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Article

Requirements, Challenges, and Use of Digital Devices and Apps for Blind and Visually Impaired

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Abstract: Visually impaired people encounter many impediments and challenges in their lives such as related to their mobility, education, communication, use of technology, and others. This paper reports the results of an online survey to understand the requirements and challenges blind and visually impaired people face in their daily lives regarding the availability and use of digital devices. The survey was conducted among the blind and visually impaired in Saudi Arabia using digital forms. A total of 164 people responded to the survey most of them using the VoiceOver function. People were asked about the use of smart devices, special devices, operating systems, object recognition apps, indoor and outdoor navigation apps, virtual digital assistive apps, the purpose (navigation, education, etc.) of and difficulty in using these apps, the type of assistance needed, the reliance on others in using the assistive technologies, and the level of satisfaction from the existing assistive technologies. The majority of the participants were 18 – 65 years old with 13% under 18 and 3% above 65. Sixty-five percent of the participants were graduates or postgraduates and the rest only had secondary education. White Cane, mobile phones, Apple iOS, Envision, Seeing AI, VoiceOver, and Google Maps were the most used devices, technologies, and apps used by the participants. Navigation at 39.6% was the most reported purpose of the special devices followed by education (34.1%) and office jobs (12.8%). The information from this survey along with a detailed literature review of academic and commercial technologies for the visually impaired was used to establish the research gap, design requirements, and a comprehensive understanding of the relevant landscape, which in turn was used to design smart glasses called LidSonic for visually impaired.

Keywords: blind; visually impaired; assistive devices; object recognition; navigation; virtual assistants; Smart Cities; Saudi Arabia

1. Introduction

The blind and visually impaired people are an essential segment of society. The number of blind adults over the age of 60 is growing at a rate of 2 million every decade [1]. Unfortunately, there is an increase in the number of diseases that may limit the ability of sight [2]. As a result, made community care, health institutions, and government agencies are concerned to meet post-disability challenges. General Authority of statistics in Saudi Arabia shows that the most prevalent disability among the Saudi population with difficulties who have one disability is (visual) difficulties, whereas the percentage of those who suffer from it reached (46.02%) of the total Saudi population with one disability. To be specific, the degree of severity is distributed as follows: light (67.8%), severe (28.5%), and extreme (3.7%) [3].

There is no doubt that modern technology is the driving force behind the expansion and advancement of institutions in many specializations across the world [4–8]. It has a positive influence on the quality of life for people whether they are normal or with special needs. Moreover, people with a disability have benefitted immensely from contemporary

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technology, especially in the fields of education and learning. Accordingly, it contributed to finding new occupations for disabled people to become more productive and creative in the workplace. For this reason, smartphones are fundamental tools for a range of assistive functions. They are integrated with a variety of sensors that offer information on motion, position, and surroundings which make them suitable as a navigation aid for blind and visually impaired people [9].

In fact, there is a growth of visually impaired and blind users who use smartphones to carry out their everyday tasks. Nowadays, a blind person can deal with modern technology easily. The ability to achieve a real natural level of living without the aid or guidance of others is remarkable. The blind people's effectiveness is evident in their execution of tasks entrusted to them, with results that exceeded in many cases compared with sighted colleagues. Furthermore, blind people's productivity has increased as a result of technological advancements which enable them to break into new areas that were not acceptable to them before [10]. These technologies should be used following the nature of the visual impairment which necessitates the use of specialized reading and writing aids. However, it is well known that blind users are more inclined to avoid services if they are aware that they may create accessibility issues, and blind users are frequently obliged to find alternative solutions to accomplish any task.

Bhowmick et al. [11] show that the area of assistive technology has grown steadily, from less than 50 articles per year in the mid-1990s to about 400 scholarly papers per year in 2014. Assistive Technology for visually impaired users is projected to expand quickly and have a significant influence on the lives of people and the elderly in ways that have never been feasible previously. We conducted an extensive review (see [12]) on the assistive technologies for visually impaired and found an array of solutions for visually-impaired and blind people continually emerging in the recent times that provide different functionalities and capabilities aimed at a wide spectrum of visual impairments.

This paper reports the results of an online survey to understand the requirements and challenges blind and visually impaired people face in their daily lives regarding the availability and use of digital devices. The survey was conducted among the blind and visually impaired in Saudi Arabia using digital forms. A total of 164 people responded to the survey most of them using the VoiceOver function. People were asked about the use of smart devices, special devices, operating systems, object recognition apps, indoor and outdoor navigation apps, virtual digital assistive apps, the purpose (navigation, education, etc.) of and difficulty in using these apps, the type of assistance needed, the reliance on others in using the assistive technologies, and the level of satisfaction from the existing assistive technologies. The majority of the participants were 18 – 65 years old with 13% under 18 and 3% above 65. Sixty-five percent of the participants were graduates or postgraduates and the rest only had secondary education. White Cane, mobile phones, Apple iOS, Envision, Seeing AI, VoiceOver, and Google Maps were the most used devices, technologies, and apps used by the participants. Navigation at 39.6% was the most reported purpose of the special devices followed by education (34.1%) and office jobs (12.8%). An awareness of the usability issues in popular applications can help designers create better solutions.

The information from this survey along with a detailed literature review of academic and commercial technologies for the visually impaired was used to establish the research gap, design requirements, and a comprehensive understanding of the relevant landscape. This information in turn was used to develop LidSonic V1.0, a pair of smart glasses called LidSonic that uses machine learning, LiDAR, and ultrasonic sensors to identify obstacles; see [12].

This paper is organized as follows. Section 2 reviews related works and the study methodology is introduced in Section 3. In Section 4, the results of the survey are presented. In Sections 5 and 6, the survey discussion, and conclusions are provided respectively.

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2. Related Works

It is a fact that assistive technology allows the visually impaired to engage with devices, and applications, and approaches the environment more easily. Also, enables people with vision problems to carry out their everyday activities and raises their quality of life to a higher level.

Mobile phones have progressed in sensor technology as much as assistive tools for the visually impaired. For example, object recognition and navigation apps, have become viable. Likewise, the ability to read items that are in visual print was a chore that a visually impaired would struggle with. Nevertheless, applications in conjunction with the increasing advancement of technology, provide users with new methods to read and perform almost everything. Among the most important topics that blind people use applications for are currency recognition, color recognition, object recognition, navigation applications, and virtual assistance. However, image processing methods' computational cost and power consumption present performance concern with portable or wearable low-power devices [12].

Researchers have investigated new developments in alternative sensory modalities. Thus, it is important to mention the speech and auditory systems. Computer and human communications made significant contributions to the exploration and development of usable and accessible user interfaces for visually impaired users [13]. In the meantime, Voiceover [14] has greatly improved mobile accessibility for visually impaired users. Because blind people utilize audio and touch as input streams for various activities. Their cellphone enables them to operate a broad range of services effectively to fulfill their daily tasks.

Simões et al. [15] provide the reader with a more broad perspective of the models. Many studies combine diverse publications that deal with the physical and logical methods of indoor positioning systems. They expand on prior works' spectrum of technologies and approaches for supporting the visually impaired. It gives researchers a more modern version of what was accomplished, as well as the benefits and drawbacks of each approach. Also, it helps to guide evaluations and debates on these issues. They present some considerations and potential developments in the development of indoor navigation and locating systems for the blind and visually impaired.

Sensors, machine learning, hybrid systems, and augmented reality are the key technologies discussed in the academic literature. In contrast, wearables and white canes are used in commercial solutions. Solutions in application development are either dependent on humans, in which the visually impaired communicate with someone who can help them recognize and navigate their environment, or they are standalone, non-external support software with solutions that do not require external human assistance [12]. Assistive technologies have emerged to help people with poor vision or vision impairment preserve their independence and safety. Calabrese et al. [16] present a unique low-cost solar-powered wearable assistive technology (AT) device whose goal is to offer continuous, real-time object identification to help visually impaired users discover items in everyday life. A camera, a system on a module processing unit, and an ultrasonic sensor are the three main components of the system. The first is a device that attaches to the user's spectacles and captures real-time video of the surrounding area. Second, a wearable device that is placed like a belt that uses deep learning-based approaches and spatial algorithms to interpret footage from the camera, detecting and recognizing items. The third component aids with the placement of objects found in the nearby region. The technology that is proposed guides the user with verbal feedback. Croce et al. [17] offer a method that enables visually impaired persons to travel in unfamiliar indoor and outdoor areas on their own. The technology which was created specifically for those with impaired vision is easily adaptable to other users. They presume that unique markers have been placed to assist users in locating pre-defined pathways. Inertial sensors and a camera incorporated within

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the cell phone are both used as sensors in their proprietary technology. The type of navigation system they provide may also give users direction estimations for the tracking system.

Users with visual impairments can use navigation assistive technology to help them move around independently by offering feedback on their environment. Vocal and tactile communication techniques are commonly used to convey this information. Ahmetovic et al. [18] researched to see how the desirability of messages supplied during aided navigation differs depending on the navigation preferences and skills of users. The visually impaired navigation demands vary according to their skills, age, and preferences [19]. To gain a deeper understanding of how current technology may be developed and exploited to make the lives of the blind and visually impaired easier and more self-sufficient. We created a web-based poll for blind screen reader users that aims to study what modern technologies can be developed and harnessed to facilitate the lives of the blind and visually impaired and make them self-dependent in their daily living.

3. Study Methodology

Google Forms was used to conduct the survey. Google Forms is a survey administration tool that comes as part of Google's free web-based Google Docs editors [20]. Because a truly random sampling would be logistically impossible because the population of interest includes blind users and there is no centralized directory of all blind persons, self-selected sampling was utilized. The purpose of this poll was to uncover problems and concerns rather than ranking or prioritizing them numerically. The questionnaire was constructed and produced to try to understand what challenges blind people encounter, whether present technology is adequate or whether there are additional areas that can be explored, and what technical solutions can be developed to help them in their everyday lives. “A questionnaire on harnessing modern technologies to facilitate the lives of the blind and visually impaired”. It was made available in Arabic using Google Forms. The survey link was distributed to visually impaired people who have access to digital devices like phones and iPads. The survey's full content is found in the Appendix.

The survey form was advertised via email and phone calls to organizations that specialize in blind and visually impaired issues. The Visual Disability Association in Buraidah [21], has cooperated in the distribution of this survey. In addition, the questionnaire was retweeted and posted on the website (see Figure 1) of the National Association of Blind in Riyadh (Kafeef) [22]. They also distributed it through WhatsApp groups. Ebsar Foundation in Jeddah [23] and Blind Charity Association in Almadinah Almonawarah [24] participated in surveying their organization. Mohamed Saad @MagicKSA, a visually impaired social activist on Twitter [25], and certified trainer for the blind has also cooperated in distributing and motivating the visually impaired to fill the forms.

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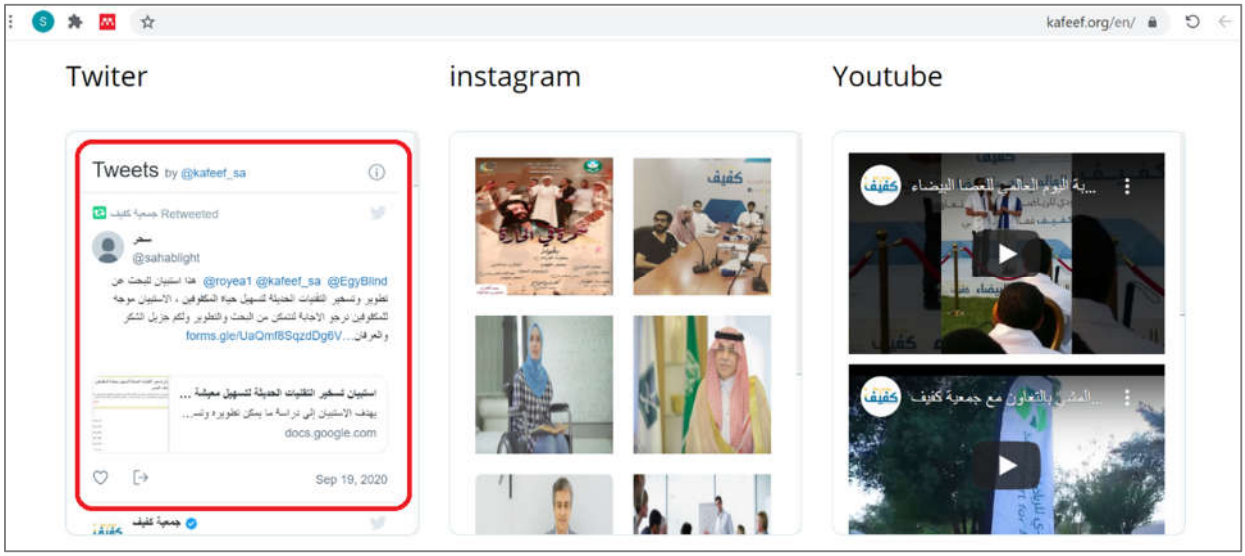

Figure 1. National Association of Blind Website.

4. Results and Analysis

4.1. Demographics

The survey was conducted between February 2021 and September 2021 among those who are at least 15 years old and suffer from any kind of vision loss. A total of 164 visually impaired people participated in the survey, representing different age groups and having varying educational backgrounds. Out of the 164 respondents (see **Error! Reference source not found.**), the youth (15 to 35 years of age) were the largest group at 78%, followed by the age groups (36-45) at 15%. This indicates that these groups use technology more frequently in their everyday lives than the other groups since the survey was conducted using Google Forms.

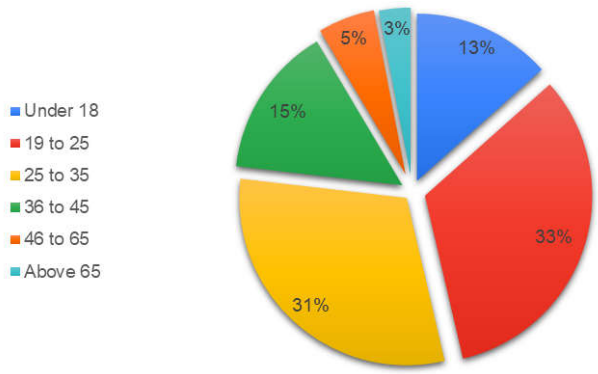

Figure 2. The Age Distribution of the Survey Participants.

Despite the difficulty of attaining a college degree for the visually impaired, close to 60% (see **Error! Reference source not found.**) of the respondents hold Bachelor's degrees. Followed by 6% holding Master's degrees, and 1% with Ph.D. degrees. This shows that people with disabilities tend to be quite determinant.

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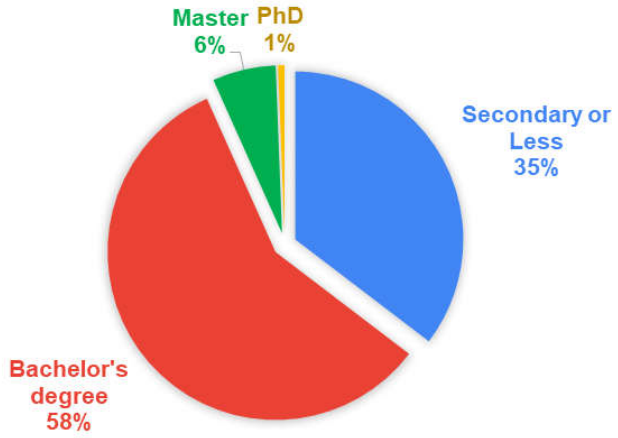

Figure 3. The Academic Qualifications of the Survey Participants.

4.2. Types of Assistive Devices

The responses showed in **Error! Reference source not found.** that the visually impaired used different types of devices. Nonetheless, the majority use white canes (48%), followed by braille displays at 29%. It is interesting to see that 25% of the respondents do not use any device at all. Those could be depending on relatives to guide them when needed. Some, however, could be reluctant to use any assistance from people or devices. Instead, they use their other senses and may not have lost all their sight.

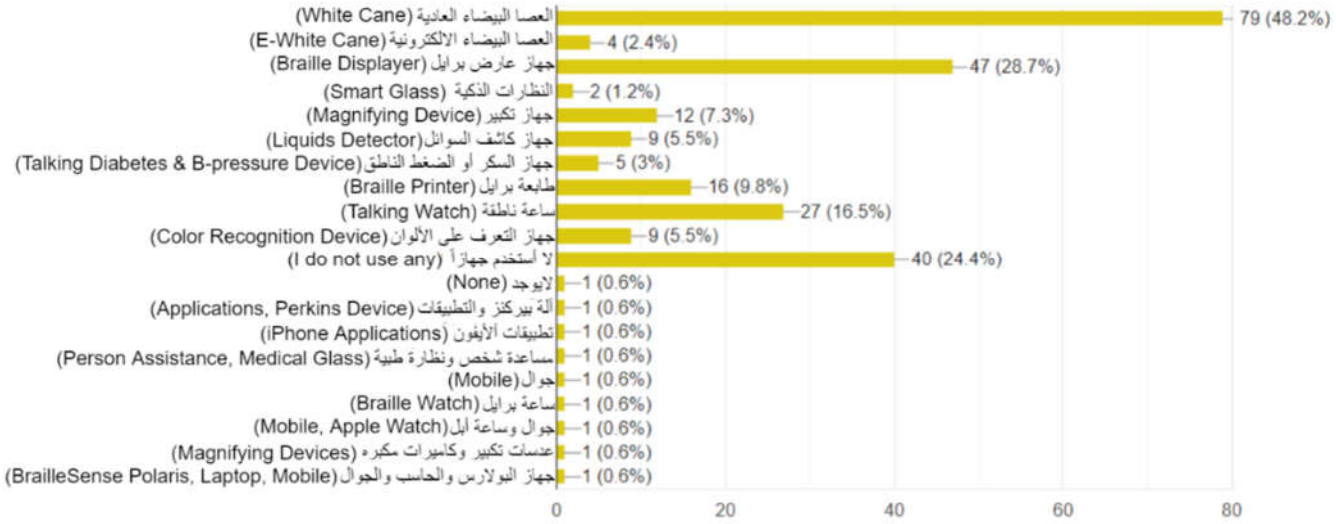

Figure 4. The Use of Different Assistive Technologies by the Survey Participants (Number and Percentage).

Error! Reference source not found. shows the majority of respondents use equipment to help them walk and navigate their way (40%) in addition to assisting them in achieving their education goals (34%). In addition (13%) of the respondents indicated that they use it for office tasks. While (7%) use the device for object recognition.

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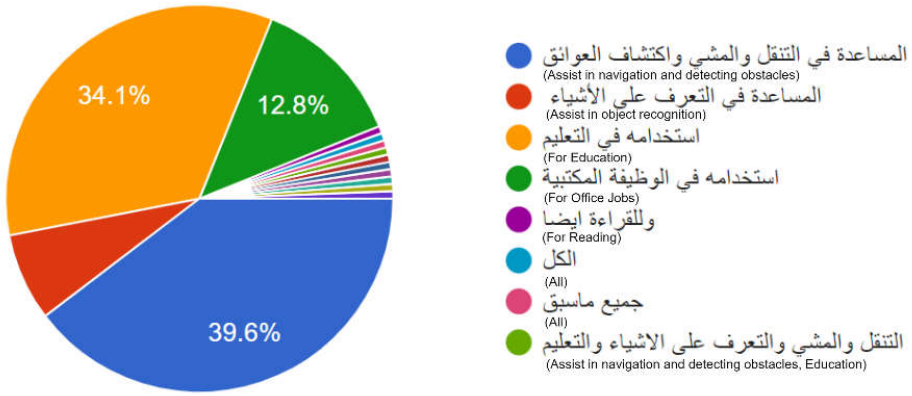

Figure 5. The Purpose of Assistive Devices According to the Survey Participants.

In indoor environments (see **Error! Reference source not found.**), the visually impaired had more than one means to assist them. White canes and mobiles were the primary tools used by the visually impaired at 49% and 48% respectively, followed by an accompanying person at 42%. This can be attributed to their familiarity with the surroundings (inside their homes). There is 13% dependant on special visually impaired devices. While (31%) rely on the remnants of vision.

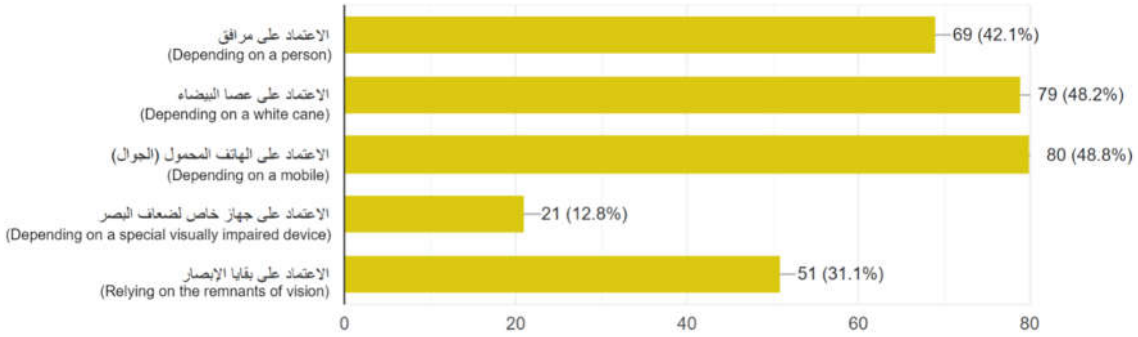

Figure 6. Survey Participant's Dependency in Indoor Environments.

We notice that to navigate outdoor environments (see **Error! Reference source not found.**), the respondents are depending more on accompanying persons (53%) vs navigating indoor environments (42%). This is expected given that the visually impaired may not be quite familiar with these outdoor environments. Furthermore, respondents equally use mobiles and white canes in these conditions.

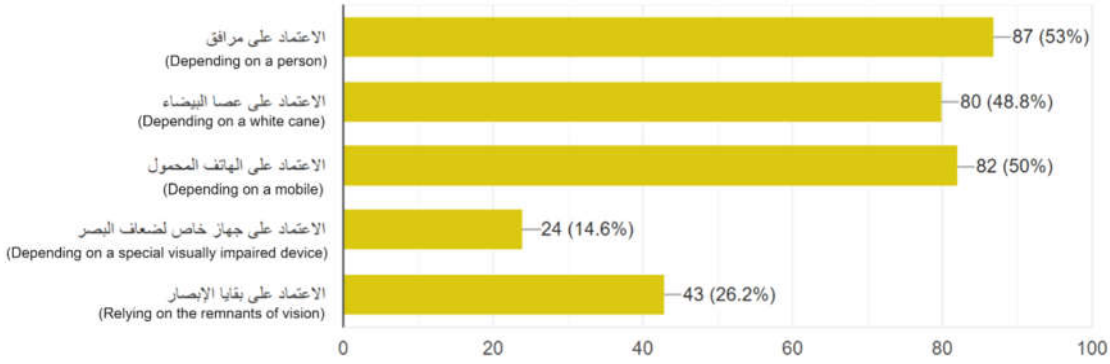

Figure 7. Survey Participant's Dependency in Outdoor Environments.

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Error! Reference source not found. shows that mobiles are the primary smart device used by the respondents (at 83%), followed by notebooks (35%) and tablets (19%). While (8%) of the respondent indicated that they do not use any smart devices.

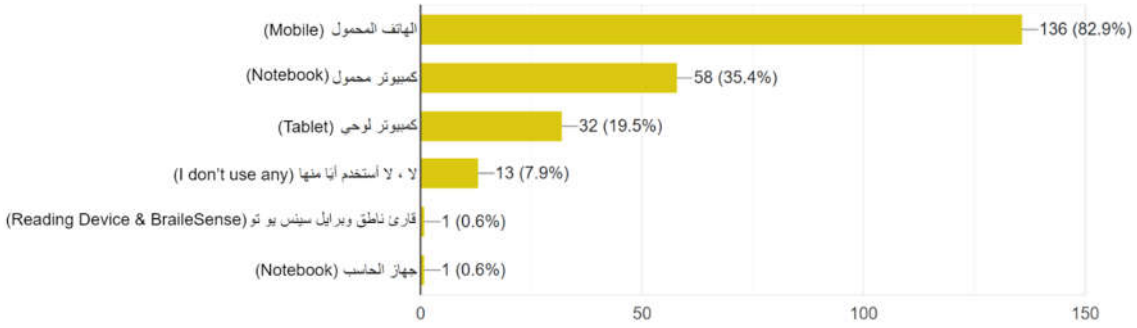

Figure 8. Most Used Digital Assistive Devices by the Survey Participants.

The survey shows how easy it has become for the visually impaired to use mobiles on their own, without asking for assistance from others (see **Error! Reference source not found.**). Only 3% fully rely on others when using mobiles, while 22% need partial assistance.

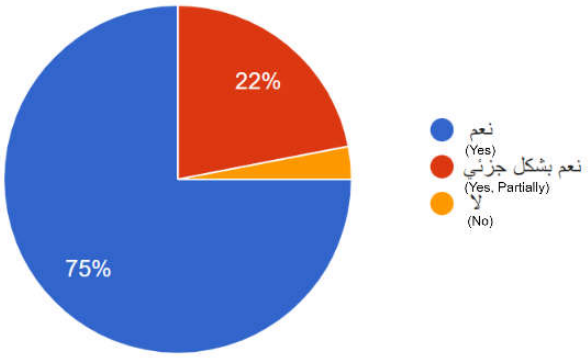

Figure 9. Do Survey Participants use a Smartphone without any Assistance?

Error! Reference source not found. shows the operating system that is quite popular with the respondents is iOS at 90%, which comes as no surprise since the people surveyed speak Arabic, and iOS includes the virtual assistant Siri, which supports Arabic. Android operating system comes second among the respondents at 20%. Since Android does not support Arabic, its users seem to be at least proficient in English.

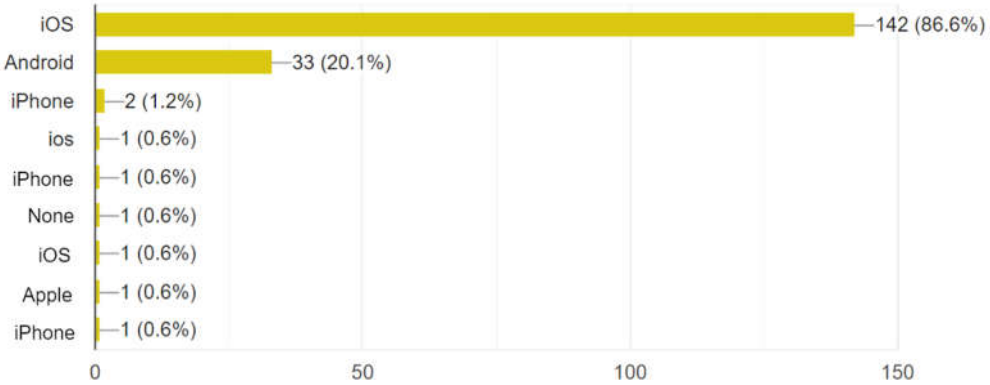

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Figure 10. The Mobile Operating Systems used by the Survey Participants.

4.3. Object Recognition

Over half of the people surveyed (see **Error! Reference source not found.**) use object recognition apps on their mobiles, which is encouraging. The remaining 44% said they do not use any kind of object recognition apps. Percentages in the following discussions will be limited to those respondents who use object recognition apps (92/164; 56%).

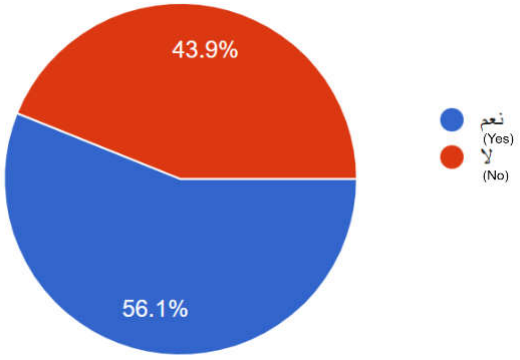

Figure 11. The Distribution of Survey Participants using Object Recognition Technologies.

Error! Reference source not found. shows that "Envision" represents the most used object recognition app on mobiles (80%), second comes "Seeing AI". Envision app helps the blind and the visually impaired to read text and documents, recognize faces, and find objects. Seeing AI is the second most popular object recognition app (22%), and that is mainly because it is only available on iOS, whereas "Envision" is available on both iOS and Android. Moreover, "Envision" can read the text in over 60 languages, including Arabic. "Seeing AI", however, is mainly limited to Latin languages. "Be My Eyes" was the third most common app used by the respondents (10%). The way this app works, nevertheless, is different from the first two. "Be My Eyes" connects blind and visually impaired individuals with sighted volunteers via a live video call. Money recognition apps and TapTapSee are equally used by the surveyed individuals (4% each).

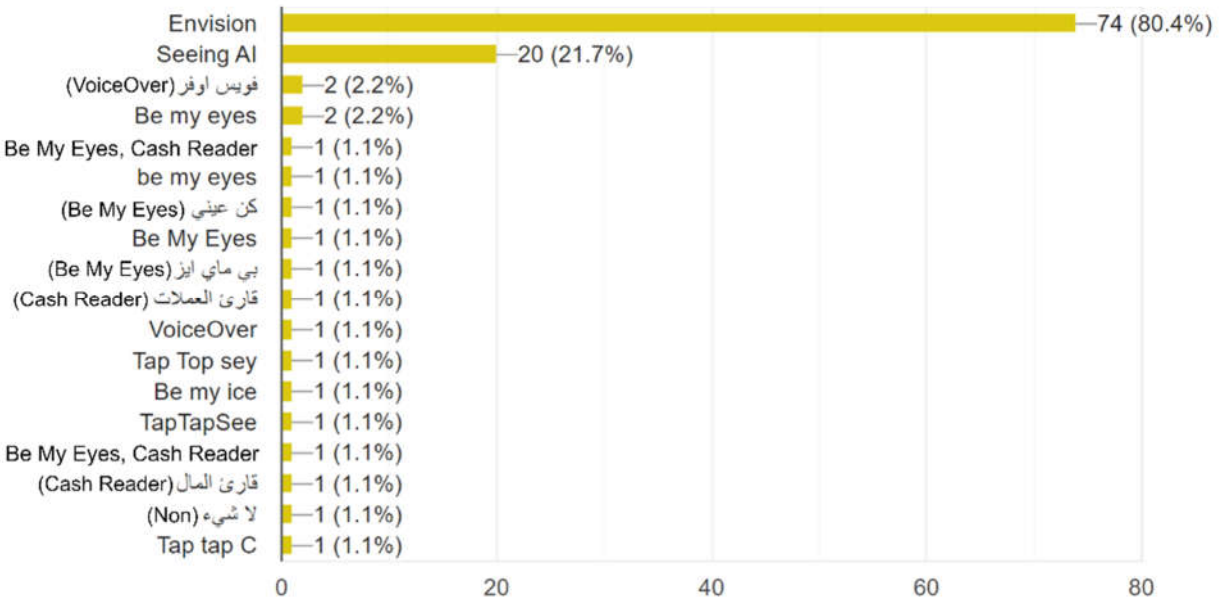

Figure 12. Popular Object Recognition Apps used by the Survey Participants.

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Most of the respondents are generally satisfied with the object recognition apps they are using (84%). While 12% were neutral and the rest were unsatisfied. Although the majority of the people surveyed indicated that they are satisfied with the object recognition app they use on their mobiles, only 40% of them said that the app helps them depend on themselves when navigating indoors and outdoors (see **Error! Reference source not found.**).

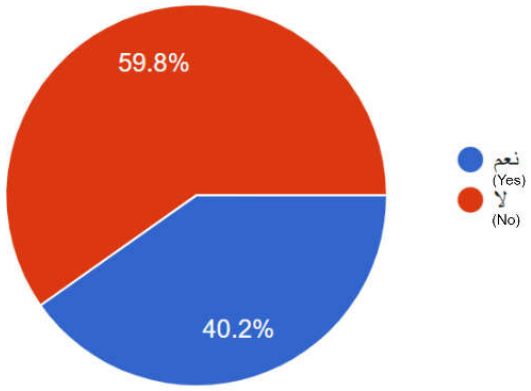

Figure 13. The Number of Participants Dependent on Object Recognition Apps.

4.4. Navigation

Little more than half of the surveyed people use navigating apps on their mobiles (see **Error! Reference source not found.**). Percentages in the following discussions will be limited to those respondents who use navigation apps (89/164; 54%).

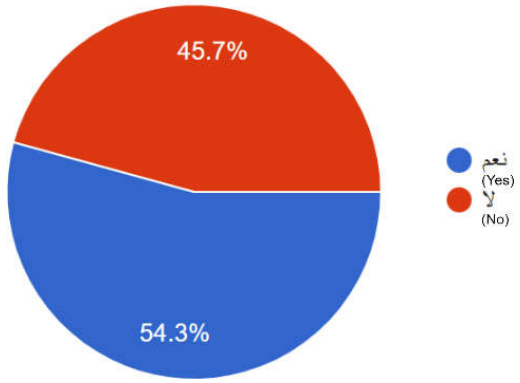

Figure 14. The Percentage of Respondents using Navigation Apps.

Almost all the respondents using navigating apps indicated that their preferred app is Google Maps. "Be My Eyes" is the second popular choice among the respondents at 30%, followed by "Ariadne GPS" (8%). While uncommon, "Seeing Assistance", "BlindSquare", and "iMove around" are used by some of the people surveyed at the following percentages: 7%, 4%, and 3% respectively as shown in **Error! Reference source not found.**.

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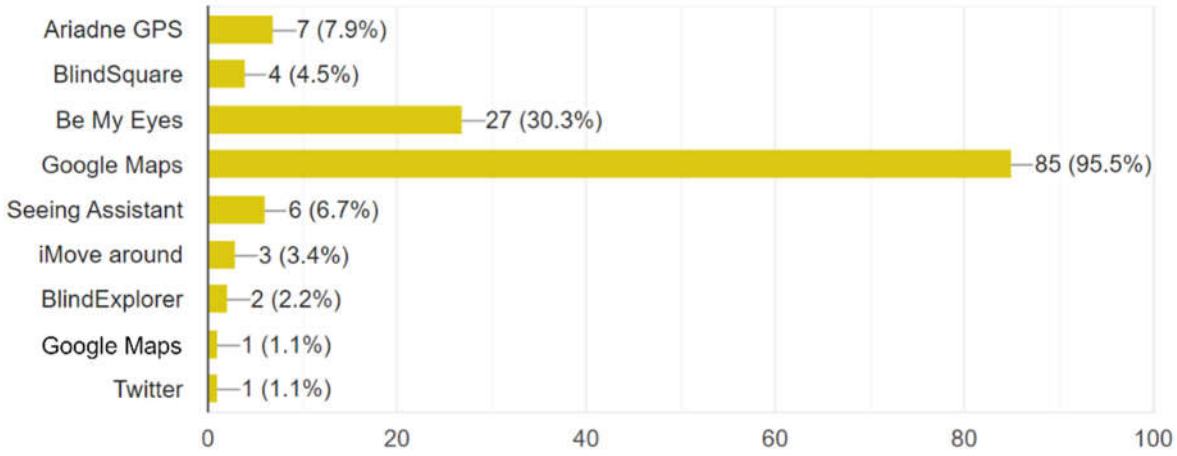

Figure 15. The Distribution of Participants using Different Navigation Applications.

We notice that using navigating apps helps the visually impaired become more self-dependent as 67 out of the 89 respondents using navigating apps have indicated so (75%). Furthermore, 83% of the respondents stated that they are satisfied with the navigating apps they are using, while 9% were neutral, and 8% of the respondents were unhappy with their navigating apps (see **Error! Reference source not found.**).

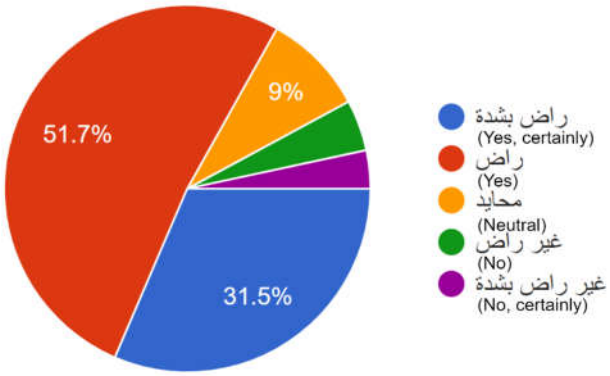

Figure 16. Do the Navigation Apps provide Satisfactory Functionality?

4.5. Virtual Assistant

While "VoiceOver" is not itself a virtual assistant, 87 out of 164 (53%) respondents reported using it as an accessibility means on their mobiles since it is a gesture-based screen reader that gives an audible description of what is on the screen as shown in **Error! Reference source not found.**. "Siri" was the second choice among the respondents (27%) when asked about the virtual assistant they use often. That is attributed to the Arabic feature it has. "Google Assistant" comes third at 5%. In the meantime, 16 out of 164 respondents (10%) indicated that they do not recognize the "Virtual Assistant" term.

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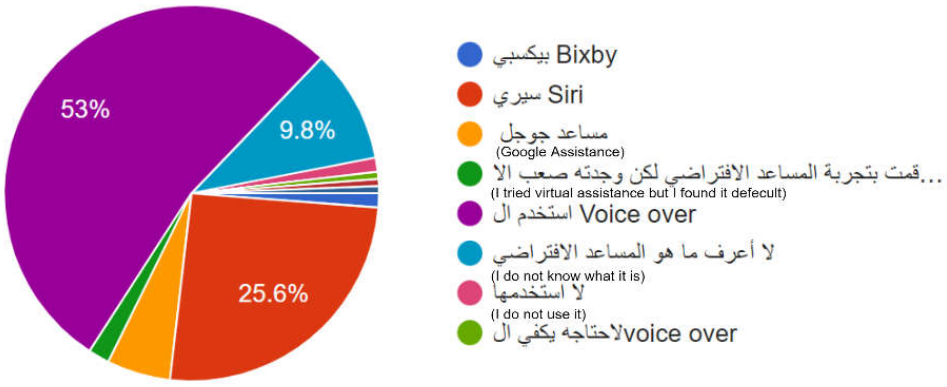

Figure 17. The Distribution of Participants using Virtual Assistance Apps.

Percentages in the following discussions will be limited to those respondents who actually use virtual assistant apps (61/164; 37%). When we asked the respondents how concerned they were about privacy issues the virtual assistants may have, the majority (29/61; 48%) indicated that they have no issues with that threat (see **Error! Reference source not found.**). However, 21 out of 61 respondents (34%) reported that they are concerned about invading their privacy when using virtual assistants. Finally, 18% said that they are somewhat concerned about the privacy issues these virtual assistants may have.

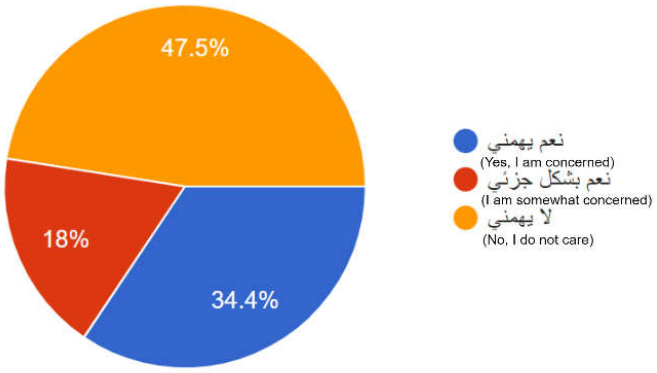

Figure 18. The Distribution of Participants on Privacy Concerns.

In the answers of the respondent on how efficient the virtual assistants they use are, the majority of them (42/61; 69%) indicated that they have found the virtual assistants to be efficient. Meanwhile, 21% of the people surveyed said they are neutral. Only 10% of the respondents do not believe that virtual assistants are efficient.

5. Discussion

This survey's findings reveal a number of critical aspects that might be enhanced for blind users of assistive devices. It is worth noting that the study is conducted on a random sample of people, the majority of whom can utilize new technology tools such as digital devices and Apps. For example, we see that 75% (123/164) of the respondents generally use some type of device to assist them in their everyday lives. While white canes were the most popular device among the visually impaired in this survey (at 48%), this percentage could have been larger because the majority of the people surveyed are blind at an early age. In brief, elder people could not comprehend modern technology as well as young impaired ones. Meanwhile, it seems that a lot of respondents became visually impaired later in their lives, which makes learning to use a new device more challenging. Although

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the braille display device is very useful for the visually impaired, only 29% of the respondents reported using it. This may also be attributed to the difficulty of using it for the older generation who grew up not using it for one reason or another. It is interesting, however, to note that 25% of the respondents indicated that they do not use any device to assist them in their lives as visually impaired/blind. That is probably because many of the respondents could be living with their families, who help them perform the tasks they cannot do on their own. That can be evident in **Error! Reference source not found.** and **Error! Reference source not found.**, which indicate that more than half of the respondents depend on an accompanying person to navigate outdoor environments whereas the percentage is going down to over 40% when it comes to navigating indoor environments.

Just as important, there have been innovations worldwide to assist the visually impaired in their lives. We have noticed, that many of the respondents did not mention any assistive devices although the usefulness and the effectiveness of these devices which facilitate their everyday tasks. Accordingly, one of the reasons can be the unfamiliarity of these tools due to limited marketing among the visually impaired. Another reason is the high price of some devices which can deter a large percentage of the respondents from using them. They believe the price is too high and they cannot afford it, or the price is not worth the features displayed by modern devices.

The survey proved that the visually impaired can use smart devices on their own as 83% of the respondents stated that they use mobile phones. When they were asked whether they use object recognition apps, 56% of the respondents reported that they use at least one app. In fact, "Envision" was the most popular. Hence, 84% initially expressed their satisfaction with the apps they have, and only 40% said that the apps helped them become more independent when the matter is about navigating indoor and outdoor environments. The respondents stated several factors that hinder them from achieving that goal of being more self-dependent. For example, the application interface needs improvement to make it more user-friendly. Another reason is the high cost of some apps, which makes them less affordable for price-sensitive users. In addition, the apps do not have color recognition features. Furthermore, some respondents indicated that the apps need to be more accurate when it comes to text and object recognition. Being compatible with "VoiceOver" is another feature the respondents would like to see on the apps they are using. Moreover, the respondents would like to see an enhancement in verbal feedback also a solution to the lack of existence of Arabic language support from some apps.

Navigation became a primary service that is used for guidance. Consequently, over 50% of the respondents reported using navigating apps on their mobiles. "Google Maps" took the lead in navigating apps used by these respondents (at 96%). Since 83% of the respondents said they are satisfied with the navigating apps they use, 75% indicated that the app helps them become more self-dependent. The respondents suggested many ideas to improve the efficiency of the navigating apps they are using. For instance, they want the apps to be more accurate while giving walking instructions. Furthermore, to operate without the need for an internet connection and, consume less battery. They also want the apps to detect and alarm them of any physical obstacles that they may face. Equally important is the VoiceOver which is an important feature used by impaired people. It enables users to deal with their devices easily.

As illustrated in the survey, "Siri" was found to be the most popular virtual assistant used because it supports Arabic. Whereas 69% of the people surveyed have generally found virtual assistants to be efficient. They suggested ideas that they believe can make the virtual assistants more functional. The respondents prefer that the virtual assistants get more access to data on the mobiles (e.g., enabling the user to choose which SMS he/she would like the assistant to read).

6. Conclusions

The challenges that visually impaired users have when it comes to object recognition apps, navigation, and virtual assistance were investigated. The following agenda represents both the survey's priority items based on the number of difficulties mentioned as well as additional proposals for future study on the topic:

- Assess the accessibility of mobile interfaces for blind users on mobile devices.
- Seek innovative ways to make mobile devices more accessible.
- More studies are needed on the sonification feedback and the potential benefits for blind people. We have to create innovative feedback concepts that are recognizable and accessible to blind people.
- There are very useful assistive technologies that are unknown and need additional marketing efforts.
- Some aspects should be considered when developing assistive devices or apps, such as accuracy and battery consumption.
- More study on assistive technologies is needed to make them more acceptable to visually impaired and blind people.
- More virtual assistance applications should support the Arabic language.

This study encourages further research on the usability and functionality of navigation applications, object recognition applications, and virtual assistance applications, and their adaptation to serve all users, including those with disabilities.

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Appendix A

The purpose of the survey is to see what advanced innovation may be developed and exploited to assist the blind and visually impaired live more independently in their ordinary activities. The survey's questions and results will be shown next.

1. Age?
    a. < 18
    b. 19 – 25
    c. 26 – 35
    d. 36 – 45
    e. 46 – 65
    f. >65

2. Education Level?
    a. Secondary or Under
    b. Bachelor
    c. Master
    d. PHD

3. Do you use a special device for the blind or visually impaired? You can select several choices for this question
    a. White cane
    b. Smart white cane
    c. Braille Display Device
    d. Smart Glasses
    e. Magnifying Device
    f. Liquid recognition device
    g. Blood Glucose Monitor or blood pressure monitor
    h. Braille printer
    i. Speaker watch
    j. Color recognition device
    k. I am not using a device
    l. Other (specify)

4. What is the main and most important purpose of equipment for you?
    a. Assist in navigation and detecting obstacles
    b. Assist in object recognition
    c. For Education
    d. For office job
    e. Other (specify)

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5. What kind of assistant do you need while navigating an **indoor** environment (you can choose more than one selection)
    a. Depending on a person
    b. Depending on a white cane
    c. Depending on a mobile
    d. Depending on a special visually impaired device
    e. Relying on the remnants of vision
    f. other

6. What kind of assistant do you need while navigating an **outdoor** environment (you can choose more than one selection)
    a. Depending on a person
    b. Depending on a white cane
    c. Depending on a mobile
    d. Depending on a special visually impaired device
    e. Relying on the remnants of vision
    f. other (specify)

7. Do you use any smart devices? Such as (you can choose more than one selection for this question)
    a. Mobile
    b. Notebook
    c. Tablet
    d. No, I don't use any
    e. other (specify)

8. Can you use the mobile without relying on others?
    a. Yes
    b. No

9. What Kind of operating system do you use?
    a. iOS
    b. Android
    c. others

10. Do you use any object recognition app on the mobile?
    a. No
    b. Yes

11. If your answer was yes: (if the answer was No then please ignore these questions 11. a, 11. b, 11. c, and 11.d)

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a. Please specify the name of the app? you can choose more than one selection for this question
    i. Envision
    ii. Seeing AI
    iii. Other …

b. Are you satisfied with the app
    i. Yes, certainly
    ii. Yes
    iii. Neutral
    iv. No
    v. No, certainly

c. Does the app help you depend on yourself while navigating indoors and outdoor?
    i. Yes
    ii. No

d. What kind of facilities and enhancements do you need?

12. Do you use a navigation app on the mobile?
    a. No
    b. Yes

13. If your answer was yes: (if the answer was No then please ignore these questions 13. a, 13. b, 13. c, and 13.d)
    a. What is the application name? you can select more than one choice
        i. Ariadne GPS
        ii. BlindSquare
        iii. Be My Eyes
        iv. Seeing Assistant
        v. iMove around
        vi. BlindExplorer
        vii. Other …

    b. Does the navigation app help you in becoming self-dependent?
        i. Yes
        ii. No

    c. Are you satisfied with it?
        i. Yes, certainly
        ii. Yes
        iii. Neutral

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iv. No
v. No, certainly

d. What kind of functionality do you like to see in your app?

14. Which virtual assistant in your mobile are you using
    a. Bixby
    b. Siri
    c. Google Assistant
    d. I tried the virtual assistant but found it difficult to use
    e. I use Voice Over
    f. I don't know about virtual assistant
    g. Other (specify)

15. If you do not use a virtual assistant then ignore the rest of the questions in 15
    a. There are known privacy issues with virtual assistants such as it records everything and sends it to a third party to be analyzed. Are you concerned?
        i. Yes, I am concerned
        ii. I am somewhat concerned
        iii. No, I do not care

    b. Is the virtual assistant efficient?
        i. Yes, certainly
        ii. Yes
        iii. Neutral
        iv. No
        v. No, certainly

    c. Do you have any suggestions to improve the assistant?

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