, clear and concise texts in the EMSC and PDC’s webpages.

Similarly, 90% of the participants discovered simple, clear and concise texts in NSC’s website where 10% of the participant were not satisfied with the organization of the texts in the website.

Q7: Are links provided on the website appropriate?

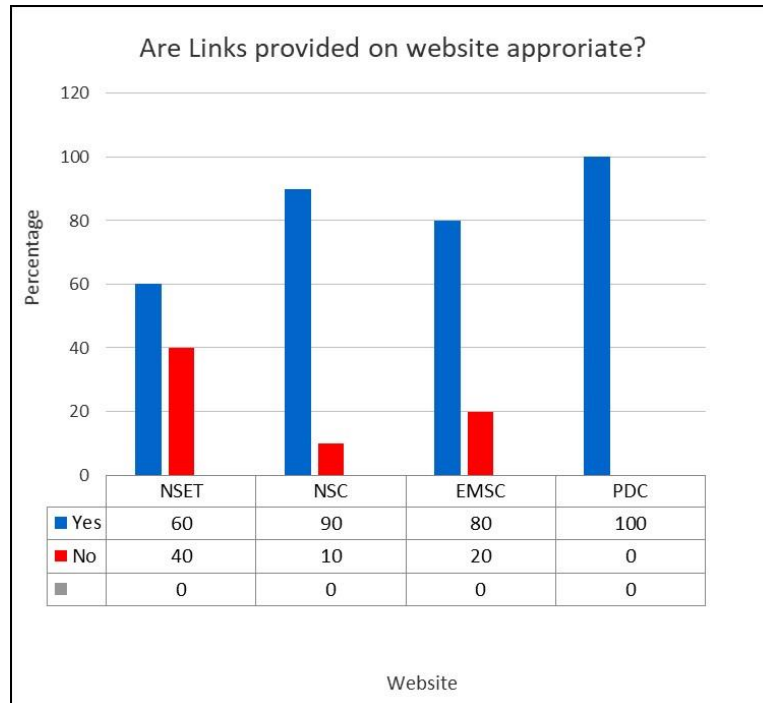


Figure 4-27 . Results presenting appropriate links on the website

Links in the websites are another essential element. Links acts as a transporter to navigate users from on page to another within the same website or view related documents. Sometimes, the links provided in the website guides you to another API such as Google. This means users will be in confusion with too many suggestions for the one link in Google.

From the above figure, 60% participants found that the link in the NSET’s website are appropriate whereas 40% did not found the link was appropriate.

In the NSC’s website, 90% of the participants found the link in the website was appropriate while 10% thought that the link wasn’t appropriate in the website. Likewise, 80% of the participants discovered the link in EMSC’s website were appropriate but 20% found the link were not appropriate in the website.

Similarly, all the participants found the link in PDC’s website guided them to their desired location where they wanted to navigate.

Q8: Did the links on the webpage guides you to the desired location on which you wanted to access?

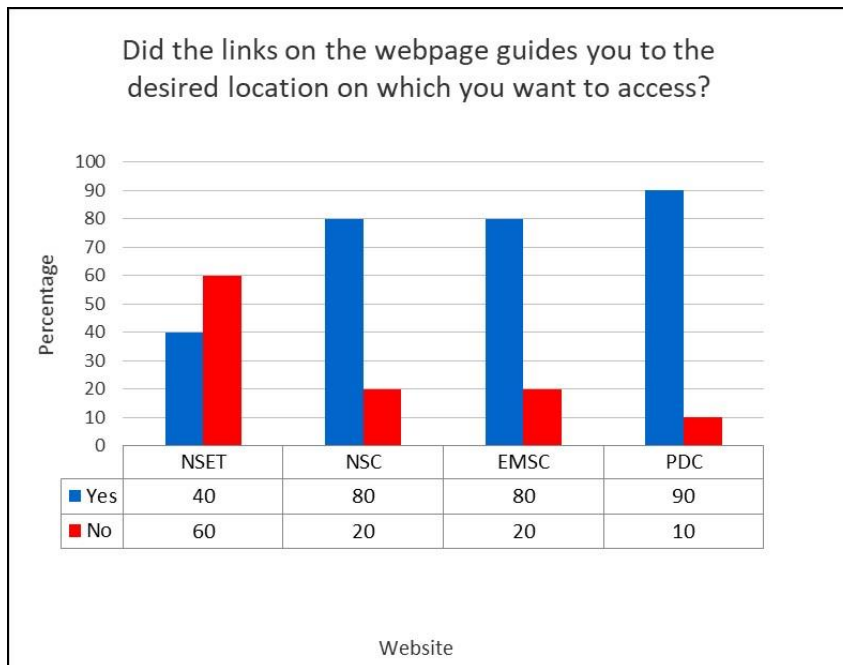


Figure 4-28 Results presenting the links in websites guiding to the desired location

From the above figure, 40% participants found that the link in the NSET’s website have guided them to their desired location whereas 60% did not found the link was not able to guide them to the desired location.

In the NSC’s website, 80% of the participants found the link in the website guided them to their desired location while 20% thought that the link in the website were not guided to the desired location. Likewise, 80% of the participants discovered the link in EMSC’s website guided them to their desired location but 20% found the link was not able to guide them to their desire location.

Similarly, 90% of the participants found the link in PDC’s website guided them to their desired location where they wanted to navigate but 10% did not found the link was able to guide them to their desired location.

Q9: Is the search tool of the website effective to retrieve the relevant information?

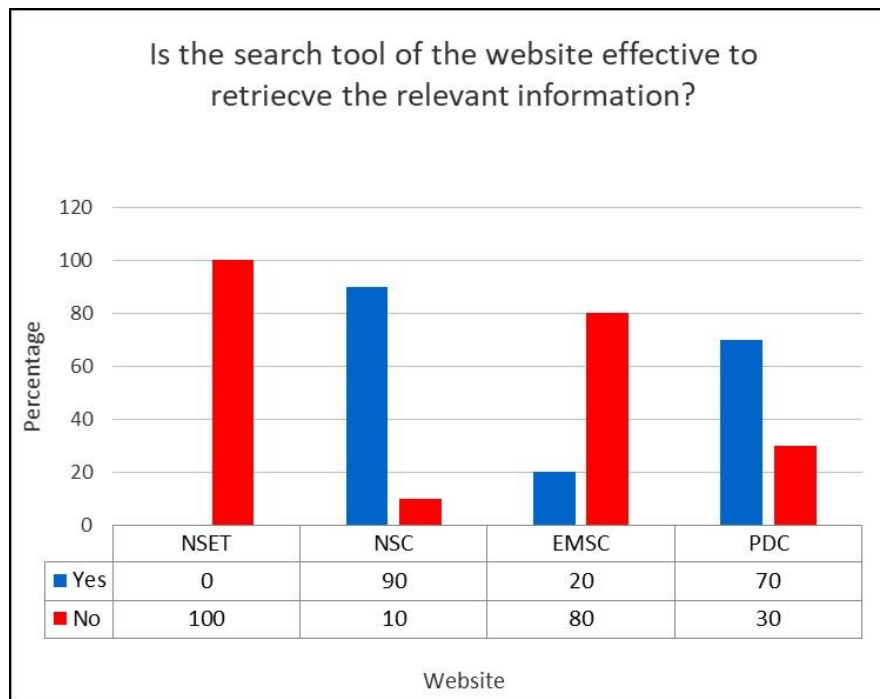


Figure 4-29 Results presenting effectiveness of search tool

A search tool is an effective tool in a website that helps a user to a better user experience and reduces the barrier for the users to reach their destination. A search tool is navigational and informational. It helps the users to navigate throughout the website easily and helps to find or acquire the information quickly.

In the given figure above, none of the participants found search tool effective in NSET’s website. 90% of the participants found the NSC’s search tool is effective and navigate them to retrieve the relevant information whereas 10% denied that search tool is not effective. Likewise, 20% of the participants were able to find the search tool effective in EMSC’s website where 80% were not able to find the search tool in the website is effective to retrieve the relevant information.

Moreover, 70% of the participants discovered search tool of PDC is relevant whereas 30% of them found search tool was not effective to retrieve the relevant information.

Q10: Did you find any form in the webpage?

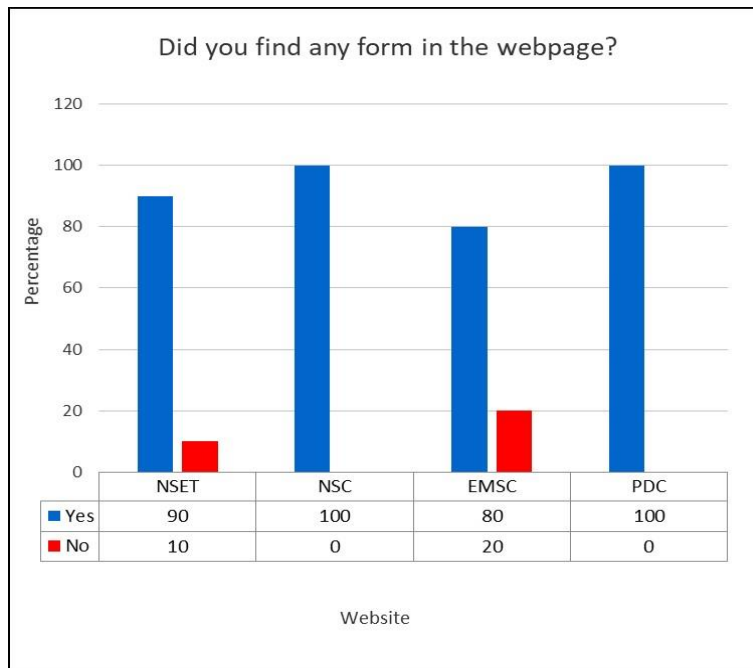


Figure 4-30 Results presenting the form in a webpage

A form is an important section in any website. A form should be designed in a such a way that it should be accessible considering diverse users. A form should be well labeled with description so that users will no find confusing while filling up the form.

In the above figure, 90% of the participants found the form in NSET’s website whereas 10% did not find the form. Likewise, 100% of the participants were able to find the form in NSC and PDC’s website. Similarly, 80% of the participants found the form in EMSC’s website but 20% were not able to find the form in the website.

Q11: If yes, did you find the form accessible?

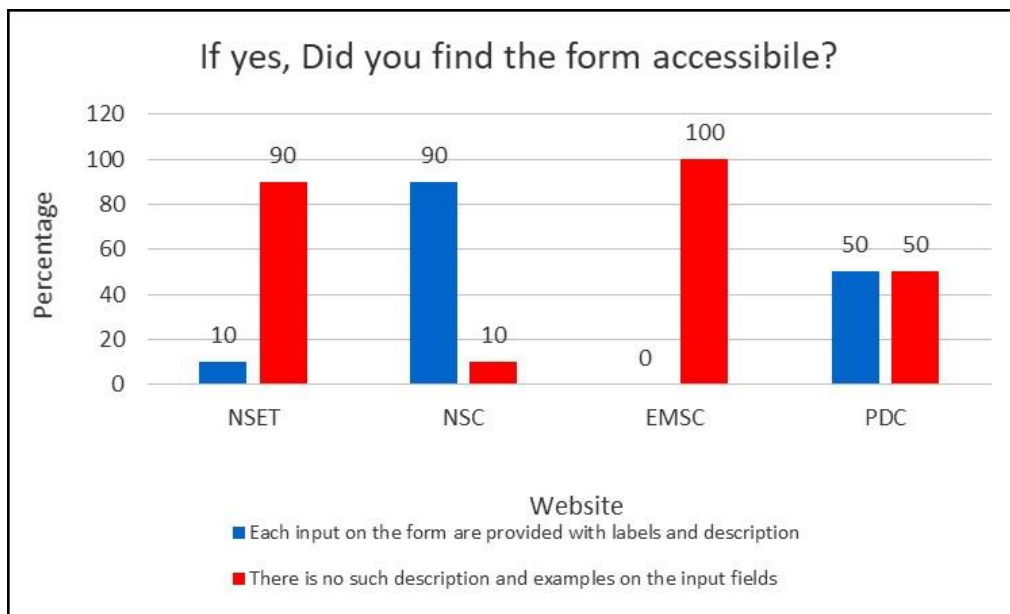


Figure 4-31 Results showing the accessibility of a form in websites

The above figure shows the statistics to what level a form in a website is accessible. 90% of the participants discovered that there is no such description and examples in the input field of the NSET’s website. Likewise, none of the participants discovered the description and examples on the input field of EMSC’s website.

90% of the participants found that each input on the form are provided with the labels and descriptions in NSC’s webpage. Similarly, half of the participant discovered that each input on the form are provided with the labels and descriptions and other half of the participants discovered that there is no such description and examples in the input field of PDC.

4.7.2. Visually Impaired Participants

During the data collection session, visually impaired participants were given the accessibility questionnaire to evaluate the level of accessibility for all of the four emergency management websites by using screen reader tool. The accessibility questionnaire consists of eleven questions all together.

Q3: Did you find any title that briefly describes the content of the webpage?

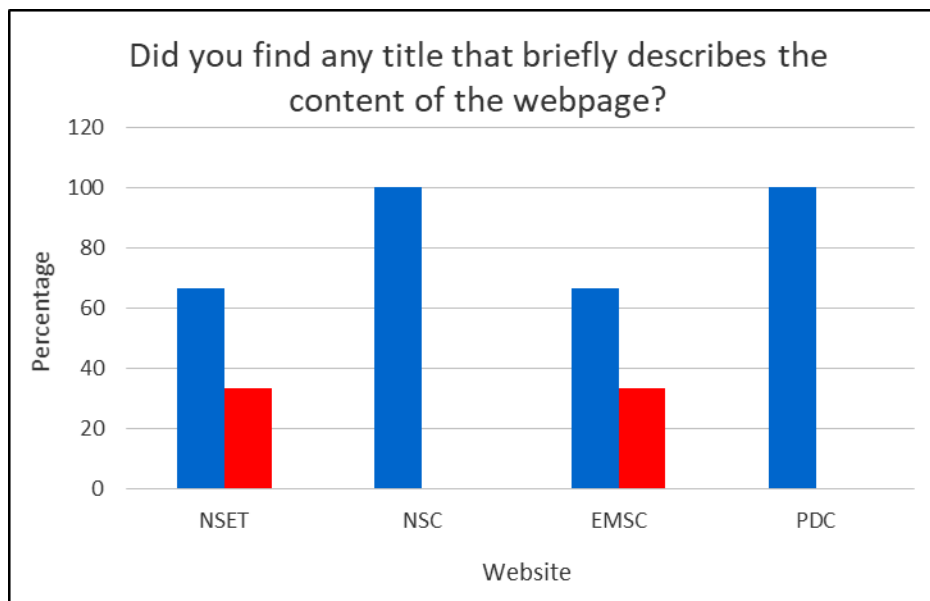


Figure 4-32 Overall statistics presenting the title that briefly describes the content of webpage

The title of the webpage always defines the content and purpose. Providing concise and unique webpage title helps to understand the content and purpose of the websites for the users using screen reader tools.

All the participant of NSC and PDC's website in the above figure discovered that these websites title briefly described the content of the website while using screen reader. Likewise, 66.7% of NSET and EMSC's website, the participants found that screen reader described the title but 33.3% on the both websites did not found the title that described the content of the webpage

Q4: Is the heading user-friendly and descriptive?

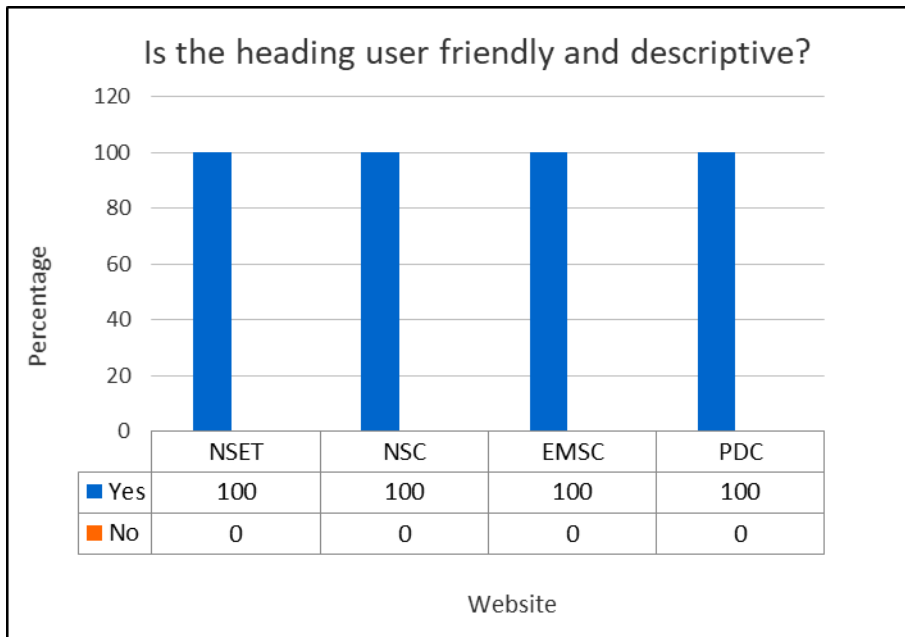


Figure 4-33 Result presenting the heading user friendly and descriptive

The heading of any webpage should be user-friendly that means navigable to each heading and should be descriptive. Some of the heading consists of the drop-down list which should be descriptive as well. Sometimes, drop-down list is designed in such a way that screen reader cannot describe the list, they just read out as “blank link or field”. Thus, heading should be user-friendly and descriptive.

From the figure above, all of the participant discovered that the heading are user friendly as well as descriptive in all of the websites.

Q5: Does the website have any missing heading?

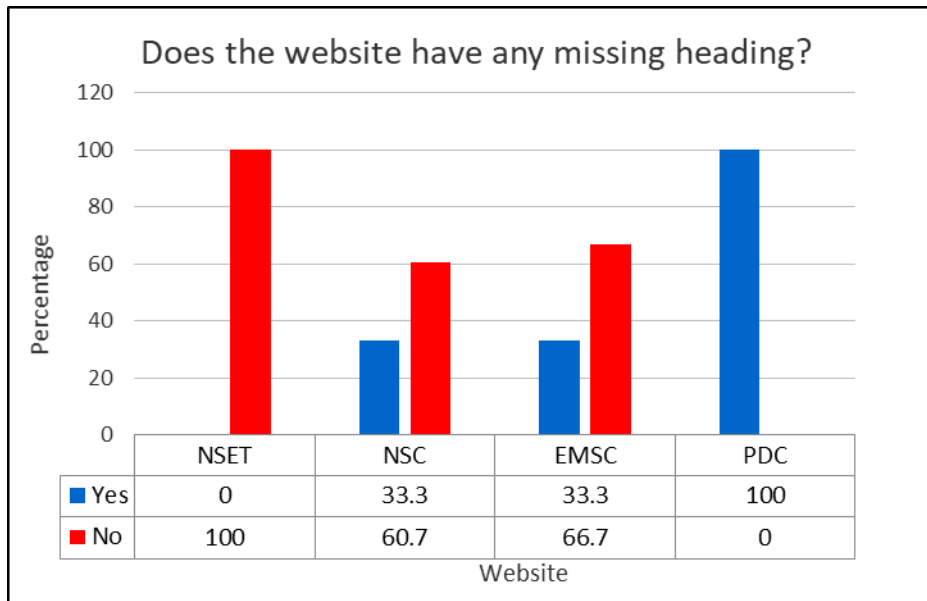


Figure 4-34 Results presenting if the website has missing heading or not?

In the given figure above, none of the participant found any missing heading in NSC’s website whereas 33.3% participant while navigating NSET and EMSC’s website found the missing heading respectively. Likewise, all the participants discovered missing heading in PDC’s website.

Q6: Is the search tool of the website effective to retrieve the relevant information?

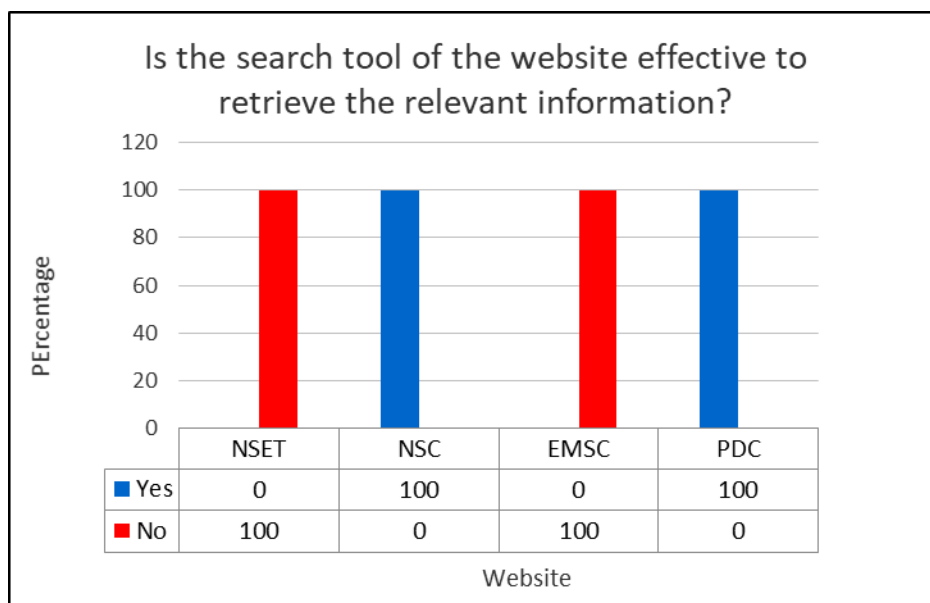


Figure 4-35 Results presenting effectiveness of search tool in the website

A search tool is an effective tool in a website that helps a user to a better user experience and reduces the barrier for the users to reach their destination. A search tool is navigational and informational. It helps the users to navigate throughout the website easily and helps to find or acquire the information quickly. For the users using screen reader tool, a search tool should be well labeled so that screen reader can read the search field. Search tool should be able to find out the content and information inside their own API.

From the figure above 100% of the participants while navigating NSC’s and PDC’s search option using screen reader found that it is effective to retrieve the relevant information. Likewise, none of the participants while navigating NSET and EMSC’s website discovered that the search tool on the website is not relevant to acquire the information.

Q7: Did images on the website have appropriate ALT tags (helpful to read by the screen readers)? If yes, did they provide meaningful information?

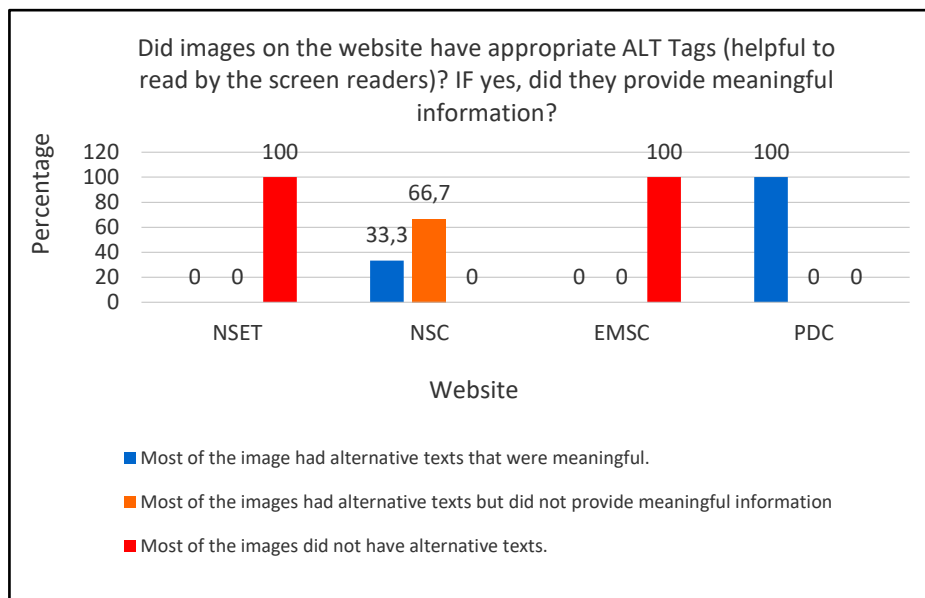


Figure 4-36 Results presenting the alt tags in image

ALT tags in the images are important while designing the website. Basically, ALT tags benefits visually impaired users when they are navigating the website through screen reader tool. ALT tags are used to describe what the image is representing.

From the figure above, none of the participants found the image that have alternative texts while navigating with screen reader in NSC and EMSC’s website respectively. 66.7% of the participants noted that most of the images had alternative texts but did not provide meaningful information where 33.3% of the participant found the image had alternative texts that were meaningful in NSET’s

website. Similarly, all the participants discovered that most of the image had alternative texts that were meaningful in PDC’s website.

Q8: Did the keyboard support do the navigation by using the tab key with your current screen reader tool?

The visually impaired users usually use TAB key to navigate around the website. The TAB key in the keyboard helps to navigate the users towards buttons, links, field for input text and so on.

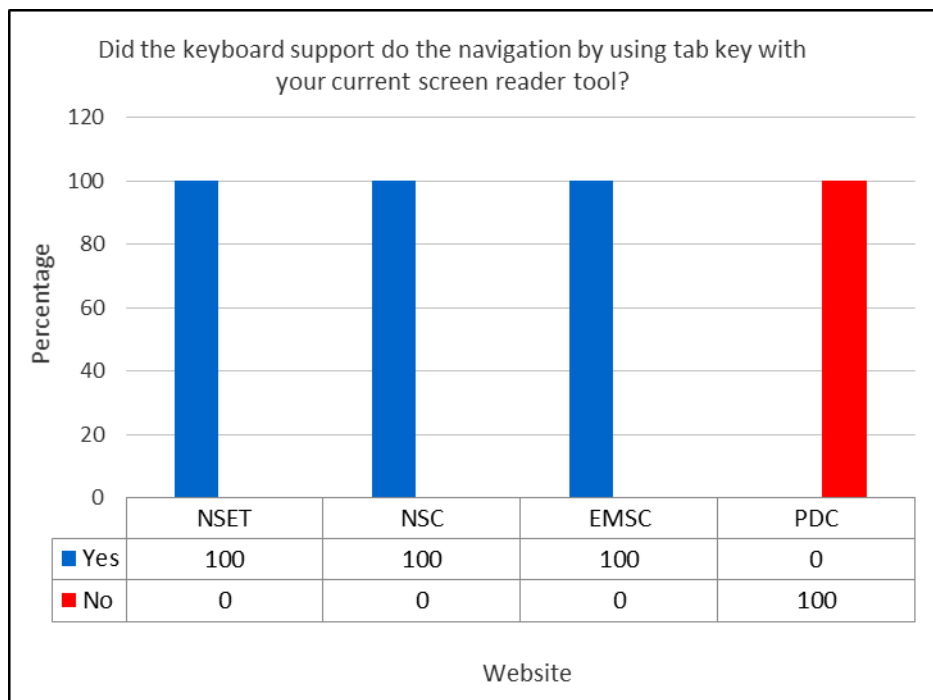


Figure 4-37 Result presenting keyboard support navigation with screen reader tool

We asked about, if the keyboard support the navigation by using tab key with the screen reader. 100% found that keyboard support the navigation by using tab key with the screen reader in all of the websites except PDC.

Q9: Did you find any form on the page?

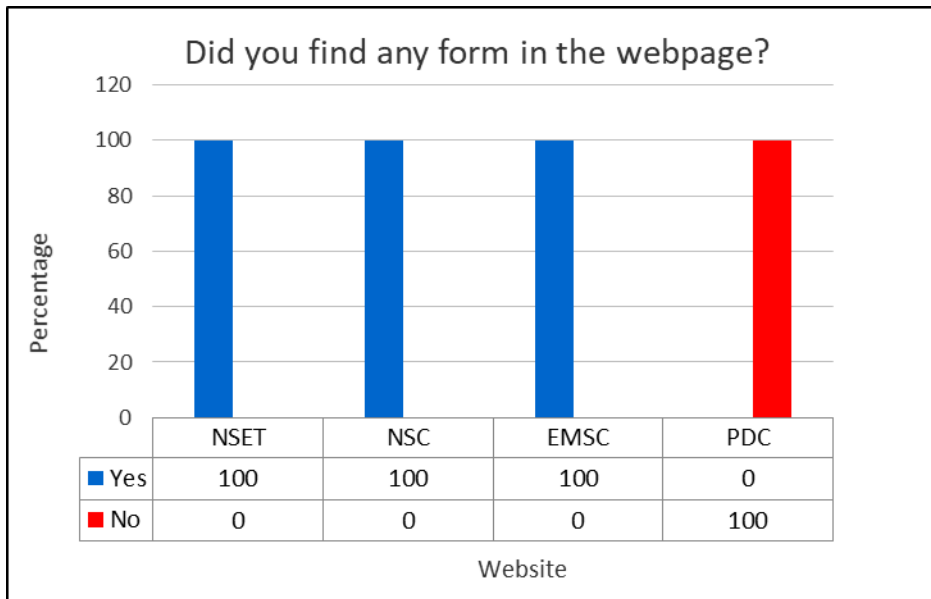


Figure 4-38 Results presenting the form in the webpage

A form in a website helps to provide the user interaction. Form can be commonly used for feedback, login, registering, commenting and so on. When the forms are accessible, it can be usable by everyone. In the case of visually impaired users, a form in each input field should be labeled properly and should be descriptive so that screen reader reads out loud and the users can perceive the information quickly and effectively.

From the given figure above, 100% of the participants found the form in all the websites except PDC’s website.

Q10: Was the form accessible to the keyboard while using it with a screen Reader?

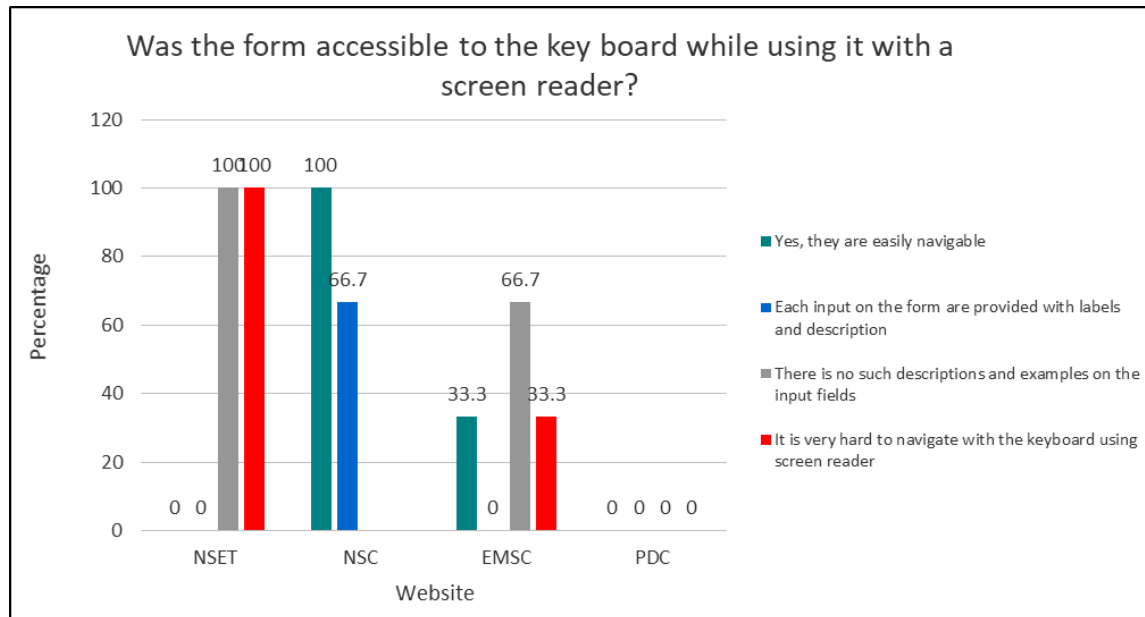


Figure 4-39 Overall results for accessible form while using screen reader

The above figure demonstrates that, 100% of the participant found that there is no such descriptions and examples on the input fields of the form as well as it is very hard to navigate with keyboard using the screen reader tool in NSET’s website.

In case of NSC’s website, 100% of the participants discovered that the form is easily navigable and 66.7% of the same participants also found that each input on the form are provided with labels and descriptions.

Likewise, 33.3% of the participants noted that the form was easily navigable, 66.7% found that there is no such descriptions and examples on the input fields where 33.3% of the participants also discovered that it is very hard to navigate with the keyboard using screen reader tool in the EMSC’s website.

Similarly, none of the participants found any type of form in Question number 9 above. Thus, the outcome for the form being accessible on PDC’s website is null.

Q11: Did you find any error while submitting the form?

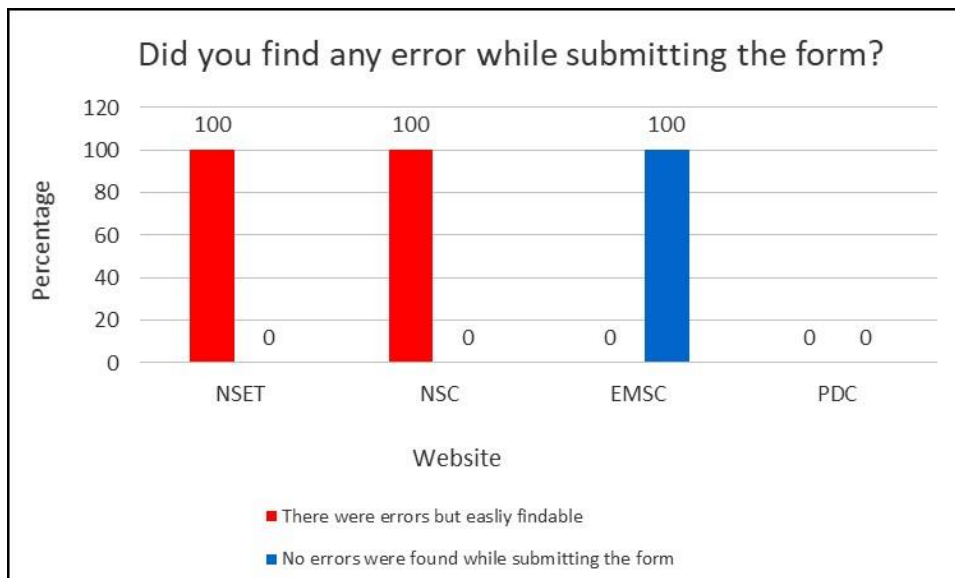


Figure 4-40 Results presenting the submission of from

While using an emergency website, a user should be able to the submit form which he/she had filled. Emergency can occur at anytime and anywhere. Users may want to provide the feedback about the emergency situation which they have felt or if they want to provide some feedback through the form. The form must be submittal.

From the figure above, we can observe that, 100% of the participants while using NSET and NSC's website figured out that there were errors while submitting the form where 100% of the participants found that there were no errors while submitting the form in EMSC's website.

Similarly, form was not found by any of the participants in PDC's website, the percentage of the error while submitting the form is null.

4.8. Results of Qualitative Data analysis

An accessible and user-friendly website holds tremendous potential to increase the inclusion of the person with disabilities or without disabilities. However, to assure that websites are accessible and usable, a web developer or a designer should follow the accessibility guidelines, universal design and its principle.

We discussed about the quantitative data analysis above resulting, usability of the website among all the four emergency management websites. We also discussed about the accessibility issues that were found among all the four emergency management websites. In the quantitative analysis, we found the results only in statistical and percentile form. The main aim of qualitative data analysis is to plot the unstructured data that was found during data collection either in texts or other artifacts into a detailed description about the important aspects of the situation or a problem (Lazar, Feng, & Hochheiser, 2017). The description of the data can be of any form such as textual narratives, graphical representation and so on.

We have designed the questionnaire in such a way that, it also provides descriptive answers and follows qualitative method analysis.

The findings were based on the objectives of the study mentioned below. Three major area were focused which are:

- a. To investigate the accessibility and usability issues and barriers faced by (define type of users- visually impaired and non-disabled) while using the website.
- b. To identify the main cause of challenges faced.
- c. To explore the possible potential solutions in making accessibility, usability and inclusive websites for everyone.

4.8.1. Content Analysis

We have used content analysis to interpret the qualitative data for our research. According to (Stemler, 2001), content analysis is a systematic technique for compressing many words of text into fewer content categories based on the explicit rules of coding. It will be a useful technique for us to describe the views of focused individual or participants.

The purpose of the content analysis on this research aims to illustrate the use of web-based content and to describe the related issues faced by the users. We used content analysis to investigate, examine and provide the results on Research Question (RQ) 2. We investigated about, which type of accessibility and usability barriers were faced by the people of Nepal while using earthquake-related emergency management websites for preparedness and during an earthquake? To answer the question, we conducted semi-structured and online interview by providing online questionnaire to the participants.

We asked two sets of questions based on accessibility and usability barriers which participants have faced during the user testing of earthquake-related emergency management websites. We also asked about reasons of occurrence as well as the improvement that can be made to make the websites more accessible and usable by everyone. Likewise, to code the data that were collected were coded in NVIVO 12 application in MAC OS.

Similarly, content analysis in this research helped us to understand the intentions of the participants, identifying difference in communications in different contexts, identifying the biasness of the communication, analyzing the flow of communication and responses while evaluating the emergency management websites.

4.9. National Society for Earthquake Technology

To begin with, Ten Non-Disabled participants and Six visually impaired participants were recruited for the interview purpose.

4.9.1. Non-Disabled Participants

Below table illustrates the coding of the data that was collected in descriptive form from the participants.

CODES (Non-disabled Participants)	CODES (Visually Impaired Participants)	CATEGORIES	GLOBAL THEMES
-Search tab is not appropriate. -Search bar link are redirected to another website.	-Search option is not appropriate. -Search option directs to google.	-Inappropriate search engine.	Accessibility issues and barriers.
-Information were not delivered properly. -Information were conveyed which is unnecessary. -Content were not managed properly. -Difficult to find information.	-Promotional information rather than real information.	-Inappropriateness in conveyance of information.	
	-Links and headings are easy to find but tough to open. -Since they are not supportive with keyboard.	-Issues on keyboard navigation while using screen reader tool.	
	-It does not respond to picture description.	-Absence of Text Alternatives in picture.	
-Designs are too old. -Layout of the website were not impressive. -Doesn't feel comfortable while using it. -Use of old design.		-Perceived need of updated technology.	

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<ul style="list-style-type: none"> -Forms weren't labeled properly. -Forms were not accessible, weren't updated with latest technology. -No reliable information while filling the form. 	<ul style="list-style-type: none"> -Forms are not accessible. -Screen reader responded blank field. 	<ul style="list-style-type: none"> -Inconvenient design of form. 	
<ul style="list-style-type: none"> -Some contents in text are too small for reading. -Font size was mostly variance. -Fonts were inappropriate. 		<ul style="list-style-type: none"> -Issues with texts and font size. 	
<ul style="list-style-type: none"> -Lack of knowledge about the accessibility. -Developer should focus on the current technological development and accessibility issues. -Lack of knowledge of Universal Design and its principles. -Lack of the knowledge of the accessibility and universal design. 	<ul style="list-style-type: none"> -Website is built without thinking about screen reader users. -Concern about all types of users. 	<ul style="list-style-type: none"> -Accessibility guidelines, universal design and its principle were not followed. 	<p>Reasons of occurrence of accessibility issues and barriers</p>
<ul style="list-style-type: none"> -Update is not made. -The website is not properly upgraded and maintained. 		<ul style="list-style-type: none"> -Obsolete website. 	
<ul style="list-style-type: none"> -Notification about the recent earthquakes should be shown. -Remainder alert system should be added. -Notification via SMS should be sent to every people. -Alert information and online feedback. -Alert information in the landing page. -There must be alert system. 	<ul style="list-style-type: none"> -Developers should be aware for every user. -Lack of accessibility test. -Priority to screen reader users. 	<ul style="list-style-type: none"> -Enabling Reminder Alert System features. -Accessibility guidelines, universal design and its principle were not followed 	

-There should be the main option including the map.		-Addition of Interactive Map	Designing and sustaining functionality for better usage
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Table 4-27 Chart presenting codes, categories and global themes for National Society for Earthquake Technology (Non-Disabled and Visually impaired participants (NVIVO)).

Accessibility issues and barriers

People without disabilities may also face different challenges and hurdles while accessing the websites. Although, web accessibility guidelines mainly focus on the users with disability, but recent research have broadened that the inaccessibility of website also affects non-disabled users (Pascual, Ribera, Granollers, & Coiduras, 2014). (Petrie , Hamilton, & Neil, 2004) also identified accessibility issues related to visual design of the website affects non-disabled users (eg., Color contrast or visual structure). (López, Pascual, Menduiña, & Granollers, 2012), also discussed that there is a high level of uncertainty regarding accessibility level of the web pages and few of the webpages reach a high accessibility level. So, web content usability and accessibility need a special attention to improve the quality of the website.

The analysis of NSET’s website provided a clear view of inaccessibility in the website. Participants discovered various number of accessibility issues and barriers while using the website. All of the participants found the search engine of the website was inappropriate and guided them to the different API i.e Google. As a result, they were not able to search the reliable information that is needed during an earthquake inside the same website.

Some of the participants reported that the accessibility issues and barriers on search engine as:

“The search engine of any website should be able to redirect to its own websites content. This website search engine directed me to google search. Now, how I will be able to search the specific information? for instance, I want to search for preventive measures to be prepared during an earthquake. If the search engine directs me towards google, I will be getting a lot of links regarding preventive measures which is not reliable.”

Participation 005, Student

“Search bar link are redirected to another website which is disgusting and difficult to find the information”

Participation 006, Student

The homepage of the website mostly consisted of the promotional aids, their events what they have done, rather than the useful information such as earthquake information. As a result, few of the participant found website inappropriate in case of conveying information. Likewise, the website was not updated since 2012 and the design of the website was too old.

The 'Contact us' page of the website consisted a form, where a user can provide the feedback. During the navigation of the form, all of the participants found the form inaccessible in non-disabled users' point of view. Participants reported that the feedback form was not labeled properly and does not provide field descriptions.

Three male participants also revealed website's issues with the font and text size. They have found variance in text and font in the website and text were too small while reading the information in the website.

Some of them also reported as:

"Content are not managed so properly, lots of information are conveyed which is unnecessary of the most of the users, forms were not accessible, were not updated with latest technology, font size were mostly variance, the layout of the website were not impressive, does not feel comfortable while using it, lacks the major technical parts which were supposed to be in the context of emergency management."

Participation 001, Student/full time employed

Reasons of occurrence of accessibility issues and barriers

When asked about the major cause behind happening accessibility issues and barriers. Almost all the participants revealed the problem with the developer not following accessibility guidelines, universal design and its principle while designing the website.

Where some of the respondents reported this way:

"The developer of the websites should first follow the WCAG 2.0 guidelines. The content in the website should be well managed so that users can find the information quickly and effectively. Other

features such as forms, text and fonts, search engine should be made accessible to be usable and accessible by everyone in earthquake situation.”

Participation 001, Student/full time employed

“It is because of the lack of knowledge among the developers about the accessibility guidelines and universal design. Today, everyone is using technology and wants to take benefit from it. Even assistive technology is widely used by the users. A developer should be aware of each and every user before designing the websites.”

Participation 003, Student

Designing and sustaining functionality for better usage

(Hwang, Keates, Langdon, & Clarkson, 2003) discussed that a website can be made more interactive and usable when it is easy to learn, understand and use under context specific conditions.

We asked about the future improvement of the website’s usability that can be usable by everyone in case of an earthquake. Being an earthquake-related emergency management website, participant poured a lot of views about a website to be usable. They commented that the website should update information related to earthquake rather than promotional events and their own events what they have done. Website needs to focus on the homepage, layout and design, the information about the latest earthquake or previous earthquake with details should be provided in the landing page which NSET doesn’t have.

Similarly, the search engine of the website was not appropriate. All of the participants reported that the search engine should be reliable to retrieve the information from its own website. During an emergency, a user may be willing to use a search engine of the website to get quick and relevant information. Overall, participants also provided their views about adding the reminder alert system via SMS in the website. The reminder alert system will help people to get notified about an earthquake and makes them prepared during the disaster.

4.9.2. Visually Impaired Participants

Nevertheless, the significance of web accessibility remains partially or completely inaccessible to certain sectors of the population still at present context. This is due to numerous reasons, including web creators’ little or no proficiency in accessibility and the lack of accurate data and knowledge. Web accessibility stands for making a website navigable and manageable by various user categories especially those who are differently able or be visually impaired when interacting with the web via

electronic devices. Web accessibility actually necessitates overcoming the most disabilities that limit an internet access. It means that people with disabilities or differently able users can use, perceive, understand, navigate, and interact with the web (Martínez, Andrés , & García, 2014).

With regard to this context, out of the six visually impaired participants, three visually impaired participants were interviewed online via Skype and following finding and results were obtained.

Accessibility Issues and Barriers

People with disabilities may face various kind of accessibility issues and barriers while using the websites. A visually impaired user may face difficulties to navigate the website with a screen reader tool if the website is not accessible. For example, image that doesn't contain ALT tag will not provide image description via screen reader to the user, form which is not labeled will restricts visually impaired users to navigate around the form. These types of inaccessibility in the websites limits disabled users to access the important features available in websites.

Three visually impaired participants were interviewed to know about the accessibility issues and barriers that were faced by them during the accessibility and usability task of NEST. All of them found that headings were descriptive but the heading that consisted drop-down list were not descriptive.

Some of them reported as:

“The drop-down menu is not responsive. Screen Reader read out as blank field while I was trying to navigate”

Participation 003, Student

All of the participants discovered that picture in the webpage did not provided any kind of alternative text, inappropriate search engine and inaccessible design of form. A form plays an important role for screen reader users. A screen reader reads and navigates only when the form is well labeled while designing. Inaccessible forms deny visually impaired users to fill out the form if they want to register, login or provide feedback during an earthquake situation. One of the participants also found the website conveys a lot of promotional aids rather than important information related to earthquake in homepage of the website.

Reason of occurrence of issues and barriers

According to the participants on occurrence of accessibility issues and barriers, all of them reported that website was designed without concerning screen reader users. The major issues mentioned were links and headings, ALT tag missing, inappropriate search engine, irrelevant information on homepage, in accessible form and so on. Being an earthquake-related emergency management

website, designers and developers should be concerned towards diverse users before designing the websites.

Designing and sustaining functionality for better usage

When asked about the future improvement of the website’s accessibility and usability, everyone commented that while designing the website, a designer should be able to follow all of the accessibility guidelines, universal design and its principle. They also added that, important features that is needed during an emergency situation must be added. Doing this, everyone will be able to use the website efficiently and effectively without any hurdle.

4.10. National Seismological Centre (NSC)

To begin with Ten Non-Disabled participants and Six visually impaired participants were recruited for the interview purpose.

4.10.1. Non-Disabled Participants

Below table illustrates the coding of the data that was collected in descriptive form from the non-disabled participants.

CODE	CODES	CATEGORIES	GLOBAL THEMES
Non-disabled Participants	Visually impaired participants		
-Feedback forms weren’t submittal. -Feedback form cannot be submitted.	-The feedback form was also not submitted easily. -The feedback forms were not submitting.	-Problem in submission of Feedback form	Accessibility issues and barriers
	-There was not much image description.	-Absence of Text Alternatives in picture.	
-Color contrast was sometimes not correct.		-Issues with color contrast	
-Preparedness tips are to be added in the website. -Preventive measures should be included.		-Preparedness tips were not present.	

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<p>-Maps are not loaded on browsers.</p> <p>-Problem in Map.</p> <p>-Map is not accessible.</p>		<p>-Problem in loading map.</p>	
<p>-Lack of use of the accessibility guidelines.</p> <p>-Lack of proper knowledge of WCAG and Universal Designing & its principle.</p> <p>-Lack of consideration of accessibility guidelines.</p>	<p>-The website developer were not conscious regarding the universal accessibility standard system.</p> <p>-Develop the website by taking the differently able people in concern.</p>	<p>-Accessibility guidelines, universal design and its principle were not followed.</p>	<p>Reasons of occurrence of accessibility issues</p>
<p>-Reminder alert feature in website make more useful to user.</p> <p>-Reminder alerts should be included in the website.</p> <p>-Remainder alert system to cellphone should be added.</p>	<p>-Reminder alerts.</p> <p>-Reminder alerts system should be added.</p>	<p>-Enabling Reminder alert features.</p>	
<p>-The feedback form should be easily submitted.</p>		<p>-Enabling feedback form submission.</p>	<p>Designing and sustaining functionality for better usage.</p>
<p>-The information regarding earthquake preparedness tips.</p> <p>-There are no preparedness tips for earthquake.</p>	<p>-The website has no information regarding earthquake preparedness tips.</p>	<p>-Addition of preparedness tips.</p>	
<p>-Color contrast can be made much better.</p>	<p>-The developer should develop the website by considering all the people.</p>	<p>-Low color contrast.</p> <p>-Acknowledge diverse users while designing website.</p>	

Table 4-28 Chart presenting codes, categories and global themes for NSC (Non-Disabled and visually impaired Participants (NVIVO)).

Accessibility issues and barriers

10 non-disabled participants were interviewed regarding accessibility issues and barriers which they have faced during the task that was given. Few of the participant found that the color contrast of the website is not suitable. Some of them reported that:

“Instead of using dark red and black color with background and font in the headings, they could have chosen other color combination that makes easy for sighted users to perceive.”

Participant 008, Student

All of the participants also reported that the map in the website that indicates affected areas was not loaded properly. Participant were asked to open the website in other browsers, same problem with the map was detected.

A feedback form is an important part of earthquake-related emergency management website where users can provide their views and feedback. In NSC’s ‘Contact Us’ page, all of the participants reported that they weren’t able to submit the feedback form. Similarly, people seek for a preparedness information and techniques to make them safe during an earthquake situation. All of the participants discovered that, there is no such preparedness tips and techniques available in the website. One of them reported as:

“Well, in an earthquake, we wanted to be safe and take care of our family. We want to know about the safety measures when earthquake really arises. So, preventive measures are necessary to be included in the website from which we will be able to know safety measures during an earthquake and make ourselves safe.”

Participant 006, Student

Reasons of occurrence of issues and barriers

Three of the participants were asked about the reasons of occurrence of above accessibility issues and barriers. Majority stated that, developer was not able to follow the WCAG accessibility guidelines, universal design and its principle. One of them reported as:

“Overall, website is good and provides reliable information about the earthquakes. Some of the issues such as loading the map, feedback submission, color contrast can be made better. To do this a developer should follow accessibility guideline defined by WCAG 2.0”

Participant 008, Student

Designing and sustaining functionality for better usage

When asked about the improvement of website’s usability for future, all of the participant commented that adding reminder alert system features will make this website usable for everyone. Likewise, few participants also reported that feedback form should be submittal and addition of preparedness tips and measures will help users to perceive safety information from the website. One of the participants also reported that the color contrast of the website should be changed to its normal background and text color.

Some of them reported as:

“Being a Nepal Government’s earthquake related website, they should be able to add the reminder alert features. Government of a country has all of the contact directory or database with them. They should be able to send alert system via SMS to the users to make them prepared during an earthquake. By doing this a lot of lives can be saved.”

Participation 001, Student/full time employed

4.10.2. Visually Impaired Participants

Out of the six visually impaired participants, three of the participants were interviewed via Skype. The following findings and results were obtained.

Accessibility issues and barriers

All the participants reported on the pictures missing alternative text that made them difficult to navigate images. Likewise, they also discovered error in submission of the feedback form in ‘Contact US’ page of NSC. One of the participants reported as:

“It will be very difficult for the screen reader users to navigate around the website if the alternative text on images or links are not provided. People want to provide their feedback regarding the

usability and accessibility issues as well as features that is needed to be updated through feedback form which cannot be submitted.”

Participant 002, Student

When asked about the reasons behind occurrence of accessibility issue and barrier, everyone reported, developers are not paying attention towards accessibility guidelines, universal design and its principle which make difficulties for the people with disabilities to access the website in an earthquake situation.

Designing and sustaining functionality for better usage

All the participants reported same kind of website’s usability for future improvement compared to non-disabled participants. The issues such as reminder alert feature, preparedness tips should be updated. They also added that developers should be aware of the accessibility guidelines and universal designed taking consideration of people with disability while designing the website.

4.11. European-Mediterranean Seismological Centre

To begin with Ten Non-Disabled participants and Six visually impaired participants were recruited for the interview purpose. The descriptive data from both user groups are coded below:

CODES (Non-Disabled Participants)	CODES (Visually Impaired Participants)	CATEGORIES	GLOBAL THEMES
-Form are available, but it is not accessible as there are no labels. -Form is inaccessible.	-Forms are not readable with screen reader.’ -Screen reader read blank field while filling form.	-Forms are not labelled properly.	
-Search option is not usable. -Search option doesnot provide results. -Search tool is ineffective	-Search option does not provide any results	-Irrelevant search engine	

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	<ul style="list-style-type: none"> -Difficult to navigate contact option -Contact option is hard to navigate 	<ul style="list-style-type: none"> -Inappropriate positioning of contact option. 	Accessibility issues and barriers
	<ul style="list-style-type: none"> -Logo and pictures are not friendly for blind person. -Image description wasn't available. 	<ul style="list-style-type: none"> -Absence of Text Alternatives in picture. 	
	<ul style="list-style-type: none"> -Headings were not levelled properly regarding keyboard keys. 	<ul style="list-style-type: none"> -Problem while navigating headings. 	
<ul style="list-style-type: none"> -Lots of information which could be unnecessary for the users were displayed in the home page. 		<ul style="list-style-type: none"> -Too much information in homepage 	
<ul style="list-style-type: none"> -Lack of knowledge of accessibility by developer. -Designer did not consider accessibility guidelines. -lack of knowledge of accessibility guidelines and tools for accessibility. 	<ul style="list-style-type: none"> -Web developers should aware for everybody like person with disabilities. -Lack of accessibility test. 	<ul style="list-style-type: none"> -Accessibility guidelines, universal design and its principle were not followed. -Acknowledge diverse users while designing website. 	Reasons of occurrence of accessibility issues
<ul style="list-style-type: none"> -The contacts options can be made more visible in the header. 		<ul style="list-style-type: none"> -Proper positioning of contact option. 	Designing and sustaining functionality for better usage
<ul style="list-style-type: none"> -Form need to be accessible. It should be universally design. -Make form accessible, changing design interface. 		<ul style="list-style-type: none"> -Form should be made accessible. 	
<ul style="list-style-type: none"> -For search option, using some visually appealing 	<ul style="list-style-type: none"> -The search field is easy to find, but it does not 	<ul style="list-style-type: none"> -Improvising search button. 	

contents or buttons would make it more helpful.	provide any search results. Update the search field.		
	-The best solution would be to review this website with a screen reader user. -Developer should make screen reader friendly website.	-Acknowledge diverse users while designing website	

Table 4-29 Chart presenting codes, categories and global themes for EMSC (Non-Disabled and visually impaired participants (NVIVO)).

4.11.1. Non-Disabled Participants

All the 10 non-disabled participants were involved in the usability and accessibility task. After the task was completed, post accessibility questionnaires were provided to the participants and following finding and results were revealed.

Accessibility Issues and Barriers

All the participant commented about accessibility issue with form which was not labeled properly and designed in a simple way without descriptions. Same number of participants also discovered that the search engine of the website did not provide any search result when search button is pressed. One of them narrated as:

“EMSC is a good website with lot of features but the design of the website lacks some other features such as the form to create new user is designed in a simple html format without any label, legends or descriptions. Also, the search tab of the website does not provide any results to the search items which is awful in an emergency period.”

Participation 001, Student/full time employed

Similarly, three of the participants also found that EMSC website consist of a lot of information in the homepage which is unnecessary. One of them reported as:

“the information on the homepage seems to be confusing with a lot of information are given. The earthquake information can be kept in another single link and other important information can be provided on that section.”

Participation 005, Student

We also asked about the reason behind the occurrence of accessibility issues and barriers. All the participants reported that the designers should always follow WCAG 2.1 accessibility guidelines and universal design principle while designing the websites. One of them also reported as:

“being as a non-disabled user, we might figure out the problem and may be can switch to another platform or the website during an emergency period. But designers and developers should be aware of the people with disability too, while designing the website. They may find very difficult to use it and may lose the important information during a disaster. For instance, search button, inaccessible form in the website.”

Participation 001, Student/full time employed

Designing and sustaining functionality for better usage

Participant were also asked about website’s usability and better improvement in future. All of the participant reported that the ‘contact us’ option in the website is in the improper position.

Participants found it difficult to navigate contact option in the webpage. One of them reported as:

“the contact us option is the main thing when it comes about earthquake or any emergency. The website contact option is in weird position. It is place at the bottom of the webpage with the social media logo and the small link as ‘if you have comment, please contact us’ which was inconvenient. The contact option should be at the top of the website where we have other headings.”

Participation 0010, Student

Some of the participant also discovered that the positioning of search option in the website was not appropriate. One of them reported as:

“As like the contact us option, the search option of the website is in the bottom which is inconvenience. The search option should be at the top of the webpage. Also, the search option of this website should use some visually appealing buttons with the text fields. Search option is just written as ‘search’ in the webpage and directs to another page then we can type and search which is time consuming.”

Participation 0010, Student

4.11.2. Visually Impaired participants

Three of the visually impaired participants were asked about the same post accessibility questionnaire after the usability and accessibility tasks. The following findings and results were obtained.

Accessibility issues and Barriers

All the participants reported that the form in the website is inaccessible while navigating from the screen reader tool. Screen reader reads the form as a 'blank field'. The same number of participants also reported that the images in the website does not consist of alternative texts which resulted them to figure out what was there in the picture. They also reported that the contact option and search option in the websites are in inconvenience position and the search option does not provide any results. Similarly, one of the participants also reported that the heading was not navigated properly with the keyboard keys via screen reader.

When asked about the reasons for occurring accessibility issues and barriers, all the participant commented that, acknowledge diverse users while designing the website and developers should strictly follow the accessibility guidelines while designing the website to make it accessible and usable by everyone.

Designing and sustaining functionality for better usage

Participant were also asked about website's usability and better improvement in future. All the participant provided same kind of opinion in regard to non-disabled participants. All of them reported that the search option should be improvised and updated so that it provides the results while searching. They also commented that the developers need to think building accessible website regarding screen reader users.

4.12. Pacific Disaster Centre (PDC)

To start with, Ten Non-Disabled participants and Six visually impaired participants were recruited for the interview purpose. The descriptive data from both user groups are coded below:

CODES (Non-disabled participants)	CODES (Visually Impaired participants)	CATEGORIES	GLOBAL THEMES
-Forms are not accessible.		-Inconvenient model of form.	

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<p>-Used captcha in form.</p> <p>-Capcha is the main issue as people find it difficult to satisfy it.</p>			
<p>-Interface is complicated.</p> <p>-Too much visually appealing content using sliders in the website.</p> <p>-Lots of technical information were also shared.</p>	<p>-Inappropriate positioning of reminder alert system.</p> <p>-Unable to navigate contact information</p> <p>-The website contains lots of information regarding earthquake, but it was not accessible.</p> <p>-It was difficult to navigate throughout the whole website.</p>	<p>-Complicated interface design.</p> <p>-Difficulties on navigating website</p>	<p>Accessibility issues and barriers</p>
<p>-Comparatively time consuming to load the relevant webpages.</p>		<p>-Issue with load speed of the website</p>	
<p>-Lack of consideration of accessibility guidelines.</p> <p>-Lack of knowledge of accessibility on web.</p> <p>-Designer may not have followed accessibility guideline.</p>	<p>-The website developer was not conscious regarding the universal accessibility standards.</p>	<p>-Accessibility guidelines, universal design and its principle were not followed.</p>	<p>Reasons of occurrence of accessibility issues and barriers</p>
	<p>-Due to lots of images and videos the website was not easily navigable</p>	<p>-Plenty of images and videos present in website.</p>	
<p>-Scrolling may get problem for visual impaired people so by changing and making accessible this feature.</p>		<p>-Ease of scrolling in website</p>	

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	-The website should improve its screen reader navigation.	-Ease of use of Screen Reader Navigation.	Designing and sustaining functionality for better usage
-Content should be simple, clear informative for the normal user.	-The relevant information was not easily accessible.	-Inappropriateness in conveyance of information.	

Table 4-30 Chart presenting codes, categories and global themes for PDC (Non-Disabled and Visually impaired participants NVIVO)).

4.12.1. Non-Disabled Participants

All the 10 non-disabled participants were involved in the usability and accessibility task. After the task was completed, post accessibility questionnaires were provided to the participants and following finding and results were revealed.

Accessibility issues and barriers

The above table presents codes, categories and global themes for PDC reported by non-disabled participants. During the interview, all the participants found that the load speed of the website is slow. Same number of the participants also reported that the design interface of PDC is complicated as it contains a lot of visual appealing contents and a lot of technical information were shared in homepage. One of the participants reported as:

“The design of the website is too complicated. There are lots of pictures and videos in the websites that makes difficulties to us as well as screen reader users. The home page of the website contains a lot of technical information. As a lay man, if I want to access any emergency management website, I will be in confusion to find the relevant information that is needed during a disaster situation.”

Participation 001, Student/full time employed

Similarly, six of the participants also discovered that the form in the website uses captcha for the security purpose. They found it inappropriate because a user may find it difficult to relate the pictures in the captcha and if the user is visually impaired then they will find it difficult to navigate too.

Designing and sustaining functionality for better usage

Participants were asked about the website’s usability and future improvement. Some of the participant reported that the scrolling of the website should be made easier. The visual contents in the website should be minimized, that may help to load the website faster as well. Few of the participants also commented that the content in the website are too technical. The way on conveying information in the website should be simpler and clearer so that everyone can perceive the information efficiently and effectively.

4.12.2. Visually Impaired participants

Out of the six visually impaired participants, three of the participants were interviewed via Skype.

The following findings and results were obtained.

Accessibility issues and barriers

The above table presents codes, categories and global theme for PDC reported by visually impaired participants. During the interview, all the participants found that PDC's website is very difficult to navigate. Unfortunately, one of the male participants left the interview after finding hard to navigate the website.

His frustration was reflected this way:

"I found this website very complicated to use. My screen reader reads main title, after I pressed tab key, screen reader reads one hundred and sixty-two links ahead of me. It is total waste of time. I cannot find this website accessible and usable in case of an earthquake."

Participant 006, Student

Somehow, two of the participants were able to navigate some of the content in the website. During that, both of the participants reported that the reminder alert is provided in the website, but the marquee element was present in that alert system. They were not able to open the specific reminder alert notification system. After that, they were completely lost with number of pictures and videos that were present in the website.

When asked about reasons of occurrence of such issue, both non-disabled participant and visually impaired participant reported that the website should be designed following the accessibility guidelines, universal design and principle. They also commented that, although, website may be accessible to some extent, the presence of huge number of pictures and video made the website very difficult to navigate.

Designing and sustaining functionality for better usage

Three of the participants were asked about the website's usability and future improvement. All the participants reported that the website should be built favoring screen reader users too. They also reported that because of the huge number of pictures, videos and links, important information regarding earthquake was not easily accessible. In this situation, we cannot make ourselves prepared

and notified in an earthquake situation. So, a developer while designing this website should be more aware of diverse users.

From the above qualitative analysis findings and results, it can be concluded that most of the issues that were discovered by the non-disabled participants were discovered by the visually impaired participants as well. Unless the issues such as absence of ALT tag on images, empty headings, issues with keyboard navigation were additional barriers that were revealed by the visually impaired users while navigating through screen reader tool.

4.13. The implication of Findings

From the systematic literature review, findings and results, key gaps associated with Universal Design and its principle, accessibility and usability barriers were identified. Firstly, automated accessibility evaluation tools were used to identify the accessibility issues related to all of the four earthquake-related emergency management websites.

4.13.1. Automated accessibility evaluation tool

After the evaluation from two of the automated accessibility evaluation tools i.e. WAVE and SortSite, we found a several issues and errors on all the four emergency management websites. The issues and errors that were discovered should be examined and solved to provide the users with the quality of the website. By doing that, diverse users can access the website uniformly with a minimum error.

Four pages including homepage, earthquake information page, warning alert page and information submission page were evaluated from all the four emergency management websites. When four pages were evaluated with automated accessibility evaluation tools, similar types of issues and errors were detected. The major issues that were detected are highlighted below.

a. Alternative texts

The issue of alternative texts was discovered on images and links among all the four pages that were evaluated. It is important to provide an alternative text to an image or a link that is used in webpages. Alternative text is an important issue for the users using the screen reader for navigation. When the correct alternative text for images and surrounding text for links are not provided, the screen reader will not be able to read an image or a link that results in difficulties in navigation for the users using screen reader. In a disaster situation, a website can provide an important message, preparedness tips, or warning alert with the help of an image or a link. A user who is visually impaired and using a screen reader will find difficulties to navigate when an alternative text for images and surrounding text in the link is not presented.

b. Labels on form control

The label with a placeholder in a form is an important element in the information submission page of a website. The issue of missing labels and placeholders for the input field in a form control was found in the information submission page as well as in search option in the homepage of all three of the websites except NSC. The Input field of any form should be labelled so that users can perceive what they want to input as well as screen reader will be able to read the input field correctly. An emergency management website can provide important features such as warning alert messages after the user submits a form. For instance, a blind user is filling a form with the help of screen reader. A screen reader tool will not read the section which a user wants to fill when a form does not contain labels and a placeholder on the input field of a form. In this situation, a user can miss out on filling the form and getting the alert messages in a disaster situation.

c. Color Contrast

The problem of color contrast was detected on each page that was evaluated on all the four emergency management websites. People with a certain vision problem can face trouble while seeing low-contrast text. The issue associated with color contrast creates a problem for the users while reading text presented on a website. There should be enough color contrast between the text and background color on a website. WCAG 2.1 AAA standard guideline suggest color contrast ratio should be 7:1 for small type text and 4.5:1 ratio for bold type text. Emergency management websites are used by everyone to access important information to keep them prepared during a disaster situation. So, while designing the websites, a developer should be aware of the foreground and background color to help users to read text clearly without ambiguity.

d. Page Title, Headings and Marquee

When the pages were evaluated by using automated accessibility evaluation tools, the problem with the page title, headings and marquee were discovered. It is important to provide a title to a page. A proper title of webpages provides users to easily identify whether the information provided on the webpages are convenient or not. For Instance, in a disaster situation, a proper page title will allow people with visual impairment to retrieve the information when multiple webpages are opened and helps to differentiate the content as well. Likewise, people with cognitive disabilities, reading disabilities and limited short-term memories can be benefited to identify the content when the title of a page is provided. By doing this, the user with several disabilities can access websites with minimum errors and can make themselves prepared during the disaster situation.

Similarly, we too found the problem with empty headings on a few pages of the emergency management websites. Headings of any page should be clear and concise so that users can find the information about what they want. In a disaster situation, a user using screen reader won't be able to perceive important information if the heading of the content is empty. It is important to ensure that all the heading contains some informative content. Besides, we also encountered the presence of marquee elements on some of the pages. While scrolling the content, it can be distracting and confusing to users, especially to the users who have certain cognitive disabilities. It also creates a problem to read out by the screen readers.

4.14.1. Experimental Study

After evaluating all the websites through automated accessibility evaluation tools, user testing was necessary to evaluate all the website. Both quantitative and qualitative analysis was performed to evaluate the issues and barriers that were encountered by the users to provide the answer to my research question two. Participants were also asked to provide their opinion regarding the reasons for occurrence of such issues and measures to solve those issues. The following key gaps were identified, they are:

- a. From the analysis, it was found that all of the four earthquake-related emergency management websites did not meet Universal Design and its principle as well as WCAG 2.1 guidelines.
- b. It was also found that the NSC and EMSC were more usable and accessible among the four websites.
- c. It was also discovered that the issues that were discovered by the non-disabled participants were discovered by the visually impaired participants as well. Unless the issues such as the absence of:
 - a) ALT tag on images.
 - b) Empty Headings.
 - c) Issues with keyboard navigation.
 - d) Inappropriate search engines.
 - e) Unlabeled search engines.
 - f) Missing labels and descriptions on the form.
 - g) Use of CAPTCHA on the form.
 - h) Forms were not submitted.
 - i) Color contrast, etc.

These were additional barriers that were revealed by the visually impaired users while navigating through screen reader tool.

- d. All the four websites were missing alternative text on images and link that made difficult to navigate website via screen reader for visually impaired participants.
- e. Pacific Disaster Centre (PDC) consists of many images and videos in their homepage while scrolling that was annoying for screen reader users to navigate throughout the website.
- f. Both non-disabled and visually impaired participants discovered inaccessible forms on all of the websites except NSC. Non-disabled participants also pointed out the forms does not contain any label or description on the field. Likewise, visually impaired participants also identified that they were not able to navigate form as their screen reader read out as 'blank field' while navigating forms. These types of issues restrict users to sign up or to provide feedback while accessing websites.
- g. Visually impaired participants also discovered missing page titles and headings. A screen reader user may not be able to navigate the page until the title and heading are read out by the screen reader tools.
- h. The search engine of NSET and EMSC was found to be inaccessible and unusable. As the NSET search engine directs users to another API where EMSC does not provide any kind of search results. In an emergency, people will be searching for various measures to keep themselves prepared and safe where NSET and EMSC failed to provide accurate information from their search engines.
- i. From the SUS analysis, NSC and EMSC were found to be usable and accessible to some extent compared to PDC and NSET. NSC being a government website failed to enable reminder alert system which is a major usability issue in terms of being an emergency management website.
- j. From the experiment, it was also identified that mobile readiness is essential in an emergency for preparedness because in that situation, users may not be able to access to the internet through computers or laptops.
- k. It was also identified that the situational disabilities affect people in an emergency. So, it is highly recommended to experiment Universal Design and accessibility issues on mobile devices apps concerning situational disabilities.

5. Discussion

This chapter includes the discussion of the summary of the analysis of results compared with the previous study and limitation of the study.

5.1. Summary of analysis results compared with the previous study

Based on similar research, (Jaziar, Gjørseter, & Chen, 2017) WAVE and SortSite were the two automated accessibility evaluation tools that were used in this study to evaluate all of the four websites. The results from the two automated tools indicate that all the four websites had violated accessibility level A checkpoint issues of 1.1.1 (non-text content). The similar checkpoint has been found to be violated in other similar studies (Jaziar, Gjørseter, & Chen, 2017), (Youngblood & Youngblood, 2017), (Kurt, 2011), (Verkijika & Wet, 2018). This kind of accessibility issues is frustrating, especially for the screen reader users while accessing the web content. Fixing this issue enables screen reader users to perceive web content easily.

Level A checkpoint 2.4.4 (link & purpose) was also violated in all the four emergency management websites. Users with assistive technology such as screen reader find it difficult to access the web content if this checkpoint is violated. Fixing this issue with meaningful purpose helps potential users to perceive the web content easily. This issue was also detected on other websites (Youngblood & Youngblood, 2017), (Jaziar, Gjørseter, & Chen, 2017). Also, Level AA checkpoint 2.4.6 (headings and labels) was violated in all the four websites. This issue was also been identified on other websites (Jaziar, Gjørseter, & Chen, 2017), (Youngblood & Youngblood, 2017).

Similarly, both automated evaluation tools detected the violation of Level A checkpoint 1.3.1 (info & relationship) and Level AA 3.3.2 (labels and instructions) on all the four emergency management websites. These issues were also identified on the previous study of (Youngblood & Youngblood, 2017) and (Jaziar, Gjørseter, & Chen, 2017). This issue should also be fixed to increase the accessibility for the users who are relying on the screen reader. In addition to, level A checkpoint 2.4.2 (page title) was violated by NSET. The screen reader users may find difficult to navigate the web content if the page title is missing. Also, violation of the checkpoint Level A 2.2.2 (Pause, Stop, Hide) was detected on the government website of Nepal (NSC). The presence of the Marquee element possess confusion to the users navigating the website content with screen reader. Fixing the issue may help in better improvement of accessibility on the website. This issue was also identified in other studies (Youngblood & Mackiewicz, 2012). WAVE also detected level AA 1.4.3 (contrast issues) in all the four websites whereas SortSite detected level AA 1.4.3 (contrast issues) as well as level AA

1.4.4 (resize text) issues. This issue has been identified in other websites (Youngblood & Youngblood, 2017).

Further, user testing was conducted among the participants on all the four earthquake-related emergency management websites. Both non-disabled and visually impaired users were recruited for the user testing purpose. The methodology of the research followed mixed-method approach to better understand the results with quantitative and qualitative analysis. This kind of method and approach was also adopted on the other research (Devis, 2012); (Madhusudhan & Noushad, 2013).

From the response of the participants, it has been found that the NSC and EMSC were usable and accessible out of four websites that was evaluated in case of disaster situations to some extent but there are lots of things that are needed to be fixed. The participants both (non-disabled and visually impaired) responded to the navigation issue as a re-occurring issues and frustration which they have experienced while accessing the emergency management websites. This issue mainly occurred on the EMSC and PDC's website. The previous study also reported that blind users were losing 30.4% of their time due to these frustrating situations (Lazer , Allen, Kleinman, & Malarkey, 2007). The study of (Youngblood & Youngblood, 2017) also suggested promoting usability testing, especially in the navigation to help to guide website development.

Another problem that was experienced by visually impaired participants is that the screen reader read all the links after the heading has been read, especially on PDC's website. They found it annoying as the website consist of a lot of links, images and videos. The previous study also points out that the users face frustration when screen reader reads out the same link every time when the webpage is been loaded (Lazer , Allen, Kleinman, & Malarkey, 2007). The previous study of (Lazer , Allen, Kleinman, & Malarkey, 2007); (Menzi-Çetin, Alemdağ, Tüzün , & Yıldız , 2017) suggested that the inclusion of *skip over* link within a webpage can minimize the frustration of hearing the links every time. The users can skip the link which they do not want to click when the webpage is loaded.

Some of the other common usability issues that both participants (non-disabled and visually impaired) experienced were the issue with the search engines. The search engine redirected them to another API which was annoying to the users, especially in NSET and EMSC's websites. The previous study of (Menzi-Çetin, Alemdağ, Tüzün , & Yıldız , 2017); (Aydın, 2013), suggested that adding an internal search engine to all webpages provides better usability experience to the users.

The research participants indicated that the form in four of the websites except NSC was inaccessible. While performing the task, participants said that the forms on the webpage does not have field labels and their screen reader reads as a blank field while navigating the form. They also

added that the feedback form of NSC and NSET cannot be submitted which is frustrating in case of emergency, if we want to provide some emergency information. The study of (Youngblood & Youngblood, 2017), suggested that the form shall allow people using assistive technology to access the information, field elements, and functionality required elements and submission of the form, including all directions and cues.

Another usability issue that was detected by both participants is not having a reminder alert system on the website, especially in NSC. They added that NSC being a Nepal government's website should be able to provide reminder alert services in times of earthquake situations. They also suggested that the government website should be able to provide alert services through SMS which is handy and will be an instant alert service. Similarly, participants also suggested that a user in an emergency may not be able to open the website and check for the notification. So, being a government website should be able to develop a mobile application that makes it relatively easy for everyone to get the alert notification instantly. The previous study also suggested that mobile readiness is essential in emergency situation for preparedness because, in that situation, users may not be able to access to the internet through computers or laptops (Youngblood & Youngblood, 2017).

It was also observed that none of the website met the WCAG 2.1 accessibility guidelines in terms of alternative text in an image. Visually impaired participants detected the absence of alternative texts in the images which were annoying. The study also suggested that the presentation of visual contents in the webpages are one of the major problems which visually impaired users encounter (Menzi-Çetin, Alemdağ, Tüzün , & Yıldız , 2017); (Aydın, 2013), (Baguma & Lubega, 2008).

Thus, findings from the analysis it can be agreed with the previous study, automated accessibility evaluation tools and user testing among the four earthquake-related emergency management websites, none of the websites were accessible. However, NSC and EMSC were found to be usable to some extent in terms of earthquake information and alert system respectively. But there are lots of content that is needed to be fixed on the websites in terms of usability and accessibility. The study somehow provides an important clue to the web developers and designers to follow Universal Design principles, WCAG 2.1 accessibility guidelines and Section 508 guidelines to make the website accessible and usable by everyone in case of disaster situation.

5.2. Limitation of the study

The findings of this study, however, possess some limitations that might have led to better results from the user experiment. This study tried to cover as many issues in context to Universal Design and research gap.

The total number of participants recruited in this study was low (16 participants). Among the total participants, 10 of them were non-disabled participants and 6 of them were visually impaired participants relying on screen reader. Other participants (eg. Motor impairments and cognitive disorders) were not been able to recruit, who may also rely on screen readers as well as elderly participants. Recruitment of more participants including emergency management practitioners, web developers, web designers would have made my research more interesting and significant results may have been generated.

During the pilot study, it was observed that the total time taken by non-disabled participants to perform the task was approximately two hours. It would have been stressful for the participants who are visually impaired using screen reader tools. So, visually impaired users were given two websites to perform user testing out of the four websites. This was done to reduce the time that a visually impaired user may take while performing the task and to reduce the stress that they might face while performing the task.

Results would have been more significant if all the visually participants have performed user testing on all the four websites. Similarly, the results could have also differed if the evaluation were performed over time.

This study aimed to find out how accessible and usable is the earthquake-related emergency management websites. In the context of usability analysis, System Usability Scale (SUS) was used to evaluate how usable were the websites. The calculation of time taken by the participants, normal distribution and co-relation could have provided more significance and transparent results.

There have been several research studies regarding Emergency Management in the context of the Universal Design of ICT. However, research on web accessibility and website evaluation on emergency management websites were very few in numbers (Jaziar, Gjørseter, & Chen, 2017). Further research on web accessibility for emergency management is necessary so that everyone will be able to access the website without hurdles.

Talking about the user testing, testing with the non-disabled participants was accomplished in real-time. However, user testing with visually impaired participants was done remotely. Remote testing can be prone to error and it is difficult to analyse all the issues and sessions during the task (Jard,

Jeron, Tanguy, & Viho, 1999). In this study, user testing was done remotely via Skype with visually impaired participants. Real-time user testing with visually impaired participants would have provided more concrete results to the research.

One of another limitation during the user testing was that one of the visually impaired participants did not perform the given task fully. This problem was encountered in the PDC website as it consists of a huge amount of images and videos in the homepage where the screen reader of the participant read "162 links" ahead which would be stressful for the participant to 'tab' 162 links to get to another heading.

The findings and results were generated with the help of automated accessibility evaluation tools and user testing. The addition of the other evaluation such as manual evaluation and including other more evaluation tools would have reaffirmed the findings.

6. Conclusion

The research aimed to identify and investigate the accessibility and usability issues that were encountered by the users (people of Nepal) while using earthquake-related emergency management websites. In the first phase, the problem and issues related to accessibility and usability among the earthquake-related emergency management were studied using various literature. The four earthquake-related emergency management websites were selected for the evaluation purpose if these websites can support disaster resilience when the users need during a disaster situation such as an earthquake.

In the second phase, earthquake-related emergency management website was evaluated with automated accessibility evaluation tools. The automated tools were used to evaluate and to check the accessibility level of all four emergency management websites. From the results, it was found that none of the emergency management websites were fully accessible for all users. Since most of these sites are experimental and updating in a regular basis except NSET, the addition of universal design, accessibility and usability features on the later version may help the users to access life-saving information during a disaster situation. Evaluation with the automated accessibility evaluation tool provided an answer to the first research question.

Similarly, user testing was conducted among the non-disabled users as well as visually impaired users to evaluate issues related to accessibility and usability on all the four emergency management websites. Semi-structured interview was conducted to find significant accessibility issues on all the websites. Whereas, System Usability Scale (SUS) was used to analyse the participants' data to find the significant result on which of the website is more usable in a disaster situation such as an earthquake. From the quantitative and qualitative analysis, NSC and EMSC were found to be more usable and more accessible to some extent in terms of earthquake-related information while compared with NSET and PDC. The significant difference was discovered between Nepalese websites and other global websites. NSC being a Nepal government website, however, it was found to be more usable and accessible through analysis when compared to other websites. Being an earthquake-related emergency management website, NSC does not provide reminder alert system features and neither any mobile application to provide ease of use to the users for preparedness in an earthquake situation. Whereas, EMSC provides reminder alert features and has interactive mobile application for instant notification.

However, there were a lot of issues related to accessibility and usability that were identified by the participants such as missing alternative texts on the images and links, missing page title and headings, inappropriate search engine, inaccessible forms, missing reminder alert features and so on. These issues provided the answer to my second research question.

Therefore, throughout the analysis of results and various literature, it can be concluded that none of the earthquake-related emergency management that were examined in this research study are accessible and usable to all the users in a disaster situation. From the analysis of the results, it can also be concluded that the web designers and web developers should be aware of the Universal Design and its principle, accessibility, and usability guidelines. They should be able to follow the principle and guidelines while developing the website considering the users with different abilities. Additionally, this study would further suggest investigating by taking care of the limitation of the study outlined in the discussion section would help to get an answer in the future.

6.1. Future Research

Base on the above conclusion, the following recommendation could help the researcher can do further investigation on the evaluation of earthquake-related emergency management websites.

- a. Although, both non-disabled and visually impaired participants were recruited. Other participants who rely on screen reader such as, motor impairment and cognitive disorders as well as, inclusion of elderly people would have provided more accurate results. Similarly, the inclusion of emergency management practitioners, web developers, web designers is highly recommended.
- b. Future work also includes using a boarder range of other evaluation methods such as manual evaluation to evaluate the universal design of the earthquake-related emergency management websites.
- c. In an emergency, people can react in a different way. Situational disabilities are also another type of disability that affects people in an emergency. So, it is also recommended to perform experiments on mobile phone apps to get better result. Experimenting Universal Design, accessibility and usability issues on mobile phone apps help to trigger situational disabilities that people may face during a disaster situation.
- d. For example, in an earthquake situation, situational disabilities such as unable to type messages on the mobile phone virtual keyboard or unable to press the buttons on the screen due to shaky grounds may lead to miss out life-saving information. Little research has been focused on this area. It is highly recommended to experiment Universal Design and accessibility issues on mobile devices apps with respect to situational disabilities.

- e. Similarly, future work also includes the inclusion of reminder alert system on the websites or in the mobile devices. By doing this, people can get prepared and first responders will be facilitated during a disaster situation.

6.2. Reflection on the research study

As a computer science student, I always had a passion to learn new and challenging things. Universal Design of ICT was new for me at the beginning. Being a citizen from a developing country, the term Universal Design was new for me. Although, term and definition were known but the implementation of Universal Design was new for me. So, being a student of Universal Design of ICT, it always motivated me to study and design the products that are accessible and user-friendly to everyone following accessibility guidelines and checklists. At the beginning, after I selected the topic, it became a challenging task for me to start the research study. When I started investigating various scientific papers, I was able to find something interesting regarding the Universal Design of ICT in Emergency Management in the context of Universal Design. I decided to evaluate the website's accessibility and usability issues that a user may face while accessing the web content. As a Nepalese citizen, I had experienced a real-time devastating earthquake in 2015 which motivated me to analyse and evaluate the earthquake related emergency-management website. It motivated me to investigate on accessibility and usability issues that people with disabilities as well as non-disabled people can face while using the earthquake-related emergency management websites. Although, it was a challenging task to conduct research on technology which was rarely known, and less research was conducted in the past to make emergency management websites more accessible and usable. It also motivated me to investigate user's opinions about the future improvement of earthquake-related emergency management websites. I have started to find out various papers related to website evaluation and try to outline the issue related with the evaluation of websites. Fortunately, I found two important articles about emergency management's website evaluation that helped me with further investigation. And finally, I started to evaluate the websites based on previous research studies, performed an experiment with the visually impaired participants and non-disabled participants from Nepal and collected the data, analysed them to provide the result to my study. Not only experimenting was a challenging task, the writing was the most challenging part which I faced but it was fun to interpret the findings of the study. I felt very lucky to have my supervisor on my side. The weekly meetings, supervision, guidance, feedbacks and suggestion from my supervisor were some of the important parts to complete this research study.

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8. Appendices

8.1. Appendix A

8.1.1. Research Consent Form

Title of Research Experiment: Evaluation of Universal Design of ICT in Emergency Management websites: An Earthquake Scenario of Nepal

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I am a student in a university-level research methods course. Currently, I am doing my masters in Universal design of ICT in Oslo Metropolitan University. This course requires us to gain applied experience in designing and conducting research. As such, I have designed a research project to study the issues and barriers that users are facing while accessing earthquake-related emergency management websites.

During this study you will be asked to complete a number of questionnaires and tasks concerning your personal experiencing on how accessible the websites are to provide emergency information during a disaster situation such as an earthquake for both abled and people with disabilities mainly visually impaired by using screen reader tools. You will also be asked for some demographic questions such as age, gender, education qualifications etc. Your participation will require approximately 30-40 minutes of your time.

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All records of the participants will be kept strictly confidential, such that I and only my supervisor will have access on it. Data will be destroyed at the end of the project. Similarly, electronic files will also be deleted at that time. The results from this study will be reported in a written research report. Information about the project will not be made public in any way that identifies individual participants.

There will be no record of video or audio of the participants. The identity of the participant remains anonymous and the participant cannot be recognized by any means. Your participation will be completely voluntary. You may withdraw at any time for any reason without explanation and without penalty. You may also choose not to answer any question for any reason.

I have read the above form, understand the information read and understand that I can ask questions or withdraw at any time. I consent to participate in today's research study.

Participant Signature

Date

8.2. Appendix B

8.2.1. Demographic Questionnaire (Non-disabled)

- a. **Participants ID:** _____
- b. **Date:** __/__/__
- c. **Age group:** Under 18 18-25 26-35 35-45
- d. **Gender:** Male Female Prefer not to say
- e. **Education:** Basic School High School Bachelors Degree
 Masters Degree
- f. **Employment:** Full-Time Part-time Unemployed Student

8.2.2. Demographic Questionnaire (Visually impaired users)

- a. **Participants ID:** _____
- b. **Date:** __/__/__
- c. **Age group:** Under 18 18-25 26-35 35-45
- d. **Gender:** Male Female Prefer not to say
- e. **Education:** Basic School High School Bachelors Degree
 Masters Degree
- f. **Employment:** Full-Time Part-time Unemployed Student
- g. **Type of**
Disability: Completely Blind Partially Blind Motor Impaired
 None
- h. If you are visually impaired, which screen reader tool do you prefer to use?
-

- i. How many years of experience do you have using screen reader tools?

8.3. Appendix C

8.3.1. Accessibility and Usability Task

- a. **Open the website in your browser:** You want to browse the emergency website for application. If you are unable to browse the URLs, you will be provided with the link to browse or external assistance is provided.
- b. **Find the earthquake information in website:** Form the homepage of the website you want to check the earthquake information that has the list of earthquake information. Please list down some of them.
- c. **Identify latest earthquake information:** From the homepage of the website, you want to find latest earthquake information for preparedness.
- d. **Identify the location map in your browser:** You want to know the area that has been affected by an earthquake in a map to keep you prepare for future aftershocks.
- e. **Are there any options to identify the felt earthquake:** You want to browse earthquake that has been felt to prepare yourself, also if you have felt and wanted to provide the feedback?
- f. **Find the preparedness tips on the website:** You want to find the preparedness tips that helps you to keep safe during an earthquake. List down some of the preparedness tips if you have found.
- g. **Identify the reminder alert in website:** You want to check whether there is reminder alert of an earthquake that provides you reminder alert during an earthquake with the means of email or text message on your mobile device.
- h. **Identify the contact information:** You want to find the contact information from the website via phone or email. Is it possible to send feedback, ask questions and get help online using the interface? Please list down those features, if available, in order to get prepared during an earthquake.

8.3.2. Usability Survey Questionnaire

a. I think that I would like to use this system frequently.

Strongly Disagree		Neutral		Strongly Agree
<hr/>				
1	2	3	4	5

b. I found the system unnecessarily complex.

Strongly Disagree		Neutral		Strongly Agree
<hr/>				
1	2	3	4	5

c. I thought the system was easy to use.

Strongly Disagree		Neutral		Strongly Agree
<hr/>				
1	2	3	4	5

d. I think that I would need the support of a technical person to be able to use this system.

Strongly Disagree		Neutral		Strongly Agree
<hr/>				
1	2	3	4	5

e. I found the various functions in this system were well integrated.

Strongly Disagree		Neutral		Strongly Agree
<hr/>				
1	2	3	4	5

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f. I thought there was too much inconsistency in this system.

Strongly Disagree		Neutral		Strongly Agree
1	2	3	4	5

g. I would imagine that most people would learn to use this system very quickly.

Strongly Disagree		Neutral		Strongly Agree
1	2	3	4	5

h. I found the system very complicated to use.

Strongly Disagree		Neutral		Strongly Agree
1	2	3	4	5

i. I felt very confident using the system.

Strongly Disagree		Neutral		Strongly Agree
1	2	3	4	5

j. I needed to learn a lot of things before I could get going with this system.

Strongly Disagree		Neutral		Strongly Agree
1	2	3	4	5

8.3.3. Usability Questionnaire

a. Are resources provided through websites based on user's information needs?

Most of the information provided are useful.

Most of the information that need to be known in an emergency situation were missing.

I cannot find the website useful in an emergency situation.

b. Is the website easy to use?

I found the content very useful and easy to use.

I found the content in webpages useful to some extent but there are issues that is needed to be fixed.

c. What is the possible solution do you consider improving the website to be more accessible and usable by everyone?

8.3.4. Accessibility Questionnaire (Non-Disabled)

a. Is the website easy to use for a normal user?

Yes No

b. Is the website load speed reasonable?

Yes No

c. Does the website work in your current browser?

Yes No

d. Is there a visual appeal on websites?

Yes No

e. Does style (text-to-background contrast, font size, etc) meets the desired styles in the website?

Yes No

f. Is text simple, clear and concise?

Yes No

g. Are links provided on the website appropriate?

Yes No

h. Did the links on the webpage guides you to the desired location on which you wanted to access?

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Yes No

i. Is the search tool of the website effective to retrieve the relevant information?

Yes No

j. Did you find any form in the webpage?

Yes No

k. If yes, did you find the form accessible?

Each input on the form are provided with labels and description.

There is no such descriptions and examples on the input fields.

8.3.5. Accessibility Questionnaire (Visually Impaired)

a. Which type of Screen Reader tool are you using?

NVDA Voice Over Other

b. How long you have been using the screen reader tool?

I am a beginner 0-5 Years 5-10 Years 10-15 years

c. Did you find any title that briefly describes the content of the webpage?

Yes No

d. Is the heading user-friendly and descriptive?

Yes No

e. Does the website have any missing heading?

Yes No

f. Is the search tool of the website effective to retrieve the relevant information?

Yes No

g. Did images on the website have appropriate ALT tags (helpful to read by the screen readers)?
If yes, did they provide meaningful information?

Most of the images had alternative texts that were meaningful.

Most of the images had alternative texts but did not provided meaningful information.

Most of the images did not have alternative texts.

h. Did the keyboard support do the navigation by using the tab key with your current screen reader tool?

Yes No

i. Did you find any form on the page?

Yes No

j. Was the form accessible to the keyboard while using it with a screen Reader?

Yes, they are easily navigable.

Each input on the form are provided with labels and description.

There is no such descriptions and examples on the input fields.

It is very hard to navigate with the keyboard using screen reader

k. Did you find any error while submitting the form?

There were errors but easily findable.

No errors were found while submitting the form.

8.3.6. Post Accessibility Questionnaire

- a. What were the remarkable accessibility issues and barriers that you have faced while using the website?
- b. What do you think the main reason behind the occurrence of these issues?

8.4. Appendix D

Websites	Errors	Alerts	Contrast Errors
National Society of Earthquake Technology (NSET) http://www.nset.org.np/	8	34	48
National Seismological Centre https://www.seismonepal.gov.np/	6	4	57
European-Mediterranean Seismological Centre (EMSC) https://www.emsc-csem.org/ - 2	15	35	100
Pacific Disaster Center (PDC) https://www.pdc.org/	19	40	127

Table 8.4-8-1 Overall errors of Homepage (WAVE)

Websites	Errors	Alerts	Contrast Errors
National Society of Earthquake Technology (NSET) NSET/Earthquakeinfo	02	12	41
National Seismological Centre National Seismological Centre/Earthquakeinfo	10	3	
European-Mediterranean Seismological Centre (EMSC) EMSC/Earthquakeinfo	14	8	43
Pacific Disaster Center (PDC) https://www.pdc.org/weather/	23	47	179

Table 8.4-8-2 Overall Errors Eathquake information page(WAVE)

Website	Errors	Alerts	Contrast Errors
National Society of Earthquake Technology (NSET) PreparednessTips	4	11	41
National Seismological Centre WarningAlert	4	3	19
European-Mediterranean Seismological Centre (EMSC) WarningAlert	15	8	44
Pacific Disaster Center (PDC) WarningAlert	3	7	8

Table 8.4-8-3 Overall Errors Preparedness or warning alert page(WAVE)

Website	Errors	Alerts	Contrast Errors
National Society of Earthquake Technology (NSET) InformationSubmission	14	18	37

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National Seismological Centre InformationSubmission	17	6	18
European-Mediterranean Seismological Centre (EMSC) InformationSubmission	18	9	43
Pacific Disaster Center (PDC) InformationSubmission	6	1	7

Table 8.4-8-4 Overall Errors on Contact page (WAVE)