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Universal Design of ICT

Minby - accessible web application to engage youths in community development

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Preface

The work presented henceforth is the master's thesis dissertation "Minby - accessible web application to engage youths in community development". This paper has been written to fulfill the graduation requirements of the Master's program in Applied Computer and Information Technology (ACIT) with specialization in Universal Design of ICT at the Faculty of Technology, Art and Design, Department of Computer Science, Oslo Metropolitan University. Despite ups and downs while working on the thesis, it was overall a great learning experience.

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Abstract

How can web applications help youths to engage in community development and e-governance? This research is a part of a larger ongoing project held by Work Research Institute (AFI), Norway who has been working since 2014 to empower and engage youths in community participation in the capital city of Oslo. In this paper, we developed a web application named Minby to investigate the potential of web solutions to increase youth engagement in participatory community building and governance. The application acts as a digital platform for youths to share ideas, opinions, and agendas related to the surroundings, and develop a social network with youths around them. We developed a web application using an agile approach with user-centered design to make the solution more inclusive and usable to diverse groups.

Digital technologies like social medias have helped connect people worldwide and made the information sharing easier than ever. There is immense potential for such online platform to fill the gaps of participation in community and governance. Youth participation is considered very important for making change in society. However, they are not well positioned and their voices are given less priority in important policy making and planning processes. Moreover, youths facing some kinds of disabilities face various challenges in participation and to share their opinions and ideas. In this context, we developed a digital platform in web with the intention to reduce the gaps between youths and their community participation. We evaluated the web application using various accessibility evaluation methods to evaluate the accessibility of the system. Furthermore, we carry out user testing to evaluate the accessibility and usability of the system among the targeted groups. We further discuss the outcomes of the evaluation processes, key methodological challenges and limitations of the study and conclude the paper with possible future works and potentials that can enhance the participation for social change.

Keywords: Youth participation, community development, accessibility, usability, agile approach, user-centered design.

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Introduction

In 2018, the population was recorded to have increased with 1.2 billion young people aged 15 to 24 years, contributing to 16 percent of the world's population (United Nations & Department of Economic Social Affairs, 2018). Thus, the need for youth participation has grown than ever for the sustainable development of society. Despite their immense potential to make changes in society, youths face certain limitations in community participation regarding critical decision-making and planning processes. There are still many unheard voices and a lack of youth participation in governance (Checkoway & Richards-Schuster, 2004).

Social media are considered an essential facilitator for social engagement in the modern era. The ease of access to a plethora of information and the comfort of building social networks without moving around and interacting with people are the reasons why social media today has millions of users (Ahmad & Sheikh, 2020). In addition to this, social media like Facebook, Twitter, and Reddit are easy ways to promote social mobilization and political engagement. In recent years, people are participating online in social movements, political rallies, and social campaigns (Papaioannou, 2013).

A high number of youths engage in digital platforms like Facebook, Twitter, Skype for daily interaction and source of information sharing. Youths also engage in various social activities such as awareness programs, social campaigns, discussion forums through these medias. Social media has open ways for youths to access and mobilize in social activities of their interest. Thus, these practices have helped create new opportunities for voices and social reforms (Kahne & Middaugh, 2012).

With the growing population of youths every year, the number of disabilities is also growing. People with disabilities are unable to access the solutions because of their limitations. Likewise, inaccessibility in social media deprives people with disabilities of accessing information, participate in information sharing and interaction. This often leads to people with disabilities feeling isolated and face discrimination in the online platform (Pinnelli, 2013). For example, people with visual disabilities are unable to access the information in images and videos that are on web pages. Many solutions have been built to provide a platform for discussions related to social concerns and community change but fail to fulfil the purpose due to accessibility issues among the

diverse group of users (Skinner, Biscope, Poland, & Goldberg, 2003). Therefore, the need to make the solutions accessible to a diverse group of users has become more critical than ever.

The evolution of many web platforms to transform social and public services into online services has made the life of people easier. However, web accessibility in web pages has always remained a subject of concern when making the services more accessible and usable to people (Brown & Hollier, 2015). Efforts have been made at the national and international levels to make the solutions accessible to many users. According to the Anti-discrimination act, all the ICT solutions should be accessible to people regardless of their disabilities. As a result, World Wide Consortium (W3C) in 2008 released WCAG 2.0 with 12 web accessibility guidelines as a standard for web solutions to make the solution accessible. Since the introduction of WCAG 2.0, software designers and developers have considered WCAG guidelines as de-facto to meet the accessibility in web contents (Sverdrup, 2018). Despite this, there are some gaps in accessibility of the web contents in existing system. Researchers strongly that suggest there is need of more ICT solutions that are inclusive to all user groups regardless of their disabilities (Pinnelli, 2013).

While developing an ICT solution, it is crucial to identify the user's requirements and their expectations from the product. The users' thought process while using the system, preferences, and drivers for user satisfaction are necessary to understand while developing a system (Hayes, 2014). User-centered design is a design process based on the active involvement of users in the design and evaluation process. It is considered an effective approach, unlike the traditional system-centered approach to achieve better usability of the product (Mao, Vredenburg, Smith, & Carey, 2005). Moreover, there are various software development approaches that are implemented based on the scope of a project. Some of the common development approaches are the waterfall model, iterative model, and agile process. Many developers find implementing agile practices with user-centered design an effective software development practice as both (agile and user-centered design) share common philosophy.

Mindful of these facts, we developed a web application named Minby, a platform for youths to share their opinions, ideas, agendas, and concerns. This application was

developed to find how such applications can help to engage youth in community development and e-governance. The primary goal of the application was to make the application as much inclusive to the users as possible. We formulated WCAG 2.0 guidelines in the software development process to make the accessible contents and features. Moreover, we followed a user-centered design with an agile process. We involved users in the evaluation process and followed an iterative process for user evaluation to get user feedbacks continuously and improved the accessibility and usability of the system based on the feedbacks. In this process, the main purpose of this thesis is to get the answers to the following research questions:

RQ1 How is it possible to engage youths in community development through accessible web solutions?

RQ2 How can an agile approach with user-centered design be an effective approach to increase the accessibility and usability of a system?

The thesis is a part of an ongoing project of Work Research Institute (AFI)[1], Norwegian Social Research (NOVA)[2] , and Oslo Metropolitan University. AFI is an interdisciplinary institute that carries out researches in various fields like sociology, anthropology, and psychology. Since 2014, researchers involved in this project have conducted researches and workshops for youths to investigate youth potentials and various tools to engage and empower them in bringing social change in the capital city of Oslo, Norway. In their research, they have mainly relied on traditional and ethnographic methods to engage youths in community development and to study the sense of belongingness in their surroundings. Further, the study strongly claims that digital technologies have the potential to engage youths in community development. (Tolstad, Hagen, & Andersen, 2017). Apart from this, many researches also affirms that web technologies can be used effectively to increase youths in community participation (Papaioannou, 2013). In this thesis, we further investigate about youth participation and how we can maximize engagement through an accessible web application.

Having presented the primary purpose of the thesis and research questions, we start Chapter 2 with literature review, where we discuss the background and state of the

[1] https://www.oslomet.no/en/about/afi
[2] https://www.oslomet.no/en/about/nova

art around existing social media, implementation of web accessibility, and software development methodologies. In Chapter 3, we define the criteria for designing and developing the system based on the existing systems and their limitations. Also, we discuss the methodologies that we implemented in the development and evaluation of the process. Chapter 4, Results, discusses system development results, evaluation and user testing process results, and results of accessibility and usability of the developed system. In Chapter 5, we discuss the interpretation of the results, their outcomes, possible limitations, and possible future works in this research area. Lastly, in chapter 6, we draw conclusions.

Literature Review

Background

The rapid evolution of information and communication technologies (ICT) has made the world smaller by connecting people worldwide through the web. One of the greatest inventions of the web is social media, where people can connect and interact with each other online regardless of physical distance (Lee, Hong, An, & Lee, 2014). Social media like Facebook, LinkedIn, Instagram and Twitter offer a platform to participate in the conversation and sharing opinions and views. They are used for different purposes in different ways. For example, people post text and attach multimedia such as images and videos. In Twitter, people can post text in no more than 140 characters; Instagram is used when users communicate through only multimedia such as images and videos. Moreover, LinkedIn facilitate users with job search and social networking related to their careers which help them strengthen professional relationships. As a result, social media users have grown immensely all around the world. Today, social media is so ingrained in society that people prefer them over traditional phone calls and emails, new letters, and post mails. For example, in 2013, there were more than 1.15 billion Facebook users and are expanding every year (Liu, 2017).

Generally, social media are used for communication and as an information-sharing platform. The rapid development of the internet has made information accessible and cheaper (Schlozman et al., 2015). Unlike traditional media, the rise of social media has given users a platform to share information rapidly, easily, and widely. It has facilitated users to create their web contents, share and be involved directly or indirectly in the field of interest and discussion (Ekström & Östman, 2015). The vast information that social media provide, has increased exposure to social mobilization and political information. People can easily express political opinions, share political interests and social issues. Thus, social media can effectively trigger administrations and communities to address the social problems and increase awareness (Keating & Melis, 2017).

Youths of today are adept to technology from an early age since they are surrounded by them. Researchers suggest that today, youths learn in different ways than before due to technology-mediated activities. Their involvement in various activities is highly

influenced by their technology practices (DeGennaro, 2008). For the majority of youths, social media has been one of the most convenient ways to express their opinions, connect with people, build networks and share information. On the contrary, we acknowledge that youths are less likely to engage in mobilization related to political activities and community development since they are busy with their studies, jobs, and adapting to changes during the transitional phase to adulthood (Henn, Weinstein, & Wring, 2002). Another major factor behind lower involvement is the lack of resources such as time, money, and mental energy required for social and political engagement.

The concept of youth participation is considered necessary in building a participatory and inclusive society (United Nations, 2019). It is an approach that focuses on engaging the youths in community agendas and prepare them to act as change agents in a democratic society (Checkoway & Richards-Schuster, 2004). Thus, as being the heavy users of social media, many studies show that online youth participation can be an effective solution to overcome the limitations in participation (Verba, Schlozman, & Brady, 1995). Furthermore, some studies also show that young adults are more likely to engage in political and social activities through online tools than older generations (Jensen & Anduiza, 2012). Online participation can help youths find their voices on political and social platforms (Keating & Melis, 2017).

Demographics

Today, there are more than 1.2 billion people who are between the ages of 15-24, making up a large proportion of the population, mainly in developing countries (United Nations & Department of Economic Social Affairs, 2018). By 2050, the number of youths aged between 15 to 24 years is expected to grow from 207 million in 2019 to 336 million in the least developed countries (United Nations, Department of Economic Social Affairs, & Population Division, 2019). With this ever-growing population arises several issues that they face in their community.

Disability is one of the significant challenges that hinder the communication and participation of a person significantly. For example, people with visual disabilities will be unable to get the information if it is only in text format. According to WHO, in 2011, around 18% of the people in the United States and more than 84 million people in EU/EEA countries live with some types of disabilities (World Health

Organization, 2011). People with disabilities face a lot of challenges in communication and participation in day-to-day life. Due to this, they face a lack of opportunities in essential services such as education, employment, health services, and participation. In some instances, people with disabilities may also feel isolation and discrimination.

Moreover, people with disabilities have limited access to the internet and social media because of their disabilities. Some of the challenges that they face while interacting with social media are misreading or misunderstanding the information presented on the screen (for people with visual disabilities), lack of IT skills to use social networking sites, and so on. Such aspects negate the concept of democratic government and limits social inclusion. Participation in social networking sites promotes social inclusion by participating in online discussions, online campaigns, and activities such as games. Such activities increases the sense of belongingness, and in return, society can be benefitted from their abilities, ideas, and opinions (Kampert & Goreczny, 2007).

Implementation of user Interface and user experience in social media

User interface and user experience play a vital role in the success of an application. The questions of how to make the applications engaging and efficient to the public directly add to the usability of the application. User interface and user experience come hand in hand when we measure the usability of a system. User interface refers to the actual layout of a page, whereas user experience refers to the feeling that users feel as they use the system (Hayes, 2014). These factors have to work together to make an application work efficiently from the user's perspective. The user interface of social media applications depends on designing the interface in a user-friendly manner that can be accessible to a large group of people as the main purpose is to connect as much as possible.

Evaluation of user interface and user experience in existing systems

Many factors need to be considered while designing an effective user interface for any website and web application. Factors like current trends and patterns in existing systems help us understand the user requirements and expectations from such a system (Hayes, 2014). According to Hayes on User Interface Design on Online social media, elements such as user-centered mentality, relationships/interactions,

user interface patterns and trends are necessary to understand to design a user interface that is engaging to users. These factors help user use the system in a comfortable and user-friendly manner.

1. User-centered mentality

   According to UI professionals Michael Cummings, considering user-centered mentality is one of the most necessary factors for the success of any interactive system. The basic interpretation of any interactive system implies that the user experience while using the system. However, its usefulness is not given much attention, due to which the system eventually falls short. Cultural aspects, beliefs, and shared expectations are aspects that the user expects while interacting with the system (Hayes, 2014). Thus, he emphasizes that the outcome of the user experience of any system depends on how the users' mentality is taken into consideration throughout using the whole system.

2. Relationships/ Interactions

   Social media allows users to maintain online relationships, form a community, and gives the user a sense of a community in a virtual world. Easy access to interacting with long distant friends and family using social media make users feel comfortable to build networks in the online platform.

3. UI patterns and modeling

   According to a computer scientist, Eric Nilsson, utilization of screen space, interaction processes, and system design play a vital role in the usability of a system. A user expects the system to work on any devices that the user wants to operate. For this, the design should be responsive, and the user should be able to access and use the system from any device (Hayes, 2014). In addition to this, an easy interface to access the features, seamless navigation throughout the webpages are key factors in the success measure of usability of the system.

4. Trends

   Social media nowadays allows users to send long text messages with images and multimedia files attached to them. Social media like Facebook allows users to attach files with messages, making the system engaging for social interaction and also accessible data sharing services. Additionally, Snapchat

and Tiktok allows users to send short and informal interactions, which is increasing in popularity (Mittmann et al.).

State of Art

User experience with existing social media

Social media has become a common ground for millions of people to create online networks outside the physical human interaction network. Some of the most popular social medias are Facebook, Twitter, and Instagram. Each of them represents different types of social media as they work differently and have a various purpose. Facebook, founded in 2004, is a social networking site where users write posts, can like and comment on other posts and share personal information along with profile pictures and various forms of multimedia like images, video, audio (Smith, Fischer, & Yongjian, 2012). Facebook also allows users to chat individually and, in a group, make phone calls and video calls through “Messenger”. With a vast pool of features, Facebook allows users to form networks and help them engage with one another. Unlike Twitter is a form of microblogging site where users are allowed to publish content in not more than 140 texts, which is also called “tweet”. The tweets can be replied to and shared. Twitter allows user to broadcast the information with ease and help them built networks and engage in discussion (Zhao & Rosson, 2009). Another social media, Instagram, helps users post pictures and allows users to interact and share with multimedia such as images and videos (Liu, 2017). There are many other social networking sites where users can make networks and interact with each other for various purposes.

Researches claim that adapting social networking sites has proved beneficial in involving users and also promotes transparency in governance by the usage of online feedback system in such systems. Moreover, social networking sites provide user-friendly and cost-effective access to governmental services and information, which are goals of e-governance (Bertot, Jaeger, Munson, & Glaisyer, 2010). However, to engage maximum involvement of user groups, it is essential to evaluate whether such systems are accessible to people with disabilities.

Web Accessibility

According to ISO 26800 in 2011, accessibility is defined as the extent to which people with the widest range of capabilities can use products, systems, or services

to achieve a specified goal (Steel & Janeslätt, 2017). In the present world, accessibility is considered as one of the fundamental rights and points out that every solution should be accessible to everyone regardless of their capabilities (Schreuer, Keter, & Sachs, 2014). World Wide Consortium's (W3C) launched a set of principles with guidelines known as Web Content Accessibility Guidelines (WCAG) 2.0 in 2008 to be followed by web developers to make the web content accessible. Norway adopted the concept of universal design as a legal requirement in all the sectors and as a requirement for ICT solutions. Under Section 18 in Norwegian Anti-Discrimination and Accessibility Act, it is stated that ICT-solutions must be universally designed (Fuglerud, 2014). Similar regulations have been implemented in most countries of Europe and the United States (Sverdrup, 2018). Also, Section 4 of the Norwegian Anti-discrimination act requires all the web solutions to be designed in accordance with WCAG 2.0.

Web accessibility in social media

Adaptation of accessibility features in the system and measure of usability are key factors for maximum participation of users while using any system. Despite this, popular social networking sites like Facebook, Twitter, LinkedIn which are hubs for millions of users have some accessibility-related issue which limits people with disabilities in using this system. Researchers claim that online platforms are even more important for people with disabilities since their access is limited due to their disabilities and should be considered as key stakeholders of social media. Accessible social media can deliver opportunities for engagement in various services and greater participation in the community (Brown & Hollier, 2015).

On the contrary, there are some gaps in the accessibility in the existing platforms which creates exclusion. Örebro municipality chose some of the services of social networking sites such as Twitter and Facebook to evaluate the accessibility of thesis systems among blind users. Although there are various techniques to assess webpage accessibility, the research mainly focused on the navigability and perceivableness of the system. The features like navigation of the page, alternative text in images, captions in videos were the primary focus of evaluation (Husnain, 2011). Husain, in the study, uses expert evaluation, user testing, and automatic tools such as screen reader, WAVE to measure the accessibility of the systems. On performing the evaluation, the study shows an average of 32 alternative text

problems on the Facebook webpage and 17 on the Twitter webpage. The author also claimed that the users who were recruited in user testing to navigate the webpage using screen readers found some major issues in the navigability of both systems. For example: there were many missing alternative texts for non-text contents in both webpages. (Husnain, 2011).

Similarly, in a case study related to accessibility of Facebook for Brazilian elderly, the author explores the issues faced by the elderly when interacting with Facebook. The author also uses WCAG guidelines to measure the accessibility of the system and focuses on only a few main pages to check them against WCAG guidelines and user testing. From the task designed to evaluate the accessibility, it was found that 12 of 20 accessibility check points were non-compliant with WCAG guidelines for the elderly (Sacramento, Ferreira, Capra, & Garcia, 2019).

Evaluation of Accessibility and Usability

Accessibility Testing

Accessibility testing is a testing process of determining the degree to which people can use and access the product and system regardless of their capabilities (Bai, Mork, & Stray, 2017). The goal of any universally designed solution should be maximum participation of diverse group users in using the product (Sverdrup, 2018). There are various methods that do not involve users to check the accessibility of the software. Automated checkers, guidelines and accessibility standards, and user testing are popular methods to check the accessibility of the software (Sverdrup, 2018).

1. Automated Testing

   Using automated tools for checking the accessibility of the websites is a fast and easy approach. Developers use automated testing using automated tools during the development process to validate the output of the system (Bai et al., 2017). Automated tools such as WAVE, Google Lighthouse, A-Checkers, SiteTool Accessibility are some standard accessibility tools that developers use to check the accessibility of their websites and web applications. Such tools are handy and make the testing process fast.
2. Assistive Technology

The contents of the software should be accessible to the greatest extent possible. Incorporating assistive technologies can support making the system accessible. Therefore, assistive technologies like screen readers and high contrast are some of the technologies that can be used during the technical testing process among the testers to check the accessibility of the contents (Bai et al., 2017).

3. User Testing

   The best approach for checking the accessibility of any software is user testing. User testing involves actual users, which can help to uncover unforeseen bugs in the system. Also, developers do not have to develop the products under the assumption of impairments and mental states. However, the process is an expensive method since it requires recruitment of actual users and planning to manage them. Therefore, it is even more important to find as many problems as possible before involving users (Bai et al., 2017).

Automated checkers such as Web Accessibility Evaluation Tool (WAVE), online tools help to evaluate the accessibility of a web page for any given URL (WAVE Web Accessibility Evaluation Tool, 2020) faster and with less effort. Assistive technology like screen readers and high contrast can help evaluate web applications before involving the users in the testing process. Developers can use these assistive technologies to approximate possible issues that can be faced by users with disabilities and make efforts to mitigate them as much as possible (Bai et al., 2017).

Usability Testing

Usability testing involves observing the users as they try to complete the task or use the designs for interaction. This testing method is highly recommended to gain contextual information of the usage among the users prior to the deployment. Through usability testing, we can uncover the design flaws that are overlooked by the designers and developers and also helps to access the performance of the system. Usability testing techniques may vary from company to company, where the testing approach can be a quantitative, qualitative, or both.

Concepts of developing a system

Agile development

Software development lifecycle refers to the development time of lifecycle that comprises planning, design, development, testing, and deployment. There may be several sub-processes within these processes. For any software to deliver in time and to generate value, stakeholders must find out what type of software development suits their demands (Ruparelia, 2010). Among various methods, agile is most commonly used in software companies. Agile software development is a method where a project is broken down into smaller sub-projects to develop and deliver small parts of the system fast. This software development lifecycle produces results in a short time and can further be sent to test and redevelopment. Continuous testing and improvement ensures better quality and bug-free system (Bai et al., 2017).

Agile with user-centered design

The agile process aims to deliver small software modules to the customer in a very short period with continuous development and testing throughout the software development lifecycle (Bai et al., 2017). Meanwhile, the user-centered design approach advocates considering the user's needs and requirements before the development. Both these process focuses on making a quality software which involves the customer requirement from the very beginning. Despite having a common goal, integration of user-centered design with the agile process is not very common in the software development lifecycle (Da Silva, Silveira, Maurer, & Hellmann, 2012).

While agile development processes and user-centered design (UCD) are considered to have come from different disciplines of the software development lifecycle, the integration of agile processes with user-centered design is slowly starting to gain focus in software development in many companies (Ferreira, Sharp, & Robinson, 2012). The agile process in user-centered design allows iterative development, which facilitates usability testing allowing to incorporate results of previous tests into the subsequent iterations, thereby constantly improving the quality of the software from the very initial phase of development (Da Silva et al., 2012). The flexibility and adaptability offered by the agile process support usability of the solution. In this thesis, we will be integrating the agile process in user-centered design (UCD) in the

development process to achieve better usability and accessibility of the application among a large group of users.

Implementation WAI-ARIA user interface for accessibility

With the launch of WCAG 2.0 by W3C, there has been an increasing demand among developers to implement WCAG guidelines in developing websites and web applications. Developers use Rich Internet Applications (RIA) such as HTML, XHTML, CSS, JavaScript, XML to make dynamic and interactive web contents. Formulation of WCAG in web development requires developers to make web contents that assistive technologies can support (Abu Doush, Alkhateeb, Maghayreh, & Al-Betar, 2013). This is helpful for people with disabilities who use assistive technologies such as screen readers to navigate the web contents. WAI group introduced WAI-ARIA specifications to improve the dynamic web pages accessible, usable and interoperable with assistive technologies. WAI-ARIA provides semantics that helps developers to embed accessibility properties in HTML and XHTML encodings (Linaje et al., 2011). Some of the examples of accessibility properties in HTML and XHTML are adding roles, properties, and states in web elements. Adding roles gives purpose to the section, and adding states and properties define characteristics that affect the interactions. Similarly, the use of the tabindex property helps in accessible keyboard navigation and is supported by assistive technologies such as screen readers.

In the next chapter, we discuss the evaluation criteria for system development, accessibility, and usability evaluation criteria, methods used for system development, accessibility and usability evaluation methods, testing process, and data collection process.

Methodology

In this chapter, we first define the evaluation criteria for our system. Then, the next task will be to describe the methods and frameworks used to develop the system and define the approaches taken to fulfil the accessibility among the targeted users. We then evaluate our system based on evaluation criteria and perform analysis.

Definition and purpose

This research is a part of a larger ongoing project ran by AFI, which started in 2014. Authors of “The Amplifier Effect: Oslo Youth Co-creating Urban Spaces of (Be)longing”, who are also the team members, have investigated various ethnographic methodologies such as story sharing and workshops to explore youth potential and engage youths in urban planning. While the research shows promising results, the team further aspires to investigate if digital technologies can help maximize engagement and empowerment (Tolstad et al., 2017).

In effort to investigate further, we developed a web application named MinBy. MinBy means “My City” in Norwegian. The system was developed with the intention to investigate how web application can be used to engage youths in community development and e-governance. Minby is a desktop web application like other social medias like Facebook and Twitter. Youths share ideas, opinions, and agendas related to the surroundings where other users of the application like and comment on the post. Later, the application is expected to be a valuable platform for governance to address the issues and agendas and bring change to the community.

Choice of technologies for system development

The user interface of the system is implemented using a client-side JavaScript framework Vue.js, and server-side implementation is done using PHP, which uses the Laravel framework. Data transfer between client and server is achieved using Asynchronous JavaScript and XML (AJAX) technology, where data representation is transferred in JavaScript Object Notation (JSON) format.

System Design

To design the prototype of the system, we used Adobe XD. Adobe XD provides various tools for designers to design pages quickly and efficiently. It allows users to edit and update designs, comment on the designs and copy the CSS of the modules during frontend development. Designs of the pages and features were inspired by

popular social networking sites such as Facebook and Twitter. The features that were developed will be described in the results section.

Frontend Development

Vue.js is a popular event-driven frontend JavaScript framework used to build a user interface. Vue utilizes the virtual Document Object Model (DOM) to manage the view. In order to update a small section on a page, vue.js creates a copy of the original DOM and makes changes to only the intended part without having to reload the whole page. This increases the performance of the application making it fast and content in few pages without taking so much of the computer resources. Vue delivers a good user experience by providing seamless UI changes (Linh, 2019).

Backend Development

Laravel is an open-source platform with a PHP framework that helps developers create elegant and expressive syntax. It offers a structured way of coding by providing built-in programs and lightweight templates. The platform follows Model View Controller (MVC) pattern, which allows better project documentation and improves performance. Building APIs in Laravel is easy and provides a secure framework for data protection. It also has good community support (Linh, 2019).

We used Vue.js with Laravel to develop the application. The reason why Vue.js is preferred with Laravel is that it allows developers to build the frontend with reactive components that support event-driven functionalities, which helps developers to implement the security aspect of PHP as well as smooth transitioning and updates of components with the help of Vue. Moreover, with more than two years of experience in backend development, I was confident in developing APIs using Laravel. I chose Vue to work in the front end also because of my experience in using both systems in my previous development projects. Also, the community for Vue.js with Laravel is vast, which provides various optimal solutions for developing the web application in an efficient way. Also, it is easy to implement accessibility features in Vue.js. Vue.js has the ability to manage high frame rates, which provides better performance than other popular JavaScript frameworks known as React.js and Angular.js (Linh, 2019).

Defining the criteria for user interface and user experience design

It is important to find out qualities and features that make the application engaging to the user. For this, designers must consider factors such as simple design and easy

interaction, attractive and relatable designs, and user engagement. We have defined the user interface and user experience design on the following elements with respect to the research.

1. **User-centered mentality**

   The application is useful for users that are looking for applications to engage themselves in community development activities. Minby allows users to share ideas and opinions on an online platform and opens room for discussion. It helps user maintain their profile and search for users in the application.

2. **Relationships/ Interactions**

   Minby allows users to have online discussions with features like comment and like the post. This gives the user the feeling of participation in e-governance and community development activities. Easy access to information and simple functionalities makes users feel comfortable using the application.

3. **UI patterns and modeling**

   Interaction processes and design of the system are inspired by Facebook as it gives a feeling of easiness to users to use the application. The function of the web application is responsive through desktops, tablets, and mobile phones, making services available to use the application seamlessly. Consistent navigation with obvious keywords and menu icons helps users to adapt the features to the application.

4. **Trends**

   Like Facebook, Minby allows users to send both long and short text messages with images while posting ideas and agendas. This gives users a platform for easy data sharing.

Differences with respect to existing social media

Minby is primarily focused on youths to share opinions and ideas and discuss issues around them. It has been developed to promote social inclusion among a diverse group of young people who are not directly involved in governance most of the time. Social media allows users to share such information and open platform for online discussions, campaigns, and awareness. However, researchers claim that people with disabilities often do not use these applications because of complex functionalities and inaccessible features (Lee et al., 2014). Also, one of the prime aspects to engage maximum users is easy access to information and simple and

intuitive designs (Hayes, 2014). Therefore, Minby allows users with a clear purpose to post ideas and agendas with simple features and very few transitions through pages to avoid confusion. The application is compact with minimal but relevant functionalities, thereby making it easy to use. Moreover, we have tried to implement a maximum of WCAG guidelines while developing the system to make it accessibility compliant.

Overall workflow sketch of the system

Figure 3.1 gives an overall view of processes that the user carries out in the system. Based on the requirements of the project and researches on current trends, users' mentality, and usability aspects of social media, we came up with the following criteria.

1. The first users should have a registration page
2. The registered user should have a login page
3. The users should be able to reset their password
4. The users should be able to view and edit their personal information
5. The users should have easy access to write posts
6. The users should have easy access to view posts
7. The users can like, comment, and save posts. Like, comment, and save will be represented in icons, which are simple and intuitive to the users
8. The users should be able to edit and delete their posts
9. The users should be able to adjust the contrast of the page
10. The user should be able to search for relevant information. Easy access to search functionality
11. Prevent users from making mistakes by showing warning signs
12. Ability to save posts for future references
13. The user should be able to navigate easily throughout the website.
14. The website should run on all the browsers
15. The application should support images to be published

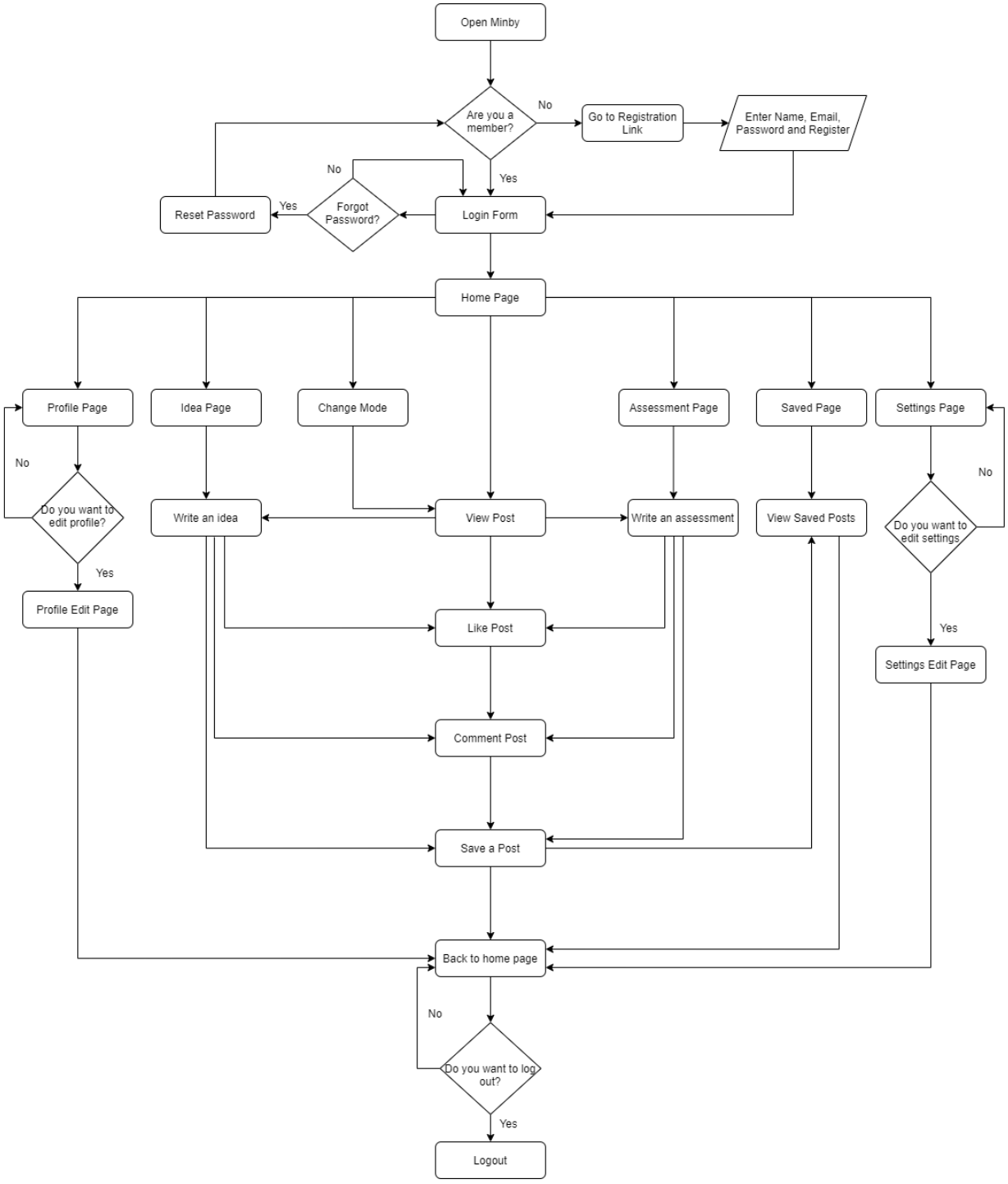


Figure 3.1: Flowchart of Minby

Definition of accessibility and usability evaluation criteria

We present a table, that maps out the features developed in the Minby application against WCAG guidelines. The evaluation criteria shown in table 3.1 are based on WCAG guidelines and principles. We followed the evaluation criteria in system development and evaluated the system based on the guidelines.

WCAG Principles	Features	Guidelines	Level of Conformance
Perceivable	1. Use of alternative text in image files and icons	1.1 Text Alternatives	A
	2. Contrast Features	1.3 Adaptable	AA
	3. Use of Color	1.4 Distinguishable	A
	4. Simple and intuitive use of functional icons in like, comment and save features	1.1 Text Alternatives	A
Operable	1. Make all the web contents accessible through keyboard only	2.1 Keyboard Accessible	A
	2. Enough time to view posts and personal information. No use of timers and sessions	2.2 Enough Time	AAA
	3. No use of animation to avoid flashes	2.3 Seizures	A
	4. Simple and easy navigation	2.4 Navigable	A, AA
Understandable	1. Use of most common terms in menu and navigation to make contents understandable	3.1 Readable	A
	2. Simple and intuitive use of icons in like, comment, and save features	3.2 Predictable	AA
	3. Error identification and prevention in forms	3.3 Input Assistance	A, AA
	4. Understandable label in user input	3.3 Input Assistance	A
	5. Consistent Navigation	3.2 Predictable	AA
	6. Ability to edit and delete personal information and own posts	3.2 Predictable	AAA
	7. Consistent function throughout the application	3.2 Predictable	AAA
Robust	1. Supports browsers like Google Chrome, Firefox, Microsoft Edge and Safari	4.1 Compatible	A

Table 3.1: Evaluation criteria of accessibility testing in Minby

Agile development with user-centered design

We used the agile software development approach because it is considered one of the most effective approaches to develop a system. We divided the system into sub-modules and developed separately for the fast delivery of the module. It is a type of iterative approach where a system is developed and tested in repetition to remove the bugs and improve the feature in each phase.

First, we divided the software development into various sprints, and evaluated each design and functionalities and redesigned continuously to achieve user satisfaction. The visual representation of the agile development process with accessibility and

usability testing is shown in Figure 3.2. Since the development process is iterative, it can be visualized as a cyclic process with three significant phases: requirement analysis and research, (re)design, and evaluation shown in Figure 3.2. Different testing methods such as user testing and technical accessibility testing, such as testing with automated checker and WCAG guidelines and testing using assistive technology such as screen readers was carried out in the application to evaluate the accessibility is also mentioned in Figure 3.2.

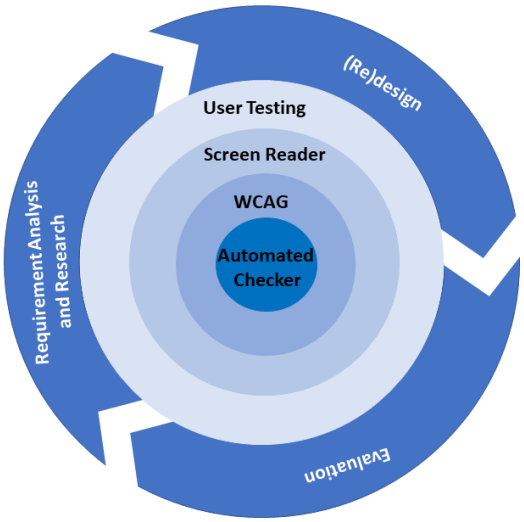


Figure 3.2: Agile Development Process with Accessibility and Usability Evaluation

Requirement analysis

In this phase, we focused on gathering all the necessary information for developing the prototype. Before we started development of the application, the research team of AFI conducted a quick and dirty prototype testing of a prototype among a group of high school students. We also gathered information on question following questions to analyze the requirement of the product: what theme of color would be appropriate for such application? what do youths expect in an application? What are the problems faced by the youths in posting views and comments in any applications? From users' feedback, it was decided that blue color would be the primary theme color of the web application after testing some of the pages among the youths. We also decided that the login and registration in the application should ask for minimal personal information.

Later, after the system development, requirement analysis was done through feedbacks of the participant based on accessibility and usability of the developed

system. It was also done during the software development process while testing the application with automated testers and programming.

(Re)design

The users' stories that were defined in the requirement analysis phase were later taken into consideration in the development of features in the system. The system is designed in a client-server model. Its user interface runs in web browsers like Google Chrome, Mozilla Firefox, Microsoft Edge, and Safari. We developed a version of software in each iteration and tested with the end-users prior to the development of the entire software. We evaluated and reported and addressed the concerns and functional errors in the next iteration and released new version for evaluation.

Evaluation

This phase involved testing, data analysis, drawing results, and evaluating the developed prototypes. The feedbacks we gathered in this phase were then analyzed to make necessary changes and forwarded for the redesign of the solution. The feedbacks were collected through accessibility testing methods such as automated tools, results from screen readers and user testing. Evaluating the system continuously helped to ensure a bug-free and robust

Implementation of WAI-ARIA in System Development

We used semantics provided by WAI-ARIA to develop accessible web contents. Some of the WAI-ARIA semantics implemented are the use of roles, properties, and states in regions, tabindex and focus in menu and buttons, aria-labelledby for form field labels, alt in not-text contents such as images. We used vue.js to generate dynamic web contents in frontend development. Figure 3.3 shows an example of implementation of semantics of WAI-ARIA such as tab-index, role in the menuitem of the application.

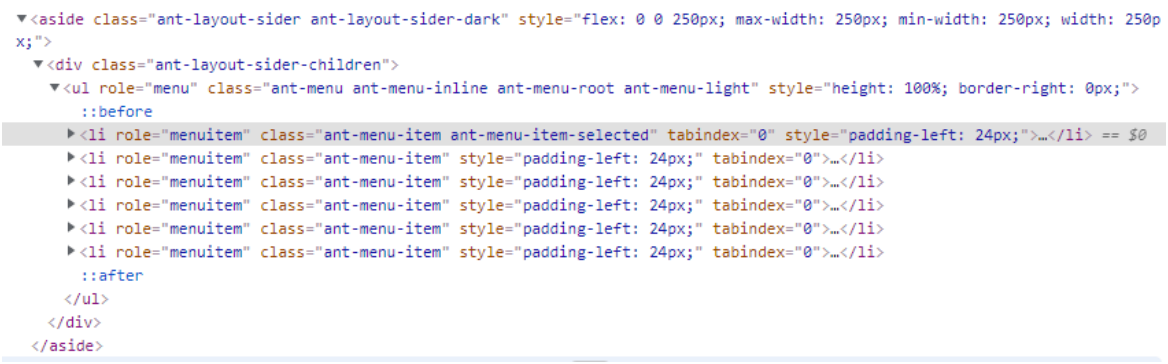


Figure 3.3: Example of implementation of WAI-ARIA in Minby Menu

Software Deployment

After each design and development in iteration, the codes were deployed in the web hosting server. We used Amazon Elastic Compute Cloud (EC2)[3] web service to host and launch our application as it provides services to launch applications for free in free trial version. It also comes with various premium packages that allows seamless resize of the cloud capacity of servers of applications. It was necessary to deploy each version of application for further testing and evaluation. The application can be accessed by visiting the webpage, Minby (http://ec2-13-51-72-125.eu-north-1.compute.amazonaws.com/#/)

Research Methodology

The main objective of this thesis is to investigate how accessible web applications can help youths to contribute to community activities. While the result could be converse, we tested the application with quantitative research.

In this thesis, we developed a web application accessible to the greatest extent possible regardless of the disabilities. It is also viable in such research to find the attitude of the users towards using such applications or the reasoning behind their preferences to use or not use such applications. Studying such behaviors would incline our research more towards qualitative study. However, this thesis only focuses on determining if the user can use or access the contents in the application even when the user is facing certain kinds of disabilities.

Testing and System Evaluation

Testing is one of the most critical processes that need to be carried out to ensure software quality. We carried out different kinds of testing to check the accessibility and usability of the system during the development process and later among the targeted users. Since agile development strategies were adapted with user experience design, questions related to user interface and user experience were prime aspects of validating the system.

Testing methods used in System Development

1. Functional Testing

[3] https://www.amazonaws.cn/en/ec2/

We carried out functional testing such as component testing, integration testing, and functional testing, which are common functional testing methods that were carried out by software developers in the development process. Component testing is carried out by running scripts to check possible bugs in the system and then forwarded for debugging. Integration testing is used to check the interaction between modules of the same system is done in the correct way. Communication between program modules is important to develop entire software (Hooda & Chhillar, 2015). Forms, search functionalities, navigable menus are some of the essential features in any web applications that were tested during the development of functionalities and features. The response from APIs and interaction with database also falls under functional testing

2. Non-functional Testing

   Non-functional testing, such as user testing, is done to check the non-functional features of the system among end-users. It evaluates the value of the product according to its usability regardless of functional features. We performed user testing among targeted users to check the accessibility and usability of the system and to check if the system can deliver what is expected. Data collected during the testing process was used for analysis in the next chapter.

Accessibility and usability evaluation methods used in system development lifecycle

WCAG 2.0 is considered as the de-facto standard in the process of development of the application as well as in the testing process. To make websites accessible, usable, and interoperable with assistive technologies, web developers should implement the guidelines set in evaluation criteria for accessibility to meet the desirable measure of accessibility. We used techniques such as automated checkers, assistive technologies, and user testing for the evaluation of the accessibility and usability of the application.

1. Automated Checker

   We tested the web pages in the application using automated testing such as the WAVE Evaluation Tool and Lighthouse tool. WAVE is an online tool that evaluates the accessibility of a web page (WAVE Web Accessibility Evaluation Tool, 2020). Since the tool is free of cost and also reliable to check

accessibility in a faster and easier way (Sverdrup, 2018), we used WAVE to evaluate the accessibility automatically. Google Lighthouse[4] is an open-source, automated tool that helps in auditing a web page. It is mainly used to improve the performance, accessibility, and quality of the web page.
Both tools are extensions of the Google Chrome browser, which made the testing process faster.

2. Assistive Technology
   We used HTML elements given by WAI-ARIA in the development of the application to make sure that the features are compliant with keyboard accessibility features, text alternatives, consistent navigation. Implementation of HTML elements like labels, tab-index helps people with visual disabilities to get the information that they cannot see and navigate through the web page using a screen reader. We tested the accessibility of the application using a screen reader. We used the Talkback screen reader of MacBook Pro, which is embedded into the computer itself. Using screen reader, the main criteria to be fulfilled was keyboard accessibility of the functionalities, alternative texts, forms, and navigation through keyboard only. We also tested some usability features by putting ourselves into the position of a user and tried to use the application from the user's point of view.
3. User Testing
   We took the survey in an iterative process. A version of the system was developed and tested in each phase. In the next phase, all the issues encountered by the participants were taken into considerations. We fixed the reported bugs, improved the features, and added more accessibility features in the next version.

Data Collection

We used accessibility and usability testing methods to test Minby to verify its effectiveness among the users. The survey was divided into two parts: pre-survey and post-survey. The first phase consisted of five participants, followed by the second phase with five more participants. In each phase, we collected their responses, took notes of bugs that they encountered, and also got some

[4] https://developers.google.com/web/tools/lighthouse/

recommendations. The following testing phase would be an improved version of the application with better accessibility features and fewer bugs. At the same time, we also added features after analyzing the requirements.

Selection of Participants

All the participants were young people between the age of 15-30 years old.
We took the survey of 6 participants in the first phase, another 6 participants in the second phase, and 6 participants in the third (final) phase. There were 18 participants altogether, with 27.8% and 72.2% of the distribution of female and male for the data collection. With the feedback we collected, we were able to find out the bugs, know issues that were unidentified during development, and also some requirements from the user's point of view. In the next phase, the system was an improved version of the previous one. In this way, we were able to implement the user-centered design with an agile approach.

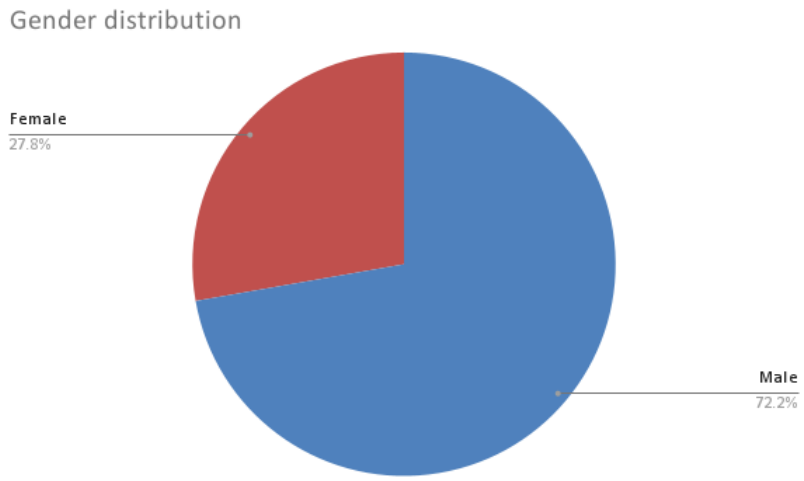


Figure 3.4: Pie chart showing number of participants in the survey based on gender

Why 6 participants per iteration?

Usability testing is considered as costly and time-consuming process. However, Neilsen (2009) proposed a cheap user testing method which involved small number of participants, also known as discounted user testing (Nielsen, 1997). In addition, according to the research conducted by Neilsen, 5 participants are enough to get 80% of the usability findings (Jakob, 2000). Thus, we implemented same practice and recruited 6 participants for each iteration based on the time constraint for the research. However, in the same study, Neilsen also mentioned that the study may not be able to predict usability issues it targets diverse group of users (Jakob, 2000).

Procedure

The selected participants were informed of what the survey was about and its purpose. They were informed of the procedures to be carried out and were asked to sign the consent form before the interview. All the terms and conditions written in the consent form will be requested to be read before the signing process. The survey was divided into pre-survey and post-survey for the same group of participants. Pre-survey was taken before performing the task, and a post-survey was taken after completing the task. We used Nettskjema[5] to build forms for the survey. After answering the pre-survey questionnaires, the participants were asked to use the developed application and perform specific tasks. We noted any kinds of difficulties or issues that the participants faced during the experiment. The duration of the survey was an average of 30 minutes. The participants were allowed to have breaks of approximately 5 minutes long in between the survey and tasks and also had the choice to withdraw from the process if they wished to do so. Figure 3.4 shows the data collection procedure implemented for this survey.

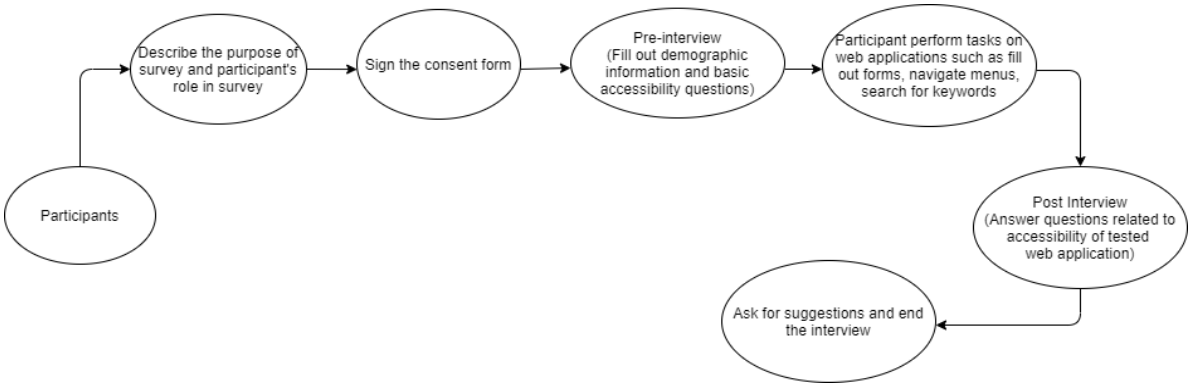


Figure 3.5: Procedure for data collection

1. Pre-survey

   Pre-survey comprised of questions about demographic information and 13 questions related to the thesis topic. The questions were related to the use of ICT solutions and online applications in their life. In the pre-survey, the users were asked questions related to the accessibility of existing systems, their interest in participation through the online platforms, and their issues. This survey was helpful for us to figure out the user's mentality and expectations

[5] https://nettskjema.no/

and issues that they encountered while using the existing platform. The questionnaires are attached in Appendix 1.

2. Tasks

   After the first series of the pre-survey, the participants were asked to use the developed application. For the task design, we use participant tasks designed by Shawn Lawton Henry, facilitator of WAI Site Task Force of EOWG (WAI Site Task Force of EOWG, 2003). We made changes to the task design according to the requirement of our research. However, we considered the task design by Henry as our base for task design. The participants were asked to perform tasks such as searching for information, filling out the forms, navigating the menus and links, and changing different modes. The list of tasks that were given to users to perform is attached in appendix 2.

3. Post-Survey

   After the task completion, the users were asked to fill out the form, which contained questions related to accessibility and usability and their overall impression of the application. We designed 20 accessibility-related questions by comparing the functionalities and features of the application with the WCAG guidelines. The questions related to usability were taken from WAI Site Usability Testing Questions (WAI Site Task Force of EOWG, 2003) and SUS. SUS is considered one of the most common practices to measure usability (Brooke, 1996). In addition to these, we also prepared some questions that were based on the premise of the application and its use. The questionnaires of post-survey are also attached in the Appendix 1.

4. Quantification of data

   All the questions were multiple-choice questions with answer choices as strongly agree, likely agree, likely disagree, and strongly disagree. For the quantitative analysis, we quantified the answers by mapping them with a score from 4 to 1, with strongly agree being a score of 4 and strongly disagree as a score of 1. However, some of the questions gave negative meaning. For example, question number 3 of the post-survey is “I found some icons and text confusing.”. For such questions, the score was flipped with 4 representing strongly disagree and 1 to strongly agree.

Ethical Considerations for data collection

To carry out the research and data collection process, we sent an application to the Norsk Senter for Forskningdata (NSD) for permission to carry out the research. NSD is an organization that assesses ethical requirements in projects publishing data collection in Norway. The application has reference number 889626 that we prepared for NSD, and it is attached to this thesis. Please refer to Appendix 4. After we received the permission, we were able to perform the survey among targeted user groups. All the personal information taken from participants has been kept confidential, thereby maintaining data integrity.

Methodologies used for data analysis

After the data collection process, the next task was to visualize and analyze the data and see the patterns. For this, we imported all the data that we have collected in a CSV format file in our local computer. We used Python[6] 3 as a programming language for data visualization and analysis. Python is a programming language used in various fields such as software development, machine learning, image processing, and data science. It is widely popular for tasks like data scraping, data visualization, and data analysis as it provides a large pool of in-built functionalities and libraries for such tasks. We used Python in Jupyter Notebook[7] , an open-source web application that allows us to perform tasks such as data cleaning, statistical modeling, and data visualization. For data visualization, we used python library, matplotlib[8].

We used vertical bar graphs for pre-survey questionnaires. In the pre-survey, our main focus was to see the trends of user experiences and preferences. Thus, we believe, vertical bar graph was most appropriate to visualize the frequency of each question in the form of a bar.

We used box plots to analyze the data. Box plot is one of the techniques to visualize the data and also used for comparing groups of data. The box plot uses the highest and lowest data points, median, and quartiles to convey the spread and level of the distribution of data (Williamson, Parker, & Kendrick, 1989). Since a box plot is

[6] https://www.python.org/
[7] https://jupyter.org/
[8] https://matplotlib.org/

considered to be efficient for comparing a group of data, we considered it as the most appropriate way of analysis for post-survey.

In the next chapter, we discuss the results of software development and testing and the results that we draw from data visualization and analysis.

Results

In this chapter, we present the results that we obtained from software development, user testing and automated testing. Furthermore, we also present data analysis from the data that we collected through user evaluation of the Minby application.

System Development

In this section, we discuss the modules that were developed in each phase, changes made in the modules, and the reasons behind the change. The application consists of five main modules that a user experiences while using the application which are as follows:

Registration

The registration feature registers first-time (not registered) users. The form takes the name, email, and password of the user. After the registration process, the user gets a verification mail to the registered email address and is redirected to the login page. We had initially planned to allow users to register and log in using social links such as Facebook and Google. However, we were not able to develop this feature within the given time constraint. Thus, it was removed in the second iteration.

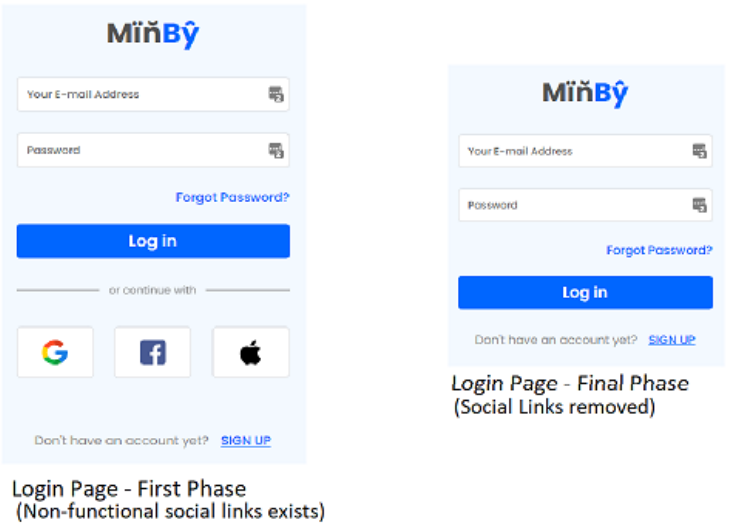


Figure 4.1: Login Page (First Phase versus Final Phase)

Login

Login is an authentication process where the user logs in using their email address and password. In case the user forgets their credentials, we developed a functionality through which the user can reset their password using their email address. After successful user authentication, the user is directed to the home page.

As shown in figure 4.1, the social icons were removed in the second iteration as they were less prioritized and were not eventually developed within the given time constraint.

Home Page

After the user logs in, the first page that they land on is the home page which is shown in figure 4.2. Figure 4.2 shows the final design of the home page. The post page consists of four main sections, which are as follows:

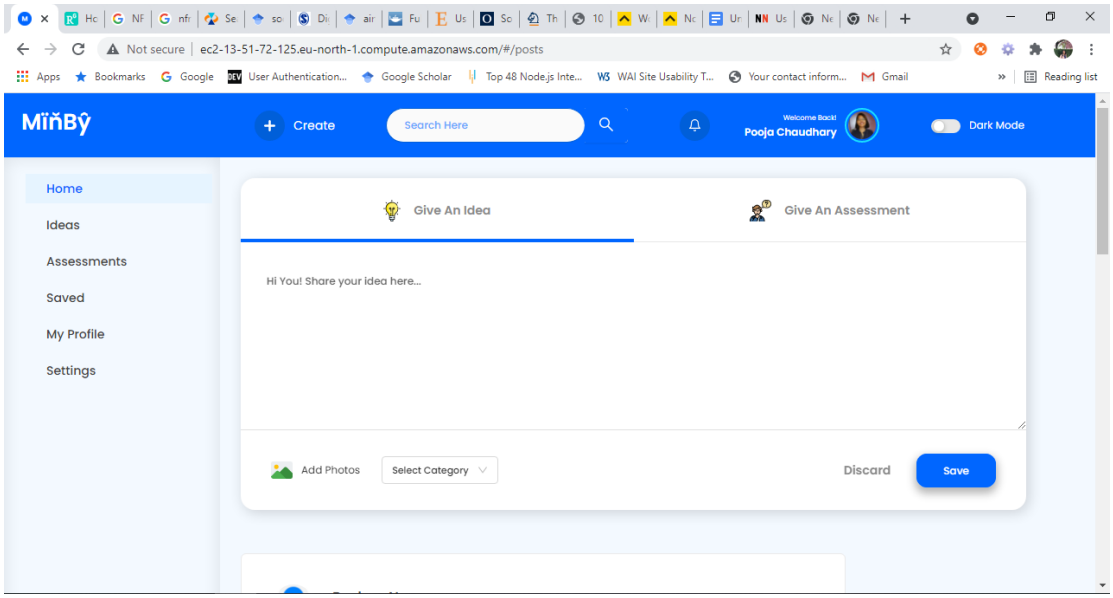


Figure 4.2: Home page of Minby with navigation, menu, and post section

1. Navigation Bar: Navigation consists of a logo, search functionality, mode change, and profile link section. This bar remains the same throughout all the pages. Figure 4.3 shows the change in the design of the navigation bar from the first phase to the final phase of development. The changes were mainly related to the color contrast of web contents and keyboard accessibility features, error handling and warnings.

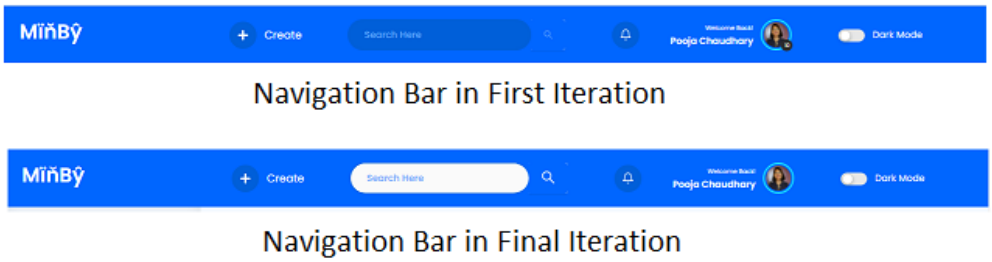
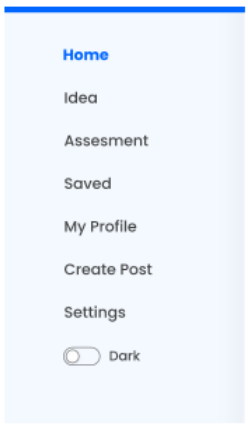
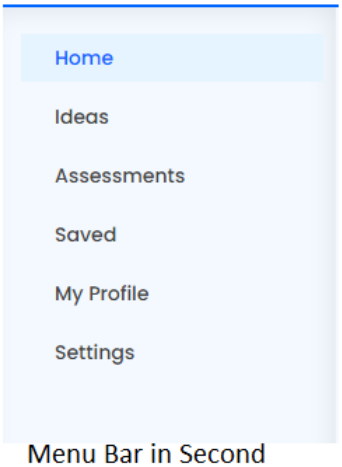


Figure 4.3: Navigation bar of Minby with logo, search option, profile link, and mode change option (First phase versus final phase)

2. Menu Bar: The menu bar consists of menu items that direct to different pages as the user clicks them. The menu bar consists of a home page link, idea page link, assessment page links, saved post page, and settings page. Like navigation, the menu bar also remains the same throughout all the pages. In the second iteration, we removed redundant menu links. Also, the option to change mode was made available in both the navigation bar and menu bar in the first phase. We removed this feature from the menu bar upon the feedback received from participants.



Menu Bar in First Iteration



Menu Bar in Second Iteration

Figure 4.4: Menu bar with page links (First phase versus final phase)

3. Post Section: The post section is where the users can post their ideas and views. Since posting ideas and assessments is the main focus of the application, we made sure that users can easily access them as soon as they login. This way, they can post in a simple and easy way. We also decided to reuse the same space for ideas as well as assessment. Therefore, we came up with a tab concept where users can switch either to idea or assessment by clicking through the tabs. At the same time, users can write their posts in the same area. The post has categories where the user selects which category it belongs to. For example, the user writes a post related to built surroundings such as buildings, libraries; the post belongs to “built surroundings” category. Moreover, users can also add images to the post to give a better interpretation of the information.

   Based on the feedback received from the participants from the first iteration, we decided to increase the color contrast of all the texts and images. Also, users kept on making mistakes in the select category option. Thus, we

decided to highlight the border of the element to make it more visible. No changes were made to the design after the second iteration.

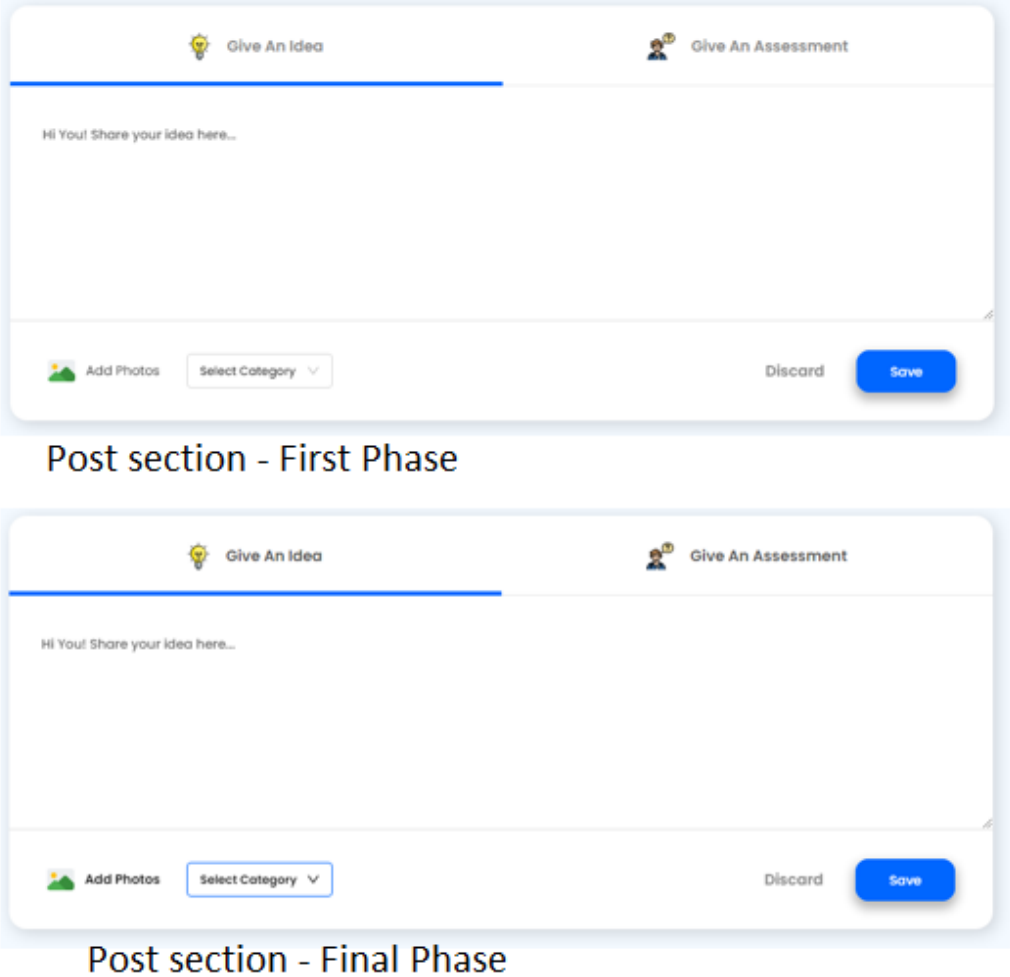


Figure 4.5: Post section (First phase versus final phase)

4. Posts List Section: The fourth section consists of lists of posts, either idea or assessment by all the users of the application. The posts are also identified by their categories. Some of the categories are social, built surroundings and policy. The user can also like, comment on posts and save posts. Further, the user can edit or delete their posts through edit and delete functionality, respectively. Based on feedbacks of each iteration, we made the following changes:

   Changes made after the first iteration

   - Functionality to edit and delete the post from the posts list. Initially, the user had to go to the detail page to perform edit or delete action.
   - Functionality to save the post

- Higher color contrast for text

Changes made after the second iteration

- Removing non-functional icons such as share icon
- Adding category to identify the category of the post

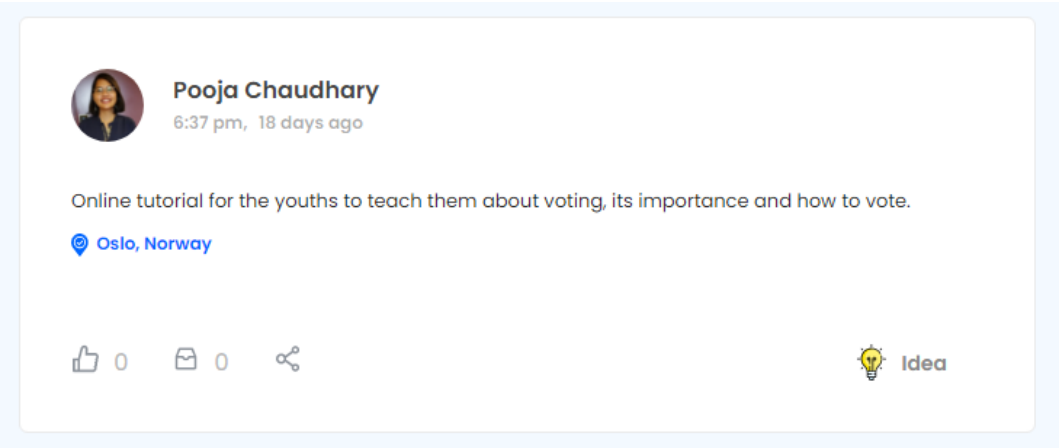


Figure 4.6: Post in post list section – First Phase

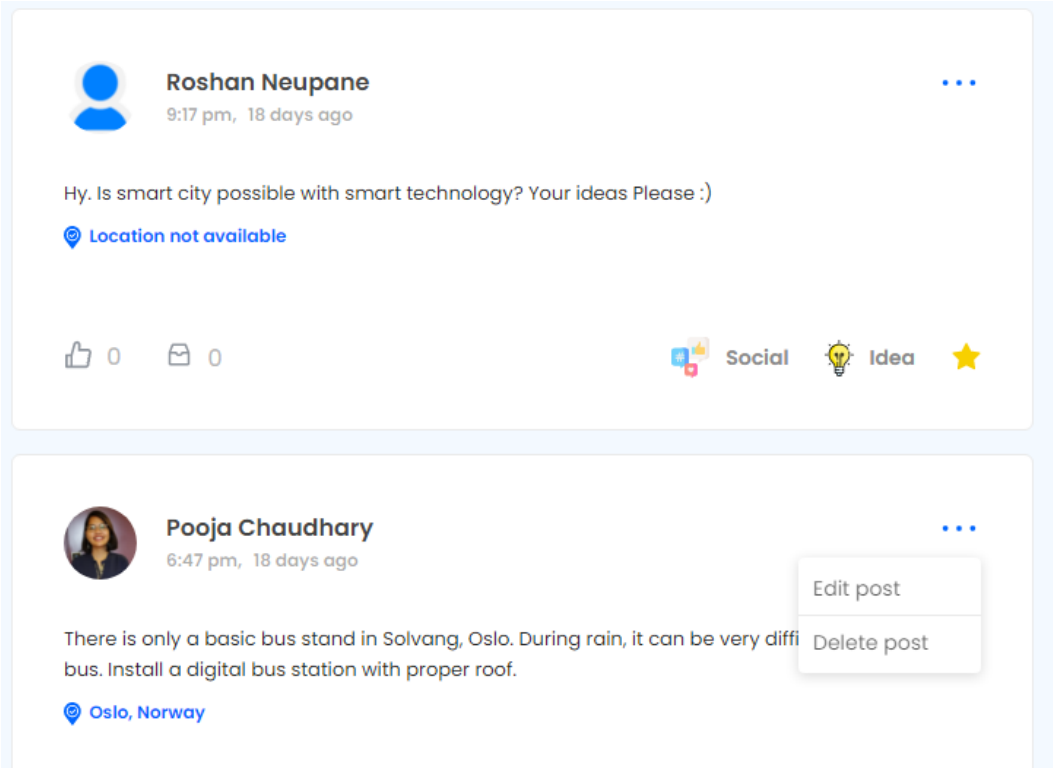


Figure 4.7: Post in post list section – Final Phase

Profile Page

The users were able to view and edit their personal information such as address, name, municipality, and other personal information on the profile page. Also, user can view their previous posts on this page.

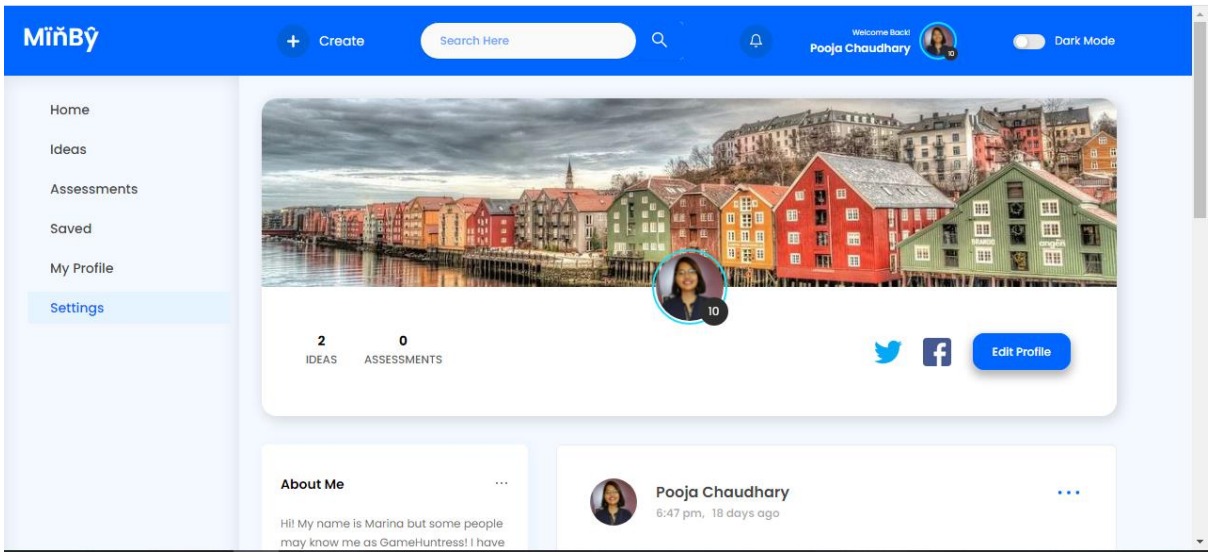


Figure 4.8: Profile page of Minby with navigation bar, menu bar and profile description – Final version

Settings Page

The settings page consists of two forms: Change Password Form and Edit Social Links Form. In the change password form, the user can change their password, and users can also edit their social links in the social links form. The changes made in the social link are reflected on the profile page.

Testing

The results for the automated testing, testing using assistive technologies (screen-reader), and user testing are presented as follows:

Automated testing

WAVE Evaluation Tool: While testing through all the pages through WAVE, we found that the login and registration page had relatively fewer accessibility issues in comparison to other pages that had more contents. Most issues were related to contrast throughout the page and were immediately addressed and, there were few missing form labels which were also fixed in the final product. There were no errors found related to accessibility of the web elements. However, the page got the warning for having redundant alternative texts for non-textual contents. We have attached the result of testing the home page with WAVE in appendix 5

Lighthouse Tool: We used Lighthouse to check the overall accessibility of the webpage. It gave an 89 percent of accessibility score for the home page in the final product. The tool illustrates that the application has passed 89% of accessibility test. We also got the suggestions regarding page structure. This means, we can increase the accessibility of Minby by implementing more accessibility features. The result of automated testing using the Lighthouse tool for the home page is attached to appendix 5.

Assistive technologies

While testing the keyboard accessibility of the application using screen readers, there were few errors that we found in the initial phases. All of the errors that were identified were fixed.

Data Analysis of User Testing

After we gathered data from the participants, the next step was to analyse and see the trends of data.

Pre-survey Data Analysis

For pre-survey, since the questions were related to the use of online platforms, users' views on accessibility of existing systems, their interest in participation through online platforms in community development and e-governance, we performed a vertical bar graph to represent the data. We found that all the scores were between a range of 57 to 64, where 72 was the maximum score of each question. We obtained an average of 60 with a median 60 of and a standard deviation of 2.7. From the statistics, we found that most participants showed higher interest in community participant and felt that there was not enough platform for engagement in community development. The statistics also shows that the participants believed online platforms could potentially be used for participation. The visualization can be seen in figure 4.10.

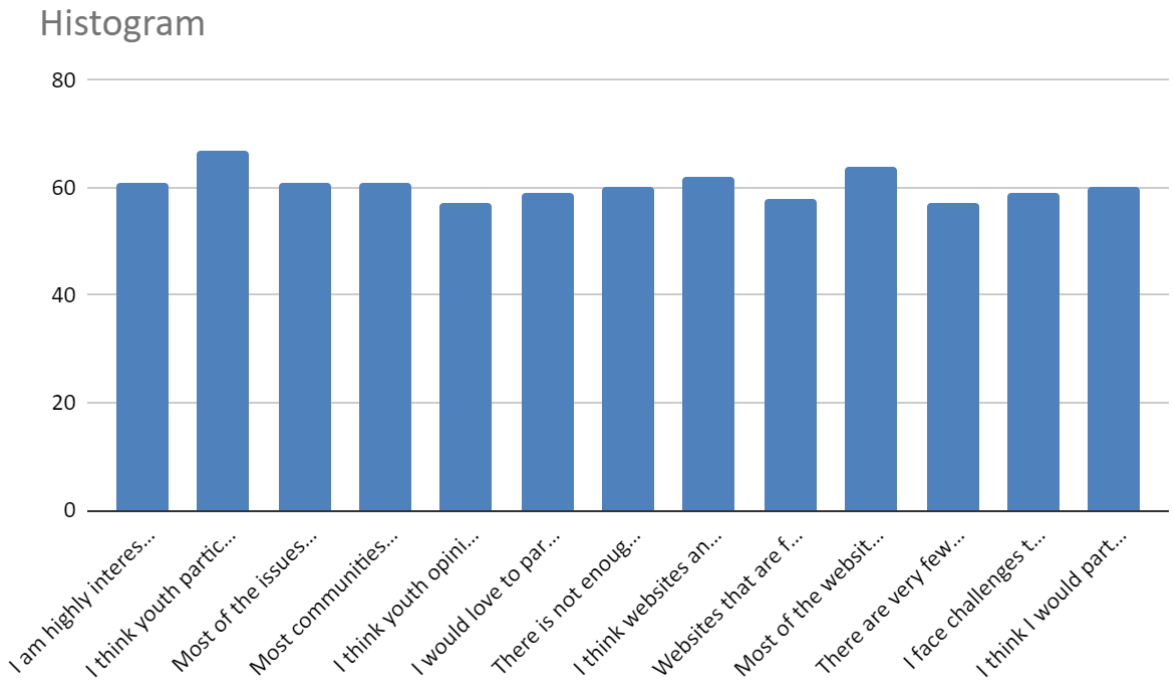


Figure 4.9: Bar graph showing the total score of each question in pre-survey of all iterations. X-axis represents the questionnaires and Y-axis represents score

Post Survey Data Analysis

For post-survey, we performed data analysis in each phase and compared them to see the change in accessibility and usability score. The scores are presented in table 4.1.

	PreQuestionnaire	PostQuestionnaire	Accessibility Related	Usability Related
FIRST ITERATION	46	121	66	55
	46	116	60	56
	45	98	49	49
	44	93	46	47
	45	96	50	46
	36	98	50	48
SECOND ITERATION	44	98	49	49
	52	132	70	62
	44	118	56	62
	42	128	66	62
	42	124	62	62
	39	133	68	65
THIRD ITERATION	47	127	67	60
	38	131	73	58
	45	118	60	58
	41	115	67	48

	45	118	60	58
	45	121	62	59

Table 4.1: Total score of each participant in pre-survey, post-survey, accessibility-related questionnaires, and usability related questionnaires in each iteration

Box Plot Analysis

For the overall score of accessibility and usability, we obtained an average of 103.7 in the first iteration with a median of 98 and a standard deviation of 11.7. In the second iteration, the average was 122 with a median 126 and a standard deviation of 13. Similarly, the average was 121 with a median 119 and a standard deviation of 6 for the third iteration.

In figure 4.11, the first three box plots, FI, SI and, TI represents the overall (accessibility + usability) score for first, second and third iteration, respectively. In figure 4.11, we can see that, there is a significant increase in the overall score of accessibility and usability questionnaires from the first iteration to the second iteration and decrease was seen in mean and median from second and third iteration. Altogether, there is increase in overall score as we moved from first iteration to last (third) iteration. This signifies that with implementation of agile practices in system design and development and evaluation process aided in increase of the overall accessibility and usability of the system.

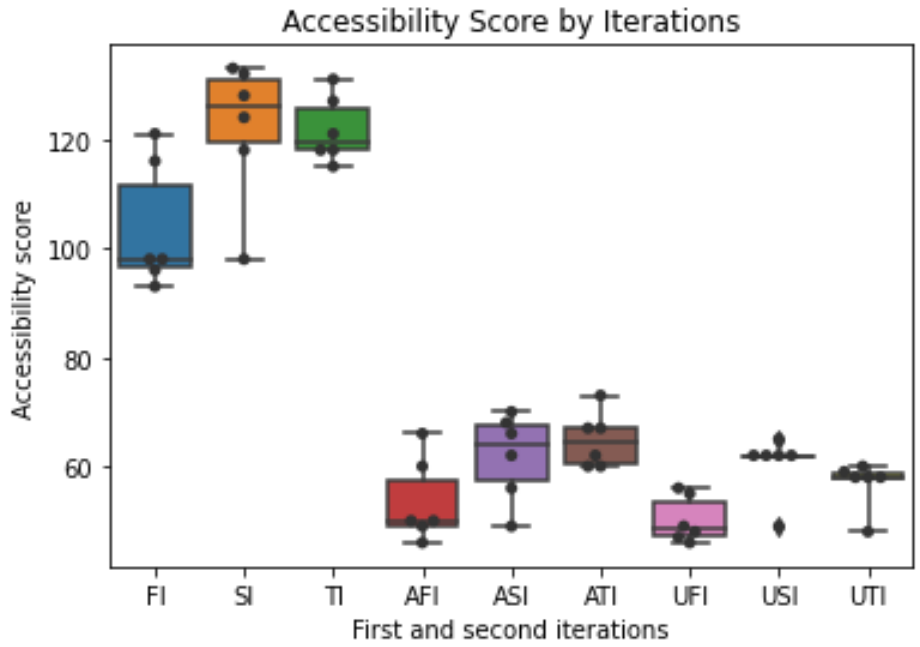


Figure 4.10: Boxplot analysis of score versus iterations where X-axis represents iteration and Y-axis represents accessibility score. Here, FI = overall score in the first iteration, SI = overall score in the second iteration, TI = overall score in the third iteration, AFI = accessibility-related in the first iteration,

ASI = accessibility related in the second iteration, ATI = accessibility related in the third iteration, UFI = usability related in the first iteration, USI = usability related in the second iteration and UTI = usability related in the third iteration

Furthermore, we performed the data analysis by separating the accessibility questionnaires and usability questionnaires to see each of their results independently. For accessibility, the mean for the first, second and third iteration was 53.5, 61.8 and 64.8, respectively, median of 50, 64 and, 64.5 respectively, and standard deviation was 7.7, 8 and, 5.1, respectively. The fourth, fifth and sixth box plots in figure 4.11, show the box plot of accessibility score in the first, second and third iterations, which are represented by AFI, ASI and ATI, respectively. The box plots show a significant increase in score while comparing the first and second iteration but do not change significantly for second and third iteration. This means the accessibility of the application increased from first iteration to second iteration but remained almost same from second to third iteration. This is expected as the accessibility issues encountered in one iteration was addressed and tested in the next iteration. Thus, implementing agile approach aided in increase in accessibility of the application.

Likewise, the last three box plots in figure 4.11, represented by UFI, USI and UTI, show box plot analysis of usability score of first and second iterations, respectively. The average score of usability related questionnaires was 50 in the first and 60 in the second iteration and 57 in the third iteration. Median was 48.5, 62 and 58 in the first, second and third iteration, respectively, and the standard deviation was 4.2 in first, 5.6 in the second and 4.4 in the last iteration. From the figure and statistics, it can be seen that there was a significant increase in usability score while comparing first and the second iteration but only a slight decrease was seen in the usability score for second and third iteration. This shows that, like for accessibility, the implementation of agile practice also positively impacted the usability of the application.

The overall analysis shows that the accessibility and usability of the system independently increased when we implemented the agile approach with user-centered design. This also verifies that the increase in overall score was contributed by both factors: accessibility and usability of the system and not by just one.

Next, we also wanted to study what are the features that contributed in the increase in overall accessibility of the application. For this, we first mapped with the WCAG

guidelines and success criteria with the features of the application, grouped some of the questionnaires that gave similar meaning and performed box plot analysis separately. The result of analysis is discussed below in detail.

1. Use of Color, Color Contrast, and Text

   Question 7: The contrast of the web contents was easy to my eyes.

   Question 8: I was able to change the contrast of the display whenever necessary.

   Question 12: I found some of the graphical contents irritating and lost focus while performing the task.

   Question 10: I was able to resize the fonts that fitted my viewing.

   The scores obtained from each participant for the above questions were first added. On doing so, we found out the average score to be 11 in the first iteration, 12.6 in second and 12.3 in the third iteration. The median was 10, 13 and 12 for each iteration, respectively and standard deviation was 1.67, 1.86 and 1.5, respectively.

Iterations ->	First	Second	Third
Use of color, color contrast and text	14	11	12
	10	13	15
	12	10	11
	10	13	13
	10	14	11
	10	15	12

Table 4.2: Overall score of accessibility questionnaires related to use of color, color contrast and text

The visualization of the score patterns was done through box plot, which can be seen in figure 4.12.

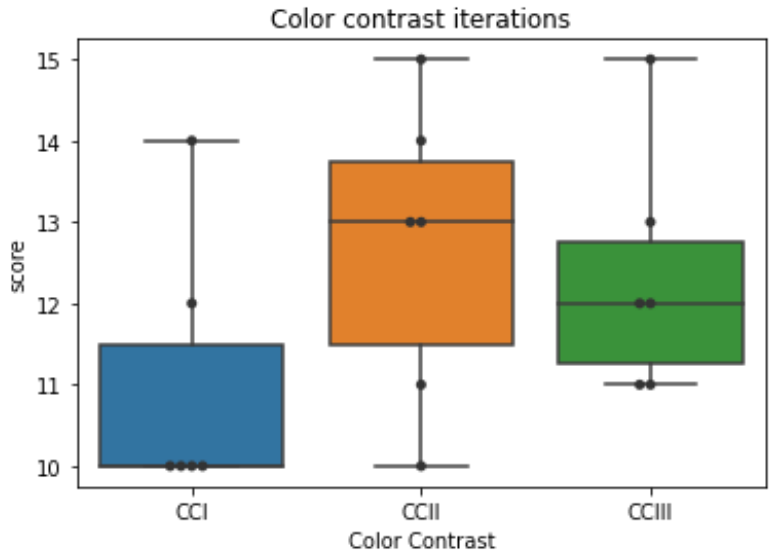


Figure 4.11: Box plot analysis accessibility score for first and second iteration for questions related to the use of color, color contrast. In figure 4.12, CCI represents the first iteration, and CCII represents the second iteration

From the analysis, we can see a sharp rise in the mean of the overall score of questions related to the use of color and color contrast in the second iteration with respect to first iteration but a slight decrease was seen from second to third iteration. This shows that the accessibility associated with the use of color and color contrast increased in second iteration and somehow remained same with a very slight decrease in third iteration. Thus, we can also say that accessibility related to use of color, color contrast and text contributed in the increase in overall accessibility of the system.

2. Navigation

   Question 13: The menu bar was easily navigable.

   Question 9: I was able to easily locate and use the search functionality in the webpage.

Iterations ->	First	Second	Third
Navigation	6	5	8
	8	8	7
	4	6	8
	5	7	7
	5	7	8
	5	8	8

Table 4. 3: Overall score of accessibility questionnaires related to navigation

Similar to the questionnaires related to use of color and color contrast, we added scores of questions 13 and 9; questions related to navigation. We achieved a mean score of 5.5, 6.8 and 7.6 in first, second and third iteration, respectively with median of 5, 7 and 8 and standard deviation of 1.3, 1.1 and 0.5, respectively. The accessibility score for navigation related questions was as plotted in box plot which can be shown in figure 4.13.

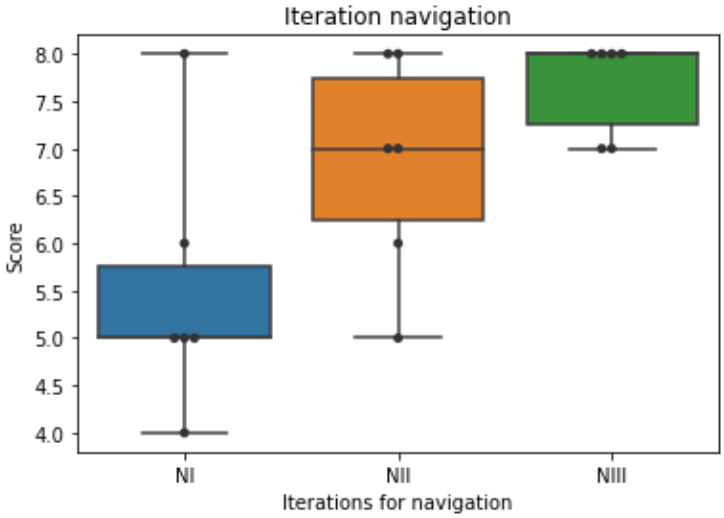


Figure 4.12: Box plot of accessibility score for first and second iteration for questions related to use of navigation. NI represents the first iteration, NII represents the second iteration and, NII represents the third iteration for navigation

The overall mean of the score drastically rose from the first iteration to the second iteration and further increased from second iteration to third iteration. However, for the third iteration, the increase was not as significant as for the second iteration. This shows that, accessibility related to navigation was improved as the iterations progressed and further contributed in overall accessibility of the system.

3. Keyboard Accessibility

   Question 5: I was able to use all the functions using the keyboard only.

   Question 6: I was able to use the functionalities with input devices like mouse and touch screen

Iterations ->	First	Second	Third
Keyboard Accessibility	6	4	8
	4	8	7
	3	4	6

	4	4	6
	5	4	5
	6	4	5

Table 4.4: Overall score of accessibility questionnaires related to keyboard accessibility

For the analysis of keyboard accessibility features, we first added the scores achieved from question 5 and 6 as they were related to keyboard accessibility performed the analysis. From this, we got an average of 4.6, 4.6 ad 6, median of 4.5, 4 and 6 and standard deviation of 1.2, 1.6 and 1.1 for first, second and third iterations. Additionally, we performed box plot analysis of the results of the accessibility score which is shown in figure 4.14.

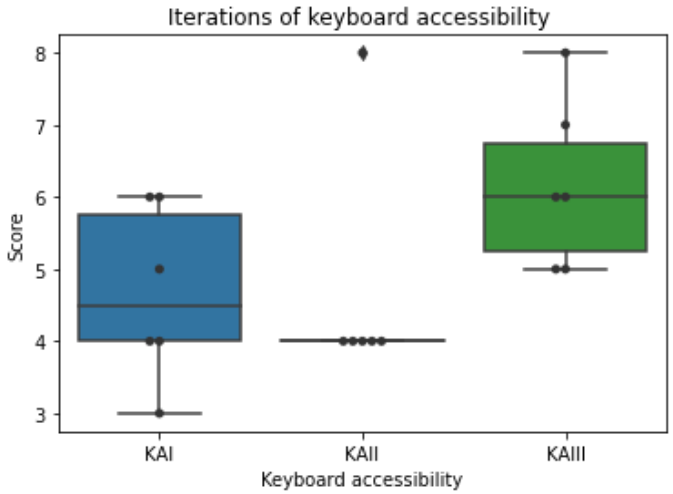


Figure 4.13: Box plot of accessibility score for all iterations versus keyboard accessibility where KAI, KAII, KAIII represents first, second and third iteration respectively for keyboard accessibility

We can see a decrease in the mean score related to keyboard accessibility from the first iteration to the second iteration from figure 4.14. It was because we were not able to measure keyboard accessibility features with the users precisely. Only 5 out of all the participants knew how to use the keyboard accessibility feature in their computer. This task was formerly designed for the people who use screen readers to access the contents in the application. However, we could not test keyboard accessibility and text alternative features among the people who do not interact with visual contents and features of the application. Therefore, the task was not performed by majority of the participants and later on reflected the result on their survey answers. But we can also see that in third iteration, the score increased in comparison to first and second iteration. This was because, relatively more number of

participants knew how to use this feature in the third iteration. Thus, the results drawn from this analysis is not precise enough to make claims on the keyboard accessibility features of the application. Perhaps, the result would be different if we had tested the application with people with visual disabilities and people who uses screen readers.

4. Readable and Understandable text content

   Question 1: All the information on the website was understandable.

   Question 2: The icons and pictures used in the website were easy to follow.

   Question 3. I found some icons and text confusing.

   Question 4: The functional icons and links were intuitive.

   Question 11: I was able to understand the warnings and messages provided by the website.

Iterations ->	First	Second	Third
Readable and understandable text content	16	13	15
	13	16	17
	13	15	14
	13	20	13
	13	17	13
	14	18	16

Table 4.5: Overall score of accessibility questionnaires related to readable and understandable text content

The sum of the scores of the questions related to readable and understandable text content is shown in table 4.5. The mean of the score was 13.6, 16.5 and 14.6, median was 13, 16.5 and 14.5 and standard deviation was 1.2, 2.4 and 1.6 in first, second and third iteration, respectively.

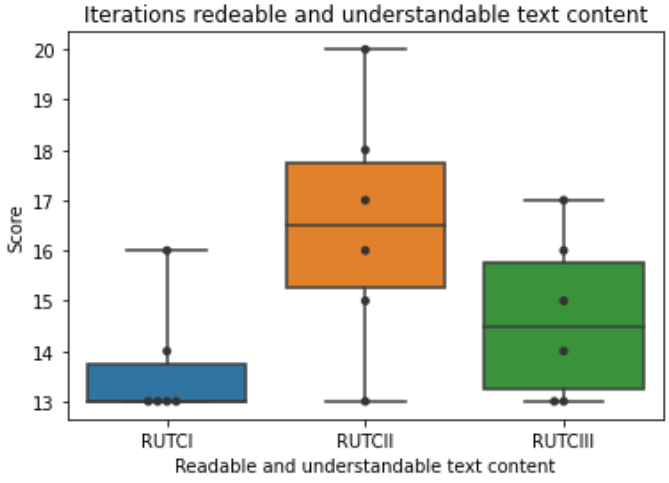


Figure 4.14: Box plot analysis of accessibility score for all iterations for questions related to readable and understandable content where RUTCI, RUTCII, RUTCIII represents first, second and third iteration for readable and understandable content, respectively

We also analyzed the questions that are readable and understandable text content using the box plot which can be shown in figure 4.15. There was a significant increase in accessibility score for readable and understandable text content in second iteration with respect to first iteration. However, there was decrease in score in third iteration. This signifies that the accessibility of application decreased for readable and understandable text content.

5. Consistent Navigation

   Question 14. I found variations in navigation in different pages of websites.

   Question 15. I found the navigation and design of all the web pages consistent throughout the website.

Iterations ->	First	Second	Third
Consistent navigation	8	4	6
	6	7	8
	5	5	8
	4	7	8
	5	5	6
	4	6	8

Table 4. 6: Overall score of accessibility questionnaires related to consistent navigation

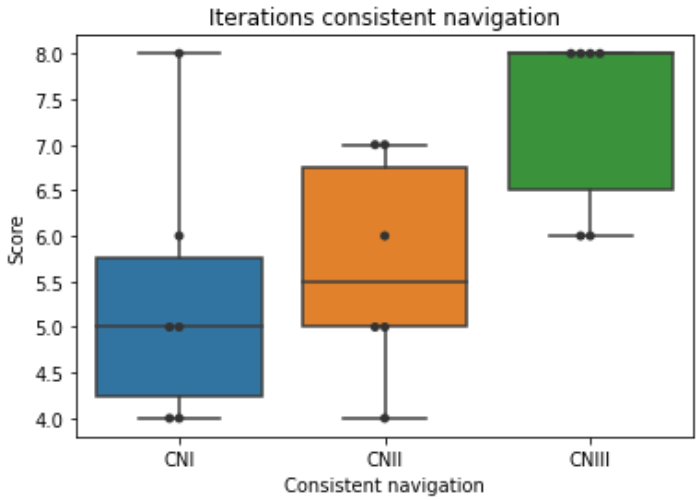


Figure 4.15: Box plot analysis of accessibility score for all iterations for questions related to consistent navigation where CNI, CNII, CNIII represents first, second and third iteration for consistent navigation, respectively

Like navigation, the same trend was followed in the accessibility of consistent navigation also. The overall accessibility of navigation increased gradually with iteration while following the agile approach.

6. Error Identification, Prevention, and Suggestion

   Question 16: I got an error warning when I entered the wrong format in the field of the form.

   Question 17: The form provided suggestions for the format of text to be filled.

   Question 18: I found it difficult to fill out forms in the website.

Iterations ->	First	Second	Third
Error identification, prevention and suggestion	12	6	10
	10	9	11
	8	9	9
	6	10	12
	8	8	10
	7	9	7

Table 4. 7: Overall score of accessibility questionnaires related to error identification, prevention and suggestion

For the questions related to error identification, prevention and suggestion, the average score was 8.5, 8.5 and 9.8 in first, second and third iterations with median of 8, 9 and 10, and standard deviation of 1.6, 2.1 and 1.3 respectively. The box plot analysis of score related to error identification, prevention and suggestion can be seen in figure 4.17.

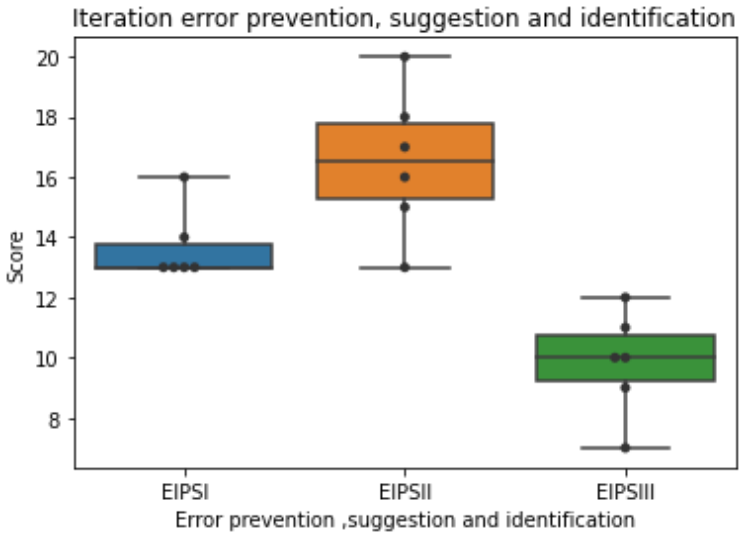


Figure 4.16: Box plot analysis of accessibility score for first and second iterations for questions related to error identification, prevention, and suggestion where EIPSI, EIPSII, EPSIII represents first, second and third iteration for error identification, prevention, and suggestion, respectively

Unlike for navigation and use of color, there was a decrease in the accessibility score for questions related to error identification, prevention, and suggestions. When we interviewed the participants, they commented that they had issues while adding the category. They got the warning but were not able to understand the warning until a few attempts. Some participants also commented that there were no appropriate suggestions for form fields and recommended to give relevant information of the form field. Thus, the accessibility of the application decreased in case of error identification, prevention and suggestion even when agile approach was practiced.

7. Change of Request

   Question 19: I was able to edit/delete the posts on the website.

Iterations ->	First	Second	Third
Change of request	1	3	4
	4	4	4
	3	4	3
	2	3	4
	3	3	3
	2	4	3

Table 4.8: Overall score of accessibility questionnaires related to change of request

The score related to change in request is shown in table 4.6. As only one question was associated to change of request, we obtained same value of mean and median, which was 2.5, 3.5 and 3.5 and standard was 1.04, 0.5 and 0.5 in first, second and third iteration respectively.

Figure 4.17: Box plot analysis of accessibility score for first and second iterations versus change of request where CRI, CRII and CRIII represents first, second and third iteration for change of request respectively

The box plot analysis of the accessibility score of change of request can be seen in figure 4.18. For questions related to change of request, there was an increase in accessibility score from first iteration to second iteration but remained constant in the third iteration. In the first iteration, participants encountered some inconsitency and errors while performing the task of editing and deleting forms in the application. The errors were fixed in the second iteration which increased accessibility score related to change of request. However, we did not change anything related to edit and delete features after the second iteration. Thus, accessibility of change of request improved altogether as we progressed through iterations.

8. Compatible

   Question 20. I was able to browse the website from different web browser of my choice.

   The accessibility score related to compatibility is shown in table 4.6. We also performed box plot analysis which can be seen in figure 4.19. The average and median score was 2, 2 and 4 for first, second and third iteration and standard deviation was 0.5, 0.8 and 1.2 respectively.

Iterations ->	First	Second	Third
Compatible	3	2	4
	3	4	4
	2	2	1
	2	2	4
	2	2	4
	2	3	3

Table 4.9: Overall score of accessibility questionnaires related to compatible

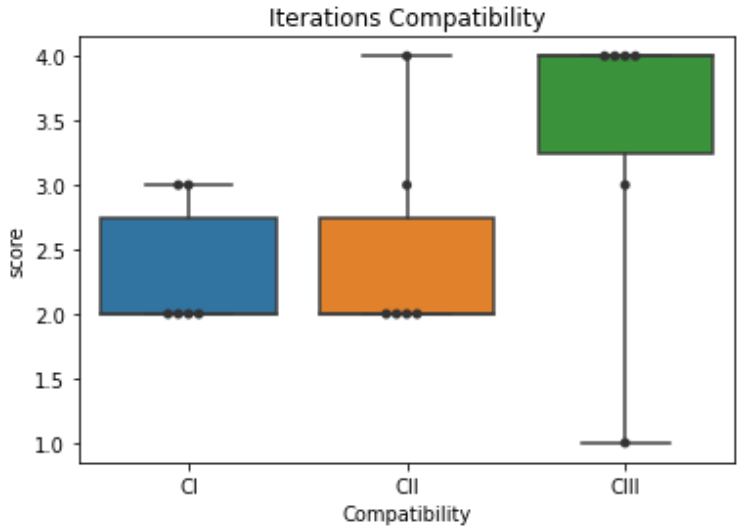


Figure 4.18: Box plot analysis of accessibility score for first and second iterations versus compatibility where CI, CII, CIII represents first, second and third iteration for compatibility respectively

We asked the participants to browse the application in browsers of their choice. Most participants used Google Chrome for browsing the application. Some of them used Mozilla Firefox and Safari. All of them were able to use the application, and none of them had a problem with using features that were related to the compatibility of the application in relation to browsers. Thus, this was reflected in data analysis for accessibility score also. There was no change in accessibility score in first and second iteration and increased in third iterations. Thus, this shows that compatibility with browsers also contributed in increase in accessibility of the application.

In this way, we performed analysis of the scores obtained from user testing. The comparative analysis of accessibility and usability of the application with iteration helped us understand the impact of implementation of agile approach with user-centered design and system development. Therefore, from analysis, agile approach proves to have positive impact on the accessibility and usability of the application.

Questions on preferences

Question: Would you prefer using this website instead of other social media to post your opinions and agendas?

Question: Do you think this website can help youth engage in community development and e-governance by posting their views, opinions, and social agendas?

For the questions where we asked the participants how beneficial they found the use of the application, all of them and responded “yes”. Majority of the participants also pointed out that they would prefer using this kind of application that are solely dedicated to community development and planning, and e-governance rather than using social medias such as Facebook, Twitter. They pointed out that this kind of application is not only beneficial for certain age groups only but should be made available for all ages. Since these applications have a distinct purpose, they do not get mixed up with other posts, unlike other social medias like Facebook and Twitter.

Post interviews

When we asked for the overall impression and experience in using the system, most participants mentioned that they liked the design and color of the website. Some participants also liked how the workflow of the system was easy and simple to follow. However, 8 participants faced some difficulties while selecting the category in the “Post Ideas or Assessment” task. On asking them about it, they replied that it was barely noticeable for them the first time. They were able to figure it out only after the error popped out. They mentioned that they would have preferred if the category section was highlighted and made it more noticeable at the time of posting and also would help them to avoid mistakes. One of the participants, who was also a student of Universal design, pointed out that the keyboard accessibility can be improved and recommended on having choices to add more contrast options rather than just having dark and light mode. One of the participants suggested that good use of icons in the menu items would make the application more intuitive and more fun to use. Participant 17 commented that the platform was a good start and can be valuable for youths. Participant 15 commented that the application has good purpose to engage youths but that it would be of greater value if the agendas were addressed by the concerned authorities in future.

Summary of main findings

1. There was increase in the overall score of accessibility and usability from first iteration to last iteration.

2. Accessibility and usability scores also individually increased when the agile approach was practiced in system development as well as user-centered design.
3. Factors like the use of color, color contrast, navigation, and readable and understandable text contents contributed to an increase in accessibility scores. In contrast, accessibility decreased for features like keyboard accessibility and error prevention, identification, and suggestions.
4. Most of the participants found the application beneficial to engage youths in community participation.

In the next chapter, we are going to discuss about the outcomes of the study, limitations of the study and possible future works.

Discussion

From the previous chapter, after we considered the accessibility and usability of each iteration, we achieved the following findings through our research.

1. The accessibility and usability increased as we performed development and testing in iterations.
2. The agile development process with user-centered design is effective in increasing the accessibility and usability of web applications.
3. Most of the participants believed Minby could possibly be beneficial to increase youth participation in community development.

In this chapter, we evaluate these findings in detail.

Agile development was very effective process when incorporated with user-centered design as it provided us to understand users' mentality and expectations in the evaluation process. This information helped us fix issues and come up with better solutions in each iteration.

While comparing the overall accessibility and usability in each iteration, there was a significant increase in the score for the overall score. Also, when we compared accessibility and usability related questions individually, we saw a significant increase from the first iteration to the last iteration. Thus, both the accessibility and usability of the application increased. Even when we analyzed some core functionalities like navigation, readability, and understandability of web contents, color contrast, there was a significant increase in accessibility score for features like navigation, readability, and color contrast. However, there were still some factors that could be improved for better accessibility, such as error identification and suggestion and keyboard accessibility. Also, for some of the features, there were no significant changes — for example, compatibility of the application with browsers. Nevertheless, all of the improvements in the application were possible because of the iterative process while developing the application.

For some of the questions that were based on keyboard accessibility, there was a relatively low score in the accessibility seen throughout the iteration. This may be because most of the users did not know how to use the keyboard accessibility functionality. We would also like to mention that participants who were studying or

working in the fields related to universal design knew how to use the functionality. We also realized that such tasks would be relevant to the users who are used to interact the application with screen readers. We could not recruit any participants who use screen readers to interact with the system. Thus, we could not test the effectiveness of the keyboard accessibility features in the application to full extent. We may have achieved different feedbacks if we the participants with visual disabilities.

We realised that without user evaluation process, we may have never been able to recognize the requirements for an accessible and usable application. This is because the improvement of the application was only possible through user feedbacks.

What we could not find through the user testing and analysis?

Apart from these findings, there were some outcomes that we could not visualize through statistical data analysis but were able to gather the information on the basis of the user's recommendation and overall impression of the application. We could not test the relevance of the alternative text for non-text contents in the application. We were not able to recruit participants who use screen readers. Such features would be appropriate to be tested among the user groups who use non-visual content for interaction.

Another challenge that we encountered was that some participants kept on forgetting to select the category option while performing the task in the "Write post" section. Their comment on such action was because the field was not highlighted enough and did not catch their attention. Even though the color contrast of text and form elements were designed with a contrast ratio greater than 4.5:1 as mentioned in guideline 1.4.3 under principle "Perceivable" of WCAG 2.1, the users ignored the field and failed to perform the task in the first attempt. Participants suggested highlighting the section to make it more distinct. This indicates that applying accessibility guidelines to web contents may not be enough to make the content relevant to the user. Another possible logical explanation could be that the participants could not find the elements as they were using the application for the first time.

Users' perception on complexity of task

The findings of this research were based on feedbacks given by users in quantitative form. The participants were asked to choose from 4 answer choices where they agree or disagree with the statement in the survey. It is necessary to point out that the answers heavily relied on the users' perception and their preferences. For example: For questions based on the design of the application, the meaning of "easy" to use the application may differ from person to person. In the same way, there is the use of many such terms whose meaning can vary from person to person such as attractive. Meanwhile, we also want to emphasize that we used the same set of tasks and questions in each iteration. This gave us a robust foundation to perform a comparative study of data in each iteration. Comparative analysis and study of the effect of change of design would be difficult if there were different sets of tasks or even different sets of questionnaires in each iteration.

Most participants commented that this application could help youths channel their voices to the people in power and authorities responsible for making policy changes. This implies that the accessible applications could possibly be an effective tool that is dedicated to the engagement of youths in community development and governance. In future, inspired by the comments of the survey participants, it would be interesting to investigate how the ideas and solutions generated on the platform can be linked with the decision makers. We believe that by creating this connection would be beneficial and enable the solutions to be carried out in life and implemented into society more effectively. However, this would have to be investigated further.

We also know that the sample size is not significant enough to draw a firm conclusion. However, this research can be considered as preliminary research for future works related to this research area.

Limitations and Future Works

The research implies that online platforms like Minby, have potential to engage youths in community development. And the accessibility and usability of the application increased as we performed the iterative development and testing process by following the agile approach. Even though we implemented WCAG guidelines to create accessible web contents, it may not be sufficient to generate user satisfaction and result in the success of such systems. While the usability of an application highly

depends on various factors such as user preferences, experiences, behaviors, studying such aspects can be beneficial to improve the usability of the application. Such a study directs the research to a qualitative approach or mixed approach. Integration of quantitative and qualitative methods in the study can further help to identify undiscovered challenges and open new opportunities for improvements.

Also, we recruited 18 participants for the user testing process. Although the results incline to generate a positive attitude among the targeted groups to increase their engagement in community development, the numbers may not be enough to draw a generalized result. This may vary if we are to recruit more participants. Recruiting more users can possibly help find out unidentified bugs, uncover more opportunities for improvement of the system based on accessibility and usability.

Only developers tested the application using the Talkback accessibility feature of MacOS to test the keyboard accessibility using a screen reader. Even though, we tried to recruit diverse participants on the basis of gender, nationality, and ability, we were not able to test the application among the users who use assistive technologies such as screen readers. Getting the application to test among people with disabilities would help us get newer perspectives and possible improvements.

Also, adding more features such as location, online chat, discussion groups, video conferencing that revolves around the periphery of community development, youth empowerment, and e-governance can be added to make the application more engaging and help youths to use this kind of application. Not limited to that, the application would be very beneficial if there are more such applications on mobile platforms as well.

The limitations that we came across in this research can be taken as possible new researches in this field of study.

Conclusion

Youths play significant role in bringing change in the community as they are a substantial part of the community. Through ICT solutions, the user can be informed of their surroundings and associated problems. In the same way, we can leverage the resources provided by ICT solutions which can help youth to empower and engage them in community development. This thesis is a small attempt to investigate on how accessible web applications can encourage a diverse group of youths to participate in community and nation as a whole to build a more inclusive place for all. We developed a web application named Minby as a platform for youths to post ideas and agendas and build a social network based on subjects revolving around their surroundings and living space. With the developed system, we addressed the research questions proposed:

We applied user-centered design with the agile approach in our research to continuously evaluate the accessibility and usability of the system among actual users. The study shows a positive inclination towards accessibility and usability with the integration of the agile approach and user-centered design. Also, the developed system seems to show a positive impact on promoting engagement in community development. We also found out that some of the features, even when were developed by following the accessibility guidelines, could not high score and showed a negative impact on the usability of the system. From this, we can say that an accessible solution cannot possibly be a usable solution and usability highly depends on factors such as user preferences, users' mentality, and expectations.

Also, the sample space for the usability testing is not significant enough to strongly make claims on the results as it may vary with a larger sample size. Furthermore, we were able to perform only three iterations for user evaluation and improvement of the system. More iterations would involve more users' feedbacks and may help uncover more issues and areas of improvement. It would also be beneficial to check the system with a diverse group of users, such as people with disabilities, to check the accessibility of the system. As such systems directly interact with a diverse group of users, it demands rigorous user testing and evaluation to meet the demand of the targeted user. The developed system is far from perfection.

Nevertheless, this study has opened a plethora of new opportunities for research in this area. The data collected in this research can be used as preliminary data for other researches related to the same field. Integration of qualitative analysis with quantitative data can help to get a clear idea of the user's behavior and their expectations from the system. Furthermore, as digital technology continues to evolve, applications that are focused on youth engagement in community development and e-governance can be developed in various devices such as mobile applications, gamification.

What Next?

The next step after this thesis would be an improvement of the application. We further plan to recruit more participants, run more iterations for system evaluation in collaboration with the research team of AFI. Furthermore, we will also work closely with the participants and modify the tasks and questionnaires to get descriptive feedback. The ultimate goal is to release the application in the real market and give youths the platform that they require for participation in community development.

Thus, we were able to complete the thesis and have a clear understanding of the agile approach with user-centered design and how accessible applications can help engage youth in community participation and e-governance.

Appendix 1

Questionnaires for Survey

All the questionnaires are multiple choice questions with possible answers as strongly agree, likely agree, likely disagree and strongly disagree.

Pre-survey Questionnaires

1. I am highly interested to be involved in community development projects.
2. I think youth participation is important for community development
3. Most of the issues faced by youths are left unheard by community
4. Most communities do not involve youths in major planning and decision-making process.
5. I think youth opinions are disregarded most of the time in developmental activities.
6. I would love to participate but there is not enough information about the platforms to post views and issues to concerned authorities.
7. There is not enough platform that promotes youth to engage in community development.
8. I think websites and web applications are good platform to empower youths and to bring their opinions and issues to light.
9. Websites that are focused on youth empowerment and engagement for community development are limited.
10. Most of the websites do not address diverse user group.
11. There are very few websites that promotes youth engagement for community development.
12. I face challenges to post my opinions and issues to web platforms since they are rarely addressed.
13. I think I would participate more in community development activities if there are accessible websites and web platforms.
14. List out the challenges faced by you in websites that are related to accessibility.

Post-survey Questionnaires

Questionnaires related to Accessibility Testing

1. All the information in the website was understandable.
2. The icons and pictures used in website were easy to follow.
3. I found some icons and text confusing.
4. The functional icons and links were intuitive.
5. I was able to use all the functions using keyboard only.
6. I was able to use the functionalities with input devices like mouse and touch screen.
7. The contrast of the web contents was soothing to my eyes.
8. I was able to change the contrast of the display whenever necessary.
9. I was able to easily locate and use search functionality in the webpage.
10. I was able to resize the fonts that fitted my viewing.
11. I was able to understand the warnings and messages provided by the website.
12. I found some of the graphical contents irritating and lost the focus while performing the task.
13. The menu bar was easily navigable.
14. I found variation in navigation in different pages if websites.
15. I found the navigation and design of all the webpages consistent throughout the website.
16. I got error warning when I input wrong format in field of form.
17. The form provided suggestions for the format of text to be filled.

18. I found it difficult to fill out forms in website.
19. I was able to edit/delete the posts in the website.
20. I was able to browse the website from different web browser of my choice.

Questionnaires related to Usability Testing

Questions mentioned below are taken from WAI Site Usability Testing Questions (WAI Site Task Force of EOWG, 2003)

1. The homepage is attractive.
2. The overall site is attractive.
3. The site has a good balance of graphics versus text.
4. The colors used throughout the site are attractive.
5. It is easy to find my way around the site.
6. It is fun to explore the site.
7. The site's content interests me.
8. The site reflects progressive, leading-edge design.
9. The site is well-suited to first-time visitors as well as repeat visitors.
10. The site has a clear purpose.
11. It is clear how screen elements (e.g., pop-ups, scrolling lists, menu options, etc.) work.

Questions mentioned below are taken from "SUS: a 'quick and dirty' usability scale" of book "User Evaluation in Industry" (Brooke, 1996).

12. I think that I would like to use this website frequently.
13. I found the website unnecessarily complex.
14. I thought the website was easy to use.
15. I think that I would need the support of a technical person to be able to use this website.
16. I found the various functions in this website were well integrated.
17. I thought there was too much inconsistency in this website.
18. I would imagine that most people would learn to use this website very quickly.
19. I found the website very cumbersome to use.
20. I needed to learn a lot of things before I could get going with this website.

Post Test Interview

Questions mentioned below are taken from WAI Site Usability Testing Questions (WAI Site Task Force of EOWG, 2003)

1. What is your overall impression of the website?
2. Do you think this application can help youth to engage to post their views and opinions?
3. Do you think this application can help in community development?
4. Recommendations to make the website better.

Appendix 2

Tasks for the participants

Website URL: http://ec2-13-51-72-125.eu-north-1.compute.amazonaws.com/#/

1. Go to the website URL. The first step in a web application is to register as a user. You should fill the form and sign yourself up to use the web application.
2. Secondly, you will have to log in to the system to access the home page. You should fill the form with the correct field values to log in.
3. As you land on the home page, feel free to explore and scroll around the page. You may give your initial reactions to the page. You are given 2 minutes to browse throughout the website. You may give impressions about the website while doing so.
4. Can you locate the area to post your ideas and assessments? Write a post, either idea or assessment.
5. Are you able to find edit and delete options? If so, you may also edit or delete your post.
6. Can you find search functionality? If yes, you may search for different contents as you desire.
7. You may explore the setting section. You can also make changes to the contrast and fonts of the web page.
8. Like, comment, and save a post from the home page. Check your saved post on the Saved post page.
9. Try also to access the contents with a keyboard only.

Appendix 3

CONSENT FORM

The current research is part of the Master Thesis in Universal Design of ICT,

Department of Computer Science, Faculty of Technology, Art and Design,

Oslo Metropolitan University

Student's Information

Name: Pooja Chaudhary

Contact details: 96755576 (poojacdy879@gmail.com)

Title of the Study: Minby – Accessible web application to engage and empower youths in community development

Purpose of the Study: The aim of this study is to develop a web application that act as a platform to gather the voices of youths, share their ideas and suggestions, place agendas for discussions to engage in community development. The application will be tested among diverse group of youths to determine the usability and accessibility of the web application.

Procedures: In order to participate in this study, participants will have to participate in two surveys and a set of tasks. One survey will take place before performing the task named as Pre-survey, where the participants will be provided with series of questionnaires to answer the questions. After that, participants will be asked to perform come task using the developed web application. After the completion of the task, the user will be provided with post-survey questionnaires where they have to answer some of the questions regarding accessibility and usability of the application. This whole procedure will approximately take 25-30 minutes.

Risks/Discomfort: There is no known medical risks involved in participating this research. If you would feel any discomfort or fatigue during the participation, you are free to take rest. You will be provided several opportunities to take rest in case of discomfort, and additional breaks can also be taken.

Benefit: Your participation may contribute to the result of the study that accessible web solutions can help to increase youth participation in community development.

Alternative to the participation: Participation in this study is voluntary and you have the right to withdraw or discontinue participation at any time. And withdrawing or discontinuing participation in the study will not have any consequences to you. You have the right to demand for your data to be deleted from the study.

Confidentiality: All the data collected during the study period will be kept highly confidential. There will be no data sharing to any governmental organizations.

I have read and understand the information about the study and all the information in this form is explained to me and I am willing to participate

_____

_____

Signature Date

Supervisor: George Anthony Giannoumis

Contact information

E-mail: gagian@oslomet.no

Visiting address: Pilestredet 52, Oslo

Co supervisor: Aina Landsverk Hagen

Contact information

E-mail: haai@oslomet.no

Visiting address: Stensberggata 26, Oslo

Appendix 4

NSD NORSK SENTER FOR FORSKNINGSDATA

Meldeskjema 889626
Sist oppdatert

29.04.2019

Hvilke personopplysninger skal du behandle?

- Navn (også ved signatur/samtykke)
- Fødselsdato
- Adresse eller telefonnummer
- E-postadresse, IP-adresse eller annen nettidentifikator
- Bilder eller videoopptak av personer
- Lydopptak av personer
- Bakgrunnsopplysninger som vil kunne identifisere en person

Type opplysninger

Du har svart ja til at du skal behandle bakgrunnsopplysninger, beskriv hvilke

Vi behandler opplysninger om religion og etnisk opprinnelse,
men ikke øvrige kategorier.

Skal du behandle særlige kategorier personopplysninger eller personopplysninger om straffedommer eller lovovertredelser?

- Rasemessig eller etnisk opprinnelse
- Religion

Prosjektinformasjon

Prosjekttittel

Et sted å være ung: Metoder og rammeverk for innovativ
medvirkning ved etablering av ungdomsalternativ i nærmiljøet

Prosjektbeskrivelse

Hvordan kan medvirkningsprosesser rigges, for å sikre et godt
tilbud som treffer den spesifikke målgruppen, og som samtidig bidrar til at
tjenesteapparatet bedre kan koordinere tjenestene sine også overfor andre
beboere i nærmiljøet? Medvirkning er lovpålagt, men blir ofte skinn-prosesser

hvor man hører på lokale innbyggere uten nødvendigvis å klare å ta det de sier i betraktning eller bruke det i utvikling og forbedring av kommunale tjenester. Prosjektsamarbeidet er mellom Moss, Drammen og Tromsø og Oslo kommune ved bydelene Østensjø, St. Hanshaugen, Alna, Grünerløkka og Vestre Aker, med AFI, NOVA og Inst. for Informasjonsteknologi (OsloMet) som FoU-partner. Prosjektets innovasjon vil være å samskape nye metoder og rammeverk for innovativ medvirkning og medforsking med ungdom selv, etter en citizen science-modell. Innovasjonen vil bidra til økt kvalitet og treffsikkerhet i tjenestetilbudet rettet mot denne gruppen, samt styrke deres stedstilhørighet, livskvalitet, opplevelse av mestring og tillit til tjenesteapparatet. Prosjektet vil gi en lærings- og utviklingsarena for innovativ medvirkning, som kan anvendes på mer generelle områder, målgrupper og tjenestetilbud i kommunene. Innovasjonen vil styrke deres betingelser for å jobbe kreativt, systematisk og tverrfaglig i lokale utviklingsprosesser sammen med aktører fra andre sektorer, som sivilsamfunn, forskning og privat næringsliv. Prosjektets hovedarbeidspakker UngStat, UngErfar, UngIdé, UngBygg, UngForsk og UngMedia, og aktivitetene UngKompetanse, UngFormidling, UngEtikk og UngAdmin vil alle ha sterk etnografisk forankring. I hver av arbeidspakkene vil lokale ungdom engasjeres inn i prosjektet på ulike vis. Prosjektet vil også tilby seks masterstipend, og engasjere elever fra ulike studiefordypninger som unge etnografiske medforskere, sammen med representanter fra kommunene.

Fagfelt

Samfunnsvitenskap

Dersom opplysningene skal behandles til andre formål enn behandlingen for dette prosjektet, beskriv hvilke

Nei

Begrunn behovet for å behandle personopplysningene

Ettersom vi vil rekruttere ungdom som skal medvirke og medforske i prosjektet, er vi avhengige av å ha oversikt over og tilgang til opplysninger om navn samt kontaktinformasjon. Vi vil rekruttere elever fra lokale skoler, og det vil da være nødvendig å registrere hvilke skoler elevene går på.

Ekstern finansiering

- Norges forskningsråd (NFR)

Type prosjekt

Forskerprosjekt

Behandlingsansvar

Behandlingsansvarlig institusjon

OsloMet - storbyuniversitetet / Senter for velferds- og arbeidslivsforskning / Arbeidsforskningsinstituttet

Prosjektansvarlig (vitenskapelig ansatt/veileder eller stipendiat)

Ingrid M. Tolstad, ingrid.tolstad@oslomet.no, tlf: 95246729

Skal behandlingsansvaret deles med andre institusjoner (felles behandlingsansvarlige)?

Nei

Utvalg 1

Beskriv utvalget

Utvalget
vil bestå av samtykkende ungdommer som bor og går på skole i kommuner/bydeler
som beskrevet i prosjektsammendraget.

Rekruttering eller trekking av utvalget

Vi vil primært rekruttere gjennom lokale skoler

Alder

10 - 19

Inngår det voksne (18 år +) i utvalget som ikke kan samtykke selv?

Nei

Personopplysninger for utvalg 1

- Navn (også ved signatur/samtykke)
- Fødselsdato
- Adresse eller telefonnummer
- E-postadresse, IP-adresse eller annen nettidentifikator
- Bilder eller videoopptak av personer
- Lydopptak av personer
- Bakgrunnsopplysninger som vil kunne identifisere en person
- Rasemessig eller etnisk opprinnelse
- Religion

Hvordan samler du inn data fra utvalg 1?

Personlig intervju

Grunnlag for å behandle alminnelige kategorier av personopplysninger

Samtykke (art. 6 nr. 1 bokstav a)

Hvem samtykker for barn under 16 år?

Foreldre/foresatte

Hvem samtykker for ungdom 16 og 17 år?

Ungdom

Grunnlag for å behandle særlige kategorier av personopplysninger

Datakilden omfatter ikke særlige kategorier opplysninger

Redegjør for valget av behandlingsgrunnlag

Deltakende observasjon

Grunnlag for å behandle alminnelige kategorier av personopplysninger

Samtykke (art. 6 nr. 1 bokstav a)

Hvem samtykker for barn under 16 år?

Foreldre/foresatte

Hvem samtykker for ungdom 16 og 17 år?

Ungdom

Grunnlag for å behandle særlige kategorier av personopplysninger

Datakilden omfatter ikke særlige kategorier opplysninger

Redegjør for valget av behandlingsgrunnlag

Gruppeintervju

Grunnlag for å behandle alminnelige kategorier av personopplysninger

Samtykke (art. 6 nr. 1 bokstav a)

Hvem samtykker for barn under 16 år?

Foreldre/foresatte

Hvem samtykker for ungdom 16 og 17 år?

Ungdom

Grunnlag for å behandle særlige kategorier av personopplysninger

Datakilden omfatter ikke særlige kategorier opplysninger

Redegjør for valget av behandlingsgrunnlag

Informasjon for utvalg 1

Informerer du utvalget om behandlingen av opplysningene?

Ja

Hvordan?

Skriftlig informasjon (papir eller elektronisk)

Tredjepersoner

Skal du behandle personopplysninger om tredjepersoner?

Nei

Dokumentasjon

Hvordan dokumenteres samtykkene?

- Manuelt (papir)

Hvordan kan samtykket trekkes tilbake?

Muntlig, elektronisk eller skriftlig. Vår kontaktinformasjon
vil fremgå av vårt informasjonsskriv/samtykkeskjema. Her vil det også opplyses
om at det er frivillig å delta, at man når som helst kan trekke seg, og at
opplysningene om vedkommende i så tilfelle vil slettes.

Hvordan kan de registrerte få innsyn, rettet eller slettet opplysninger om seg selv?

Ved muntlig, elektronisk eller skriftlig henvendelse vil
prosjektdeltakerne få tilgang til hva vi sitter på av personinformasjon, og vil
kunne få utskrift av eit transkriberte intervjuer med seg selv, og utdrag fra
feltnotater (det som direkte omhandler den personen).

Totalt antall registrerte i prosjektet

100-999

Tillatelser

Skal du innhente følgende godkjenninger eller tillatelser for prosjektet?

Behandling

Hvor behandles opplysningene?

- Maskinvare tilhørende behandlingsansvarlig institusjon

Hvem behandler/har tilgang til opplysningene?

- Prosjektansvarlig
- Interne medarbeidere
- Student (studentprosjekt)

Tilgjengeliggjøres opplysningene utenfor EU/EØS til en tredjestat eller internasjonal organisasjon?

Nei

Sikkerhet

Oppbevares personopplysningene atskilt fra øvrige data (kodenøkkel)?

Ja

Hvilke tekniske og fysiske tiltak sikrer personopplysningene?

- Flerfaktorautentisering
- Adgangsbegrensning

Varighet

Prosjektperiode

01.10.2018 - 01.07.2021

Skal data med personopplysninger oppbevares utover prosjektperioden?

Ja, data med personopplysninger oppbevares til: 01.07.2022

Til hvilket formål skal opplysningene oppbevares?

Forskning

Hvor oppbevares opplysningene?

Internt ved behandlingsansvarlig institusjon

Vil de registrerte kunne identifiseres (direkte eller indirekte) i oppgave/avhandling/øvrige publikasjoner fra prosjektet?

Nei

Tilleggsopplysninger

I formidling og publisering av forskningsresultater vil vi
kun bruke persongjenkjennelige bilder/video der prosjektdeltagere har
samtykket.

Appendix 5

Accessibility

These checks highlight opportunities to improve the accessibility of your web app. Only a subset of accessibility issues can be automatically detected so manual testing is also encouraged.

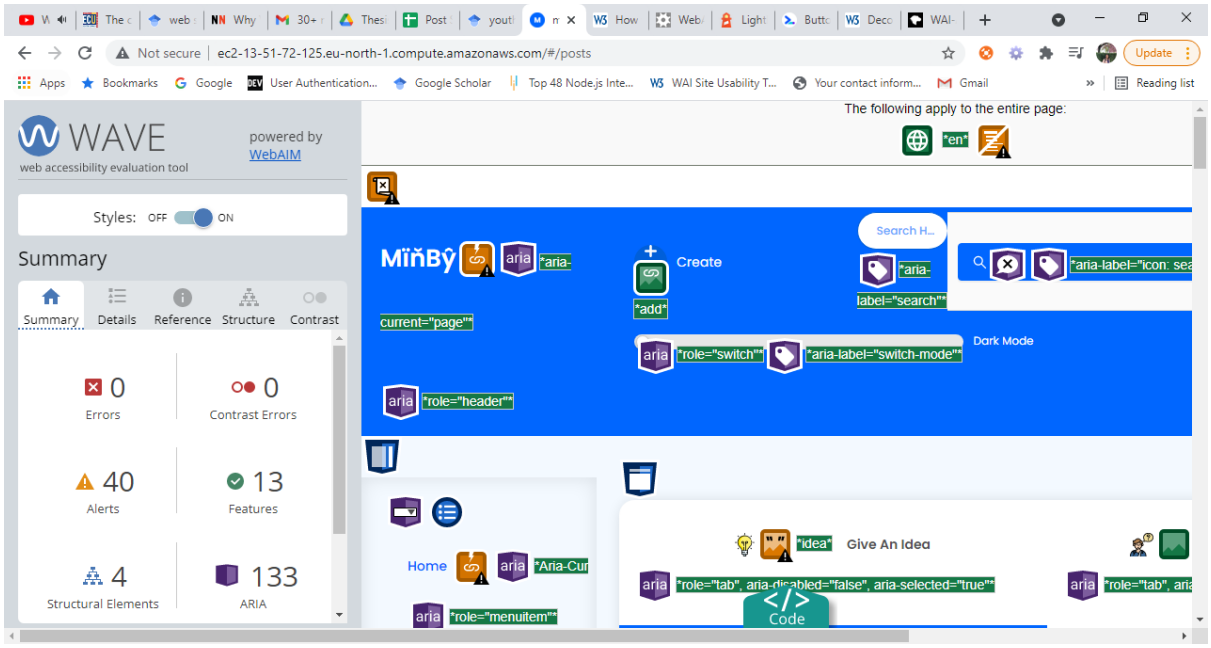
ARIA — These are opportunities to improve the usage of ARIA in your application which may enhance the experience for users of assistive technology, like a screen reader.

▲ `[role]` values are not valid

Additional items to manually check (10) — These items address areas which an automated testing tool cannot cover. Learn more in our guide on conducting an accessibility review.

Passed audits (13)

Not applicable (30)


Not secure
ec2-13-51-72-125.eu-north-1.compute.amazonaws.com/#/posts
WAVE
web accessibility evaluation tool
powered by
WebAIM
Styles: OFF ON
Summary
Summary
Details
Reference
Structure
Contrast
0
Errors
0
Contrast Errors
40
Alerts
13
Features
4
Structural Elements
133
ARIA
The following apply to the entire page:
"en"
MĭnBŷ
aria
"aria-
current="page""
Create
"add"
Search H...
"aria-
label="search""
"aria-label="icon: sea
aria
"role="switch""
"aria-label="switch-mode""
Dark Mode
aria
"role="header""
Home
aria
"Aria-Cur
aria
"role="menuitem""
"idea"
Give An Idea
aria
"role="tab", aria-disabled="false", aria-selected="true""
</>
Code
aria
"role="tab", aria

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