Czech University of Life Sciences Prague

Faculty of Economics and Management

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Master's Thesis

UX and Usability Analysis of a Web Portal for Farmers

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

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DIPLOMA THESIS ASSIGNMENT

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Thesis title

UX and usability analysis of a web portal for farmers

Objectives of thesis

The main objective of this thesis is to analyze the UX and usability of the web application for farmers, which was created by the Bangladesh Government. The aim of this paper is to show the importance of User-Friendly Web Design, UX and Usability. All the fundamental components of user-friendly design will be shown step by step, as well as the basic principles of UX and Usability and their application in the farmers' web app. A significant portion of this thesis will be devoted to investigating how a farmers' App can a user be friendly and best usability for farmers and disabled people, what features, and functionality will make it more efficient, effective, and satisfactory for them.

Methodology

The synthesis of relevant information from various reliable resources represented by printed literature, scientific articles, web sources and surveys will be done and used in the thesis.

The importance of UX and Usability and its development will be analyzed. The essential components of UX and Usability, its guidelines and technologies are going to be examined in this thesis. The practical data will be collected by a survey from Bangladeshi Farmers and recent valuable statistical data. This thesis will create by investigating the given data and assessment of the impact of UX and Usability for Bangladeshi Farmers.

Based on the theoretical knowledge of UX and Usability and practical results, the conclusion of the thesis will be formulated.

The proposed extent of the thesis

60 – 80 pages

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Web, UX, Usability, Bangladesh, Farmers, Web Design, Disable People, User Friendly Design, WCAG 2.1

Recommended information sources

GARRETT, Jesse James, 2002, c2003. The elements of user experience: user-centered design for the Web. Indianapolis, Ind.: New Riders. ISBN 978-0735712027.

MAGUIRE, Martin a Paul ISHERWOOD, 2018. A Comparison of User Testing and Heuristic Evaluation Methods for Identifying Website Usability Problems. MARCUS, Aaron a Wentao WANG, ed. Design, User Experience, and Usability: Theory and Practice [online]. Cham: Springer International Publishing, 2018-06-02, s. 429-438 [cit. 2021-07-09]. Lecture Notes in Computer Science. ISBN 978-3-319-91796-2. Dostupné z: doi:10.1007/978-3-319-91797-9_31

Marli Ritter, Cara Winterbottom, 2017. UX for the Web: Build websites for user experience and usability

ROSSON, M B. – CARROLL, J M. *Usability engineering : scenario-based development of human-computer interaction*. San Francisco: Morgan Kaufmann, 2002. ISBN 1-55860-712-9.

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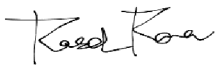
Declaration

I declare that I have worked on my master's thesis titled " UX and Usability Analysis of a Web Portal for Farmers" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the master's thesis, I declare that the thesis does not break any copyrights.



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Mohammad Rasel Rana

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I want to dedicate this Thesis to my Parents who left this world.

UX and Usability Analysis of a Web Portal for Farmers

Abstract

The agricultural sector in Bangladesh plays a vital role in the country's economy, a large portion of the population are farmers and contributing significantly to its GDP. Most of the farmers have the lowest education and knowledge of modern farming technology. A web-based information portal for farmers has been launched by the Bangladesh government. The portal is not user friendly and standard accessibility to the farmers. For this target population, A UX and Usability portal offer useful agricultural resources and information that will increase productivity and profitability. The research analyzes the efficiency of the site in satisfying the requirements and preferences of disabilities farmers while considering their low level of digital literacy, education and Physical disorder. Results show that the user interface, plain language, and simple navigation of the portal significantly increase user engagement and happiness. The requirement for audiovisual aids and text-heavy content, however, presents difficulties for farmers with poor reading ability. To increase accessibility and usability, recommendations call for the inclusion of multimedia components such as movies and audio tutorials. Also, adding real time Weather updates, disaster alerts, Digital Assistant Service, Use of AI for Digital Image Search to find out the crop's diseases and the voice search in Bangla Language will make this portal more dynamic and user friendly to the farmers. As a modern website gateway should offer up-to-the-minute market pricing updates for different crops in nearby and regional marketplaces of Bangladesh, financial resources like loans, subsidies, and government programs in order to expand their agricultural practices. Beside that it is essential to fix the flaws. Additionally, offering on-demand assistance and local language options might increase user adoption. Overall, the study highlights the significance of farmers portal for user-centered design and customized features to create an intuitive and efficient digital platform for Bangladeshi farmers without formal education.

Keywords:

Web Design, UX and Usability, Web Accessibility, disabled people, HTML, CSS, Java Script, PHP, Web Content Accessibility Guidelines, Survey, Web Design, User Friendly.

UX a analýza použitelnosti webového portálu pro farmáře

Abstrakt

Zemědělský sektor v Bangladéši hraje zásadní roli v ekonomice země, velká část populace jsou zemědělci a významně přispívají k jejímu HDP. Většina zemědělců má nejnižší vzdělání a znalosti moderní zemědělské techniky. Vláda Bangladéše spustila webový informační portál pro zemědělce. Portál není uživatelsky přívětivý a farmářům standardní přístupnost. Pro tuto cílovou populaci nabízí portál UX a použitelnosti užitečné zemědělské zdroje a informace, které zvýší produktivitu a ziskovost. Výzkum analyzuje efektivitu stránky při uspokojování požadavků a preferencí negramotných farmářů s ohledem na jejich nízkou úroveň digitální gramotnosti. Výsledky ukazují, že uživatelské rozhraní, srozumitelný jazyk a jednoduchá navigace na portálu výrazně zvyšují zapojení a spokojenost uživatelů. Požadavek na audiovizuální pomůcky a obsah s velkým množstvím textu však představuje potíže pro zemědělce se špatnou schopností číst. Aby se zvýšila dostupnost a použitelnost, doporučení vyžadují zahrnutí multimediálních komponent, jako jsou filmy a audio tutoriály. Také přidání aktualizací počasí v reálném čase, upozornění na katastrofy, služby digitálního asistenta, použití umělé inteligence pro digitální vyhledávání obrázků ke zjištění nemocí plodin a hlasového vyhledávání v jazyce Bangla učiní tento portál dynamičtějším a uživatelsky přívětivějším pro zemědělce. Jako moderní webová brána by měla nabízet aktuální informace o tržních cenách pro různé plodiny na blízkých a regionálních tržištích v Bangladéši, finanční zdroje, jako jsou půjčky, dotace a vládní programy, aby se rozšířily jejich zemědělské postupy. Kromě toho je nezbytné opravit nedostatky. Kromě toho může nabídka pomoci na vyžádání a místních jazykových možností zvýšit přijetí uživatele. Celkově studie zdůrazňuje význam farmářského portálu pro uživatelsky zaměřený design a přizpůsobené funkce pro vytvoření intuitivní a efektivní digitální platformy pro bangladéšské farmáře bez formálního vzdělání.

Klíčová slova:

Webový design, UX a použitelnost, přístupnost webu, osoby se zdravotním postižením, HTML, CSS, Java Script, PHP, pokyny pro přístupnost webového obsahu, průzkum, webový design, uživatelsky přívětivý.

Abbreviations

HTML – Hypertext Markup Language

CSS – Cascading Style Sheets

JS – Java Script

SEO – Search Engine Optimization

ROI – Return on Investment

W3C – World Wide web Consortium

WA – Web Accessibility

WCAG – Web Content Accessibility Guidelines

WD – Web Design

PHP – Hypertext Processor

UI – User Interface

UX – User Experience

e.g. – “for example,”; i.e. – “that is”.

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1. Introduction

In recent years, The Internet has become a powerful force, changing how we communicate, get information, and do business around the world. Bangladesh, a country in South Asia, has seen a substantial increase in internet usage, creating a variety of opportunities for all facets of society. One such sector that has greatly benefited from the internet's presence is agriculture, where farmers have found new avenues for knowledge sharing, market access, and improved efficiency through enhanced User Experience (UX) and usability website for general farmers (M. K. Baowaly and M. Bhuiyan, 2012).

A major section of the population is employed in the agricultural industry, which also considerably boosts Bangladesh's GDP. However, farmers often face challenges related to access to timely information, market fluctuations, and modern agricultural practices. This is where the internet has made a remarkable impact, bridging the gap between farmers and vital resources. Farmers in Bangladesh can now easily access useful agricultural information and services thanks to the growing affordability of smartphone and the improving internet infrastructure. They can obtain weather updates, learn about new farming techniques, access market prices for their produce, and connect with experts and fellow farmers for guidance and support. Farmers now have the knowledge they need to make wise decisions, enhance their methods, and raise their overall output. Moreover, the integration of User Experience (UX) principles and usability in digital platforms has further enhanced the internet's benefits for farmers in Bangladesh. UX concentrates on creating user-friendly, intuitive interfaces that put efficiency and ease of use. By incorporating UX principles, agricultural websites, mobile applications, and other digital tools have become more accessible to farmers with varying levels of digital literacy (Talukder B., Saifuzzaman M., and VanLoon G., 2016).

By attracting more clients and earning their loyalty, web accessibility, together with site optimization, functionality, and design, plays a crucial part in achieving successful business outcomes. The major goal of this diploma thesis is to show that government can lose a significant portion of potential income by failing to improve better web

accessibility for farmers. People with unique access needs have grown to be a significant market sector in modern society. Because it is impossible to accomplish web accessibility without carrying out the web design and development process, web accessibility and web design are associated in this article. This thesis's theoretical and practical components are intertwined since the theoretical part's knowledge will be used to carry out the practical part (Kashem M., Faroque M., Ahmed G., and Bilkas S., 2013).

2. Objectives and Methodology

2.1 Objectives

The main objective of this thesis is to analyze the UX and usability of the web application for farmers, which was created by the Bangladesh Government. The aim of this paper is to show the importance of User-Friendly Web Design, UX and Usability. All the fundamental components of user-friendly design will be shown step by step, as well as the basic principles of UX and Usability and their application in the farmers' web app. A significant portion of this thesis will be devoted to investigating how a farmers' App can a user be friendly and best usability for farmers and disabled people, what features, and functionality will make it more efficient, effective, and satisfactory for them.

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3. UX and Usability of Web

3.1 Introduction to Web UX and Usability

In recent years, technology and the Internet have revolutionized a variety of industries, including agriculture. In Bangladesh, where agriculture is vital to the economy, it has become increasingly essential to harness the power of the web through user experience (UX) design and usability. Utilizing well-designed web applications can significantly improve the productivity, decision-making, and overall agricultural experience of farmers in Bangladesh, who face numerous challenges in their daily work (Dey B., Newman D. and Prendergast R., 2011)

One of the primary goals of web UX and usability for farmers in Bangladesh is to bridge the digital divide and ensure inclusivity. It is crucial to design web applications that are accessible and user-friendly, even for farmers with limited technical knowledge or access to high-speed internet. By prioritizing simplicity, clear navigation, and appropriate language, farmers can effortlessly navigate through the application, access relevant information, and utilize various features to make informed decisions about their agricultural practices (Juergen S., Andreas S. & Sven S., 2020).

Furthermore, a well-designed farmers' web application should provide valuable functionalities and features tailored to the specific needs and challenges faced by farmers in Bangladesh. This may include real-time weather updates, crop disease and pest management information, market prices, agricultural techniques, and best practices. By consolidating such information into a single, user-friendly platform, farmers can save time, reduce risks, and optimize their farming operations. The impact of web UX and usability in the agricultural sector extends beyond individual farmers. It can contribute to improved productivity, increased yields, better market access, and enhanced overall agricultural practices in Bangladesh. Additionally, by facilitating knowledge sharing and collaboration among farmers, the web application can foster a sense of community and empowerment within the agricultural sector (Dey B., Newman D. and Prendergast R., 2011).

Figure 3.1. User Experience Components (smashingmagazine.com, 2023)

web UX and usability for farmers in Bangladesh offer tremendous potential to transform the way agriculture is practiced in the country. By designing intuitive, accessible, and feature-rich web applications, farmers can overcome challenges, access crucial information, and optimize their farming processes. The effective utilization of web UX and usability principles can empower farmers, enhance productivity, and contribute to the sustainable growth of the agricultural sector in Bangladesh (Dey B., Newman D. and Prendergast R., 2011).

3.1.1 Web Usability

The success of a website design or web application hinges on the designer's ability to comprehend the users' requirements, desires, and limitations. This method of designing based on the requirements of the user is known as the User-centric Centre (UCD), and it is central to contemporary design. User research, including interviews and observations, is commonly conducted prior to designing a website to gain a deeper understanding of how the site will address problems or be utilized. To guarantee that their designs are usable, designers typically run a number of specialized tests at each stage of the design process. If it is not clear to users where content is located or how to proceed to the next stage in the process, the design will be revised. Usability and Web UX (User Experience) are two interrelated ideas that are crucial for the creation of effective and user-friendly websites (Juergen S., Andreas S. & Sven S., 2020).

The term "web UX" describes a user's entire interaction with a website. Usability, accessibility, graphic design, information architecture, and interaction design are just a few of the components it contains. The objective of web UX is to create a positive, engaging, and meaningful experience for website visitors, ensuring that they can readily achieve their objectives and find value in the website's content or services. Usability, on the other hand, emphasizes on how simple it is for users to interact with and navigate a website. It entails the creation of intuitive and effective interfaces that enable users to complete duties without confusion. Usability considers elements like simplicity, clarity, learnability, efficiency, and error prevention. Usability's primary goal is to make a website user-friendly and maximize user satisfaction (Lew P., Olsina L., & Zhang L., 2010).

Usability's broad objectives include the clear and concise presentation of information and options, the absence of ambiguity, and the placement of essential items in relevant fields. Important to the Internet's usability is the content's compatibility with various devices and browsers. Another issue with the website's usability is that it is appropriate for all ages and genders. (Robbins, 2012)

3.1.2 User Experience Design (UX)

The interaction designer's objective is to make the site as straightforward, efficient, and enjoyable as feasible. The design of the user interface is closely related to the design of interaction. The functional layout of the website and the particular tools (buttons, links, menus, etc.) that users use to browse material or carry out tasks are often the focus of this type of analysis. User Experience Designer is the more recent title for this position in the discipline of Web Design. Designer UX adheres to a more holistic approach, as all site interactions are positive (Aldora, J., 2021).

The UX design is founded on an in-depth understanding of users and their requirements gleaned from observations and in-depth interviews. For a website or application that includes its visual design, user interface, quality, and message content, as well as its overall performance. For this to be a successful experience, it must complement the organization's identity and strategic goals (Tidwell, 2011).

3.1.3 User Interface Design (UI)

Designing a user interface (UI) entail developing user interfaces for various devices with a focus on ensuring that the interface of each application, program, or web presentation, etc. retains its high efficacy and user-friendliness. The objective of user-centric interface design is to maximize the user's productivity through interaction with the interface. A well-designed user interface makes it simple to complete the assigned task without drawing undue attention to yourself. Graphic design and typography are utilized to maintain the efficacy of a design, influencing how the user performs certain interactions and enhancing its aesthetic appeal (Brophy P. M., & Craven J., 2007).

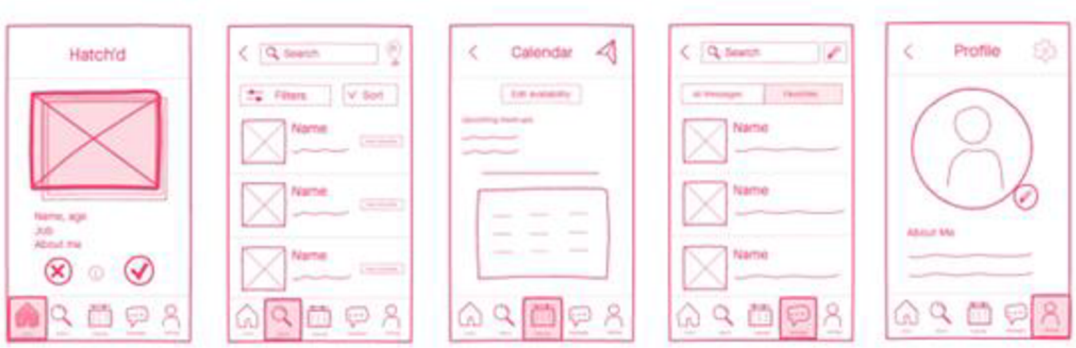

Figure 3.1.3. Wireframes of UI Design (Aldora, J. ,2021).

Design aesthetics can either improve or hinder the usability of interface functions. The design process must strike a balance between technical functionality and visual elements (such as a mental model) in order to create a system that is not only functional, but also user-friendly and adaptable to users' changing requirements. Interface design is involved in a broad variety of projects, including computer systems, automobiles, and commercial aircraft. All these projects are largely based on the same fundamental human interaction, but they also require specialized skills and knowledge. Consequently, designers tend to specialize in specific project types and develop skills based on their experience, whether it be software development, user research, Web Design, or industrial design. (Cao, 2017)

3.1.4 Responsive Web Design

In order to produce websites that automatically adapt to various screen sizes, device kinds, and device orientations, responsive web design is a method of online design and development. In other words, a responsive website is developed to deliver an excellent

viewing experience across a wide range of devices, such as desktop computers, tablets, and mobile phones. The main goal of responsive web design is to guarantee that the website's content, layout, and functionality can be accessed and are aesthetically pleasing regardless of the device being used. This eliminates the need to construct different versions of a website for various devices, thereby simplifying development and maintenance (Meltem H., Murat B., 2023)

3.1.5 Responsive web design principles and techniques:

- Fluid Grids: Measuring layout elements with relative units, such as percentages, as opposed to pixels. This makes it possible for the content to smoothly resize and adapt to different screen sizes.
- Implementing CSS techniques, such as max width: 100 percent, to ensure that images resize proportionally and do not overflow or distort the layout on smaller displays.
- Media Queries: Applying various styles and changing the layout depending on the features of the device, such as screen width, resolution, and orientation, using CSS media queries.
- Utilizing viewport-based units and CSS rules to adjust font sizes and line heights to ensure readability across devices.
- Mobile-First Methodology entails designing and developing a website with a mobile-first mentality, concentrating first on the needs and limitations of smaller screens, and then progressively enhancing the experience for larger screens (The Interaction Design Foundation, 2023)

Figure 3.1.5. Responsive Website on Different Devices (Shastri, A., 2020)

By adhering to these principles and techniques, a responsive website can adjust its layout, font sizes, and image sizes to provide an optimal user experience on any device. This ensures that site visitors can navigate, read content, and interact without excessive magnification or scrolling. Responsive web design is essential in today's multi-device environment because it enables websites to be accessible and user-friendly across a broad variety of devices, thereby enhancing user engagement, satisfaction, and ultimately the website's success (Meltem H., Murat B., 2023).

3.1.6 Considerations for web UX and usability

Here are some important web UX and usability factors to consider:

- **Designing**: a well-structured and user-friendly navigation system that enables users to readily locate and access various website sections.
- **Responsive design**: is the process of developing a website that adjusts to various screen sizes and devices, assuring a consistent and optimized user experience across desktop, mobile, and tablet devices.
- **Readability and legibility**: refer to the use of appropriate typography, font sizes, and colour contrast to make the website's content simple to read and comprehend.
- **Visual design**: Applying consistent branding, aesthetically attractive layouts, and appealing visuals to enhance the website's overall appearance and feel (The Interaction Design Foundation, 2023).
- **Page load speed**: optimizing the website's performance and minimizing loading periods in order to prevent user frustration and increase engagement.
- **Form design**: Designing user-friendly forms that are simple to complete and provide users with plain instructions and feedback (BREWER, 2006).
- **Error handling:** Implementing error messages and validation mechanisms that assist users in understanding and correcting input errors.
- **Accessibility:** By following accessibility principles and standards, such as providing alternative language for images and utilizing semantic HTML syntax, make sure that the website is accessible to people with impairments. By contemplating these aspects of web UX and usability, designers can create websites that are intuitive, user-friendly, and provide visitors with a positive

experience, thereby increasing engagement and achieving the website's goals (The Interaction Design Foundation, 2023)

3.1.7 Reasons to Comprise Web UX, Usability and Accessibility

Web Usability enhanced User Satisfaction by focusing on web usability, ensure that web application provides a satisfying user experience. Users who find it easy to navigate, locate information, and perform tasks are more likely to be satisfied with their experience. This leads to increased engagement, repeated visits, and positive word-of-mouth recommendations. Considerations for web usability include accessibility, which enables a wider range of users to utilize web application, including those with disabilities or low technical proficiency. It should make sure that website is inclusive and usable by people using assistive technologies by following accessibility principles (Denga A., 2022)

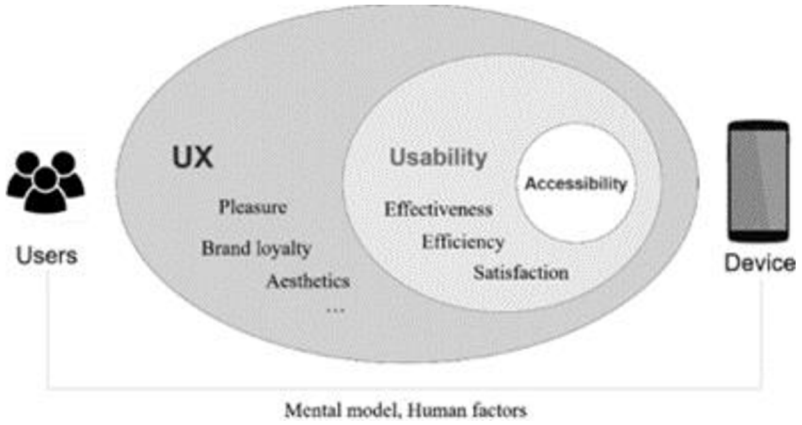

Figure 3.1.7. Mental Model According to Human Factors (The Interaction Design Foundation, 2023)

Usability directly impacts conversion rates. When a web application is user-friendly and intuitive, it reduces friction in the user journey and makes it easier for visitors to convert into customers. Simplifying the checkout process, optimizing forms, and reducing unnecessary steps can significantly boost conversion rates. In today's digital landscape, competition is fierce. Investing in web usability can give a competitive edge by differentiating web application from others in industry. Users are more inclined to select an easy-to-use website that offers a smooth experience over a complex and confusing website (Juergen S., Andreas S. & Sven S., 2020).

Prioritizing web usability during the design and development stages can save both time and money in the long run. Early usability problem detection and resolution can help prevent

more expensive future redesigns or improvements. Usability testing and feedback loops can help identify areas for improvement and optimize web application efficiently. A usable web application minimizes user errors and frustration. By designing intuitive interfaces, providing clear instructions, and offering helpful error messages, can guide users and prevent them from making mistakes. As a result, users have a more pleasant user experience and are able to complete their tasks more quickly. This enables farmers in Bangladesh to access vital agricultural information on-the-go, making web application more convenient and accessible (Dey B., Newman D. and Prendergast R., 2011).

Prioritizing web usability offers numerous benefits, including enhanced user satisfaction, improved accessibility, increased conversion rates, a competitive advantage, time and cost savings, reduced user errors, and a mobile-friendly experience. A user-centric web application that effectively addresses the demands of Bangladeshi farmers was created by adding web usability into the design and development process (Juergen S., Andreas S. & Sven S., 2020).

On the other side, there are a number of strong arguments in favor of giving Bangladeshi farmers' web accessibility top priority. Web accessibility ensures that farmers with disabilities have equal access to crucial agricultural information and resources available online. It allows them to stay informed about the latest farming techniques, market trends, weather forecasts, government policies, and other essential information necessary for their livelihoods. Accessible websites and online platforms enable farmers to connect with a broader range of potential buyers, suppliers, and agricultural service providers (Denga, A., 2022). By removing barriers and ensuring usability for farmers with disabilities, web accessibility facilitates their participation in online marketplaces, e-commerce platforms, and other digital channels. This expands their opportunities for selling their produce, negotiating fair prices, and accessing necessary inputs. Web Accessibility empowers farmers to leverage digital tools, agricultural apps, and online platforms that improve their productivity and efficiency. Accessible interfaces and assistive technologies enable farmers with disabilities to use these tools effectively, leading to better decision-making, optimized farming practices, and ultimately higher yields (Sohaib, O. And Kang, K. ,2017)

Web accessibility fosters an inclusive environment for farmers to connect, collaborate, and exchange knowledge. Accessible online forums, communities, and social media platforms enable farmers to share their experiences, ask questions, and learn from each other. This collaborative space enhances their skills, problem-solving abilities, and overall farming practices. Many government services and agricultural support programs in Bangladesh are moving towards online platforms. By ensuring web accessibility, farmers with disabilities can access and benefit from these services, including agricultural subsidies, financial assistance, training programs, and disaster management resources (Talukder B., Saifuzzaman M., & VanLoon G., 2016).

This promotes equitable distribution of government support and empowers farmers to improve their farming practices and resilience. Web accessibility promotes the empowerment and inclusion of farmers with disabilities, allowing them to actively participate in the digital agricultural landscape. It helps overcome barriers and prejudices, ensuring that farmers with disabilities are not left behind in the digital transformation of the agricultural sector. By providing equal access to information, markets, and opportunities, web accessibility supports their economic and social inclusion by prioritizing web accessibility for farmers in Bangladesh, we can create a more equitable agricultural ecosystem that leverages the power of the internet to benefit all farmers, regardless of their abilities. It is not only a matter of social responsibility but also a strategic investment in the agricultural sector's sustainable development and the well-being of farming communities. Implementing enhanced web accessibility for websites in Bangladesh offers numerous advantages that should be carefully considered. (Kashem, M., Faroque, M., Ahmed, G., & Bilkas, S., 2013).

It's crucial to remember that many nations have laws requiring websites to be accessible. For instance, the European Union's "Accessibility of Public Websites - Accessibility for People with Disabilities: Council Resolution 2002," Canada's "Canadian Human Rights Act of 1977," Hong Kong's "2001 Hong Kong Digital Strategy," and the United States' "Section 508 - an extension to the American Workforce Rehabilitation Act of 1973" are examples of national laws that emphasize the availability of information and communication technologies (ICT) and the web. These laws take various approaches, such as establishing

human and civil rights for free ICT access, ensuring ICT availability in government purchases, or mandating accessibility for all ICT products on the market (Brewer, 2006).

Secondly, from an ethical and moral standpoint, it is crucial to create a web environment that is accessible to users with disabilities and avoids discrimination based on their physical condition. Insufficient web accessibility hinders certain individuals from using websites, leading to unfairness. Moreover, the disabled community is no longer a marginalized group and possesses the right and means to express their opinions publicly. They strongly oppose discrimination, and organizations that are perceived as not supporting disabled individuals may face significant challenges in terms of public relations (Tajmim J. I. T., 2022)

Thirdly, web accessibility can foster loyalty, trust, and potentially boost revenues. According to a recent poll by the Bangladesh Bureau of Statistics (BBS) in 2022, there are approximately 47.42 lakh people, or 2.4% of the entire population, who are physically or intellectually challenged, or people with disabilities. Also, 80 percent of the are involved with agriculture. More people with disabilities than previously estimated in terms of number. By ensuring web accessibility, organizations can effectively cater to this substantial population segment, potentially expanding their customer base and cultivating positive relationships (Hartson R., & Pyla P. S., 2012).

Hence, it is essential for Bangladesh to acknowledge the legal obligations, ethical considerations, and potential business benefits associated with implementing enhanced web accessibility. By embracing web accessibility, organizations can create a more inclusive digital environment that addresses the needs and rights of individuals with disabilities (Bangladesh Bureau of Statistics (BBS), 2022).

3.1.8 How to Evaluate Web UX and USABILITY.

Assessing the web UX and usability of a Farmers app in Bangladesh involves evaluating how effectively the application meets the needs of farmers, how intuitive its design is, and how easily farmers can navigate and utilize its features. There are several methods available to evaluate web UX and usability, including conducting usability testing, gathering user feedback, analyzing user metrics, and employing expert evaluations. By employing these evaluation methods, developers and designers can gain insights into areas

of improvement, identify usability issues, and make data-driven decisions to enhance the overall user experience of the Farmers app in Bangladesh (Dey B., Newman D. and Prendergast R., 2011).

Measurement website user experience (UX) for its effectiveness depends on two metrices. The objective metric emphasizes on tracking and comparing quantifiable components. Things such as the time required to complete the task, the task's success rate, and user errors. Subjective metrics can include user satisfaction, website rating, and other factors. The qualitative metric is an additional essential metric to consider when evaluating the UX effectiveness of a website. When it comes to measuring a website's qualitative metric, measure a site visitors' experience quality, satisfaction, and ratings, amongst other things. The behaviour metrics of a website are expressed as numbers that enable to identify user engagement with a site during their visit (Zaki T., & Islam M. N., 2021)

3.2 Introduction to Web UX and Usability Initiative

3.2.1 Usability testing

Usability testing is the process of discovering methods to improve a website User Interface and Experience by observing users interacting with the website. It is a UX research method trained specifically on the efficacy of website. Usability is the disagree to which users can complete a given task with the targeted website (Zaki T., & Islam M. N., 2021).

When properly executed, usability testing reveals pain points in the user journey and highlights obstacles to effective usability. It will also help to learn about the users' behaviours and preferences in relation to a website, as well as uncover opportunities to design for unanticipated requirements. Usability testing can conduct at any stage in the design process after initial ideas have been transformed into design solutions, but the earlier it done, the better. Usability testing can conduct with both low-fidelity and high-fidelity prototypes, and testing should continue after the product has been released into the wild (Aldora, J., 2021).

3.2.2 Usability testing methods

Many usability testing techniques have the potential to uncover both behavioural and attitude-related findings. Performance testing has the greatest opportunity for focusing on both and will probably need the most careful planning.

- Interview Testing
- User Scenario Testing
- Performance testing
- Card sorting
- Tree testing
- Eye tracking (Nielsen Norman Group, 2004)

3.2.3 Approach of Usability testing

UX (User Experience) and usability testing involves several essential stages.

- Define Objectives and Goals: Clearly state the aims and objectives of the testing process. Determine which specific aspects of the user experience wish to evaluate and what expect to learn from the testing.
- Identify Target Users: Determine the user group or groups that will be tested. Consider demographics, levels of experience, and specific user personas that pertain to product or website.

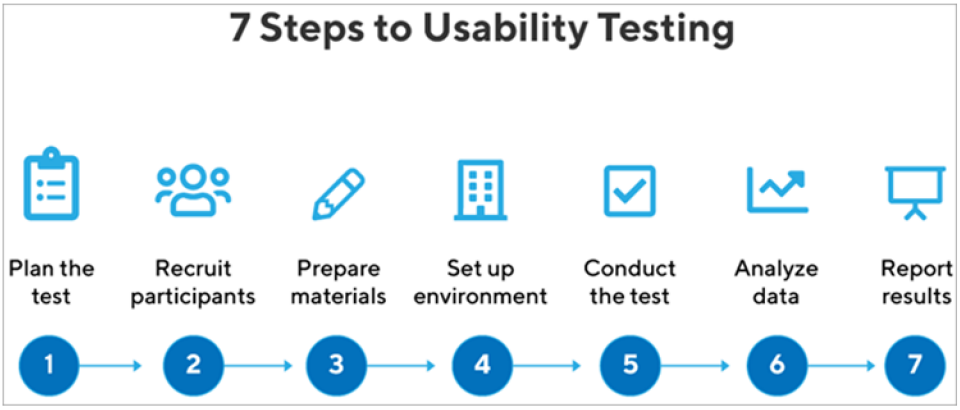

Figure 3.3.3. Approach of Usability Testing (semanticstudios.com, 2022).

- Create Test Scenarios and Tasks: Create test activities and scenarios that reflect the real-world situations people might experience when using product or website. These scenarios and assignments should be designed to evaluate usability and user experience characteristics.
- Select Appropriate Testing Methods: Based on objectives, budget, and available resources, appropriate testing methods are selected. Common methods include moderated usability testing (in which a facilitator guides the user through the tasks), unmoderated remote testing (in which users' complete tasks independently), heuristic evaluation (expert evaluation based on established usability principles), and A/B testing (comparing two versions of a design) (Vijay, 2023).
- Administer the Examinations: Administer the examinations to the participants in-person or remotely. Provide clear instructions and encourage test-takers to ponder aloud in order to record their thought processes and receive feedback. Observe and record participant interactions as well as their experiences, challenges, and suggestions.
- Collect and Analyze Data Collect data from the testing sessions, such as video recordings, observation notes, and submitted questionnaires and surveys. Identify

patterns, trends, and recurring issues by analyzing the data. Consider both quantitative and qualitative data (For instance, success rates, task completion times, user comments and feedback).

- Document and Communicate Results: Results should be recorded and communicated in a clear report that includes the findings, conclusions, and suggestions. Share the report with the appropriate stakeholders, including designers, developers, and decision-makers, to ensure that the insights are comprehended and incorporated into the design and development process (Nielsen Norman Group, 2023).

UX and usability testing is an iterative process, and multiple testing cycles may be necessary to achieve optimal results. By continuously evaluating and refining the user experience, it is possible to develop products that are more in line with user requirements and expectations (Vijay, 2023).

3.3 Web UX and Usability Improvement benefits

3.3.1 Facets of the User Experience and Usability

Facet or quality of the user experience, the success and perception of a product or service are significantly influenced by the excellence of user experiences. User experience (UX) is the term used to describe how well a website, app, or system interacts with and pleases its users. A high-quality user experience is characterized by several essential characteristics. Usability involves ensuring the product is simple to navigate, comprehend, and use, with efficient and intuitive interfaces (Krystyna S., 2017).

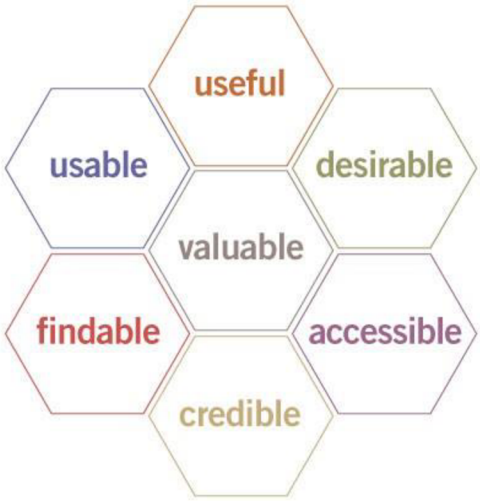

Figure 3.4.1. User Experience Honeycomb (semanticstudios.com, 2004)

- Useful: As practitioners, cannot be satisfied to stay within the lines outlined by managers. The courage and imagination to question the usefulness of products and systems, and then apply the knowledge of craft and medium to define more usefully innovative solutions.
- Usable: The interface-centered methods and perspectives of human-computer interaction do not address all facets of web design, despite the continued importance of usability. Usability is essential but insufficient.
- Desirable: Recognizing the power and importance of image, identity, brand, and other components of emotional design is necessary to moderate the pursuit of efficiency (semanticstudios.com, 2004).
- Findable: We must strive to design websites and objects that are navigable and searchable so that users can discover what they need.
- Accessible: In the same way that our structures are equipped with elevators and ramps, our websites should be accessible to people with disabilities (over 10 percent of the population). Today, it is both a prudent business decision and the moral thing to do.
- Credible: We are beginning to understand, because of the Web Credibility Project, the design elements that affect whether consumers trust and believe what we say.
- Valuable: websites must deliver value to sponsors. User experience for non-profits must advance the mission. It must increase customer satisfaction and contribute to the bottom line for for-profit organizations (Lew P., Olsina L., & Zhang L., 2010).

3.3.2 Benefits of Web UX and Usability

Enhancing web UX, Usability and Accessibility benefits organizations financially as well as being a matter of inclusivity and legal compliance. Businesses may reach a wider audience, increase user engagement and happiness, boost brand reputation, and reduce legal risks by improving web accessibility. Consider the following budgetary issues when enhancing online accessibility:

- Increased client base: More people can reach by making sure website is accessible to those with impairments. According to the World Health Organization, 15% of people

globally are impaired. are disabled. Someone may be rejecting potential clients and losing their business if they overlook online accessibility.

- Increasing web accessibility: Not just for people with disabilities, improving web accessibility may enhance user experience for all users, boosting user engagement and conversion rates. Websites that are accessible are frequently more user-friendly, simpler to use, and offer a better overall experience. Increased user engagement, extended website visits, and improved conversion rates might result from this, which ultimately boosts sales and revenue (Juergen S., Andreas S. & Sven S., 2020).
- Better search engine optimization (SEO): SEO best practices and web accessibility guidelines frequently overlap. Positive user experiences are given priority by search engines like Google, and accessibility elements like correct header structure, elucidating alt text for images, and simple navigation help a website rank higher in search engine results. A website's organic traffic can increase and online presence can be enhanced with higher prominence in search engine results.
- Improved brand reputation: Showing that care about accessibility and inclusivity can improve brand's reputation. Customers like businesses that place an emphasis on accessibility and are more inclined to support and endorse them. A strong brand reputation can result in more client loyalty, repeat business, and favorable word-of-mouth recommendations, all of which can have a beneficial financial impact.
- Long-term cost savings: Improving online accessibility may require early investments in performing audits, implementing design modifications, and training employees, but it can save money in the long run. Prevent expensive retroactive updates and lower ongoing maintenance costs by incorporating accessibility into the development process from the start (Aldora J.,2021)
- ROI: Investing in web UX and usability can result in a positive ROI. By developing an intuitive and user-friendly web application, businesses can increase consumer satisfaction and conversions. A seamless user experience can result in increased revenue through increased sales, recurrent business, and customer retention.
- Increasing a website's usability can lower the cost of customer assistance and training. When users can simply navigate a website and complete tasks, they are less likely to require assistance or make mistakes. Because of this, fewer customer service resources are required, which lowers operating costs and increases overall efficiency.

- A well-designed web application with superior UX and usability can provide a business with a competitive advantage. It can increase market share, draw in new customers, and keep existing ones. The favorable effect on customer acquisition and retention can result in increased revenue and a stronger market position.
- Enhancing web UX and usability has an immediate effect on consumer satisfaction. Customers who are pleased with the experience are more likely to use the website, make purchases, and refer others to it. Positive word of mouth can lead to organic growth and a larger consumer base, thereby contributing to a company's financial success (Hartson, R., & Pyla, P. S., 2012)..
- Poor UX and usability can lead to user frustration, resulting in increased bounce rates, abandoned purchasing carts, and a decline in customer loyalty. These negative experiences can have financial consequences, as businesses lose potential revenue and forgo opportunities for repeat business. Resolving usability issues reduces user frustration and increases revenue potential.
- Investing in web UX and usability is not only a short-term expense, but also a long-term investment in the success and sustainability of the business. A web application that is well-designed and consistently provides a positive user experience can create trust, brand loyalty, and a solid reputation. This long-term value can lead to an increase in customer lifetime value and sustained financial expansion (Brophy P. M., & Craven J., 2007)

When improving a website's usability and user experience, financial concerns are essential. By focusing on return on investment, cost reduction, competitive advantage, customer satisfaction, conversion rate optimization, mitigating user frustration, and long-term sustainability, businesses can make well-informed decisions and investments that result in enhanced financial performance and overall success. Businesses can gain significantly from investing in web UX, Usability and Accessibility. Organizations may develop a more inclusive and lucrative online presence by broadening their client base, boosting user engagement and conversions, improving SEO, minimizing legal risks, strengthening brand reputation, and reaping long-term cost savings (Juergen S., Andreas S. & Sven S., 2020).

3.3.3 Costs Savings after UX, Usability and Accessibility Improvement

It can be difficult to estimate the actual cost savings that will result from accessibility improvements because it depends on several variables, including the exact enhancements done, the size of the website, and the type of business. The user experience (UX) of a site has never been as important as it is today. When navigating the web, users desire a quick, frictionless experience. They desire whatever it is they seek, and they desire it immediately. risk alienating users, losing sales, and falling behind the competition if website is not up to par (Dey B., Newman D. and Prendergast R., 2011).

A website does not need to be upgraded for new technologies if web accessibility has been enabled because an accessible web page is already set up for new web technologies. The second benefit of web accessibility is that it minimizes the need for increased server capacity, which lowers server expenses because accessibility lessens server overload. There is no need to develop several versions of the website because enhanced Web Accessibility makes the information usable on a variety of devices. Because accessible webpage currently complies with all accessibility laws, there is no risk of potential large legal costs in the case of accessible website. Reduced prices for materials in other forms, lower human costs, and numerous other perks are also hypothetical advantages of web accessibility. (Henry, 2012)

Financial factors are essential considerations when improving web UX and usability. By focusing on ROI, cost reduction, competitive advantage, customer satisfaction, conversion rate optimization, mitigating user frustration, and long-term sustainability, businesses can make informed decisions and investments that lead to improved financial performance and overall success (Juergen S., Andreas S. & Sven S., 2020).

4. Web Design

4.1 Defining Web Design

The process of developing and structuring a website's visual layout, organizational structure, and functional elements is known as web design. It includes a variety of fields like as coding, user interface (UI) design, user experience (UX) design, and graphic design. A website's visual elements and the technological setup that enables user access and interaction are both part of web design. It includes color schemes, fonts, graphics, buttons, menus, forms, and responsive design for multiple devices (Krystyna S., 2017). An engaging, user-friendly, and aesthetically pleasing online presence that effectively communicates the brand, engages people, and allows for seamless interaction with the website's features and content is the aim of web design. The user's needs, accessibility, usability, and the website owner's business goals are all considered in effective web design. To create the best possible digital experience for visitors, a balance between aesthetics, functionality, and performance is required (Meltem H., Murat B., 2013)

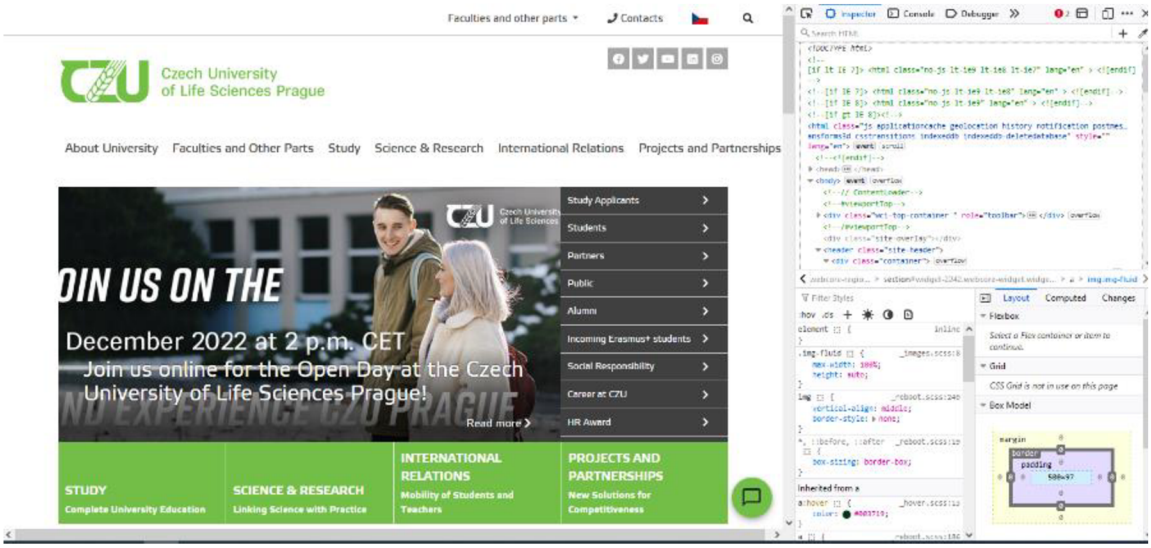

Figure 4.1 CZU Website with HTML, CSS and JavaScript Inspect (author)

The logical organization of web pages is also created by web designers, who also consider the most practical ways to enter information and work on the project's visual appearance. More specifically, the development and maintenance of websites rely on a diverse set of

skills and disciplines. Among the many components of web design are graphic design, writing, including the use of proprietary software and standardized code, user experience design, and search engine optimization. It is customary for many people to work in teams to cover different areas of the design process, even if some designers manage every aspect of it (Salvi, 2017).

Most people evaluate a website's design from one of two basic perspectives when deciding whether it is "good" or "bad." There is a stringent usability angle that emphasizes functionality, efficient information presentation, and usability. Then there is the purely aesthetic viewpoint, which is concerned only with the design's artistic merit and aesthetic appeal. Some people get caught up in the aesthetics and visuals and neglect the user, whereas some usability experts become preoccupied with user testing and neglect the user. Maximizing both is necessary to reach individuals and hold their interest (Beaird, 2010).

4.1.1 Web Design Milestones

"The process of creating a website is comparable to both art and bridge construction. The creation of a useful, aesthetically beautiful website is the aim of the web designer, but the demands of the users should come first. Due to this objective, the process of creating a website typically follows a clear structure: the terms of reference stage, information structuring, graphic design, real development, and what is known as web mastering (Beaird, 2010).

The following groupings can be used to categorize the key phases of the web design process: TOR - Terms of Reference The volume of the site, its functionality, the primary guidelines for the visual representation, and the site's structure are determined based on a clear knowledge of the reason why the site is being built. After the customer has approved the technical assignment, the stage is complete. Information structuring (usability and wireframe) - This refers to the way the site's material is presented and arranged. includes a wide variety of inquiries, from choosing the most practical methods of information distribution to considering the logical structure of web pages (Salvi, 2017).

Layout and graphic design - In the graphical editor, the site's visual area is put together with the aid of graphic elements that serve as decoration or navigation. A graphic file that

represents the visual representation of the upcoming web page serves as the real design of the website. Web development - At this stage, the graphic image is divided into individual components and converted into code that can be seen via a browser utilizing HTML and CSS technologies. At this point, the programming procedure is truly intended to convert the visual representation of the web page into a genuine website that keeps its features, acquires interaction, and maintains the imagined Web Design (Krystyna S., 2017).

Web mastering: During this phase, steps are performed to help the site be distributed and delivered effectively across the network. includes search engine optimization and hosted hosting. Since the main goal of this stage is to maintain the functionality of the website, increase user usage, improve network findability, maintain the page's original 27 qualities, and eventually add new additions and improvements to ensure that users continue to visit the website, this stage may also be referred to as maintenance of the website (Beaird, 2010).

4.1.2 Frontend and Backend Architecture

The front-end and back-end development processes are often the two main parts of a website development process. The term "front-end" refers to a broad category of languages and technologies that are used to open a page in a browser, make it visible, and cause it to function as it was intended to. Web front-end and back-end architecture refers to the division of responsibilities and the underlying technology stack used in the development of a web application (Adams, C. & Boulton, 2007).

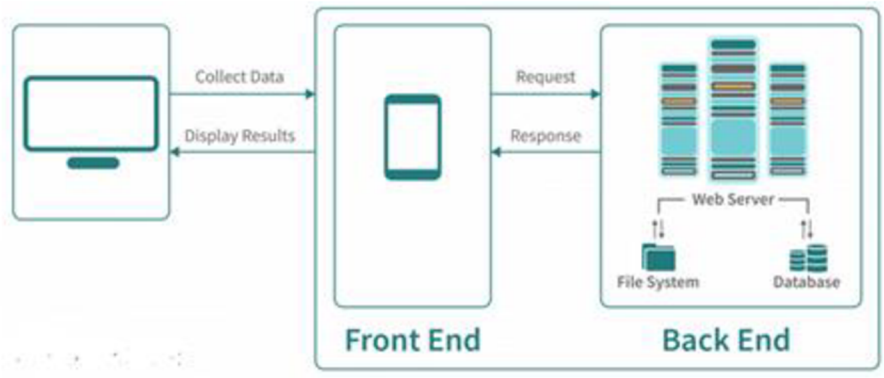

Figure 4.1.2 Web App Architecture (InterviewBit, 2022)

Through the use of APIs (Application Programming Interfaces) or other data exchange techniques, the front-end and back-end components can communicate with one another. APIs allow the front-end to request and send data to the back end for processing and retrieval. The architecture of a web application depends on various factors such as scalability, performance, security, and development requirements. Common architectures include the traditional monolithic architecture, where the front-end and back-end are tightly coupled, and the modern microservices architecture, where the application is divided into smaller, independent services that communicate with each other (DUCKET, 2005).

The front-end and back-end architecture work together to create a cohesive web application, where the front-end handles the user interface and interactivity, while the back end manages the underlying business logic, data processing, and integration with databases and external systems. The frontend essentially consists of anything that affects what a user sees on the screen, including the design and some programming languages like HTML, CSS, and Java Script. Without having any prior experience with back-end development, front-end development can be done. Static sites are those that are developed solely through front-end development, without the usage of a back end. For example, a simple web presentation of a restaurant or a hair salon business could be made using a static site. No data must be kept in the database for this to work. Except for a website's visual overhaul, pages essentially never change (Godbolt,2015).

Back-end development, also referred to as "server-side" development, basically describes how a website works, gets changed, and updated. This is true of whatever a user cannot view through a browser, such as databases and servers. To build a dynamic website that is constantly updated in real time, back-end development is used. All the data, including user profiles, downloaded photographs, and blog entries, must be saved in the database for a dynamic site to function effectively. The database interface is depicted in Figure 4.1. The back-end development typically involves the usage of languages like PHP, Python, Ruby, etc. for these objectives (Salvi, 2017).

4.1.3 Technologies for Structure, Presentation, Behaviours and Functionality

HTML, CSS, and JavaScript are the three fundamental web building elements. The most widely used language for constructing web pages is HTML, or Hypertext Markup

Language. Hypertext refers to the linking structure of web pages (HTML documents). Thus, the link on a website is known as Hypertext. HTML is a Markup Language, which means it is used to simply "mark-up" a text document with elements that instruct a web browser on how to structure and display it. The web design language known as CSS was created with the goal of making the process of presenting web pages simpler. A web page's appearance is managed using CSS. The color of the text, the font style, the distance between paragraphs, the size and placement of columns, the background pictures or colors, and a number of other effects can all be altered using CSS. Most of the time, CSS is coupled with HTML or XHTML (DUCKET, 2005).

Web pages frequently use JavaScript, a dynamic, lightweight programming language. Client-side script can interact with users and generate dynamic pages thanks to its implementations. It is an interpretable object-oriented programming language. These three programming languages are the fundamental tools for developing static websites (Ali, 2014).

4.1.3.1 HTML5 for Structuring

HTML5 is a flexible and potent web development tool. It offers a vast array of new features and enhancements that transform the way websites and applications are created. HTML5 enables developers to construct interactive, dynamic, and multimedia-rich web pages that offer a consistent user experience across devices and platforms. The incorporation of semantic elements improves the structuring and organization of content, thereby enhancing its accessibility and SEO (GRANT E., 2016)

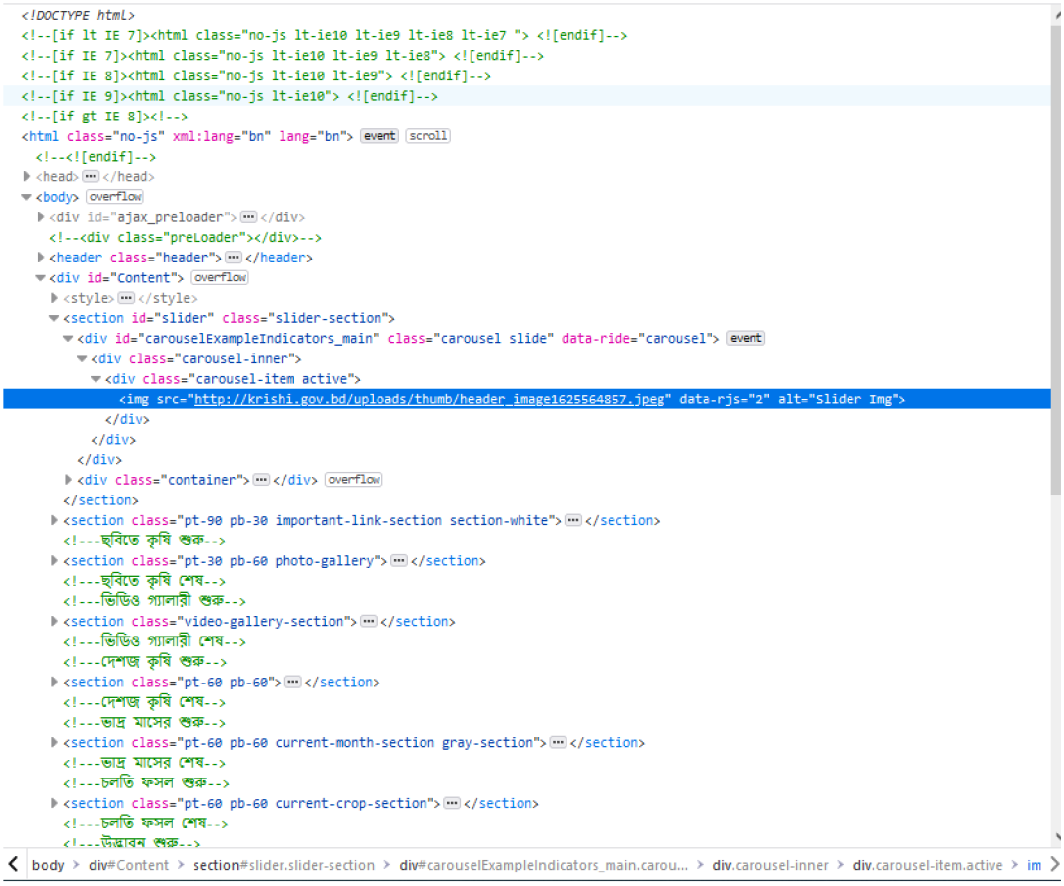

Figure 4.1.3.1 HTML Layout Elements of CZU web (author, 2023)

Additionally, HTML5 has native support for audio and video components, doing away with the requirement for third-party plugins and enabling uninterrupted streaming of multimedia content. Canvas enables the creation of sophisticated graphics, animations, and visual effects directly within a web page. HTML5 also provides offline capabilities, responsive design, enhanced forms, and a vast array of web APIs, enabling developers to construct robust and engaging web applications. HTML5 is a fundamental building block for contemporary web development, allowing developers to construct visually appealing, interactive, and feature-rich websites and applications that provide an exceptional user experience (Connor, 2012)

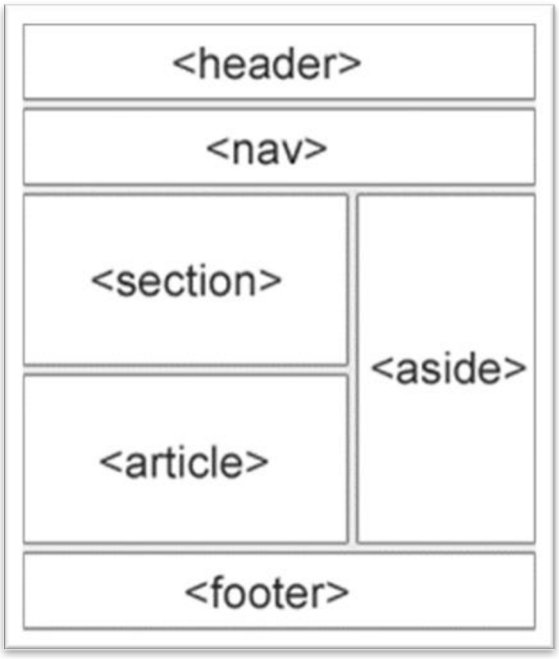

Figure 4.1.3.1. HTML Layout Elements (w3schools).

In the First Principle of Web Content Accessibility Guidelines 2.0, which states that "web content must be Perceivable," it is stated that the author of a web page must *" If there is any non-text content, provide text alternatives so that it can be converted into the other formats that users need, such as big print, braille, voice, symbols, or simpler language."* (Cardwell, 2008)

4.1.3.2 CSS for Presenting

CSS is an abbreviation for cascading style sheets. This coding language influences how a website will look and be organized. CSS, along with HTML, is essential to web design. Without it, websites would consist only of text on a white background. Prior to the development of CSS in 1996 by the World Wide Web Consortium (W3C), the form and functionality of Web pages were severely constrained. Earlier browsers displayed a page as hypertext, consisting of simple text, images, and links to other hypertext pages. There was no discernible layout, just a single column of paragraphs stretching across the page (Adams C. & Boulton Mark & Clarke…, 2007).

They placed the "style" in style sheets, allowing Web pages to be designed for the first time. The first commercial browser to understand and use CSS was Microsoft's Internet

Explorer 3. It was released in 1998. Support for specific CSS functions still differs from browser to browser. The W3C, which continues to oversee and develop Web standards, has just published a new CSS standard, CSS3. With CSS3, developers anticipate that all main browsers will interpret and render each CSS function identically (Ducket, 2005).

4.1.3.3 JavaScript for Interactivity

JavaScript is a flexible programming language utilized predominantly for web development. Programmers can create dynamic and interactive web pages using this client-side scripting language, which executes in the browser. JavaScript facilitates the incorporation of interactivity into web pages, which makes them more engaging and user-friendly. It enables real-time updates, interactive forms, image sliders, and other dynamic components that improve the user experience (ALI Z., 2014).

*"JavaScript is a programming language designed to introduce custom behaviours and interactivity to web pages. It is a client-side scripting language, meaning that it operates on the user's machine and not on the server, unlike languages such as PHP, Ruby, etc. JavaScript, also known as a dynamic and loosely typed programming language, is dependent on the capabilities and configurations of the user's browser" (*Robbins, 2012).

Because JavaScript is a multi-paradigm language, it supports both the functional and object-oriented paradigms for programming. It can be used for a variety of purposes, including DOM manipulation, event management, AJAX requests, and server-side development using frameworks such as Node.js. All modern web browsers support JavaScript, making it a highly compatible language for web development. It gives programmers the ability to create cross-platform apps that work with a variety of hardware and operating systems. JavaScript's ecosystem is vast and thriving, with numerous libraries, frameworks, and tools for developers (Park, T. H., Dorn, B., & Forte, A., 2015).

Popular frameworks like React, Angular, and Vue.js facilitate and quicken the development process by offering reusable components and effective workflows. JavaScript is a high-performance programming language, and modern JavaScript engines have become substantially faster over time. This makes it possible for developers to make online apps that are user-friendly, effective, and responsive. Community Assistance There is a sizable and

vibrant developer community for JavaScript all across the world. This community provides developers with extensive resources, tutorials, documentation, and support, making it simpler for them to learn JavaScript and solve problems (BAHRII R. & PETROVSKYI S., 2022).

JavaScript allows developers to easily alter the Document Object Model (DOM) and page style elements since it combines well with HTML and CSS. This gives users more control over how web pages behave and appear. JavaScript has a simple syntax and a gentle learning curve, particularly for those who are already familiar with HTML and CSS. Its accessibility to novices and rapid prototyping and development are made possible by its simplicity. JavaScript is a potent web development language due to its interactivity, versatility, compatibility, rich ecosystem, speed, community support, and integration with HTML and CSS. It enables developers to construct dynamic and engaging web applications that meet the constantly changing needs of modern users (Robbins, 2012).

4.1.3.4 PHP for Dynamics

PHP, which stands for Hypertext Pre-processor, is an extensively utilized server-side scripting language for web development. It is especially suitable for constructing dynamic and interactive websites. PHP offers several benefits for web development. PHP's frictionless integration with HTML enables programmers to embed PHP code directly in HTML files. This makes it easy to combine server-side dynamic functionality with static content, resulting in dynamic and malleable web pages. PHP is supported by the majority of web servers and works on a wide range of operating systems, including Windows, Linux, macOS, and Unix. This extensive compatibility makes it an adaptable option for web development projects in diverse environments (Park T. H., Dorn B., & Forte A. ,2015).

PHP's extensive array of built-in functions and libraries simplifies common web development duties. Among other things, it facilitates database connectivity, file manipulation, form processing, and image processing. This abundant functionality accelerates development and reduces the need to write code from inception. PHP is a programming language that is open-source and maintained by a sizable and vibrant community (Adams, C. & Boulton, 2005).

PHP's open nature ensures continuous development and frequent updates, while the community provides extensive documentation, resources, and support. Developers can easily obtain support, share their expertise, and contribute to the expansion of the PHP ecosystem. PHP is extremely scalable and capable of managing applications and websites with large traffic. It integrates well with prominent database management systems, such as MySQL, enabling the efficient management of large datasets and concurrent user interactions. PHP's scalability makes it appropriate for projects of various sizes and degrees of complexity. PHP offers a variety of frameworks, such as Laravel, Symfony, and CodeIgniter, that facilitate the development process and encourage code reuse. These frameworks provide pre-built modules, MVC (Model-View-Controller) architecture, routing systems, and other tools to enhance code organization and accelerate development (ALI Z., 2014).

PHP is renowned for its speedy execution and minimal server resource consumption. PHP provides efficient performance through optimizations and caching techniques, allowing websites and applications to respond promptly to user requests. One of the largest developer communities is found for PHP, which promotes cooperation and knowledge sharing. This thriving community contributes to the evolution of PHP, offers support via forums and communities, and creates innovative libraries and extensions. PHP provides, simple integration, comprehensive platform support, extensive functionality, open-source nature, community support, scalability, frameworks, performance, and a large developer community. These benefits make PHP a popular choice for web development, allowing programmers to efficiently create dynamic, feature-rich, and scalable web applications (Nixon, 2015)

4.2 Web Accessibility

> *"Web accessibility means that people with disabilities can use the Web. Web accessibility refers more particularly to the ability of persons with disabilities to interact, perceive, comprehend, and navigate the Web as well as to contribute to it. Web accessibility also assists others, such as older individuals whose capacities change with age."* - W3C (World Wide Web Consortium, 2023)

Web accessibility refers to the design and development of websites and web content that allows people with disabilities to perceive, navigate, comprehend, and interact with the web effectively. It seeks to eliminate obstacles that prevent individuals with disabilities from accessing and using websites, thereby promoting equal access to online information and services. Digital accessibility is, in layman's terms, ensuring that website and mobile apps are accessible to everyone, regardless of barriers, and that content is reachable in all possible directions; it is ensuring that have not excluded people with visual, hearing, motor, or cognitive impairments from content. It continues from there. Accessibility is not limited to individuals with disabilities. It concerns everyone. There are circumstances - situational or transient - that can impact ability to access the web or mobile applications. Accessibility, usually referred to as the capacity to use, describes the availability of tools, services, and goods for people with impairments. To make these products accessible, some people must use assistive technology (Zaki T., & Islam M. N., 2021).

Section	Indicator	Description	Meaning	Why it Matters?
ERRORS		Missing alternative text	Image alternative text is not present	a alt attribute is required for each image. Screen reader users or when the picture is inaccessible won't have access to an image's content without substitute text.
		Linked image missing alternative text	An image without alternative text results in an empty link.	Images that are the only thing within a link must have descriptive alternative text.
		Missing form label	A form control does not have a corresponding label.	A form control's function or purpose might not be made clear to screen reader users if it lacks a properly matched text label.
		Empty link	A link contains no text.	If a link is text-free, the user will not be informed of its purpose or function. For users of keyboards and screen readers, this may cause confusion.

		Broken ARIA reference	The target for the reference does not exist.	ARIA labels and descriptions will not be presented if the element referenced does not exist in the page.
A L E R T S		Redundant alternative text	The alternative text for an image is the same as nearby or adjacent text.	When images are not accessible or screen readers are being used, alternative text that is identical to neighboring or adjacent text will be displayed many times.
		Field set missing legend	A field set does not have a legend.	A field set legend presents a description of the form elements within a field set and is especially useful to screen reader users.
		Redundant title text	Title attribute text is the same as text or alternative text.	The title attribute value is used to provide *advisory* information. It typically appears when the users hover the mouse over an element.
		No script element	A <no script> element is present.	JavaScript enabled, <no script> cannot be used to provide an accessible version of inaccessible scripted content.
		Redundant link	Adjacent links go to the same URL.	When adjacent links go to the same location this results in additional navigation and repetition for keyboard and screen reader users.
		Possible heading	Text appears to be a heading but is not a heading element.	Heading elements (<h1>-<h6>) provide important document structure, outlines, and navigation functionality to assistive technology users.
		Skipped heading level	A heading level is skipped.	Headings provide document structure and facilitate keyboard navigation by users of assistive technology.
		Unlabeled form element with title	A form control does not have a label, but has a title.	The title attribute value for unlabeled form controls will be presented to screen reader users.
Contras tErrors		Very Low contrast	Very low contrast Between foreground and background colors.	Adequate contrast is necessary for all users, especially users with low vision.

Figure 4.2. Types of accessibility errors, that can be founded by WAVE accessibility evaluation tool, their meanings, and descriptions (Krystyna S., 2017).

If their infirmities are not considered, users with disabilities cannot access any products, devices, or services. One thing is lacking new opportunities, but these users may experience discrimination due to a disability. Websites contain illustrative graphics and images to make the site more visually alluring or to convey a specific message. There is an attribute in HTML

that displays alternative text if an image cannot be viewed. This attribute assists individuals with disabilities, such as visual impairments, who require assistive technologies to access web content. If these assistive technologies are used, text-to-speech software will recite the web content. Some individuals with colour blindness may not be able to distinguish between normal text and interactive links and areas due to the similarity between these elements. For some users, the similarity makes differentiation more difficult. This issue can be resolved in various methods. Underlining the link text is one option because it distinguishes links from normal text and makes the distinction more apparent. Creating a link icon is a further alternative (Brophy P. M., & Craven J., 2007).

4.2.1 Accessibility guidelines

Accessibility guidelines comprise of numerous requirements that instruct designers and developers on how to create content that is accessible to a broader audience. Users originate from diverse backgrounds and can utilize the Internet according to their capabilities and requirements. The WCAG guidelines are organized into four main principles, each addressing a different aspect of web accessibility:

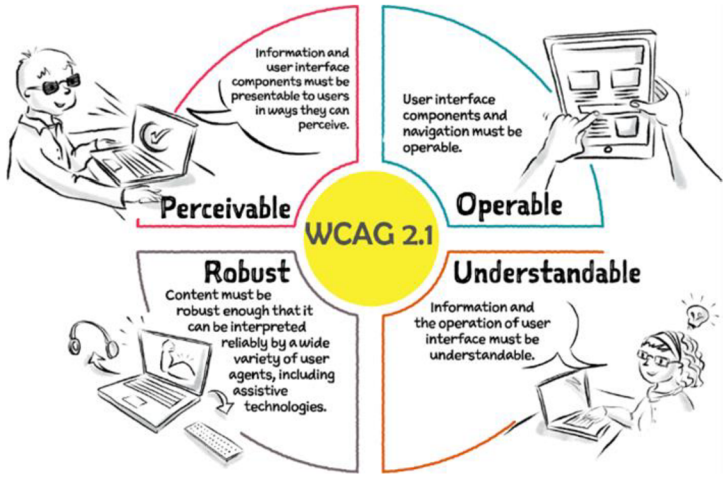

Figure 4.2.1 Accessibility Guidelines - Abbreviated version of The WCAG map (Spotify for Developers, 2023).

- **Perceivable**: It is necessary to display information and user interface elements so that users with various sensory capacities can understand them. Key factors include providing alternatives for non-text content (such as

images or multimedia), ensuring adequate color contrast, and providing text alternatives for audio or video content.

- **Operable**: Users who use keyboard navigation or assistive technology, as well as those with other types of disabilities, must be able to use the user interface and navigation. This entails guaranteeing keyboard accessibility, allowing users ample time to interact with the content, and avoiding content that could trigger convulsions or other unpleasant physical effects.
- **Understandable**: The website's functions and content should be presented in an easy-to-understand way. This entails utilizing straightforward language, rationally structuring the content, giving clear cues and instructions, and reducing mistakes and confusion.
- **Robust**: Websites should be designed to work reliably with different user agents, including assistive technologies, to ensure compatibility and accessibility across platforms. This principle emphasizes using standardized markup, avoiding deprecated or proprietary technologies, and providing fallback options for content that may not be supported by certain user agents (Spotify for Developers, 2023)

The WCAG guidelines specify three conformance levels: A (the lowest), AA (the most common), and AAA (the highest). Each level has distinct success criteria that must be met in order to attain conformity. There are other regional or industry-specific accessibility guidelines and standards. In the United States, for instance, the Section 508 Standards outline accessibility requirements for federal agencies, while the European Union's European Accessibility Act (EAA) seeks to harmonize accessibility requirements across member states (Sloan, D., Heath, A. C., Hamilton, F., Kelly, B., Petrie, H., & Phipps, L., 2006).

4.3 UX, Usability and Accessibility in the Software Development Lifecycle

Integrating accessibility into the software development lifecycle (SDLC) ensures that accessibility considerations are considered throughout the development process. By incorporating accessibility from the earliest phases of development, organizations can

save time, effort, and resources by preventing accessibility issues and integrating accessibility into the development process naturally (Zaki T. & Islam M. N., 2021). Here are some important considerations:

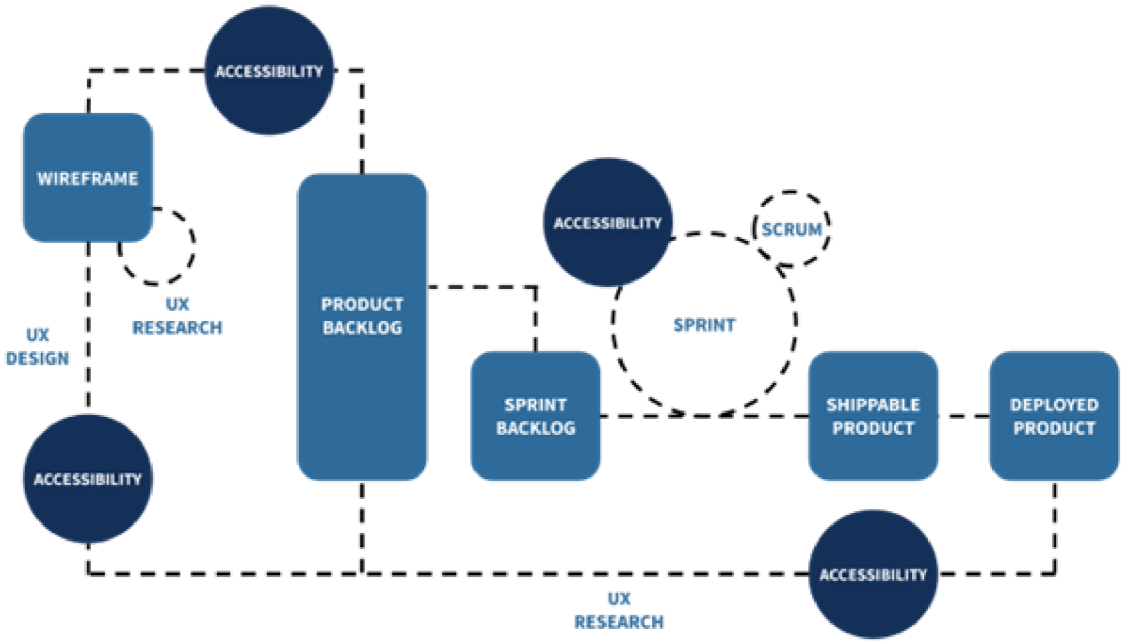

Figure 4.3 Accessibility in the Software Development Lifecycle (Spotify for Developers)

- Requirements Include accessibility requirements in the initial phase of requirements gathering and documentation. Identify the intended audience, including users with disabilities, and establish the required accessibility standards or guidelines.
- Design and Prototyping: When constructing wireframes, mock-ups, and prototypes, consider accessibility. Ensure that the interface is designed to be perceivable, operable, and understandable by disabled users. Use accessible colour schemes, provide adequate contrast, and design for keyboard navigation.
- Follow best practices for accessible coding during development. Make sure keyboard accessibility and offer text replacements for non-text content (like alt text for photos). Validate the accessibility of the code using assistive technology testing (Spotify for Developers, 2023).

- Incorporate accessibility testing into the process of quality assurance. Utilize both manual and automated accessibility testing tools and include users with disabilities in usability testing. Test a variety of assistive technologies and platform types to ensure compatibility.
- For developers, designers, and content producers, list accessibility best practices, methods, and recommendations. Provide the development team with training on accessibility principles, WCAG guidelines, and the use of assistive technology.
- Continuously monitor and maintain accessibility standards. Audit the website or application's accessibility on a regular basis and promptly resolve any issues that are discovered. Maintain a current understanding of accessibility guidelines and standards.
- Collaboration and Accessibility Champions: Promote collaboration throughout the SDLC between designers, developers, testers, and accessibility specialists. Designate accessibility champions or experts who can provide direction and support initiatives (Spotify for Developers, 2023).

4.4 Impact of Web Design on Company's Performance

4.4.1 Benefits of Web Design Improvements on Branding

Web design plays a crucial role in establishing and improving a brand's online presence. In today's era, desktop computers are being replaced by mobile devices. The benefit of a responsive website is that the visitor can view the site's content regardless of location or activity. "Responsive Web Design is a collection of techniques and technologies that make delivering a single application to a variety of devices as easy as possible." (Sharkie & Fisher, 2013).

From SEO, branding, and customer loyalty to conversion rates and increased traffic, and more, the site's Web Design plays a significant role in how visitors and potential customers perceive the brand. This chapter examines how well-designed websites support e-branding and disseminate product information to prospective customers in lieu of buyers' own

information gathering efforts. "Websites are an effective instrument for brand building. A well-designed website promotes brand recognition, whereas an improperly designed website can destroy a brand. Three phases are overlapping rather than distinct. User requirements regarding functionality and web interfaces vary by stage. When establishing a brand, the Web Design should be dynamic. Since Web Design has a significant impact on all three stages of e-branding in various ways, the sections below describe the fundamental Web Design considerations for each stage. (Cook, 2003)

4.4.2 Web Design impact on SEO and Conversion Rates

Redesigning a website is a marketing instrument that can increase conversion rates. A website redesign enhances the navigability and user-friendliness of a website, so improving the overall user experience and facilitating the discovery of desired information or actions by visitors. These actions may include subscribing to a newsletter, downloading a white paper, or making a purchase. This feature will serve to incentivize visitors to prolong their stay on website, delve deeper into the details of offerings, and potentially engage in a transaction (Zhao C., Lu, J., & Duan, F., 2009).

Design trends are continuously evolving; consequently, a company's brand and online presence must adapt to these ongoing changes. Advanced SEO and increased traffic are the most essential aspects of a commercial website, along with the user perception of its brand. Without traditional Web Design structures, which search engines use to crawl a website, its discoverability and traffic decrease. Inasmuch as search engines recompense websites that invest in enhancing responsiveness, Responsive Web Design is also a crucial element of successful optimization. Web Design always has the potential to affect a web page's search engine ranking, beginning with HTML structure and concluding with website aesthetics (Grappone J., & Couzin G., 2011).

Furthermore, it is imperative to understand that the field of Web Design has the potential to impact the conversion rates of a firm. The relationship between navigation and usability and conversion rates is evident. Websites that are difficult for users to navigate will likely be deemed unattractive, and users will lose interest in these sites. Undoubtedly, the website's "call-to-action" elements are the text and navigation. When designing "attractive" websites, colours are one of the most essential factors. There is a need to distinguish when to use bold

and red text versus "calm navy" to elicit trust in the minds of users. From SEO, branding, and customer loyalty to conversion rates and more, a website's Web Design plays a significant role in how the brand is perceived by website visitors and potential customers. (Hendricks, 2015)

Conversion Rates:

It is imperative to ensure that website possesses the capability to be accessed and operated effectively across a diverse range of devices and web browsers. Responsive design and compatibility testing aid in reaching a larger audience and delivering a seamless experience, thereby boosting conversion rates (Grappone J., & Couzin G. ,2011). The presence of slow-loading pages might lead to visitor frustration and adversely impact conversion rates. can improve the overall user experience and increase conversions by optimizing design elements that affect page performance, such as image sizes, code efficiency, and caching. Web design enables the strategic placement of conversion-focused website elements. This includes prominent calls to action, persuasive copy, trust indicators (such as testimonials and security insignia), and conversion-friendly forms. Well-designed forms have the ability to minimize resistance and motivate visitors to engage in the intended action (HENRY, 2015).

5. Practical Part

5.1 People with Disabilities in Bangladesh

In Bangladesh, as in many other nations, the prevalence of disabilities can vary based on age, geographic location, and socioeconomic status, among other factors. However, approximately 2.8 percent of the population in Bangladesh is found to have a disability by Bangladesh Bureau of Statistics, 2021. This result accounts for both men and women. 2.80 percent of the Bangladeshi population is disabled; 3.28 percent of men and 2.32 percent of women are disabled.

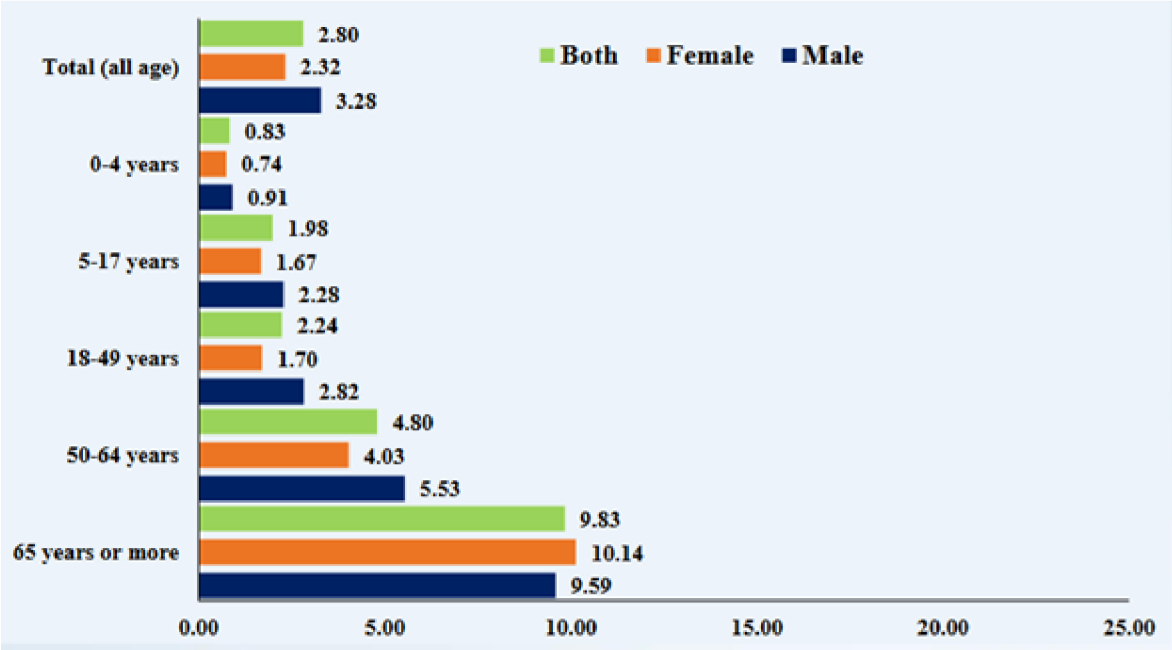

Figure 5.1 Percentage of persons with at least one domain of disability by sex and age group (Bangladesh Bureau of Statistics, 2021).

The disability rate in rural areas is 2.89 percent, which is slightly higher than the urban rate of 2.45 percent. It is lower among younger population members than elderly population members: only 0.83 percent of children aged 0-4 years, 2.24 percent of adults aged 18-49 years, and 9.83 percent of those aged 65 and older have disabilities. By division, Khulna has the highest percentage of people with disabilities (3.62 percent), followed by Rangpur (3.54 percent) and Rajshahi (3.30 percent), with Sylhet having the lowest percentage (2.15 percent). Disability has an inverse relationship with household wealth status, decreasing as household wealth quintiles increase from lowest to highest levels (3.79 percent among the

poorest population, 2.77 percent among the middle quintile population, and 1.97 percent among the richest quintile population). Disability is not a condition that is exclusive to one gender; both males and females can be afflicted by a variety of disabilities. Physical disabilities (such as mobility impairments or visual or auditory impairments) may be accompanied by intellectual disabilities, developmental disabilities, and mental health conditions. Disability prevalence rates can be affected by cultural factors, societal attitudes, and the availability and accessibility of healthcare and support services. Some disabilities may also be underreported due to stigma, discrimination, and lack of awareness (Bangladesh Bureau of Statistics, 2021).

Although specific statistics on the gender distribution of disabilities in Bangladesh may not be readily available, efforts are being made to promote gender equality and inclusiveness in disability-related policies, programs, and services to ensure that both males and females with disabilities have equal access to education, healthcare, employment, and other opportunities (Bangladesh Bureau of Statistics, 2021).

5.1.1 Farmers with Disabilities in Bangladesh

Farmers with disabilities in Bangladesh may face obstacles relating to accessibility, lack of appropriate agricultural equipment and machinery, limited access to training and resources, and social stigma and discrimination. These obstacles can impact their productivity, income generation, and well-being as a whole. Government, non-governmental organizations, and development agencies are working to address the needs and promote the inclusion of disabled farmers in Bangladesh. Provision of assistive devices, promotion of inclusive agricultural practices, provision of training and skill development programs, and advocacy for the rights and empowerment of disabled farmers are among the initiatives. Local disability organizations, agricultural cooperatives, and community-based initiatives also play an important role in aiding, sharing knowledge, and promoting social inclusion for farmers with disabilities in Bangladesh. This initiative seeks to ensure that all cultivators, regardless of disability, have equal access to resources, opportunities, and a dignified way of life (Bangladesh Bureau of Statistics, 2021).

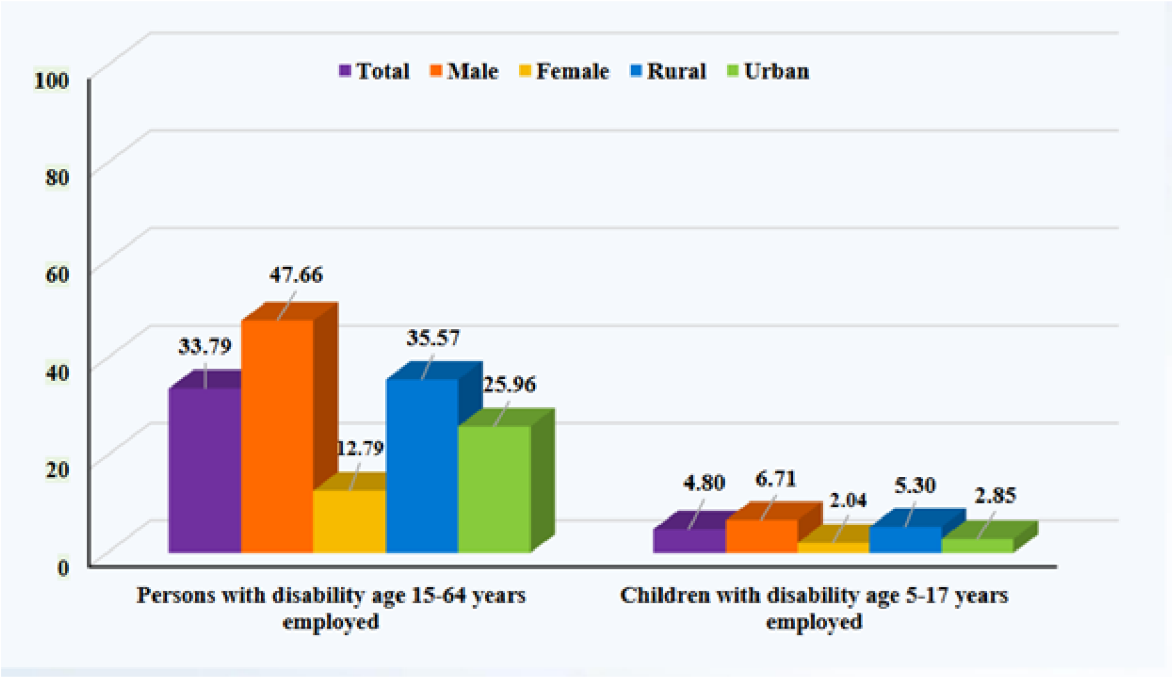

Figure 5.1.1 Percentage of disabilities aged 5-17 years in employment by sex and area (Bangladesh Bureau of Statistics, 2021).

In Bangladesh, 86 percent of people with physical and leprosy-related disabilities are directly engaged in agriculture Access to education remains a major obstacle for students with disabilities. Although the government has made efforts to promote inclusive education, limited infrastructure, a lack of trained instructors, and social stigma prevent disabled children from fully participating in mainstream schools. Available special education schools and inclusive education programs have limited scope. Farmers in Bangladesh are disadvantaged or disabled due to their lack of education or limited educational opportunities. While education is not a disability in and of itself, a lack of education or limited access to quality education can hinder the potential and opportunities of individuals, including farmers, particularly in a developing nation like Bangladesh (Bangladesh Bureau of Statistics, 2021).

Access to quality education can be difficult in rural areas of Bangladesh, where farming is prevalent, due to factors such as limited infrastructure, insufficient resources, and a lack of qualified instructors. Farmers who lack access to education may have difficulty implementing modern agricultural practices, utilizing technological advances, and gaining access to information and resources that could increase their income and productivity. It is

essential to note, however, that lack of formal education does not necessarily indicate disability. Numerous farmers in Bangladesh have acquired knowledge and abilities through hands-on experience, traditional knowledge, and informal learning within their agricultural communities. Government, non-governmental organizations, and development organizations are working to enhance educational opportunities for farmers in rural areas. This includes programs such as adult education, vocational training, and agricultural extension services that provide producers with practical knowledge and assistance. These initiatives seek to equip farmers with the knowledge, skills, and resources necessary to increase their productivity and overall well-being.

Education empowers individuals, including farmers, by providing them with the knowledge, skills, and opportunities to enhance their livelihoods and break the cycle of poverty. By addressing the educational requirements of farmers, it is possible to increase their adaptability to changing agricultural practices, access to market opportunities, and overall quality of life (Bangladesh Bureau of Statistics, 2021).

5.2 Web UX and Usability Analysis and Accessibility Testing

5.2.1 Accessibility Testing

The "WAVE" Web Accessibility evaluation tool has been used to evaluate the Web Accessibility of websites. The "WAVE" accessibility checker was created by "web AIM"; this tool identifies all accessibility violations and suggests how to remedy them. I have tested a government e-portal for Bangladeshi Farmers by WAVE. I tried and figured out the flaws of the website (Figure 5.2.1.1).

Figure 5.2.1.1 Screenshot of Accessibility testing on farmers e-portal (http://krishi.gov.bd/) by Bangladesh Government (author 2023)

This tool annotates a copy of the page being evaluated and displays the original web page with embedded symbols that indicate the accessibility issue for each element (Figure 5.2.1.1).

Figure 5.2.1.2 Screenshot of Accessibility testing on farmers e-portal by Bangladesh Government (author 2023)

There are few sections indicating the various categories of Web Accessibility violation cases (such as "errors", "alerts", etc.). The icons associated with each indicator are enumerated below.

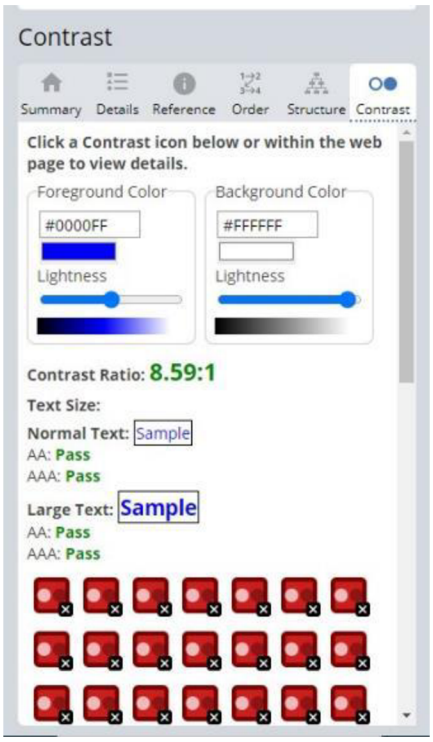

Figure 5.2.1.2 Screenshot of Color Contrast of farmers e-portal (author, 2023).

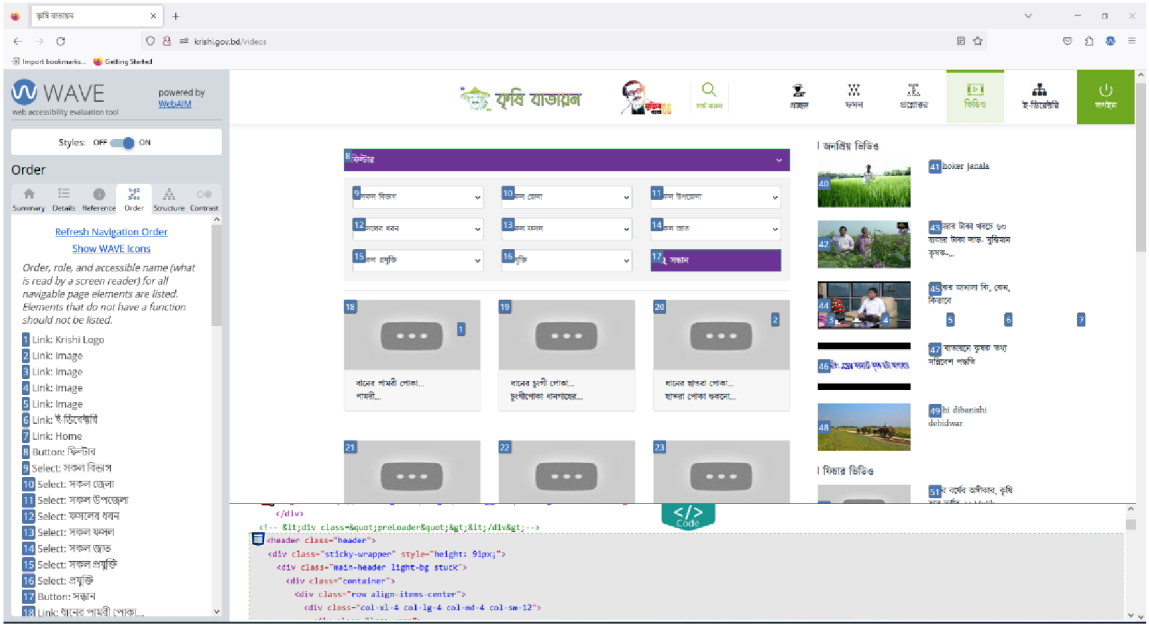

Figure 5.2.1.3 Screenshot of farmers e-portal (author, 2023).

5.2.2 UX and Usability Testing Via INTERVIEWS Method

There are several essential usability testing methods. Among them INTERVIEW method of testing is one of the popular one. In interview testing, End User are asked to several topic, listen their process and follow up questions about the UX and Usability of the system. This is frequently a combination of techniques and strategies that will talk to users, observe how they use the product, and learn how they feel about it afterwards (Schroeter E., 2021). In Interview method was implemented by conducting a survey with farmers asking real time questions and showing the website functionality. Interviews are a great complement to almost any other research method; use them to understand decisions made during card sorting studies, follow up with usability testers, or expand on feedback from ongoing listening surveys. This method of UX research is a reasonably quick and easy way to gather qualitative user data.

UX and Usability related survey was conducted with Farmers of Bangladesh.

- The survey has been created using paper form and has 2 sections including UX and Usability, and Visualization.
- Weight scale chosen from 1 (Dislike / Disagree/Not Satisfied) to 5 (Fully Like/ Agree/ Satisfied).
- Survey was conducted with farmers of age between 22 to 55.
- Survey was conducted in 5 different cities of Bangladesh with 50 People.
- This Survey was formed like Interviews Method of UX and Usability

Questions for farmers are mainly organized to know-

- their experiences during use of the portal,
- their pain points of the portal,
- about their feelings,
- users care or priority of the system.
- Also, noted users' motivations. aspirations and desires.

Survey Questionnaires was more like to know the farmers experiences. Survey was conducted in Bangla (Bangladeshi Language). In Result(average), lowest number of weight indicate to Highly Disagreed/Unsatisfied and highest number of weights indicate to High Satisfaction level.

Weight Scale of Result:

1 (Highly Disagree/ Unsatisfied)

3 (Moderate Agree/ Satisfied)

5 (High Agree/ Satisfied)

Questionaries was conducted,

Survey Questionaries	Result (average)
Krishi.gov.bd can be accessible via Mobile or Tablet.	1.8
Usually, I check this website.	2.5
I am aware of all functionalities.	2.2
This website updates Real time information.	1.8
There is helpline to support farmers.	3
Portal shows real time market price.	1
Necessary information can be found easily.	2

Table 5.2.2: Survey few questions with average feedback.

In table 5.2.2, Average Result indicate the average of the answer from user. According to the average result, no question was highly satisfied. Most of the question was moderate satisfied. Some questions were highly unsatisfactory.

Result from survey be visual in Pie chart, All the are satisfied value regarding the different parameters of the website.

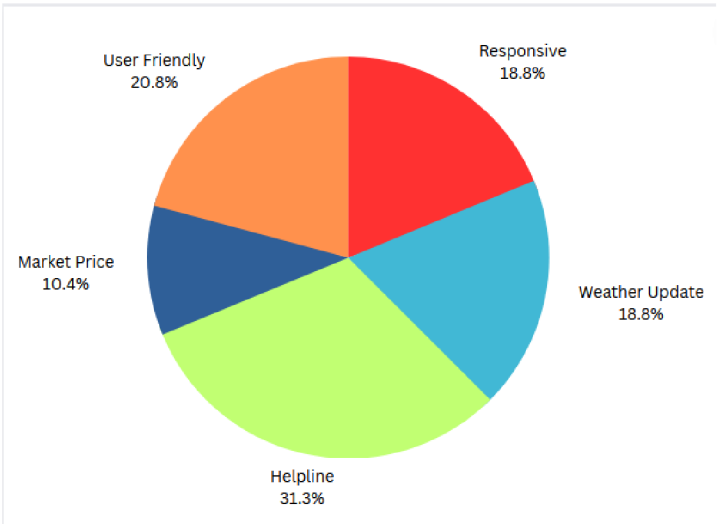

Figure5.2.2.1: Visualization of Survey Result.

Most of the farmers are expressed their statement via their own language which has been noted as a formal way. The above percentage show that the information portal fulfils their requirements considering their needs.

The Survey was conducted in 5 different cities of Bangladesh.

City Name	Gender	Persons Interviewed
CUMILLA	Male (18), Female (2)	20
RANGPUR	Male (4), Female (1)	5
CHITTAGONG	Male (7), Female (0)	7
RAJSHAHI	Male (8), Female (2)	10
SYHLET	Male (4), Female (4)	8

Table: City, Gender and number of Person interviewed during the survey.

This table represent the numbers of farmers have the knowledge on Modern technology of farming according to the survey I have conducted.

City Name	Knowledge on Technology	No Knowledge on Technology
CUMILLA	15	5
RANGPUR	1	4
CHITTAGONG	2	5
RAJSHAHI	1	9
SYHLET	4	4

Table: Shows the Farmers Education in different City.

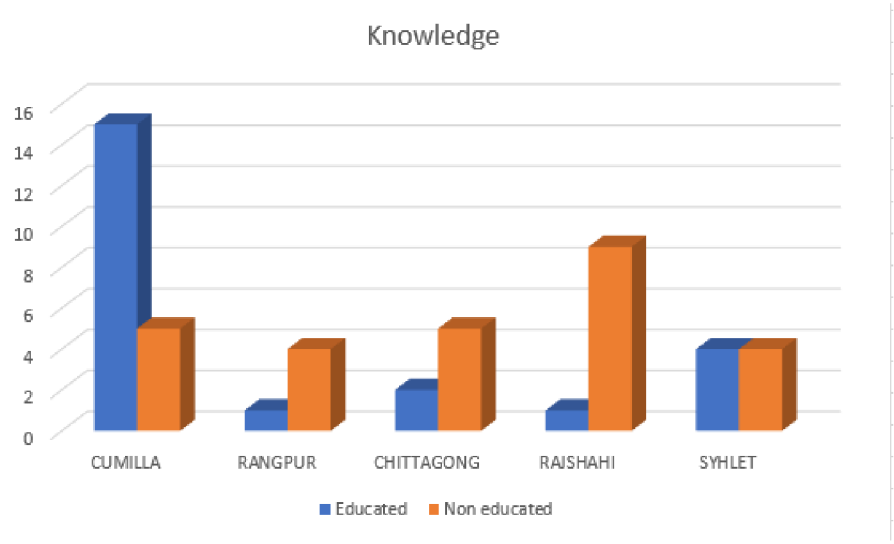

Figure 5.2.2.3: Knowledge of Technology in different city from survey (author).

In figure 5.2.2.3, educated indicates the knowledge of modern technology and modern farming they have. According to the survey, they took this modern technology by attending different government seminar and also learned from internet. The highest number of modern farmers are in Cumilla. They have knowledge on few modern technologies which can help them to grow crops. But in Rangpur is the lowest number of modern persons. They do not have any knowledge about modern farming or technology. They use the ancient method to cultivate their crops. Due to this old method of farming, they cannot grow crops as they need. And they have less knowledge on fertilization, better farming etc.

5.2.3 USER SCENARIO TESTING

During Testing the User Scenario, 5 farmers have been asked who have knowledge on basic technology and education. Random features are asked to find out from the portal and counted times how long it takes to find out. User scenario testing is a crucial step in the evaluation of user experience (UX) and usability. It entails developing precise, plausible scenarios or situations in which a customer could engage with a good or service. These scenarios were designed to evaluate the usability of the product and spot any possible problems or areas that could need development. The End User was not provided any hints during this process.

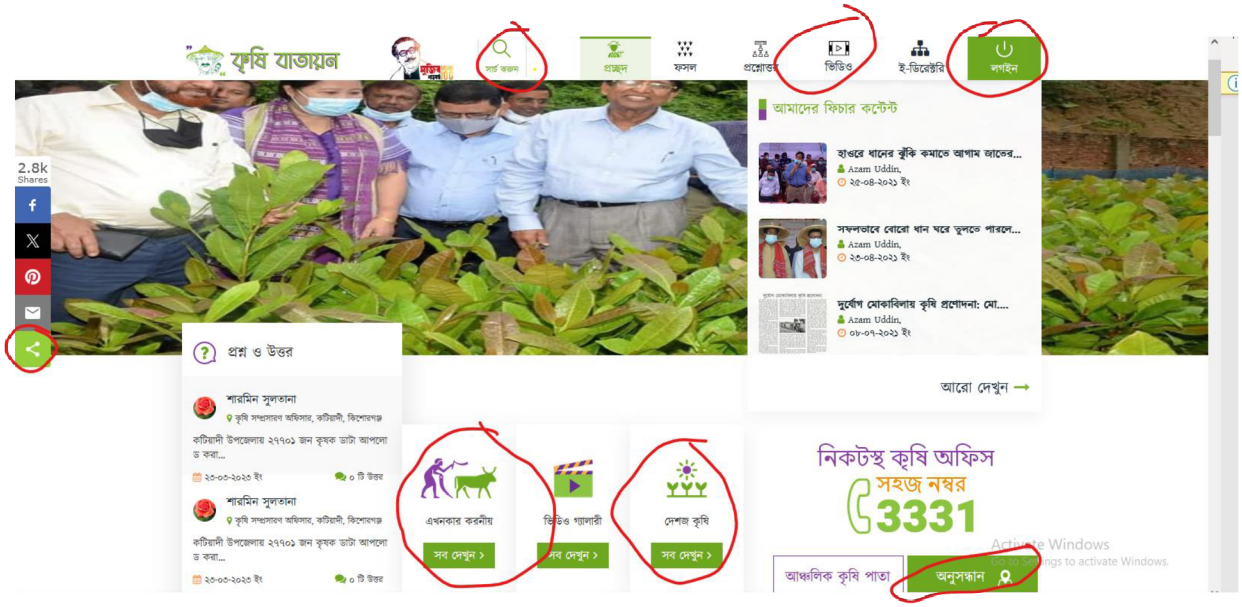

Figure 5.2.3.1 User Scenario point are red marked and asked them to find from the portal.

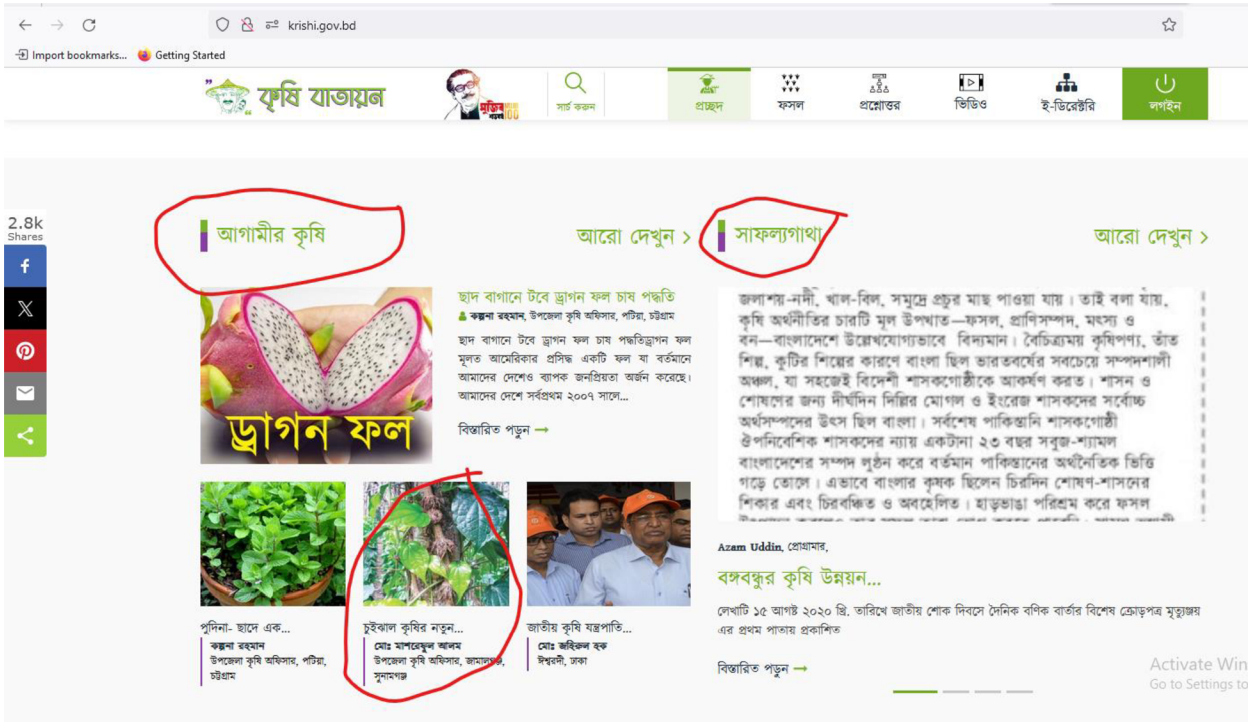

Figure 5.2.3.2 User Scenario point are red marked and asked them to find from the portal.

I have conducted this User Testing with 5 farmers where they have been requested to findout some keyword from the website and their finding time was noted. Average finding time have been shown in this table. Users are asked this point to find and their findout time. All are asked in Bangladeshi local language in Bangla.

Name of the keyword	Time (Average)
Search	10 Seconds
Video	05 Seconds
Local Farming	40 Seconds
Login	15 Seconds
Success History	50 Seconds
Future Agriculture	60 Seconds
Choijhal Farming	75 Seconds

Table 5.2.3: Manual User Scenario Testing data.

In table 5.2.3, User Scenario Testing data has been shown. In standard user scenario, a keyword should be found within few seconds. According to the different User Experience data, A user takes about 50 milliseconds to form an opinion about a website will user stay or leave (thesemanticstudio, 2023). User needs a lot of time to find a keyword or features from the website. CHOIJHAL farming keywords took longer time to find out from the website. All the features are not much organized considering to user experience. The website structure should as the important point should not be much depth. So, from this user scenario data table, I can conclude that the website is not good user friendly according to the User Experience Standard.

5.2.4 Responsive Testing

To create a farming app that serves consumers in Bangladesh, responsive web design is essential. The software should adapt to multiple screen sizes and resolutions without any problems, especially given the wide variety of devices and connectivity issues in rural locations. To accommodate users with varied degrees of computer literacy, the user interface should be simple to use, intuitive, and have large, obvious buttons.

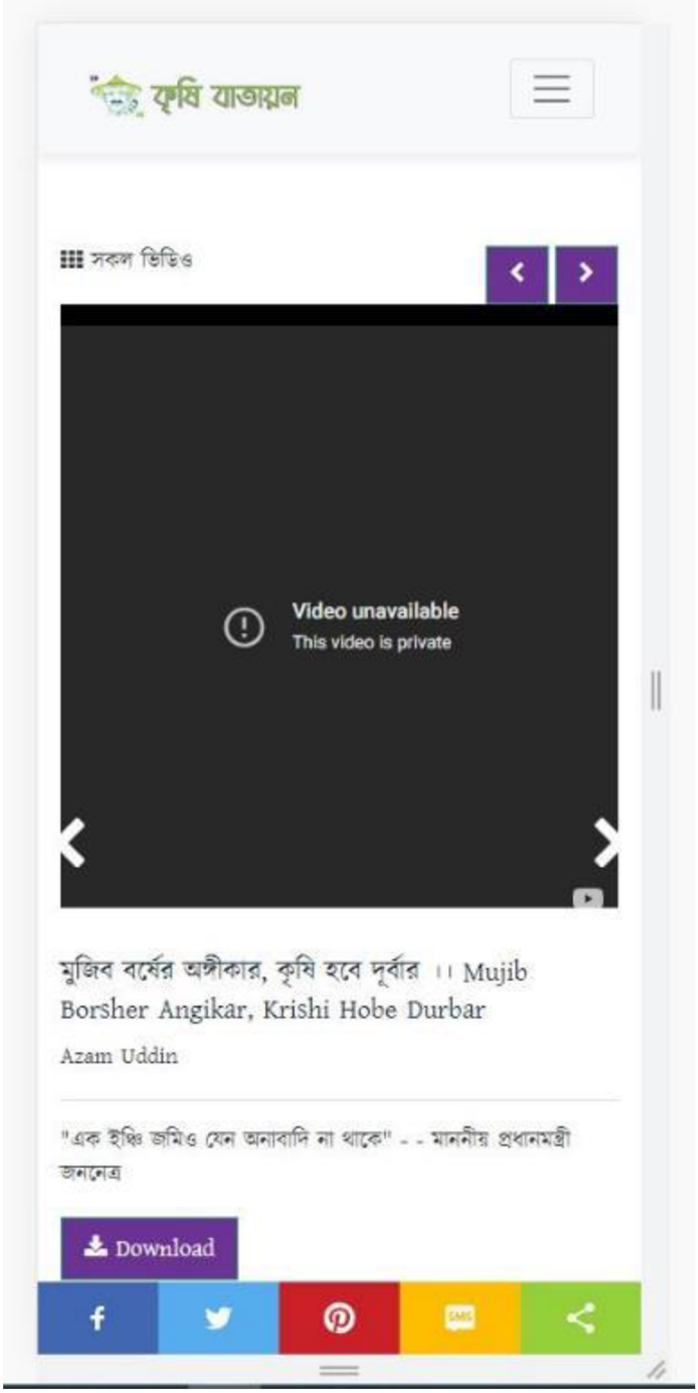

Figure 5.2.4. Screenshot of Responsive Test (Mobile View) of Farmers App (author, 2023)

I have tested the responsive of the farmer apps and found several things are not well played with responsive. The website show error for Video Player if we make the website to mobile View. Farmers with spotty internet access can use the program with minimal data usage and performance optimization (Figure 5.2.4).

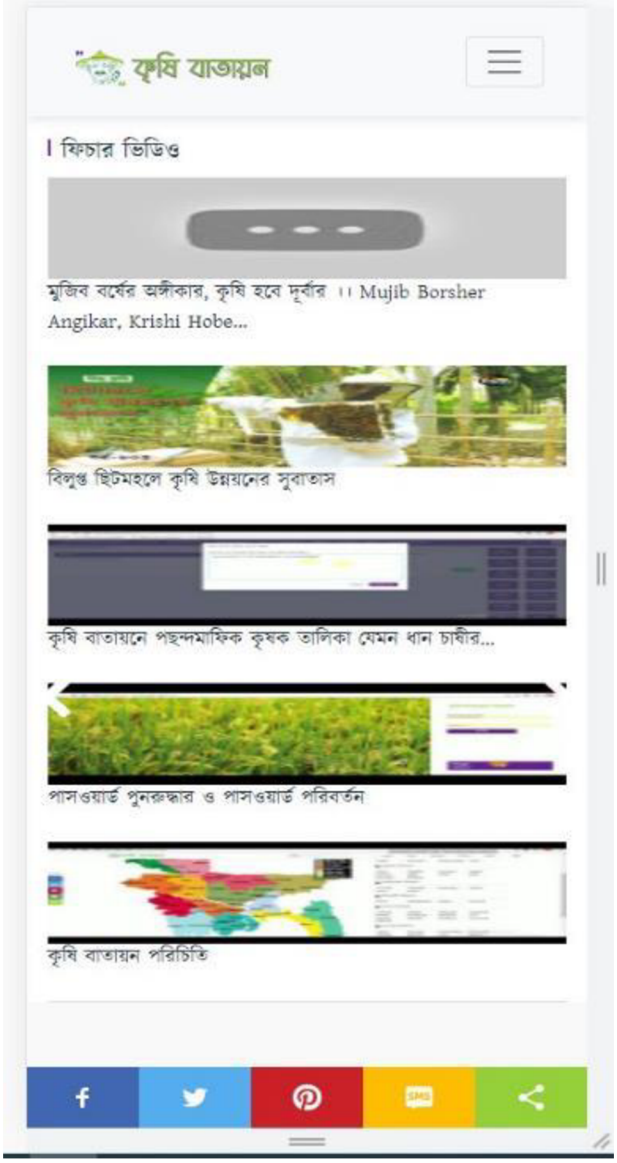

Figure 5.2.4.1 Screenshot-2 of the Responsive Test (Mobile View) of the Website (author, 2023).

We have also found that the text and picture is not responsive as well. The Text is in Bengali Language, but in mobile view the text was not suitable readable to the reader. Also, the picture was not in suitable view. The reference link was not working properly. The target audience may easily understand and relate to the material thanks to localization in Bengali. By delivering regional information and enabling farmers to access crucial functions even without an internet connection, location-based services and offline capability increase the app's utility. The software must be improved over time in response to user input and iterations to satisfy the changing needs of Bangladeshi farmers (Figure 5.2.2.1).

5.2.5 Performance Testing

` As Performance also one of the components of User Friendly. So, I have also conducted a performance test. During Performance Testing, I have tested the network use of the website. First, I have tested some keyword to search in the portal.

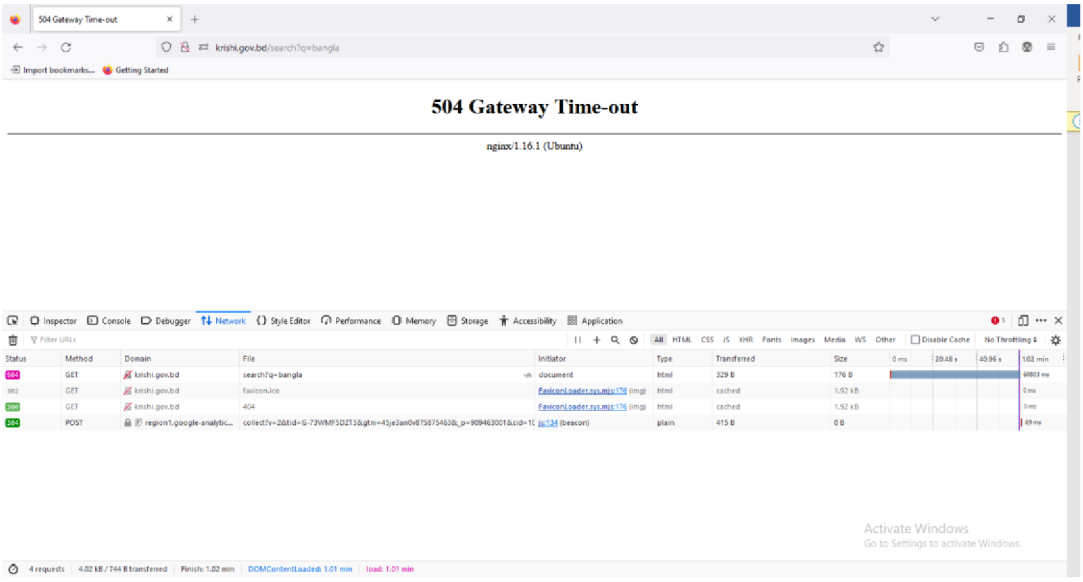

Figure 5.2.5.1: Checking the Network Performance of the website.

During the Search testing, its failed to response back. So, there is some issue with search option also. We have also tested other pages,

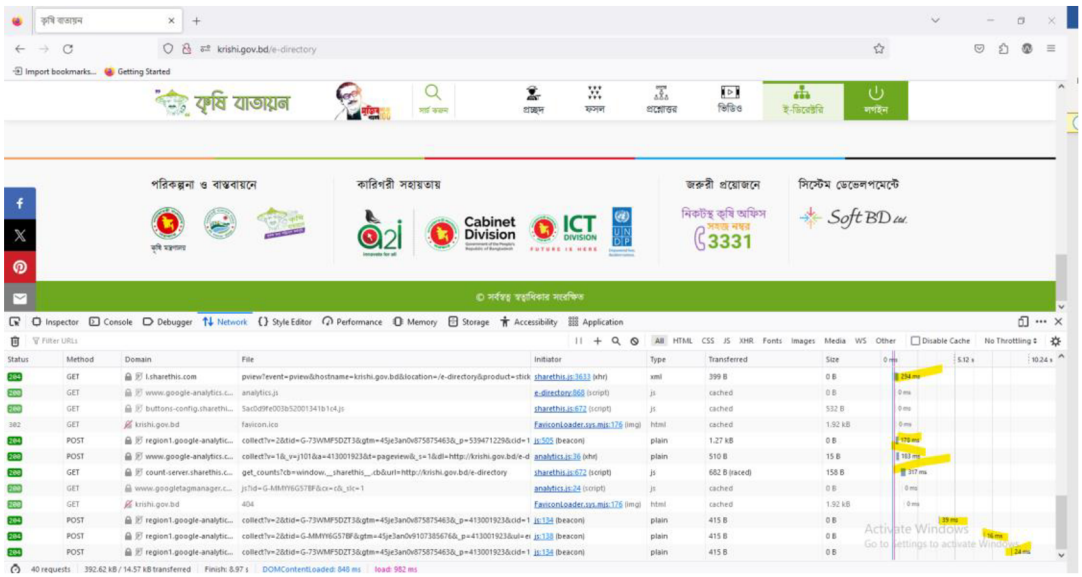

Figure 5.2.5.2 Network Testing.

During network testing of the other pages, I found that that response from the server is in a short time. So, we can say that others page network and performance much better.

5.2.6 Manual Features Testing

There are a few flaws in the apps. Few Hyperlinks are not working properly. Also, few image is not loading or missing in the apps.

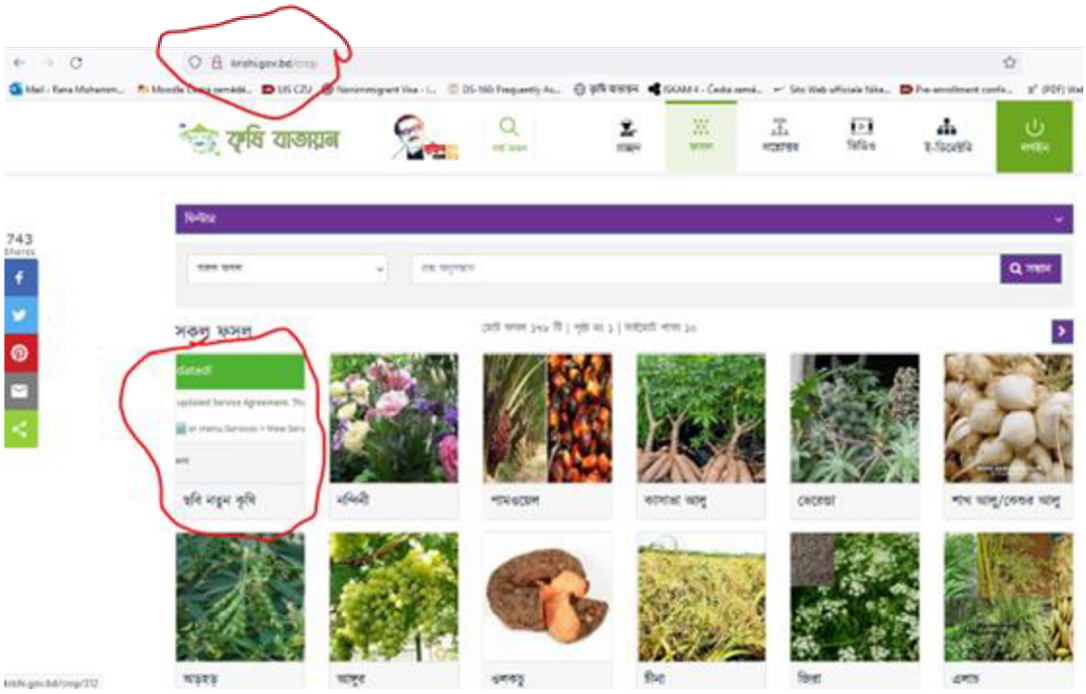

Figure 5.2.3 Screenshot of the Web Application of Krishi (author, 2023)

Also, the website connection is not secure via SSL. The utilization of the Secure Sockets Layer (SSL) standard security technology is prevalent in many client-server interactions, such as a web server (website) and a browser, or a mail server and a mail client. This technology facilitates the establishment of an encrypted connection between these entities. (Figure 5.2.3).

The weather update information on the website is also not working. It was not providing real time data (Figure 5.2.3).

Figure 5.2.3 weather update features in Web portal (author, 2023).

6. Results and Discussion

6.1 Analytics Interpretation of krishi.gov.bd Website

I have tested it analytical data via *SimilarWeb* Analytical website. *SimilarWeb* (www.similarweb.com) is a free service provided to create detailed basic statistics of visitors to websites.

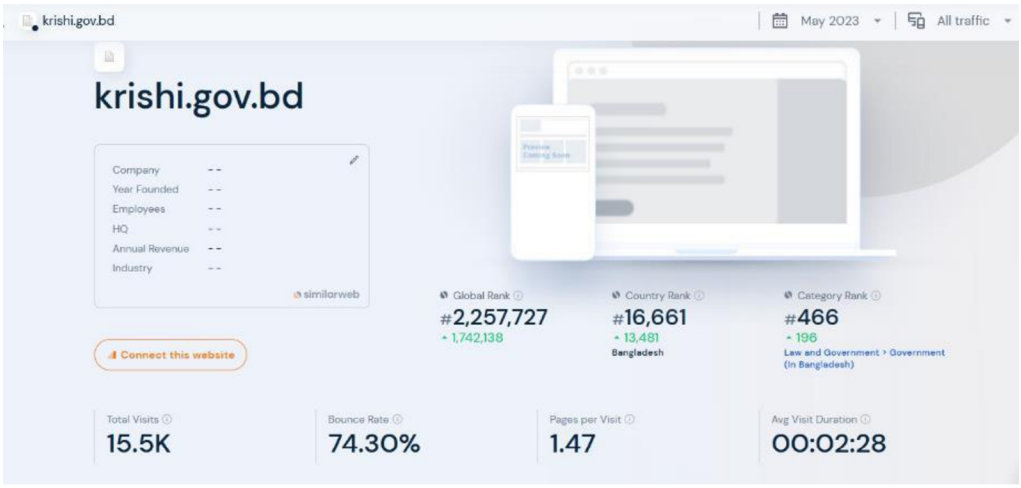

Figure 6.1. Screenshot of Analytics Interpretation of krishi.gov.bd Website (author,2023)

According to the SimilarWeb, Total Visitor in May'23 is more than 15 thousand. Average Page Per visit 2.28 Minutes. And the bounce rate is 74.30 percent which is huge. So, the website is not suitable to user. According to data from SimilarWeb, the average bounce rate is between 41% and 55%, with a range between 26% and 40% being ideal, while anything over 46% is seen as "high." (Figure 6.1).

6.2 UX, Usability and Accessibility Analysis.

6.2.1 Accessibility Analysis

The following market sectors and websites have been chosen in order to test the web accessibility of the websites in those areas that are most frequently accessed by Internet users with access needs. This is because these businesses offer services

across the whole market. The number and types of errors on the selected web pages are displayed in the table below. The most prevalent issues across all evaluated web pages are, as indicated in the table, the absence of alternative texts, empty links, missing form labels, the absence of script elements, redundant links, and low contrast. (Fig. 6.2.1).

	Indication	Errors	Numbers of Errors
KRISHI.GOV.BD		Missing alternative text	**107**
		Linked image missing alternative text	**45**
		Missing form label	**10**
		Empty link	**25**
		Broken ARIA reference	**33**
		Redundant alternative text	**15**
		Field set missing legend	**1**
		Redundant title text	**21**
		No script element	**14**
		Redundant link	**44**
		Possible heading	**9**
		Skipped heading level	**3**
		Unlabeled form element with title	**7**
		Very Low contrast	**198**

Figure 6.2.1 Number of errors on some Farmers Web Application detected by WAVE evaluation tool.

As according to the Bangladesh bureau of Statistics, almost 2 million people of Bangladesh are colorblind. And many of them are farmers. So, from this accessibility test, I can state that Color Contrast is 198 which is really very bad number considering the colorblind farmers. They will get the proper information due to not considering them in the design.

In the meantime, missing alternative text number also so high which is also an important point for the farmers. Colorblind farmer may confuse without Alternative text in button. Linked image missing alternative text is also a matter of worry that invalid image cannot provide proper meaning without alternative text. Redundant title link errors also a good point to consider.

6.2.2 UX and Usability Analysis

A survey was conducted with 50 Bangladeshi farmers in 5 cities of Bangladesh. The survey was conducted physically with farmers asking different questions what they want about the farmers information portal. Among them most of the farmers are male with a few numbers of female farmers. Their age was between 22-50.

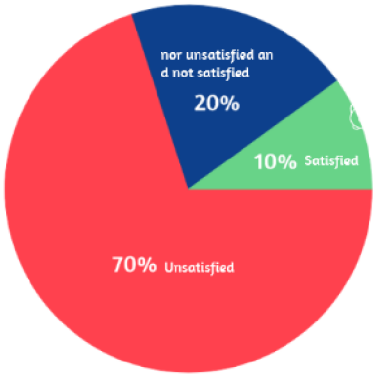

Figure 6.2.2 Result of Satisfaction of Farmers from Survey (author, 2023)

In the Survey found that 70 percent of farmer are not satisfied with the current information portal from government of Bangladesh. 20 percent of them are both agreed. 10 percent of them satisfied. During Survey, they were also asked for card sorting features they want in the portal. (Figure 6.2.2).

6.3 Features expectation from Farmers

6.3.1 Mobile Application of the portal.

Farmers mainly want a mobile app beside the mobile responsive portal. The Mobile App will help them to easily browse the content and also, they can upload images of their

damage's crops. By uploading their insecticides crops, they will automatically get the suggestion remediations from the apps.

Figure 6.3.1 Mock up of mobile App version for Krishi Govt Portal (author, 2023).

A smartphone app is bringing about dramatic improvements in agriculture, relieving farmers' suffering by educating them about farming and boosting production to develop rural economies.

6.3.2 Image and Voice Search

Farmers who may have weak literacy skills but can detect visual cues and patterns may benefit from such a feature. The farmers were suggested to add voice and image search service into the website. It will be helpful to search any query from the informational database without reading the text. As they have less education the voice and image service search can make their searching easier. A voice and image search function could be a useful addition to an internet portal for Bangladeshi farmers who lack education. With the help of spoken commands, this feature would make information and resources more accessible to farmers who may not be proficient readers.

Figure 6.3.2. voice Search logo (author, 2023)

Voice and Image search makes it easier for farmers with low literacy levels to obtain information since it eliminates the need for typing and reading. They only need to speak their inquiries or requests into the website portal, and the system will process it and deliver the necessary resources, advice, or information. This simplification may assist remove obstacles brought on by illiteracy and improve farmers' access to important agricultural data. An Image and voice search option that supports regional languages like Bengali will be helpful to Bangladeshi farmers who may not be fluent in written English or have low literacy skills. Farmers may more easily search for information, ask questions, and get answers that are more pertinent to their requirements by being able to connect with the website portal in the language of their choice.

Natural and intuitive interaction: For people who aren't used to using keyboards or navigating complicated user interfaces, voice and image search offers a more natural and intuitive method of dealing with technology. Farmers may communicate in a way that seems more familiar and comfortable by asking their questions out loud, which lowers any potential technological hurdles they could encounter. Hands-free operation: Since farmers frequently need to perform agricultural operations with their hands, typing or using a mouse is inconvenient for them. Farmers can access information while working in the fields or engaging in other agricultural tasks thanks to voice and image search's hands-free functionality. Farmers can multitask without disrupting their job because of this feature, which increases efficiency and convenience.

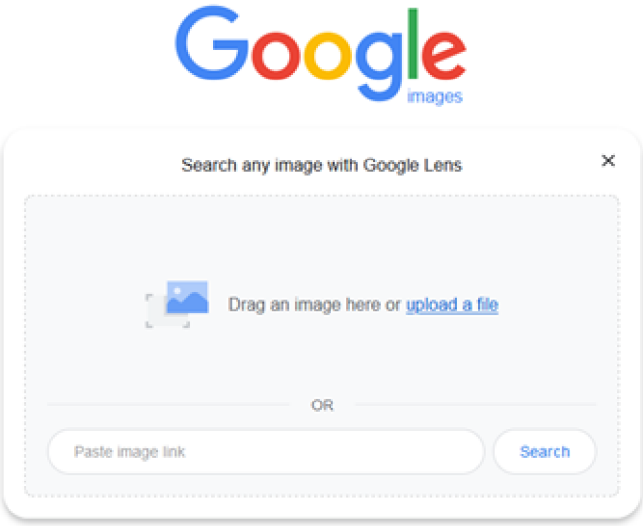

Figure 6.3.1.1 Sample Image Search by Google (Google.com, 2023)

Contextual and customised answers: An Image and voice search tool that is well-designed can offer contextual and personalized answers that are suited to the requirements of farmers. The system can give more pertinent and useful information by utilizing data like location, cropping patterns, and prior interactions. For instance, farmers can use voice commands to ask about the weather, pest control methods, or crop-specific information and get customised recommendations depending on their situation.

Voice-based agricultural hotline: Including a voice-based agricultural helpline in addition to the voice search feature can aid ignorant farmers even more. Farmers can call this helpline, which can be accessible through the website portal, for immediate advice and direction from agricultural specialists or extension personnel. Farmers may ask questions, get answers, and get real-time assistance in their native tongue, which helps them overcome obstacles and make wise decisions.

6.3.3 Digital Assistant/Chat Helpline features

It can be quite helpful to include a chat element or chatbot for ignorant Bangladeshi farmers. Farmers who might find it difficult to read or navigate the website can still access information and support thanks to this method of communication. Farmers anticipate that the website portal will give them knowledge about recognizing, avoiding, and successfully managing pests and diseases. This can include information about the life cycles of pests,

integrated pest control techniques, natural alternatives, and when pesticides should be used properly. Farmers can reduce crop losses by receiving timely information on disease outbreaks and control actions. Many ignorant farmers could find it difficult to read and comprehend printed material. They may benefit from a more approachable and user-friendly interface provided by an online chat function or chatbot. It is simpler for farmers to ask for and receive information when using voice-based interactions or straightforward text-based talks in the regional tongue. Farmers may receive real-time support from the online chat function or chatbot. They have access to information whenever they need it since they can ask inquiries and instantly get answers. Farmers may use this feature to get assistance even after typical business hours because it may be accessible around-the-clock.

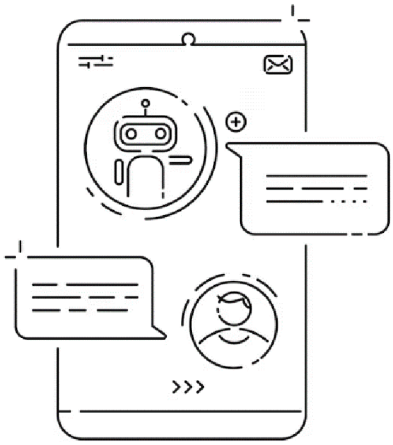

Figure 6.3.2 Chatbot Sketch (freepik.com, 2023).

The chatbot may also adjust to the farmer's level of language skill and give explanations that are simple and to the point. Based on the particular questions and needs of farmers, the online chat function or chatbot can provide personalized advice. In order to comprehend the farmer's background and offer specialized ideas and answers, it can pose pertinent questions. The user experience is improved, and the content is more useful thanks to this tailored approach. The chatbot can provide detailed directions on how to browse the website, access the various parts, and locate pertinent information for farmers who may be unfamiliar with technology or online platforms. They can go beyond any stumbling blocks they may encounter when using the web portal thanks to this functionality. Farmers with weak literacy skills may find it very helpful to have voice-based engagement features in addition to text-

based conversation. It is easier for them to communicate and get information when they express their questions or commands, and the chatbot can react appropriately.

6.3.4 Weather Update and Alerts Update

For Bangladeshi farmers, weather warnings and updates are essential components of an informational website. Seasonal changes and weather patterns have a significant impact on Bangladesh's agriculture; thus, farmers must have access to current meteorological data in order to efficiently plan their farming efforts. Farmers may stay informed about changing weather conditions and take necessary action by incorporating weather updates and notifications.

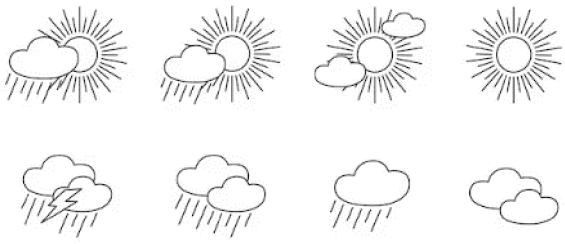

Figure 6.3.3. Weather Update Logo (author, 2023)

These functions offer precise forecasts that consider the local climate's factors like humidity, temperature, and wind speed. In addition, the web portal may provide warnings and alerts about extreme weather conditions like cyclones, floods, or droughts, allowing farmers to take precautions to save their livestock and crops. The availability of accurate weather information enables farmers to make informed decisions on planting, pest management, irrigation, fertilization, and harvest. This valuable knowledge aids in minimizing potential losses and enhancing agricultural productivity.

6.4 Dynamic Web Portal with latest Information

Most of the farmers are not able to read and write. They have less education and modern farming technology. So, they want a modern website with modern web features. A contemporary informational online gateway must meet several demands for Bangladeshi farmers. Accessing current and pertinent information, refining their agricultural methods, boosting output, and raising their overall revenue are all fundamental to these aspirations.

Real time Access to agricultural information: Farmers anticipate timely and reliable information on a variety of areas of farming from a modern informational online portal. This contains details on crop cultivation methods, weather predictions, market prices, pest and disease control, and agriculturally related government regulations. Farmers can adopt modern farming techniques and make informed decisions with the aid of readily available information.

Updated Advice relevant to each crop: Farmers in Bangladesh grow a wide range of crops. They anticipate that the website portal will provide recommendations and advice specific to their geographical location and farming practices. This can include details on post-harvest management, crop selection, seed varieties, fertilization strategies, and irrigation procedures. Farmers that adhere to this guidance have the potential to optimize both the quantity and Caliber of their agricultural produce.

Management of pests and diseases: Crop pests and diseases can significantly reduce agricultural productivity. Farmers anticipate that the website portal will give them knowledge about recognizing, avoiding, and successfully managing pests and diseases. This can include information about the life cycles of pests, integrated pest control techniques, natural alternatives, and when pesticides should be used properly. Farmers can reduce crop losses by receiving timely information on disease outbreaks and control actions.

Update Prices and market information: Access to precise market data is essential for farmers to make decisions about how to sell their produce. Real-time updates on market prices for various crops in local and regional marketplaces should be available on a contemporary website portal. Farmers can plan their production and marketing strategies by using information on market trends, demand-supply dynamics, export potential, and value-added agricultural products.

Financial and agricultural resources: In order to advance their agricultural techniques, farmers frequently need access to financial resources, such as loans, subsidies, and government programs. Information regarding these resources, eligibility requirements, application processes, and contact information for pertinent financial institutions and

governmental organizations should all be available on the online portal. Furthermore, information about agricultural tools, technology, and other resources that can boost productivity have to be easily accessible.

Training and capacity building: Farmers' ability to adapt to evolving agricultural techniques depends on ongoing learning and skill development. The website portal may provide videos, webinars, and training materials on a range of agricultural subjects. These resources can address topics including precision agriculture, sustainable agricultural methods, water management, and post-harvest processing procedures. Collaborative learning can also be supported by allowing knowledge-sharing among farmers and connecting farmers with agricultural specialists.

Networking and community involvement: The internet portal ought to present chances for farmers to interact, exchange knowledge, and work together. Farmers can share expertise, get assistance, and build useful networks by using discussion boards, online groups, and interactive platforms. Collective learning and support can be facilitated by increasing contacts between farmers and creating a sense of community.

7. Conclusion

As Bangladesh is an agricultural country. A major section of the population is employed in the agriculture, which also considerably boosts Bangladesh's GDP. However, access to current knowledge, changes in the market, and contemporary agricultural practices are frequently problems for farmers. The internet has had a notable influence here, connecting farmers with essential resources. cheaper smartphone and expanding internet connectivity, Bangladeshi farmers may now quickly access essential agricultural information and services. A portal is a useful tool that answers the unique requirements of farmers by giving them access to timely, relevant real time information and data. By putting an emphasis on UX and usability, the portal can improve the user's experience overall, making it simpler for farmers—including those with little education or technological know-how—to explore, comprehend, and successfully utilise the resources that are provided. Most of the farmers are not able to read and write. They have less education and modern farming technology. They can be beneficial via this information portal making more simpler and user friendly.

According to the Accessibility standards, there are lots of flaws in the current existed web portal apps. The website was not maintaining standard guidelines for disabled people. There are flaws in Image loading, hyperlink, alter text, video, and real time data. The website was build considering the colour-blind disability farmers. Also, the website is not user-friendly considering farmers who have less knowledge of education and technology. In Accessibility Test via WAVE Tools, colors contrast was the highest errors about 198, which may be a problem for the colorblind people. As according to the Bangladesh bureau of statistics, almost 2 million people of Bangladesh are colorblind, it should take care of them to fix the colors contrast. Colors contrast will be the burden for colorblind farmers using the portal. It may also can be implemented keyboard functionality.

An Interview Method testing was conducted among 50 peoples between age group 22-50 and male female both joined in the survey. But the number of the female was less comparing to male farmers. The survey results indicate that most farmers express dissatisfaction with the existing web portal. 70 percent farmers are dissatisfied with current web portal, 20

percent are not satisfied nor dissatisfied, and rest 10 percent are satisfied, they do not care about the latest update. In User Scenario testing, found that it was taking much time to find out random keyword from the website. The website is not well-structured for users and significant features are in depth.

During the User Scenario Testing, 5 farmers have been asked who have knowledge on basic technology and education. Random features are asked to find out from the portal and counted times how long it takes to find out. These scenarios were designed to evaluate the usability of the product and spot any possible problems or areas that could need development. The End User was not provided any hints during this process. In standard user scenario, a keyword should be found within a few seconds. But they took almost 1 minute on average to find any keyword from the website. Now considering the user scenario, I can state that this website is not much friendly for the end user.

Also, Responsive test has been conducted considering the mobile and tablet view. The website is not designed according to the responsive standards. The Text is in Bengali Language, but in mobile view the text was not suitable readable to the reader. Some meta has been broken during the responsive test. And During the Network Testing, it was showing better performance and loaded the data in a short time. During Manual Testing, Security issue has been found. The website was not following the standard security of encryption. Transferring data can be hacked by hackers during transactions. Their standard security protocols SSL were missing. Besides that, the website provided some hard coded text, like the weather update, and some videos.

In conclusion, it is important to remember that while technologies are developing quickly, everything should be updated with technology and latest technology should be implement. Every end user needs to be benefited. Consideration the metrices of designing, responsive design, readability and legibility, visual design, page load speed, form design, error handling and accessibility of the UX and Usability, the portal failed to fulfil most of the metrices. This portal should be well structure considering the accessibility, user friendly and security. A significant portion of the population are disabled in particular—are the ones who most need access to them. As a result, every new technology must be usable by everyone, both now and in the future.

8. References

1. Kemp, S. (2023). Digital 2023: Bangladesh — DataReportal – Global Digital Insights. DataReportal – Global Digital Insights. https://datareportal.com/reports/digital-2023-bangladesh
2. Baowaly, M. K., & Bhuiyan, M. H. (2012). Accessibility analysis and evaluation of Bangladesh government websites. Accessibility Analysis and Evaluation of Bangladesh Government Websites. https://doi.org/10.1109/iciev.2012.6317487
3. Talukder, B., Saifuzzaman, M., & Vanloon, G. (2016). Sustainability of agricultural systems in the coastal zone of Bangladesh. Renewable Agriculture and Food Systems, 31, 148–165. https://doi.org/10.1017/S1742170515000095
4. Kashem, M., Faroque, M., Ahmed, G., & Bilkas, S. (2013). The Complementary Roles of Information and Communication Technology in Bangladesh Agriculture. Journal of Science Foundation, 8(1-2), 161–169. https://doi.org/10.3329/jsf.v8i1-2.14639
5. Tajmim, J. I. T. (2022). Number of persons with disabilities twice than previously assessed. The Business Standard. https://www.tbsnews.net/bangladesh/health/number-persons-disabilities-twice-previously-assessed-440522
6. Bangladesh Bureau of Statistics. (2023). http://www.bbs.gov.bd/site/page/29855dc1-f2b4 4dc0-9073-f692361112da/Statistical-Yearbook
7. Dey, B. L., Newman, D., & Prendergast, R. (2011). Analysing appropriation and usability in social and occupational lives. Information Technology & People, 24(1), 46–63. https://doi.org/10.1108/09593841111109413
8. Zaki, T., & Islam, M. N. (2021). Neurological and physiological measures to evaluate the usability and user-experience (UX) of information systems: A systematic literature review. Computer Science Review, 40, 100375. https://doi.org/10.1016/j.cosrev.2021.100375
9. Denga, A. (2022, December 7). A Short History of UX Design. Uxcel. https://uxcel.com/blog/a-short-history-of-ux-design

10. Sauer, J., Sonderegger, A., & Schmutz, S. (2020). Usability, user experience and accessibility: towards an integrative model. Ergonomics, 63(10), 1207–1220. https://doi.org/10.1080/00140139.2020.1774080
11. Lew, P., Olsina, L., & Zhang, L. (2010). Quality, Quality in Use, Actual Usability and User Experience as Key Drivers for Web Application Evaluation. In Lecture Notes in Computer Science (pp. 218–232). Springer Science+Business Media. https://doi.org/10.1007/978-3-642-13911-6_15
12. Gube, J. (2010, October 5). What is user experience design? Overview, tools and resources. Smashing Magazine. https://www.smashingmagazine.com/2010/10/what-is-user-experience-design-overview-tools-and-resources/
13. DUCKET, J. (2005) Accessible XHTML and CSS web Sites. Indianapolis: Wiley Publishing. p458, ISBN-13: 978-0-7645-8306-3
14. Bahrii, R., & Petrovskyi, S. (n.d.). FEATURES OF MODERN WEB APPLICATION TESTING. Vìsnik Hmel′nic′kogo Nacìonal′nogo Unìversitetu, 309(3), 70–74. https://doi.org/10.31891/2307-5732-2022-309-3-70-74.
15. Adams, C., Boulton, M., Clarke, A., Collison, S., Croft, J., Featherstone, D., Lloyd, I., Marcotte, E., Rubin, D. & Weychert, R(2007). Web Standards Creativity: Innovations in Web Design with XHTML, CSS, and DOM Scripting. In Apress eBooks. https://doi.org/10.1007/978-1-4302-0390-2
16. Aldora, J. (2021, December 14). UX design practice: what problem will I solve? - UX Planet. *Medium*. https://uxplanet.org/ux-design-practice-what-problem-will-i-solve-8f204e4aa160
17. Shastri, A. (2020, January 28). Making a Responsive Web Design - AltCampus - Medium. Medium. https://medium.com/altcampus/making-a-responsive-web-design-3ee34b3ee63a
18. Chung, S. J., & Ghinea, G. (2020). Towards developing digital interventions supporting empathic ability for children with autism spectrum disorder. Universal Access in the Information Society, 21(1), 275–294. https://doi.org/10.1007/s10209-020-00761-4
19. Web Application Architecture - detailed explanation. (2022, June 17). InterviewBit. https://www.interviewbit.com/blog/web-application-architecture/
20. User experience design. (2004, June 21). Semanticstudios.com. http://semanticstudios.com/user_experience_design/

21. Accessibility guidelines. (n.d.). Spotify.com. Retrieved November 27, 2023, from https://developer.spotify.com/documentation/accessibility
22. Vijay. (2023). Usability Testing Tutorial: A Complete Getting Started Guide. Software Testing Help. https://www.softwaretestinghelp.com/usability-testing-guide/
23. HTML Layout Elements and Techniques.(2023). https://www.w3schools.com/html/html_layout.asp
24. Baturay, M. (2013). Responsive Web Design: A New Type of Design for Web-based Instructional Content, Procedia. Procedia - Social and Behavioral Sciences, 106, 2275–2279.
25. Responsive Design: Best Practices. (2023, May 30). The Interaction Design Foundation. https://www.interaction-design.org/literature/article/responsive-design-let-the-device-do-the-work
26. Brophy, P. M., & Craven, J. (2007). Web Accessibility. Library Trends, 55(4), 950–972. https://doi.org/10.1353/lib.2007.0029
27. Sloan, D., Heath, A. C., Hamilton, F., Kelly, B., Petrie, H., & Phipps, L. (2006). Contextual web accessibility - maximizing the benefit of accessibility guidelines. https://doi.org/10.1145/1133219.1133242
28. Curcio, K., Santana, R. C., Reinehr, S., & Malucelli, A. (2019). Usability in agile software development: A tertiary study. Computer Standards & Interfaces, 64, 61–77. https://doi.org/10.1016/j.csi.2018.12.003
29. Stadnik, W., & Nowak, Z. (2017). The Impact of Web Pages' Load Time on the Conversion Rate of an E-Commerce Platform. In Advances in intelligent systems and computing (pp. 336–345). Springer Nature. https://doi.org/10.1007/978-3-319-67220-5_31
30. Schroeter, E. (2021, September 6). A Guide To Usability Testing: Tools, Methods & Examples. CareerFoundry. https://careerfoundry.com/en/blog/ux-design/usability-testing-guide/#performance-testing
31. Beaird, J. (n.d.). Beautiful Web Design. Canada: SitePoint. 2010. 79 pages.
32. Bias, R. G., & Mayhew, D. J. (Eds.). (2005). Cost-justifying usability: An update for the internet age (2nd ed.). Morgan Kaufmann.
33. Krystyna, S. (2017). The Role of Web Design and Web Accessibility in Attracting Customers to the Business. 76.

34. Duckett, J. (2005). Accessible XHTML and CSS Web Sites: Problem, Design, Solution. Hungry Minds.
35. GRANT, E. (2008) Eight Reasons to Embrace Web Accessibility.http://www.webdesignerdepot.com/2015/04/8-reasons-to-embrace-website- accessibility/
36. Park, T. H., Dorn, B., & Forte, A. (2015). An analysis of HTML and CSS syntax errors in a web development course. ACM Transactions on Computing Education (TOCE), 15(1), 1–21.
37. Salvi, C. (2017). Everything You Need to Know About Programming Languages.
38. Godbolt, M. (2016). Frontend architecture for design systems: A modern blueprint for scalable and sustainable websites. O'Reilly Media. https://www.oreilly.com/library/view/frontend-architecture-for/9781491926772/copyright-page01.html
39. Ilyas, M. (2012). A Study of Web Accessibility Barriers for Older Adults. Nazimabad: CIS Journal, 813.
40. Henry, S. L., Abou-Zahra, S., & Brewer, J. (2014). The role of accessibility in a universal web. Proceedings of the 11th Web for All Conference.
41. Robbins, J. N. (2012). Learning Web Design: A beginner's guide to HTML, CSS, JavaScript, and web graphics (4th ed.). O'Reilly Media.
42. Rutter, R., Lauke, P. H., Waddell, C., Thatcher, J., Henry, S. L., Lawson, B., Kirkpatrick, A., Heilmann, C., Burks, M. R., Regan, B., & Urban, M. (2006). Web accessibility: Web standards and regulatory compliance (1st ed.). APRESS. https://books.google.at/books?id=dlJ94KZqwqcC
43. Allam, A. H., & Dahlan, H. M. (2013). User experience: challenges and opportunities. Journal of Information Systems Research and Innovation, 3(1), 28-36.
44. Battarbee, K., & Koskinen, I. (2005). Co-experience: user experience as interaction. CoDesign, 1(1), 5-18.
45. Hassenzahl, M., & Tractinsky, N. (2006). User experience-a research agenda. Behaviour & information technology, 25(2), 91-97.
46. Benyon, D. (2019). Designing user experience. Pearson UK.
47. Karapanos, E., Zimmerman, J., Forlizzi, J., & Martens, J. B. (2009, April). User experience over time: an initial framework. In Proceedings of the SIGCHI conference on human factors in computing systems (pp. 729-738).

48. ALI, Z. (2014) JavaScript tutorialpoint. https://www.tutorialspoint.com
49. Hartson, R., & Pyla, P. S. (2012). The UX Book: Process and guidelines for ensuring a quality user experience. Elsevier
50. Ford, S. A., & Babb, E. M. (1989). Farmer sources and uses of information. Agribusiness, 5(5), 465-476.
51. Dey, B. L., Pandit, A., Saren, M., Bhowmick, S., & Woodruffe-Burton, H. (2016). Co-creation of value at the bottom of the pyramid: Analysing Bangladeshi farmers' use of mobile telephony. Journal of Retailing and Consumer Services, 29, 40-48.
52. Zhao, C., Lu, J., & Duan, F. (2009, November). Application and Research of SEO in the Development of Web2. 0 Site. In 2009 Second International Symposium on Knowledge Acquisition and Modeling (Vol. 1, pp. 236-238). IEEE.
53. Grappone, J., & Couzin, G. (2011). Search Engine Optimization (SEO): An Hour a Day. John Wiley & Sons.
54. HENDRICKS, D. (2015) IMPACT Of Web Design On SEO, Branding. https://www.forbes.com/sites/drewhendricks/2015/02/11/understanding-the-full-impact-of-web-design-on-seo-branding-and-more/#177a7b2664fe
55. Bangladesh Government. (2010, January 1). Farmers portal for Bangladesh. http://krishi.gov.bd/. Retrieved July 8, 2023, from http://krishi.gov.bd/
56. O'CONNOR, J.(2017). WCAG 2.1 under exploration. W3 Consortium official website.https://www.w3.org/blog/2016/10/wcag-2-1-under-exploration/
57. Caldwell, B., Cooper, M., Reid, L. G., & Google, I. G. (n.d.). Web content accessibility guidelines (WCAG) 2.0. Ysu.edu. Retrieved November 27, 2023, from https://ysu.edu/sites/default/files/mathematics-achievement-center/Hawkes%20Learning_Web%20Content%20Accessibility%20Guidelines%20(WCAG)%202.0.pdf
58. Nixon, R. (2014). Learning PHP, MySQL & JavaScript: With JQuery, CSS & HTML5. Oreilly & Associates.
59. Moran, K. (2023). Usability testing 101. Nielsen Norman Group. Retrieved from https://www.nngroup.com/articles/usability-testing-101/
60. Figure Source: Google images. (n.d.). Google.com. Retrieved June 27, 2023, from https://www.google.com/imghp?hl=en&ogbl
61. Figure Source: ČZU. (n.d.). ČZU. Retrieved October 02, 2023, from https://www.czu.cz
62. Figure Source: কৃষি বাতায়ন. (n.d.). Gov.Bd. Retrieved February 7, 2023, from http://krishi.gov.bd/
63. Figure Source: Free pik(2023) Free Sketch Pic.https://freepik.com

9. List of pictures, tables, graphs.