https://doi.org/10.51153/kjcis.v5i2.125

Enhanced Accessibility of Facebook Messenger for Blind Users

Mamoona Atif Swati[1] Dr. Mustafa Madni[2] Dr. Uzair Iqbal Janjua[3]
Dr. Iftikhar Ahmed Khan[4]

Abstract

With the growth in technology, social networking has become an essential factor in human life. People connect and share information through social media applications like Instagram, Facebook, and Twitter. Though, it is witnessed that using such applications is challenging for blind users. Such applications are also stated to be incredibly inaccessible. This study examines the usefulness of the Facebook Messenger application by using smartphone devices for visually impaired and blind users. Firstly, a pilot experiment is conducted with five selected blind people, and their performance and interaction are observed with the existing Facebook Messenger application. A prototype is designed and implemented based on existing Web Content Accessibility Guidelines (WCAG) to minimize the difficulties observed during the initial experiment.
Further, twenty-one blind users experienced the proposed prototype and the existing messenger application. The findings have shown that the proposed prototype design fulfills the efficiency and user satisfaction for blind users. Finally, future work is recommended based on the acquired outcome to enhance the usability of social media applications.

Keyword: Accessibility, social networking, blind users, WCAG 2.0 guidelines.

1. Introduction

In recent years, smartphones have increased and will reach 6,648 million users by 2022 [1]. Smartphones are generally used to communicate, share photos and videos, play games, use social media applications, etc. Social media applications play a vital role in sharing information and a central role in socializing with people. It is stated that compared to other media platforms, Facebook is 67.4% popular [2]. Therefore, such applications must be adaptive to every environment and accessible to most users. However, blind or Visually Impaired (VI) people cannot utilize the applications effectively and efficiently because of accessibility issues, especially while accessing graphics [24]. Accessibility allows blind users to access the features virtually [3]. Facebook Messenger is generally accepted and widely considered more convenient than the Facebook website [16].

[1]Department of Computer Science | COMSATS University Islamabad | mamoonaswati393@gmail.com
[2]Department of Computer Science | COMSATS University Islamabad | tahir_mustafa@comsats.edu.pk
[3]Department of Computer Science | COMSATS University Islamabad | uzair_iqbal@comsats.edu.pk
[4]Department of Computer Science | COMSATS University Islamabad, Abbottabad | iftikharahmed@cuiatd.edu.pk

However, Facebook Messenger applications should be developed under a comprehensive perspective to provide equal access to every citizen. Hence, the effectiveness of social networking applications is evaluated with people without any visual impairment. Though, the concerns are more significant for the part of VI people. As reported by World Health Organization, there are 285 million VI, out of which 39 million people are fully blind [4]. Hence, using mobile or social media applications is challenging with such impairment. Thus, blind people need a sighted person for assistance to access an application, which is helpful, but it is not prudent as sighted people are not always around or available.

Moreover, it is stated that 75% of people think that highly accessible applications are well-developed with assistive technology [5]. Above all, the complexity of the application is another challenge in accomplishing various tasks. The social media applications like Facebook Messenger have complex tasks, for example, creating a group, sending a message, deleting a conversation, etc.

There are several proposed guidelines to make the applications accessible and usable for blind users, like the World Wide Web Consortium's (W3C) Web Content Accessibility Guidelines (WCAG) [6]. However, WCAG 2.0 has given the means to measure the website's accessibility. Even though there are no such well-recognized guidelines to assess the accessibility of mobile phone applications [7]. The absence of implementing such procedures in websites and applications is also listed in the literature as a significant issue [10] - [15] that reduces the accessibility and loss of control. Therefore, it generates uncertainty in understanding the information, which reduces the interest of blind people and affects their overall performance [14]. Hence, examining the interaction between social media and blind users is necessary. This study aims to develop an accessible prototype of a messenger application based on problems identified in previous work [23]. Moreover, an experiment is performed to measure the performance of the proposed messenger using the System Usability Scale SUS questionnaire [9].

The rest of the paper is formatted as follows: Section two is the literature review that discusses the state-of-the-art techniques in social media and accessibility. Section three describes the proposed methodology, followed by section four, which presents our results. The last sections contain the conclusion and future work.

2. Literature Review

Social networking sites are a communication bridge between people. People communicate and share information on social media [17]. However, due to some accessibility issues, VI or blind users cannot access social networking sites correctly. Also, blind people conceptualize web interaction differently than sighted people [18].

Some solutions are already provided for the difficulties faced by blind users. World Wide Web Consortium provided design standards for developers to make a web application accessible [3]. Furthermore, authors have developed accessible smartphone applications for blind users. The author created a flexible wayfinding smartphone application for all users. The application was further tested by eight VI users, which showed that VI users could use the application without any help [19]. In another study, VI and blind users experienced visual content on social networking sites and conducted qualitative research to discover the challenges, practices, and experiences of blind users [8].

Moreover, the author identified the use of social media in rural and peri-urban India [20]. They have also observed how the participants used computers, social media platforms, and smartphones. Further, the weaknesses and strengths of Facebook, WhatsApp, and Twitter for blind people are discussed, and a thorough analysis of how blind people with less income in India have adopted a social media voice opportunity.

Another study identified problems with the Facebook homepage [21]. The Facebook homepage interface was redesigned to an accessible version using HTML 5 and Human-Computer Interaction guidelines and was further evaluated. Furthermore, the author assessed the affects caused in VI people while using the features of Facebook and compared their experience to the experiences of sighted users. Once the author collected the information, statistical analysis was performed to estimate users' feelings [22].

After studying various research contributions, it was evident that VI and blind people face inaccessibility issues, particularly with Facebook. Also, it is observed that there is little or almost no work done on measuring Facebook Messenger's accessibility. Moreover, the majority of the work is based on the website.

3. Proposed Methodology

Most of the present literature on Human-Computer Interaction (HCI) lies in the paradigm of positivism with the critical concept of discovering the undiscovered. Positivism falls toward the quantitative dominant research approach as an empirical phenomenon is considered to yield empirical prediction. In this study, as shown in figure 1, a quantitative dominant research approach has been followed using a controlled experiment method to define the real cause of the phenomenon and fundamental casual relations.

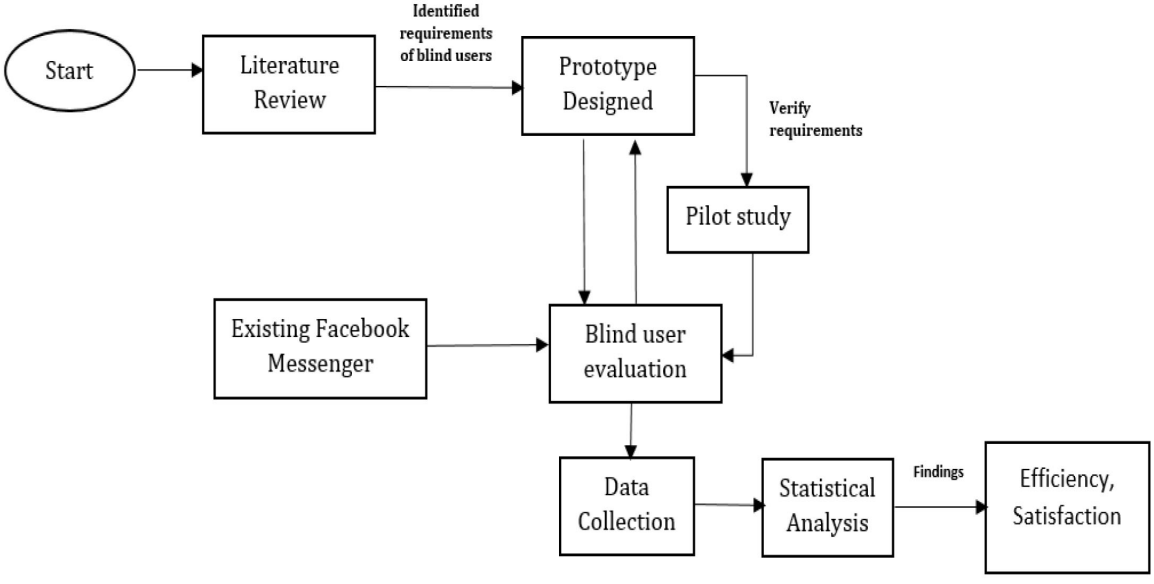

Figure 1: Block Diagram of the proposed methodology

The study is performed in two phases. Initially, the user's opinion is assessed for the existing Facebook Messenger, which identifies the user's thought through the tasks listed in Table I and the importance of WCAG guidelines through the current Facebook messenger [23]. Although, in this research, a comparative evaluation is performed among the existing Facebook messenger and the proposed messenger. During the experiment, the participant needed to narrate the tasks verbally while performing. The participants started describing the study, but it was observed that it slowed their productivity, and the participants' attention was distracted while explaining their job while interacting, which resulted in making mistakes.

Table 1: Tasks performed by blind users

No.	Tasks
T1	Create a new group
T2	Add participants to the group
T3	Send a message in the group
T4	Create an admin
T5	Delete Conversation
T6	Modify the group name
T7	Send a voice message and send it to the group
T8	Leave the group

A. PHASE II: Evaluation of Proposed Facebook Messenger

This section gives the quantitative approach of the experimental studies based on interaction experiences of both the proposed and existing messenger using a multi-touch smartphone device.

i. Goals

The study's primary goal was to evaluate the usability of the two different messengers, i.e., existing Facebook Messenger and the proposed messenger for social networking for blind users using smartphones. This study may be beneficial in determining the usefulness of the messenger application for social networking from the user's perspective.

ii. Device Used

The device used is the Samsung Galaxy J6 smartphone with Android Operating System, a commercially available touch-screen phone with improved image quality. This system is equipped with the Tru-Octa Core processor and 3.0 GB RAM. The Messenger applications are adequately adjusted before experimenting.

iii. Participants

Twenty-one participants (VI and blind users) were involved in this study. All the participants were chosen from the Government school of blind, Shamsabad in Rawalpindi, Pakistan. Amongst these participants, 11 were males, and 10 participants were females. The age of participants was between 18 to 36 years old. The selection criteria are based on their skills and experience using smartphones, familiarity with assistive technologies, and using existing Facebook Messenger.

iv. Task

For this study, the tasks were selected based on sharing information between group members, interaction, and transmission using social media applications. The jobs are: create a group, add participants in-group, create admin, modify group name, delete a conversation, and leave a group.

v. Hypothesis

A null hypothesis is formalized to determine the performance of the system. It is stated as there is no difference in task completion time when using the existing Facebook Messenger and the proposed messenger.

vi. System Development

The proposed messenger was designed and developed as an interactive and functional high-fidelity prototype. These prototypes were created using the Justin Mind tool. It allows the development of an interactive mobile application for the selected tasks. For each job, audio feedback is provided to the user to minimize confusion, and users do not need any assistance from other people.

The first task was to create a group. The button to create a new group is located at the end, as shown in Figure 2 (i). When the switch is tapped, it gives audio feedback as 'create a new group.' Once the group has been created, it provides feedback to the user as ' group created successfully. Once the group is completed successfully, the user can add a participant in-group and start a group chat. The audio feedback facilitates the user, and s/he does not need assistance from others. It differentiates between adding participants while creating a group and adding more friends after the group is completed, as shown in Figure 2 (ii).

Users can select any member and can create an admin. Furthermore, users can delete, block, or call any selected member, as shown in Figure 2 (iii). Moreover, the group details are categorized in the group details. Also, appropriate menu categories are adopted, so the user can easily access the digital content, as shown in Figure 2 (iv). The group details include the properties of a group such as a share link, request a member, delete a conversation, change color, emoji, name or photo, etc.

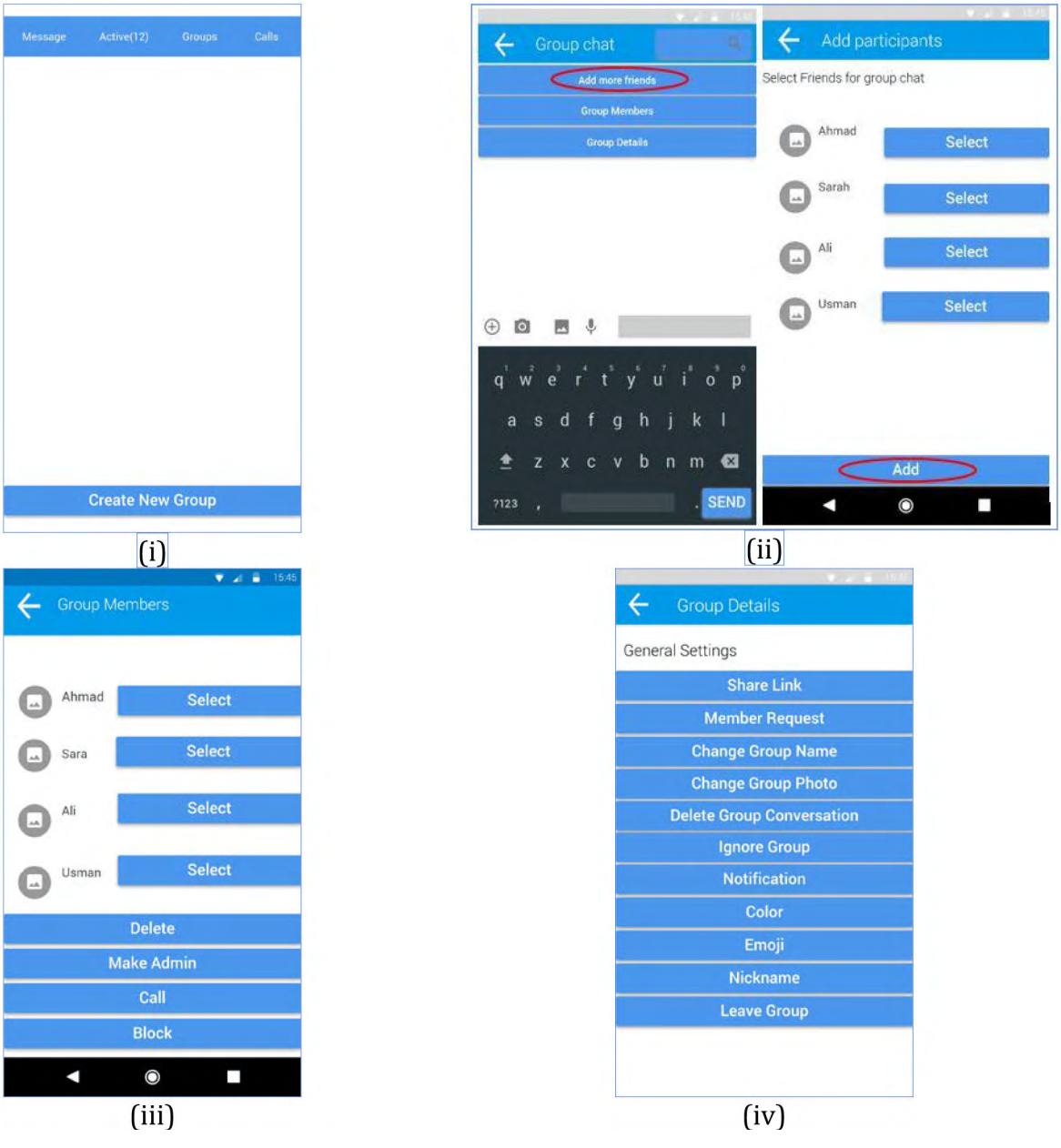

Figure 2: UI design of proposed messenger (i) create a new group, (ii) Add participant to a group, (iii) group members, and (iv) group settings

In this development of the proposed messenger, the aim was simplicity and minimized navigation depth compared to the existing Facebook messenger. Hence, the depth of the tasks (such as changing the group name, deleting the conversation, and leaving the

group) is minimized to increase the simplicity and reduce the navigation steps. As a result, blind people will efficiently perform all tasks in fewer steps. There are five steps in the existing Facebook messenger to change the group name, whereas, in the proposed messenger for the blind, the user only needs three simple steps to complete the same task, as shown in Figure 3 (i). The user needs five steps in existing Facebook Messenger to delete a conversation. As depicted in Figure 3 (ii), the user can complete the task in three simple steps in the proposed messenger. The navigation steps to reach an icon are reduced and minimized. Similarly, the user needs five efforts to leave a group in the existing Facebook messenger. Users only need three steps to complete the same task in the proposed messenger, as shown in Figure 3 (iii).

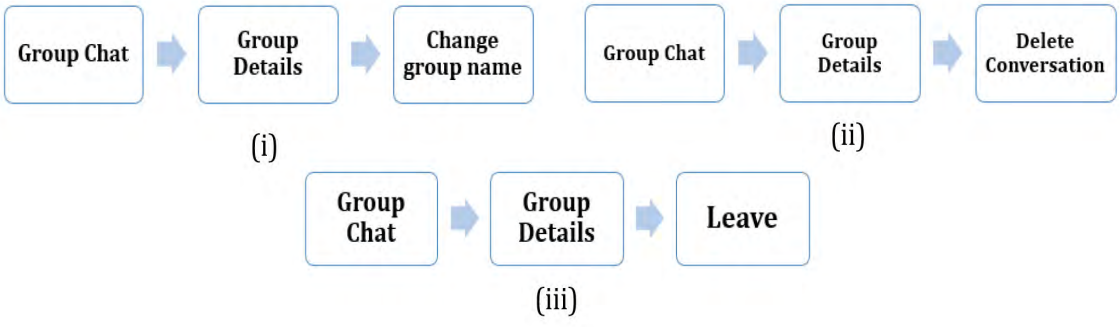

Figure 3: Steps while performing tasks (i) change group name, (ii) delete a conversation, and (iii) leave the group.

i. Procedure

The setting and smartphone setup for this study were organized in the laboratory in the Government school of blind, Shamsabad in Rawalpindi, Pakistan. The laboratory provides a comfortable seating arrangement for test participants. The procedure of this study is divided into three stages: before the experiment, i-e, the initial stage, to get consent and fill in demographic information, one which comprises the training and assessment of several tasks, and finally gathering the feedback of participants.

In the initial stage of the experiment, consent forms were read aloud to all the participants. The participants agreed to the terms and allowed us to record them. Afterward, they were repeatedly told the time to start the experiment and were provided time to fill in demographic information.

In the second stage, all the participants were given a comfortable seating arrangement, and all tasks were explained again to clarify their doubts about the participants. Afterward, the participants randomly experienced existing Facebook messenger and proposed messenger using a smartphone.

In the third stage, after the participants randomly experienced both the proposed and existing messenger, they presented their feedback using objective measure (efficiency) and subjective measure (user satisfaction by System Usability Scale questionnaire).

4. Experimental Analysis

The experiments are based on discovering the Facebook messenger's accessibility for blind users. Hence, phase I of the study explores the user's perspective about the tasks and shows the importance of Web Content Accessibility guidelines through existing Facebook messenger. Though, it is noticed that blind users face various issues while using such applications. According to the identified findings, the succeeding experiment is implemented, empirically assessing the accessibility of both existing and proposed Facebook messenger. The results of Phase 1 are mentioned in the previous research paper [23].

The previous study showed that blind users faced problems while performing the tasks, but they could finish them with human assistance. The responses of the blind people were compared with the WCAG guidelines, as shown in Table II, and discussed in the prior study [23]. These guidelines have four principles, i.e., perceivable, robust, operable, and understandable[6].

Table 2: Comparison of problems with WCAG guidelines

Principles	Description	Task Identified with problem related to principle
Perceivable	The user interface (UI) must provide the exact message to the user that is intended for the user.	T1, T2, T5 and T7
Operate-able	All the components and the UI must be operate-able by users.	T1, T2, T4, T6, and T9
Understandable	The operation and the content on the UI are easily understandable for the users.	T1, T2, T3, T4 and T8
Robust	The content on the UI should be perceived reliable by most of the users and the assistive technologies e.g. screen reader for VI	None

This section illustrates the findings of the research on both interfaces. It empirically assesses the accessibility of both the existing Facebook messenger and the proposed messenger. The data were converted from the questionnaire and objective measurements to the SPSS tool for statistical analysis. In total, 3 out of 24 participants stopped due to the incapability of using a smartphone. Of these 21 participants, 10 were females, and

11 were male. The gathered data is cleaned before applying any statistical analysis by removing missing values and outliers using a box plot.

Initially, efficiency is measured to complete all tasks of the application. Most participants spent time assigning an admin and changing the group name. Figure 4 shows the time calculated to achieve the existing Facebook messenger and proposed messenger tasks.

An independent t-test was conducted to compare the mean for existing and proposed Facebook messenger. Every participant performed all eight tasks on both interfaces. The time for every job is depicted in Table III. The result of the Independent T-Test showed a significant difference in the scores for existing Facebook messenger (M=21.3, SD=3.59) and proposed Facebook messenger (M=9.7, SD= 2.2) conditions; t (40) = 12.54, p= 0.00; hence H0 is accepted. Overall results of the T-Test propose that the time to complete tasks in the proposed messenger is less than the existing Facebook messenger.

Table 3: Task Completion Time of Existing Facebook Messenger and Proposed Messenger

Tasks	Existing Facebook messenger (Mean ± SD)	Proposed messenger (Mean ± SD)
T1: Create a new group	19.85 ± 7.185	14.54 ± 6.99
T2: Add participants to the group	15.48 ± 4.14	7.98 ± 5.05
T3: Send a message in the group	26.78 ± 6.76	3.29 ± 1.99
T4: Create an admin	51.15 ± 2.68	19.58 ± 8.67
T5: Delete Conversation	9.97 ± 14.04	6.64 ± 5.76
T6: Modify the group name	32.89 ± 13.92	12.72 ± 7.19
T7: Send a voice message and send it to the group	20.19 ± 1.93	6.19 ± 1.73
T8: Leave the group	5.13 ± 2.09	5.96 ± 3.9

The efficiency of both interfaces is compared by comparing the mean values, as depicted in figure 8. Hence, the proposed messenger consumes less time to finish tasks than the existing Facebook messenger application. The chart shows that the time consumed to create an admin and send a message is more significant in the current Facebook Messenger than in the proposed messenger due to usability issues and lack of feedback.

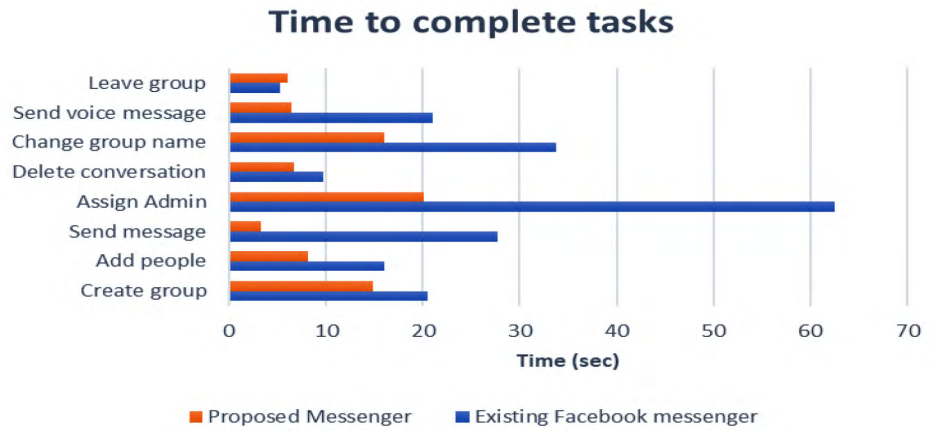

Figure 4: Time to complete tasks in both interfaces

An interview has been conducted to measure the usability of the proposed interface of Facebook messenger for blind users. The obtained data have a Cronbach's Alpha value of 0.73. To analyze the SUS questionnaire, the scale of odd questions is subtracted by one, and the scale of actual questions is removed by 5. The final result is added and further multiplied by 2.5 [26]. A result below 70 means that the system has some usability issues, and scores above 70 are better [27]. The results are above average.

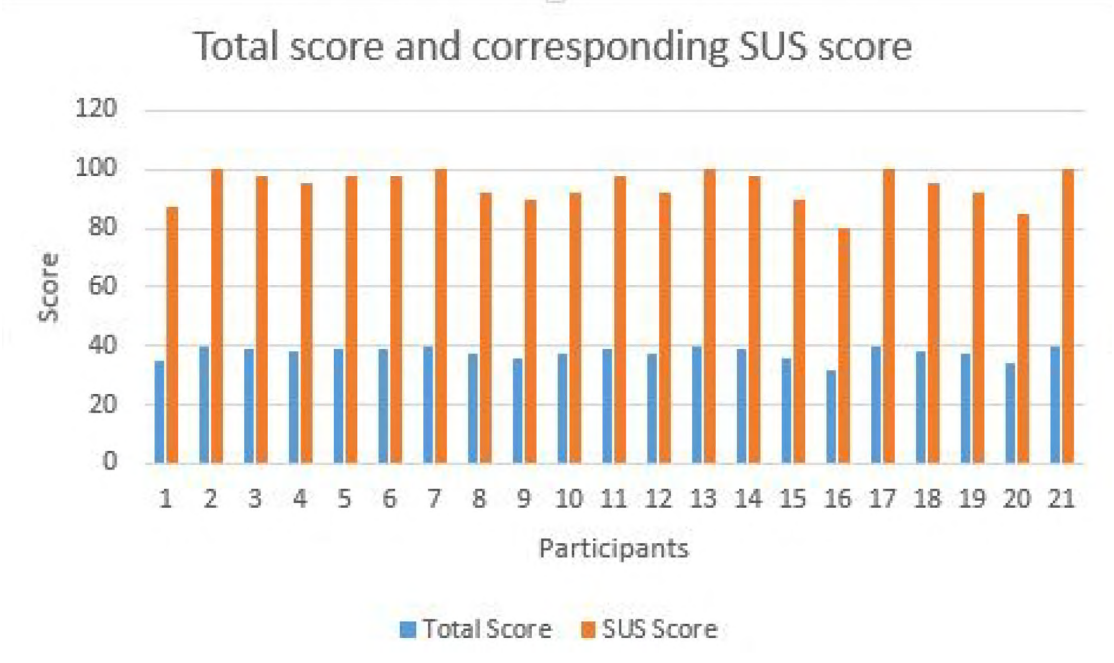

Figure 5: Total score and corresponding SUS Score

The graph presented in Figure 5 shows the overall and corresponding SUS scores. The Cronbach Alpha Test is applied to the questionnaire to measure the consistency between the related items. According to the rule of thumb, the reliability coefficient is only acceptable if the result is above .70 or higher [27]. The alpha coefficient for 21 items of our questionnaire is 0.733, suggesting that the items have high internal consistency.

5. Discussion

The previous study's findings exposed that blind users face problems accessing social media because of the inaccessible content [23]. Therefore, several guidelines are suggested to make the mobile applications and websites more accessible for VI and blind users, such as Web Content Accessibility Guidelines (WCAG) and World Wide Web Content (W3C). The absence of such guidelines results in the lack of accessibility to social networking applications. Subsequently, the interest of blind users and overall performance is affected by the absence of accessibility to social media applications.

The study highlighted that the number of Facebook users worldwide is 67.4%, a comparatively higher value [2]. Thus, it indicates that Facebook is used more than other social media mobile applications. However, Facebook is inaccessible for blind users because of its great visual content. As a result, an overall interview was conducted with blind users related to the Facebook Messenger mobile application. Hence, it is discovered that blind users and VI have not yet identified group chat features in Facebook Messenger. Therefore, Facebook group chat in Facebook messenger aids fascinating social options for all blind users, such as updating the group name, creating a group for people with the same interests, sending a message to various people at a time, and deleting the entire group chat at once, etc. Thus, formative experiment research was conducted (Phase I) to present this feature and identify accessibility problems that blind users encounter.

Moreover, the experiment was qualitative research-based. As we recognized through an investigation in Phase I, blind users faced issues related to navigation, understanding the context, and accessing the menu items [23]. Hence, the existing guidelines can be used to fix such identified challenges.
Furthermore, a summative experiment study was conducted to measure efficiency and satisfaction. Hence, to calculate the efficiency and identify a highly accessible interface for the blind, an experiment was conducted randomly on both interfaces by the same participants. One experiment is performed on the available Facebook messenger application, and the second experiment is performed on the Facebook Messenger Prototype for blind people. Each participant is supposed to serve all similar tasks on both interfaces. We observed and noted the time consumed for the participant to complete every task.

A. Experiment on Existing Facebook Messenger

The outcomes showed all 21 participants completed the first task, while some of the participants consumed time to finish the task as they could not find create a new group button. Participants 2, 17, and 19 stated that the excessive amount of options makes it difficult for them to find the button. The participants did not face difficulty adding people and finished the task in less time except for participant 2. The participant needed guidance in finding the button to add friends. While sending a message, all the participants effectively completed the task, but participant 6 faced a little trouble finding the send button.

The participants successfully reached the voice message icon but with trouble. However, making a member admin of the group was time-consuming and challenging. As mentioned earlier, the task includes six navigation steps, which increases the time to finish the task. The participants were able to change the group name, but few of them consumed time. Once the participants reached the button, they could quickly delete the conversation and leave the group in less time.

B. Experiment on Advanced Facebook Messenger Prototype

The results determine that the experiment performed on the Facebook Messenger prototype consumed less time finishing the tasks than the already available application. As a result, participants did not face any difficulty or confusion in completing the tasks. The reason is appropriate audio feedback and applied guidelines on the prototype. The audio feedback helped participants in navigation. As for sending a voice message, the voice icon explains how to send a voice message: hold the button, record the audio, and then release it; once the participants release the controller, the message will be sent to the group. Hence, the time to reach the button is observed and noted, while one of the tasks that took time was to assign an admin. The outcome illuminates that every participant completed all tasks in less time, except Participant 11 took the time to finish the first task. Participant 2 consumed time to change the group name. The result of the experiment proved that the proposed Facebook Messenger prototype is accessible to blind users compared to the Available Facebook Messenger.

This paper aims to resolve the issues related to the accessibility of the Facebook Messenger mobile application. A contribution was added to the discussion by offering blind people's experiences with selected tasks in the messenger. The meeting was held around the challenges faced by blind people and solutions provided for them.

6. Conclusion

We recognized the issues and difficulties which were faced by the participants while completing the tasks. Then their identified problems were noted down. Most of the issues encountered by the participants were related to the items, understanding the main context of the task and content, recognizing the menu, and navigation. Additionally, these problems were compared with the four WCAG 2.0 principles, i.e., perceivable, understandable, robust, and operable.

We recognized the issues and difficulties faced by the participants while completing the tasks. Then their identified problems were noted down. Most of the issues encountered by the participants were related to the items, understanding the main context of the task and content, recognizing the menu, and navigation. Additionally, these problems were compared with the four WCAG 2.0 principles, i.e., perceivable, understandable, robust, and operable.

WCAG 2.0 guidelines were recommended and implemented to reduce the problems and difficulties for the blind in accessing social media applications. There were 12 recommended guidelines in the previous paper to increase the accessibility of the Facebook messenger application. In this paper, we have developed a Facebook messenger prototype to solve the accessibility problem of the Facebook messenger for blind people. A final controlled experiment is conducted to measure the time and satisfaction between both interfaces. Furthermore, time is measured through a t-test. The result of the t-test rejects the null hypothesis and proves that both systems are not equal.

Our research has identified several essential details. We can suggest the following research directions: The study is open to identifying accessibility problems faced by VI and blind users while accessing other social media applications, e.g., Instagram, Snapchat, and WhatsApp. A set of guidelines can be compared with the problems identified by blind users. With the help of these guidelines, we can implement the interfaces of other social media applications specifically for Blind users. Moreover, the satisfaction and usability of implemented interfaces can be further compared with existing interfaces of other social media applications. Besides, this experiment is conducted for a particular area and in a specific region. The data can be further collected from all the country's regions to make it a generic model.

References

[1] Statista, "Smartphone users worldwide." [Online]. Available: https://www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/. [Accessed: 25-Feb-2021].

[2] GlobalStats, "Social Media Stats." [Online]. Available: http://gs.statcounter.com/social-media-stats/all/pakistan#monthly-201707-201807.

[3] R. Babu, (2011) "Developing an Understanding of the Nature of Accessibility and Usability Problems Blind Students Face in Web-Enhanced Instruction Environments.," ISBN: ISBN-978-1-1248-7865-2.

[4] W. H. ORGANIZATION, (2010) "Global Data on," p. 17.

[5] A. M. Michalska, C. X. You, A. M. Nicolini, V. J. Ippolito, and W. Fink, (2014) "Accessible Web Page Design for the Visually Impaired: A Case Study," Int. J. Hum. Comput. Interact., vol. 30, no. 12, pp. 995–1002.

[6] M. Cooper and L. G. Reid, (2014) "Web Content Accessibility Guidelines (WCAG) 2 . 0," pp. 1–33.

[7] Park, K., Goh, T., & So, H. (2014). Toward accessible mobile application design: developing mobile application accessibility guidelines for people with visual impairment.

[8] V. Voykinska, C. Tech, and G. Leshed, (2016) "How Blind People Interact with Visual Content on Social Networking Services," DOI:10.1145/2818048.2820013. pp. 1584–1595.

[9] Y. Borodin, J. P. Bigham, G. Dausch, and I. V Ramakrishnan, (2010) "More than meets the eye: A Survey of Screen-Reader Browsing Strategies," Proc. 2010 Int. Cross Discip. Conf. Web Access. - W4A '10, pp. 1–10, 2010.

[10] C. N. Nobre, M. R. G. Meireles, and D. B. F. D. A. Silva, (2018) "Emotionally Oriented Analysis of the Experiences of Visually Impaired People on Facebook," Journal: ACM Transactions on Accessible Computing, vol. 11, no. 3.

[11] W. Seo and H. Jung, (2018) "Understanding Blind or Visually Impaired People on YouTube through Qualitative Analysis of Videos," Proc. 2018 ACM Int. Conf. Interact. Exp. TV Online Video - TVX '18, pp. 191–196.

[12] A. Vashistha, E. Cutrell, N. Dell, and R. Anderson, (2015) "Social Media Platforms for Low-Income Blind People in India," Proc. 17th Int. ACM SIGACCESS Conf. Comput. Access. - ASSETS '15, pp. 259–272.

[13] E. Brady, M. R. Morris, and J. P. Bigham, (2015) "Gauging Receptiveness to Social Microvolunteering," Proc. 33rd Annu. ACM Conf. Hum. Factors Comput. Syst. - CHI '15, pp. 1055–1064.

[14] S. Wu, J. Wieland, O. Farivar, and J. Schiller, (2017) "Automatic Alt-text: Computer-generated Image Descriptions for Blind Users on a Social Network Service," ACM Conference: Cscw, pp. 1180–1192.

[15] J. A. Smith, M. R. Lind, D. Colton, D. Colton, and S. Hunsinger, (2010) "Website Accessibility for Users with Visual Impairment," Journal: Information System Education Journal, vol. 8, no. 53.

[16] Voykinska, Violeta & Azenkot, Shiri & Wu, Shaomei & Leshed, Gilly. (2016). How Blind People Interact with Visual Content on Social Networking Services. DOI:10.1145/2818048.2820013.

[17] De Nooy, W., Mrvar, A., & Batagelj, V. (2018). Exploratory Social Network Analysis with Pajek: Revised and Expanded Edition for Updated Software (3rd ed., Structural Analysis in the Social Sciences). Cambridge: Cambridge University Press. doi:10.1017/9781108565691

[18] R. Babu, (2014) "Can Blind People Use Social Media Effectively? A Qualitative Field Study of Facebook Usability," Am. J. Inf. Syst., vol. 2, no. 2, pp. 33–41.

[19] M. C. Rodriguez-Sanchez, M. A. Moreno-Alvarez, E. Martin, S. Borromeo, and J. A. Hernandez-Tamames, (2014) "Accessible smartphones for blind users: A case study for a wayfinding system," Expert Syst. Appl., vol. 41, no. 16, pp. 7210–7222.

[20] A. Vashistha, E. Cutrell, N. Dell, and R. Anderson, (2015)"Social Media Platforms for Low-Income Blind People in India," Proc. 17th Int. ACM SIGACCESS Conf. Comput. Access. - ASSETS '15, pp. 259–272.

[21] P. Grober and J. Koster, (2017) "An Analysis to Overcome Shortcomings to Improve the Accessibility for the Blind: A Case Study on Facebook's Homepage," Proc. - 12th Int. Conf. Signal Image Technol. Internet-Based Syst. SITIS 2016, pp. 442–449.

[22] C. N. Nobre, M. R. G. Meireles, and D. B. F. D. A. Silva, (2018) "Emotionally Oriented Analysis of the Experiences of Visually Impaired People on Facebook," Journal: ACM Transactions on Accessible Computing, vol. 11, no. 3.

[23] Mamoona Atif Swati, Tahir Mustafa Madni, Uzair Iqbal janjua and Iftikhar Ahmad,(2021) " Accessibility of Social Media Application for Blinds," Conference of ICCIS

[24] S. Reinders, (2021), " Accessible interactive 3D models for blind and low-vision people", ACM SIGACCESS Accessibility and Computing, issue 129, Article No. 6, pp 1-7