# Usability Design and Evaluation of Smartphone for Elderly Users

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**Abstract:** This study looks into the usability issues older people have when using smartphone interfaces, concentrating on pinpointing particular obstacles to efficient use. We evaluated all of the functions available on smartphones now by conducting usability tests on senior citizens to gauge how accessible and user-friendly these interfaces are. The study identifies important areas—such as small touch targets, intricate navigation, and a lack of customization options—where older folks' demands are not well met by current smartphone designs. The research makes specific design recommendations based on these findings to enhance the usability and inclusivity of smartphones for senior citizens. These suggestions act as a manual for designers and developers to produce smartphone interfaces that are easier to use and more accessible, therefore improving the elders' digital experience.

**Keywords:** Adaptability; Efficiency; Usability; Heuristic Evaluation; Momentous Revolutions; Satisfaction.

## 1. Introduction

Smartphone usage turns out to be a prime addiction of the 21st century and no one is immune from the charm of this addiction. In the modern era people of all age groups are obsessed with this technology. No other gadget has that much influence on the world today. We might infer that the invention of the mobile phone was one of the most momentous revolutions in human history since the number of active smartphones exceeds the total number of individuals living on the earth. It has been proven from various surveys that people spend more money on mobile phones than they spend to eat. About 95% of people with smartphones stated that this gadget is inappropriate to consider as a device which is utilized infrequently, meaning that the percentage of individuals who headed to their homes to retrieve their mobile device was really significantly greater than the number of those who headed back home to retrieve their purses; this device is a tool that is needed each day, and the United States Supreme Court has finally recognized that this is, indeed, an extension of one's personality [1].

In the year 2019, Everything Everywhere (EE) introduced 5G technology but according to experts, 5G may cause cancer in humans. Since the launch of first-hand phones this technology is advancing day by day and the number of users has exploded.  Today this technology appears as a necessity of life, more people on this earth have access to a cell phone than a toilet. According to a new TIME Mobility poll 84% of people said that they cannot spend a single day of their life without their smartphone. A research report shows that on average a person touches their phone 2,617 times in a day [2].

## 1.1. Smartphones and Their Uses

A report by the World Bank shows that in the year 2014 almost 97% of people around the globe are mobile phone users [2]. while in the year 2000 only 11% people around the world own mobile phones. The research report of GSMA 2015 presents that 4.7 billion of the world's population owns mobile phones. This growth rate is 63%. In the year 2020 global mobile phone users are approximately 5.6 billion with the penetration rate of 72%. The use of mobile phones is growing day by day and the adaptation of this technology has kept on going up globally from the year 2003. Smartphones are equally popular among rich and poor, adults and elderly, now this gadget is accessible for juniors. The kids even at the age of 12 are smartphone users. The report of UNESCO shows that smartphones are popular among all age groups and categories of users including illiterate persons. The reason behind this massive adaptation is the facilities which these phones provide us. The hand phones eliminate the element of distance and brings people closer to each other by facilitating the communication between them and also modifies the mode of communication. They let people communicate through phone calls, video calls, or text messaging and also provide internet connectivity. These devices improved our living standards by upgrading the connectivity [3]. In early times letters connect the people world widely which were a very slow way of communication then landline phones gain the popularity due to its improved mod of communication afterward mobile phones replace them because people looked for telephone booths if they have to make an urgent call when they are outside but smartphones allow them to make and receive phone calls. The smartphones are also becoming an essential tool in educational institutes for academic purposes [4]. Students use various features of smartphones to stay connected with their teachers, access online resources to gain knowledge, share information and coordinate with other fellows, stay up-to-date and read e-books [5]. Through smartphones students can explore more knowledge than they can do ever before [6]. The smartphones let the students receive online lectures and communicate with their lecturers situated in an extensive geographic area. They are also helpful for e-learning, distance learning and m-learning programs. Mobile phone technology makes learning easier and more successful in such types of learning programs [7]. This technology offers more cost-efficient learning programs which play a vital role in liberating people globally [8]. Through smartphones, students from remote areas can also avail the opportunity to learn and get trained by more professional educators [9]. The mobile cameras are used in recording important visuals during experimentation and lectures [10]. Mobile phones are widely used in managing the administrative tasks of educational institutes. Smartphones also gain popularity among teachers because they let them communicate with their students [11]. Many teachers form chat rooms to resolve issues, to clear subject related doubts and   for other study related discussions, they also utilize whatsApp to communicate with their students. The use of study related blogs is also popular among teachers for academic purposes [12]. Many teachers encouraged the students to use smartphones during class to explore more detail on the subject. Some studies reveal that students enjoy the academic activities more when educators let them use smartphones during classes [13].

## 1.2. Broadening the User Base of Smartphones

Creating user interface design that can be convenient for everyone is not possible for most of today's smartphones based on universal design. To create the standard mobile phones for all, the designers and manufacturers negate the requirements of as few people as possible and assume that all users have the similar needs. Universally designed mobile phones and other services are created to facilitate as many people as possible by keeping in mind a diverse range of abilities and situational factors. The universal designs are manufactured for a broader range of audiences with the hope that these designs work well for all users. To create universal Graphical User Interface design for mobile phones it is essential to identify diverse requirements of the users first. To develop a deep insight into mobile phone users, we categorize the users into a divergent set based on the way they interact with these gadgets, their abilities and other characters [14].

## 1.3. Why do Some Elderly People Struggle with Smartphone Interfaces?

Although it ought to be obvious that elderly people are the quickest growing sector of the smartphone market, an appreciable digital divide persists between senior and youthful demanding smartphone users. So it is widely conceived that the primary reason for this has something to do with accessibility but the researchers learned that the senior citizeons' paramount concern is the possibility of committing an error on a smartphone. Many of the senior mobile phone users use just some core

applications (call or alarm) of their mobile phones and are not as engaged with their smartphones as the younger respondents because it was difficult or too slow for them. Another possible reason for such behavior may be the students' low self-confidence in their competencies of using smartphone. Smartphones are not designed to cater for the specific needs of senior citizens hence; the latter take longer time to execute a task on the said gadgets [15]. The seniors also experience such issues concerning interface design as font size, size of the icons, screen size, or target size. They also have difficulties in dragging, dropping or tapping on targets display on the screen. Below, we present a few of them, which should be solved by designers to help elderly population to use age friendly smartphone interface [3].

1.4. Contributions of the Research

The study offers numerous noteworthy advancements in the comprehension and improvement of smartphone interface usability for senior citizens. First of all, it provides a thorough grasp of the obstacles to efficient utilization by recognizing and classifying the difficulties older users encounter while interacting with cellphones. Second, the study assesses how well the current smartphone interfaces solve these issues, offering information on the usability gaps that continue to exist. Thirdly, the research adds useful answers to the field by suggesting and testing particular design changes meant to enhance the user experience for senior users. Finally, the study's conclusions provide insightful recommendations that may be used to future work by designers and developers to produce smartphone interfaces that are easier for the elderly to use and more accessible.

## 2. Literature Review

Smartphones also gaining popularity among the students due to their diverse features which helps students in learning process like internet services allow them to explore new fields and gather knowledge, social networking sites make them more social and connect them with experts, online dictionaries facilitate them in learning other languages and e-books and novels teach them about different cultural.  According to M. Saran, G. Seferoğlu, and K. Cagiltay a large number of students widely use smartphones to download the study material which is uploaded by institution or teacher [16].

Online platforms provide them the opportunities to learn anything from anywhere around the globe at any time or in any age.  To identify the common practices of mobile usage among the students for education purposes R. Kant conducted a survey in which 90 students participated. The results of this survey reveal that all participants own a smartphone which they use to avail the internet service and a great number of participants except that smartphone is an essential tool for higher education, android phones are more popular among students due to their easy-to-use Graphical User Interface, e-reader is least popular due to its high cost and social networking sites are most visited sites [17].

E. Ezemenaka conducted a case study to find out the effects of usage of internet enabled phones during class hours on learning behaviors of students. In this study 200 students participated and recorded their opinion through a questionnaire and 15 students were interviewed to study their behavior in depth. The results of this study shows that smartphone usage doesn't have a negative impact on the learning process but it can cause distraction during study [18]. According to I. Halder,and S. Halder there is a huge difference in the smartphone usage  behavior of students with respect to the gender, educational level and medium of education [19]. But many studies encouraged the students to use smartphones during class to explore more detail on the subject F. Wang, X. Chen, and W. Fang, study reveals that students enjoy the academic activities more when teachers let them use smartphones during classes [13]. J. T. Tessier allows students to use smartphones to find out relevant studies on the topic under discussion. His studies reveal that smartphones improve the student's academic performance [20].

The adoption of mobile phones has increased dramatically therefore a large number of research studies have been conducted to understand mobile phone users and their behavior. The researchers observed the pattern of user interaction with various mobile applications to identify the issues and challenges faced by the users. Tremendous work has been done to solve these issues in order to construct more user-friendly interfaces. In early times the manufacturers and research communities both assumed all the mobile phone users as homogenous consumers with similar requirements [21].

People from different regions belong to distinct cultures so, they have divergent perceptions about various graphics, icons, layouts and patterns. Their behaviors and expectations are also variant, due to which they use mobile interfaces in different manners. Therefore, the interface of advanced mobile phones

has been designed keeping in view the cultural diversity. The people around the globe have different social norms which led anthropologists to define the term "Cultural" However, there is no specific definition for this term but   according to G. Hofstede culture is the "programming of the mind"[22].

**3. Research Methodology**
This chapter describes the methodology which is implemented to conduct this research work.
3.1. Significance
It is important to recognize the different demands and skills of elderly because the existing mobile user experience is not able to meet their wants and needs [23]. Elders would continue to being a minority in the decades to come [24], which is why the primary goal of this dissertation is to emphasize the necessity of restructuring cellphone applications to assist elders.
3.2. Research Approach
For this study, user-centered research approaches are recommended in order to better understand older adults and their diverse needs.  Various research approaches are utilized at different stages to obtain a comprehensive comprehension of people and their needs. Therefore, in order to define the study approach, we call it the "Mix Method" research technique [17].  There are three main stages to the research done for this project. In the first stage, we thoroughly studied the literature to gain more knowledge on aging factors, smartphones, elderly people, and their effects. In the same phase, tests and a survey are conducted to determine the problems older adults experience using smartphones.. As a research strategy, a semi-systematic literature review is used to collect, organize, and analyze data (first phase). This aids in our comprehension of the issues and challenges related to the creation of a graphical user interface for senior citizens.  In the second step, a functional prototype of the senior smartphone interface is developed based on user preferences collected via a post-experimentation survey. This functional prototype of an outdated user interface is evaluated using a heuristic evaluation technique. This evaluation helps determine the level of satisfaction of the targeted consumers.  The overall "qualitative" nature of this research stems from the fact that the main objective of the study is to find the answers to questions that are centered around "what," "why," and "how," rather than "how much" or "how many" [13].
3.3. Data Collection Process
To thoroughly understand each user's feedback and to properly identify the problems and challenges in interface design, there was an analytical aspect and some qualitative aspects to the experimental test technique. The introductory survey, the experimental test, the data collection process, and the follow-up assessment made up the three primary parts, which were used to develop prototypes of research-related smartphone interfaces. Every test and survey was meticulously observed, documented, and assessed.
Based on a range of users, a number of interface design-related difficulties were found in this study. The research encompassed an examination of alternate interface design viewpoints for diverse data sets that are meant to be exhibited on smartphone interfaces [25].
The questionnaire is a very economical means of getting user data. A well-crafted questionnaire can be a great tool for root cause analysis [9].
3.4. Preliminary Survey and Questionnaire

**Table 1.** Questions of Preliminary Survey [5]

|  |  |
|---|---|
| **Demographic Information** | Age |
|  | Gender |
|  | Qualification |
|  | Current work status |
|  | What type of smartphone do you own? |
|  | How often do you use your smartphone? |
|  | What do you mainly use your smartphone for? |
|  | How long in total have you been using a smartphone |
|  | Are you suffering from any health issues? |
|  | If yes, then to which extent? |

| **Experience with smartphone** | Type of smartphone |
| | Experience with smartphone |
| | Frequency of daily use |
| | Frequently used features |

Participants were given an initial questionnaire to gather demographic information and learn about their experience with smartphones [26]. There are two portions to this questionnaire. The first one asks questions about the user's past, including their gender, age, native language, and educational attainment. The questionnaire's part two was made to evaluate how users interact with handsets so that the benefits might be easier to comprehend [13].

3.5. Participants

Usability researcher Robert Virzi found that 80% of usability difficulties may be found with just 5 individuals, and 95% can be found with 20 participants. As a result, 20 people were chosen to carry out this study. Male and female seniors over the age of sixty were chosen at random to be participants. The participants included both inexperienced and seasoned smartphone users.

Participants who were currently using cellphones were welcome to participate in the survey and experimental evaluation, which were designed to understand attitudes regarding smartphones among all elder people [5] [27].


**4. Experimental Test and Use Cases with Elderly People**

This investigation focused primarily on the effectiveness of elder users' interactions with the smartphone interface and their perceptions of it. The observer asked the participants to think aloud while closely observing the number of clicks made on each task, the accuracy with which they completed it, and the speed at which they completed it in order to record data about the test procedure. Test research involved making observations while the subjects were using their smartphones [5].

The user is required to employ the "think aloud" technique during the test, as this allows the researcher to record each user's level of knowledge [28] about the interface and whether or not it was correct by listening to their thoughts during each test [27] [38].

Users were primarily concerned with two aspects of application testing: ease of use and availability of all necessary information. This test's main objective was to ascertain how well the user could navigate each interface and take in all of the information.

4.1. User Interface Test: Task # 01

**User Interface Test: Category of Task** Daily basic task (Visibility)

**User Interface Test:  Titleof Task** Visibility of the system statuses

**User Interface Test task description**

The smartphone should provide visible objects, activities, and choices to prevent requiring the user to recall meaningless or superfluous information [29]. This is regularly broken by the smartphone User Interface, which makes it difficult for elderly users to keep an eye on the system's condition. In order to determine how effectively elders can see the system state, I devised this exam. The test has been divided into smaller tasks in order to more accurately identify the problems that elders face [30] [39].

**Sub-task no. 1.** The test subjects were instructed to recognize and from the lock screen, read loudly the date and the time, by the observer in order to complete this task.

**Sub-task no. 2.** The test subjects were instructed to recognize and from the lock screen, read loudly the date and the time, by the observer in order to complete this task.

**Sub-task no. 3.** The test subjects were instructed to recognize and from the lock screen, read loudly the date and the time, by the observer in order to complete this task.

**Sub-task no. 4.** The test subjects were instructed by the observer to determine and state out loud whether or not the phone is connected to WiFi from the home screen.

**Sub-task no. 5.** The people taking the test were asked to identify and confirm that they had received a missed call or text message on their home screen by an observer.

4.2. User Interface Test: Task # 02

**User Interface Test: Category of Task** Daily basic task (Visibility)

**User Interface Test:  Titleof Task** Unlock operations

**User Interface test task description**

The screen locking feature is essential for security purposes because it prevents unauthorized access to devices. Because of the poorly designed interface and insufficient, clear instructions to guide the user through tasks, unlocking operations are difficult [31]. I also dissect this procedure into smaller tasks in order to identify common issues that elderly users encounter when using a locked screen [32] [41].

**Sub-task no. 1.** The test subjects were instructed by the observer to enter a PIN number to unlock the smartphone.

**Sub-task no. 2.** The test participants were instructed by the observer to input a password to gain access to the smartphone.

**Sub-task no. 3.** The test subjects were instructed by the observer to enter a pattern to unlock the smartphone.

**Sub-task no. 4.** The testers were instructed by the Observer to make swipes to unlock the smartphone.

4.3. User Interface Test: Task # 03

**User Interface Test: Category of Task** Daily basic task

**User Interface Test:  Titleof Task** Make phone call

**User Interface test task description**

The primary use of a smartphone is to make phone calls, and the majority of elderly users exclusively use their devices for communication [33]. To assist elder consumers, it is crucial to pinpoint the user interface-related problems that are connected to the calling function [34]. This feature allows users to keep in touch with their family and friends. I break this task down into several sub-tasks to discover the most possible faults [35] [41].

**Sub-task no. 1.** The first subtask required the participants to dial a phone number directly from the keypad, as instructed by the observer.

**Sub-task no. 2.** In subtask number two, the observer instructed the participants to make a phone call by using a number from the phone book by utilizing the scroll bar to find it.

**Sub-task no. 3.** In subtask number three, the observer instructed the participants to dial a phone number by utilizing the search bar to look it up in the phone book.

4.4. User Interface Test: Task # 04

**User Interface Test: Category of Task** Daily basic task

**User Interface Test:  Titleof Task** Text messaging for communication

**User Interface test task description**

The connectivity of smartphones with the internet is very important for various factors. Most of the features of these devices are useless without internet connectivity and Wi-Fi is the key for internet connectivity. Therefore, it is very essential to understand all User Interface issues which make this feature difficult to use, especially for senior citizens. The observer instructed the participants to connect their devices to Wi-Fi and keep a careful eye on the work to identify issues.

**5. Results and Discussion**

5.1. Investigation of Initial Responses for Questionnaire

The participants were first exposed to the smartphone interface usability testing during the first week. Twenty people were chosen to take part in the usability test as volunteers. These participants were novel or experienced educated senior users of smartphone devices. Before they accepted to participate, the participants were informed that the tests' objective was to assess the usability and efficacy of smartphone interfaces to identify the challenges that the elderly faced while interacting with smartphones.

Prior to participating in the above-described experimental test, the participants were required to complete this first questionnaire. This questionnaire provided clarification on their usage frequency, history, and previous smartphone usage. Furthermore, the survey comprises inquiries designed to apprise the investigator of any medical conditions that respondents may be experiencing that could potentially impact their utilization of smartphones.

**Table 2.** Candidates' Demographic Survey

| Candidate id | Candidate's Gender | Candidate's Qualification | Age Group | Health Related Issues | Employment Type/Retired |
|---|---|---|---|---|---|
| Candidate 1 | Male | Graduate | 60-70 | Mild to moderate | Full time |

| Candidate 2 | Male | Graduate | 71-80 | Mild to moderate | Retired |
|---|---|---|---|---|---|
| Candidate 3 | Male | Graduate | 60-70 | Mild to moderate | Full time |
| Candidate 4 | Male | Graduate | 60-70 | Mild type | Full time |
| Candidate 5 | Female | High school | 60-70 | Mild type | Retired |
| Candidate 6 | Male | Graduate | 60-70 | Mild to moderate | Full time |
| Candidate 7 | Male | Graduate | 71-80 | Mild to moderate | Retired |
| Candidate 8 | Male | Undergraduate | 60-70 | Mild to moderate | Full time |
| Candidate 9 | Female | Graduate | 60-70 | Mild to moderate | Part time |
| Candidate 10 | Male | Graduate | 60-70 | Mild type | Full time |
| Candidate 11 | Female | Undergraduate | 71-80 | Moderate to swear | Retired |
| Candidate 12 | Male | Graduate | 60-70 | Mild to moderate | Full time |
| Candidate 13 | Male | Graduate | 60-70 | Mild to moderate | Full time |
| Candidate 14 | Male | Undergraduate | 60-70 | Mild to moderate | Full time |
| Candidate 15 | Male | Graduate | 71-80 | Mild to moderate | Part time |
| Candidate 16 | Female | Graduate | 60-70 | Mild to moderate | Part time |
| Candidate 17 | Female | High school | 81-90 | Moderate to swear | Retired |
| Candidate 18 | Female | High school | 60-70 | Mild type | Retired |
| Candidate 19 | Female | Graduate | 71-80 | Mild to moderate | Part time |
| Candidate 20 | Female | Undergraduate | 81-90 | Moderate to swear | Retired |

We were able to ascertain certain crucial information on the target audience from the preliminary survey following the results analysis. Most elder adults who use mobile devices frequently are under 71 years old. The results of the survey show that 65 percent of elder persons who use cell phones are in the 60–70 age range. As people age, their health may begin to deteriorate; for example, their vision may become less clear and vivid, and their finger flexibility may also decline. A survey found that every smartphone user over 60 deals with health-related issues. As to the poll, mild to moderate health concerns are reported by 65% of elderly smartphone users. 20% of people are concerned about less serious health issues, whereas 15% of people have moderate to severe health difficulties. There is not much of a gender gap among mobile device users, with male elder users slightly outnumbering female users. 60% of smartphone users who are 60 years of age or elder are men, and 40% are women.

Most senior citizens have prior experience with smartphones. Over 70% of people over 60 have been using smartphones for more than two years, according to the survey. 25% of elderly people have one to two years of experience with smartphones, compared to just 5% who are brand-new users who have just had their devices for a year or less.

Elderly folks frequently use their mobile phones to make phone calls; others might use it to browse the news or get information on websites. The most common device used in daily life is the smartphone. Studies reveal that 15% of senior citizens use smartphones for online shopping, and nearly 40% of them use them for internet browsing.

Only 25% of senior users use their devices to read online content, such as books, newspapers, etc. because they have vision problems. The majority of the elderly (90%) use their smartphones for entertainment purposes. They watch movies, view short videos, or listen to music (usually religious content).

Due to physical decline, including a loss of mental and physical capacity, lder people dislike mastering complicated smartphone capabilities. Mobile devices are frequently used for simple tasks like texting or making calls. Nearly all senior adults use smartphones to call friends and family, according to this study poll. Some elder adults prefer phone conversations to texting because they find texting difficult and frustrating. The findings show that just 30% of seniors use text texting.

When seniors encounter problems with the functionality on their mobile device, they typically seek help from friends or family. When there are many options, people won't try out new functions or programs unless they really must. Although they found it difficult to set up these functionalities, almost 75% of seniors said they used their smartphones as alarm clocks, time and date checkers, and clocks. Thus, in order to enable them to utilize the more sophisticated capabilities of these digital items, the elderly demand that

smartphone user interfaces be made simpler. Features like the radio and compass are useless for the elderly.

## 5.2. Analysis of Experimentation Responses

Because the observer's duties were predetermined prior to the experiment, they could focus their experimental evaluation of the smartphone interface on a specific set of user tasks. These assessments were designed to evaluate smartphone feature actions relating to key management, both basic and supplementary. These sample tasks are the main way elder adults use their smartphones to connect and do important chores. The elderly are either encouraged or discouraged from using smartphones due to the complexity of these tasks.

Throughout the investigation, the researcher painstakingly logs every concern raised by the elderly, removes any duplicates, and combines the information onto one page. By the time this phase was over, the observer received a list of all the usability issues that had been discovered, along with an explanation of the causes and locations of each issue. After that, participants were asked to rank the potential fixes for the issues.

In order to ascertain the extent to which usability concerns impact senior users, twenty elderly adults were evaluated for this investigation. The researcher greeted the participant and went over the purpose of the experiment before handing them a smartphone with the factory default settings and asking them to finish tasks. In order to detect any usability problems and monitor the task completion success rate, testers watched as the participant used the smartphone throughout the test.

### 5.2.1. Test task number: 01 (System Status)

- **Sub-task no. 1 & 2.** The participant's goal was to identify and read out the date and time from the lock screen as instructed by the observer. The tester noted during the test that only 35% (N=6) of participants could tell the time, and only 15% (N=2) had read the date and day displayed on the lock screen. This was because of the low contrast between the unlock screen and background, as well as the small font size, which reduces visibility as shown in Figure 1(a).

- **Sub-task no. 3 & 4.** In this mini-task, the participant's job was to read out loud the battery level and indicate whether or not the phone is online. Once more, as Figure 1 (b) illustrates, it was nearly invisible due to the low contrast between the home screen and background as well as the very small font and icon sizes. These tests continue to have a very low success rate; just 5% (N=2) of elderly people with relatively moderate vision-related problems were able to correctly evaluate the system status.

- **Sub-task no. 5.** The participants in this subtask were asked to report that they had received a text message or missed call notification on their home screen, according to the observer. As seen in picture 1(c), it was nearly invisible due to the low contrast between the home screen, background, and the location of alert messages as well as the excessively small font and icon sizes. Only 1 percent (N=1) of the elder adults who completed these tasks satisfactorily were able to understand the alert notifications.



**Figure 1.** Visibility of System Status

*5.2.2. User Interface Test task number: 02 (Unlock Device)*

- **Sub-task no. 1.** During the test, the participant was instructed to turn on the phone and enter the password to unlock the smartphone by the observer. While performing this activity, it was seen that some elder users were having trouble understanding the term "password" and needed assistance to unlock the screen. Others who were familiar with the term had memory problems and needed assistance remembering their password. Ninety percent of participants (n=18) needed assistance to finish this activity. They are now having trouble inputting a 4-digit PIN code even after they have grasped the meaning of PIN and have helped themselves to memorize the password. Due to the tiny onscreen keys and the weak background contrast, which made the forescreen invisible, 65% of the participants (N=15) found it difficult to complete the exercise (figure 2(a).

- **Sub-task no. 2.** The observer asked the participants to unlock the smartphone using their password during the test, and it was noted that 65% (N=15) of elder adults have vision problems at this point due to the small on-screen keyboard keys and the low contrast between the background and forescreen, which makes the on-screen keyboard invisible, as seen in figure 2(b).

- **Sub-task no. 3.** Testers note that 30% (N=8) of senior smartphone users are unable to unlock the screen by entering a pattern due to trembling hands and inadequate finger movement. The observer requested the participants to complete this activity by inputting a pattern.

- **Sub-task no. 4.** The test participants were instructed to unlock the smartphone by swiping it; the task had a 100% success rate (N=20) among the elderly; however, 30% (N=4) of the elderly took longer or made more attempts to complete the task. Nevertheless, when the test participants were asked to read the instructions for swiping up on the screen, as illustrated in figure 2(c), they were all not able to read.
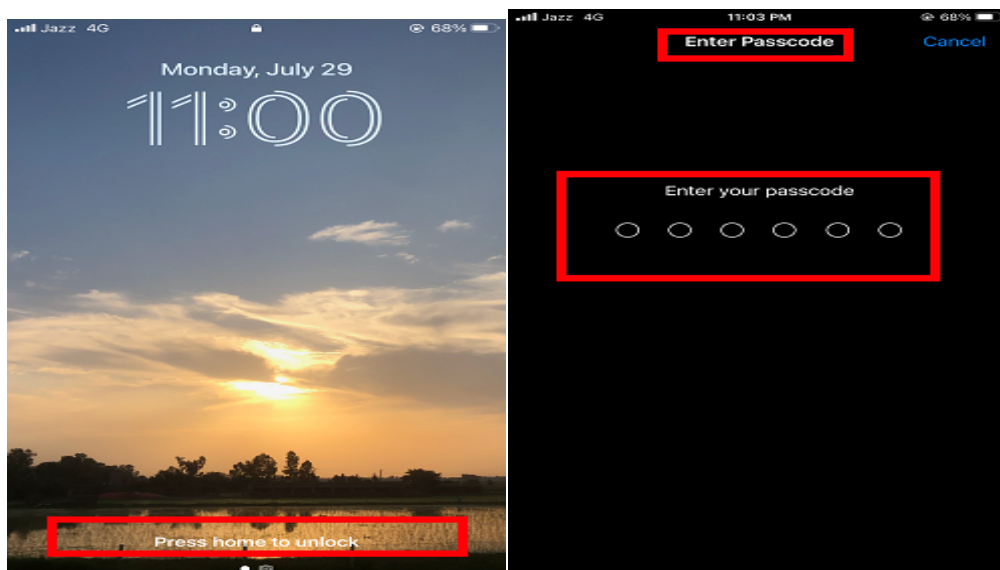


**Figure 2.** Unlock operations

**Table 3.** Summary of Post-experimentation Survey

| Font size survey | Percentage |
|---|---|
| 12pt (N=0) | 0% |
| 14pt (N=11) | 55% |
| 18pt (N=06) | 30% |
| 24pt(N=03) | 15% |
| **Font style survey** | |
| Arial San Serif (N=09) | 45% |
| Garamond Serif (N=03) | 15% |
| Helvetica San Serif (N=06) | 30% |
| Times Serif(N=02) | 10% |
| **Color contrast survey** | |

| | |
|---|---|
| Red is on a white background (N=12) | 60% |
| White is on a dark blue background (N=04) | 20% |
| Orange is on a white background(N=01) | 05% |
| Yellow is on black background(N=02) | 10% |

**Select the font size or typeface by yourself?**

| | |
|---|---|
| Yes (N=14) | 70% |
| No (N=2) | 10% |
| Not Really (N=4) | 20% |

**Select the line space by yourself?**

| | |
|---|---|
| Yes (N=14) | 70% |
| No (N=2) | 10% |
| Not Really (N=4) | 20% |

**Select Icon image for home button?**

| | |
|---|---|
| Simple/ symbolic (Home) (N=2) | 10% |
| 3D Illustration (Home) (N=14) | 70% |
| 2D Illustration (Home) (N=4) | 20% |
| Select icon size | |
| 120x120 (N=1) | 5% |
| 152x152 (N=7) | 35% |
| 167x167 (N=12) | 60% |

**Select one to change the pages**

| | |
|---|---|
| Scroll text (N=4) | 40% |
| Press button to change the page(N=12) | 60% |

**Select auto-correction to fix typing errors?**

| | |
|---|---|
| Yes(N=16) | 80% |
| No(N=4) | 20% |
| **Input method survey** | |
| Typing with the keypad (N=13) | 65% |
| Handwriting (N=8) | 40% |
| Voice speech input (N=12) | 60% |

## 6. Conclusion

Current trends show that an increasing number of elder individuals are using smartphones; this trend is a result of the aging global population and the annual increase in the proportion of elderly users. Globally, the number of elderly people is increasing, which highlights the need to create technologies that are suitable for this demographic segment and meet their needs. However, this significant portion of the population appears to have been overlooked by mobile makers and research communities, who view them as a unique set of users with unique requirements. Because of this, neither the physical hardware nor the software interface is designed with senior users in mind. The findings indicate that the majority of elder adults who frequently use mobile devices are under the age of 71. Of senior citizens who use cell phones, 65% are between the ages of 60 and 70. As people age, their health may begin to deteriorate; every smartphone user over 60 has health-related issues, and 65% of elder smartphone users have mild to moderate health issues. Fifteen percent of people have moderate to severe health issues, compared to twenty percent who have milder concerns. There is not much of a gender gap among mobile device users, with male elder users slightly outnumbering female users. According to experimental tests, just 30% of elder people can tell the time, and only 10% of participants can read the date and day displayed on the lock screen. These issues are attributed to the small font size and low contrast between the unlock screen and background. Merely 10% of elder individuals with very mild vision-related problems were able to correctly

read the system status, and only 5% of elderly individuals were able to correctly interpret the alarm notifications. The onscreen keys' small size and the forescreen's weak background contrast make unlocking the device challenging for elder users. Ninety percent of the elderly have trouble remembering their PIN because they don't understand what it means. Seventy-five percent of senior citizens are unable to use the on-screen keyboard to input passwords. 40% of elder people have trembling hands and bad finger timing, which prevents them from entering the sequence to unlock the device. Although the onscreen directions for this operation are inappropriate, it is discovered throughout this experimentation that the swipe option is the simplest approach to unlock the screen. According to this study, 90% of senior citizens have had trouble finding keypads where they may directly enter numbers because of incorrect and unlabeled iconography. 60% of senior citizens report having trouble finding numbers because of decreased font sizes and language-related issues. Seventy percent of senior citizens cannot recognize the little scroll bar. According to research, 80% of senior citizens report having trouble typing text using an onscreen keyboard since the keys are too small for their hands and are not usable by the elderly. Additionally, it is noted that the send button lacks user friendliness. 95% of senior citizens have had trouble recognizing text message notification notifications.

## 7. Recommendations

Tremendous work has been done in various dimensions to improve the elderly experience with smartphone devices but there are still some issues and challenges that need to be addressed.

Firstly the interface design of mobile web browsers is adapted from web portals which leads to poor user interaction therefore, a mobile-specific design approach is required to design the interface of the mobile web browsers. Secondly**,** a customized interface design is required for seniors to access mainstream social networking. Thirdly, identify the way through which smartphones can be helpful for seniors to decrease social isolation. Fourthly, the guidelines for designing GUI for elderly users are based on outdated studies therefore, the study is required to recognize that these guidelines are still valid to use. **Fifth:** The guidelines to develop user interfaces for elderly users are derived from elder technologies therefore, these guidelines need to be revised according to current technologies and trends.

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