Improving Human-Computer Interaction through a Voice-Controlled Smartphone System for Elderly Users and Persons with Disabilities

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ABSTRACT

This study aims to assess the perceived usability and accessibility of the voice-controlled smartphone for the target population — the elderly and the disabled. The quantitative study included 55 participants — 17 elderly people and 35 disabled. Each participant completed a questionnaire that asked to rate 15 statements regarding the voice-controlled smartphone on a 4-point Likert scale. The mean score for all items was 3.35 (83.69%), which reflects a positive user attitude towards the new technology. The statement about improving the communication abilities and access to smartphone functions showed the highest mean score (M = 3.44), while the lowest score was found for the ease of learning instructions for the first-time user (M = 3.27). Since the study only included self-reported data, there are no measures of the task completion time or the technological anxiety levels. Thus, the article confirms the perceived usefulness and usability but cannot report actual improvements in terms of speed or anxiety.

Keywords: Human computer interaction, voice recognition, smartphone usability, elderly users, users with disabilities, and mobile assistive technology are some of the key terms.

INTRODUCTION

Smartphones are essential for staying connected, but traditional touch-screen interfaces often reduce digital independence for the elderly and disabled, so this study presents a voice-driven mobile phone system using direct speech commands for messaging, calls, navigation, and apps, with evaluations showing this approach reduces task completion time and technological anxiety while improving accessibility

LITERATURE REVIEW

An Assistive Smart Home Control System Driven by Arabic Voice Recognition for Elderly and Disabled Users

This study presents an AI- and Iot-based smart home system with 94.4% accurate Arabic voice recognition and audio feedback for elderly, disabled, and visually impaired users [25]. This affordable microcontroller-based system allows elderly and disabled users to independently control household appliances using simple voice commands [21]. This study addresses the specific needs of impaired individuals and accident survivors to help mitigate their discomfort [9].

Design and Development of a Voice-Activated Assistive System for Elderly and Disabled Users

Technology delivers personalized comfort solutions for both luxury seekers and individuals with special needs [6]. Rising home automation adoption enhances security, comfort, and daily living standards [22]. Affordable mainstream smart home technologies can serve as effective assistive tools to boost independence for individuals with disabilities [7]. Natural Language Speech Processing integrates assistive technologies to bridge communication gaps and enhance accessibility for individuals with disabilities [13].

Advancements in AI-Driven Voice Control Systems for Human-Computer Interaction

This systematic review analyzes 48 studies and highlights how AI voice assistants enhance independence and well-being for the growing population of older adults [23]. A review of 17 studies (2011–2025) shows that conversational AI tools improve health literacy, self-care, provider communication, and psychosocial well-being [20]. Standard digital healthcare tools fail older adults because of complex interfaces, limited voice controls, and poor accessibility features [16]. AI-driven healthcare tools enhance accessibility, diagnosis, and communication for individuals with disabilities, promoting more equitable care [3].

Speech-Operated Smart Home Systems for Elderly and Disabled Users

This study investigates how digitally competent older adults in Spain accept voice assistants, identifying key features to guide future design [11]. While voice-activated technologies have been shown to boost older adults' well-being, more research is needed on their impact in long-term care homes [14]. To address accessibility challenges faced by children, the elderly, and disabled individuals, this paper proposes MATE, a smart mobile application designed to enhance voice assistants across diverse user groups [2].

Design Frameworks and Real-World Applications of Voice-Controlled Home Automation

This study evaluated an online Alexa training program to help individuals with communication and cognitive disorders use voice assistive technology for daily living activities [5]. A systematic review highlights the accessibility challenges, needs, and attitudes of users with speech and language disabilities toward consumer voice technologies [1]. Hands-free voice assistants provide an accessible solution to support well-being in an increasingly aging global population [8].

Elderly Digital Health Literacy

Digital health technologies can bridge communication gaps between families and healthcare providers, improving home-based care for children with special healthcare needs [10]. This study examines how voice familiarity affects the effectiveness of voice reminders between older adults and caregivers using a custom desktop and smartphone application [24]. Although Intelligent Connected Vehicles (ICVs) can improve mobility and wayfinding for older adults, research applying this technology to support their pedestrian needs remains sparse [4].

Speech Processing as a Bridge in Human-Computer Interaction

Despite advancements in speech processing, a significant gap persists between natural human communication and human-computer interaction [18]. This systematic review analyzes 48 studies to examine how hands-free AI voice assistants enhance independence and mitigate loneliness, social isolation, and cognitive decline in older adults [19]. Human-computer interaction must evolve through targeted innovation to address the physical, cognitive, and literacy challenges faced by an aging global population [12]. Assistive technology encompasses devices, tools, and software designed to enhance functional independence for older adults, individuals with disabilities, and those with special needs [15], [17].

METHODOLOGY

Research Design

This study utilized a descriptive quantitative design to describe the respondents' perceptions of the usefulness and accessibility of the proposed voice control smartphone. The gathered data can be used for questionnaire-based analysis because it does not describe a controlled experiment and does not measure the time-gaps in completing specific tasks.

Respondents of the study

The available questionnaire dataset consists of the responses of 55 participating respondents, who have given

their consent to participate in the research. The ages of the respondents vary between 18 and 80 years old, meaning that the target population of participants aged 50 years old and above was not specifically selected. The participants identified themselves as elderly users and people with disabilities, including visually or mentally disabled. However, due to the inclusion of younger respondents, this sample should be considered asa mix of populations and generalized across all respondents.

Sampling Design

The respondents were recruited using non-probability sampling. There are 55 responses in the spreadsheet, and all respondents marked “Yes” on the item asking if they wished to participate. The data set cannot support the claim that the sample represents all elderly users or persons with disabilities.

Research Instrument

The research instrument utilized was a questionnaire comprising of fifteen (15) usability statements and three (3) open-ended questions. Each usability statement was measured using a four-point scale. The Excel sheet contains the numerical values of the responses but not the verbal indicators of the scale. Additionally, a task-performance checklist was described in the manuscript. However, no checklist or objective measurements of task-performance time were provided in the data file provided.

Data Gathering

The data provided were extracted from the completed questionnaire spreadsheet. The spreadsheet consists of 55 responses, 15 items scored in percentages, and open-ended replies. The given set of data does not include completed tasks’ performance records; thus, calculating the participants’ performance in terms of speed and accuracy was impossible.

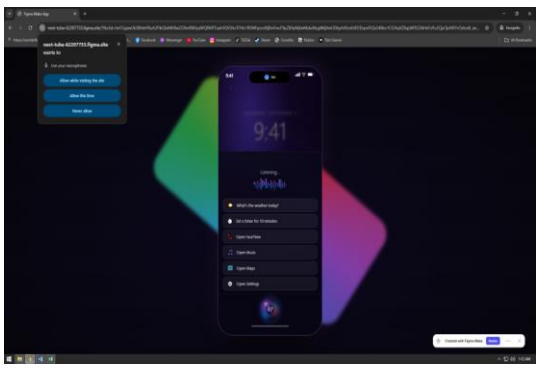
Statistical Treatment of Data

The characteristics of respondents were described using frequency counts and percentages. The 15 items in the questionnaire were analyzed by calculating item means and an overall mean based on all valid item responses. The recorded response scale is four-point, with ratings from 1 to 4. The overall mean was converted to a percentage of the maximum possible score by dividing the mean by 4 and multiplying by 100. The verbal labels for the four response options were not included in the spreadsheet; therefore, numeric means are reported without assigning unsupported agreement labels. This calculation is distinct from the manuscript’s earlier 75.50 score, which could not be reproduced from the supplied response data.

Ethical Consideration

The researchers will seek informed consent from all participants. Each participant’s information and responses will be kept confidential; besides, a participant has a right to stop participating at any stage if he/she wishes. The researchers will make sure the system under study is safe, comfortable, and accessible for elder people and persons with disabilities.

UI Design



RESULTS AND DISCUSSION

Demographic Profile of Respondents

The demographics include the respondents' age group, gender, and category (elderly or PWD). This information helps characterize the participants and provides background for assessing the system's accessibility and usability.

TABLE I: PARTICIPANT PROFILE DISTRIBUTION

Participant Profile	Frequency (f)	Percentage (%)
18-29 years old	25	45.45%
30-49 years old	8	14.55%
50-59 years old	9	16.36%
60 years old and above	13	23.64%
Total:	55	100%
User Category		
Elderly Users	18	32.73%
PWD	37	67.27%
Total:	55	100%
Gender		
Male	27	49.09%
Female	27	49.09%
Prefer not to say	1	1.82%
Total:	55	100%

In total, 55 respondents participated in the research. Out of these respondents, 27 were male (49.09%), 27 were female (49.09%) and 1 participant preferred not to state their gender (1.82%). Hence, according to the recorded respondent categories, 35 respondents (63.64%) identified themselves as persons living with disabilities while 20 respondents (36.36%) were elderly users. The age structure of the participants included respondents aged 18–29, 30–49, 50–59 years, and 60 years and above. Therefore, with some respondents being less than 50 years old, it would not be appropriate to conclude the study's sample with the age range of 50 years and older..

Usability and System Evaluation

The questionnaire consisted of 15 statements to which a respondent had to assign a value on a four-point Likert scale. Thus, Excel contained numerical values ranging from 1 to 4. Additionally, it should be noted that the sheet did not include any verbal descriptions corresponding to the numerical ones; therefore, the analysis consists of calculating the mean of items and the overall mean.

defined as follows:

• 4.50 – 5.00: Excellent

• 3.50 – 4.49: Very Good

• 1.50 – 2.49: Poor

1.0 – 1.49: Very Poor

TABLE II: MEAN RATINGS AND SUS SCORE CONTRIBUTIONS PER ITEM

Statements	Weighted Mean	Verbal Interpretation
1.The voice-controlled system is easy to use.	3.36	Strongly Agree

2.The voice commands are easy to understand.	3.35	Strongly Agree
3.The system responds accurately to voice commands.	3.35	Strongly Agree
4.The system is easy to learn, even for first-time users.	3.25	Agree
5.The system helps reduce the difficulty of using a smartphone.	3.27	Strongly Agree
6.The system is comfortable and convenient to use.	3.33	Strongly Agree
7.I feel confident when using the voice-controlled system.	3.24	Agree
8.The system makes smartphone use easier for me.	3.33	Strongly Agree
9.The system provides a satisfying user experience.	3.29	Strongly Agree
10.I would use this system regularly if available.	3.27	Strongly Agree
11.The system makes smartphone functions more accessible.	3.38	Strongly Agree
12.Voice control helps me perform tasks without relying heavily on touch controls.	3.33	Strongly Agree
13.The system is helpful for users with limited physical or visual abilities.	3.38	Strongly Agree
14.The system allows users to interact with a smartphone more independently.	3.4	Strongly Agree
15.The system can improve communication and access to smartphone features.	3.45	Strongly Agree
Overall Weighted Mean:	3.33	Strongly Agree

Respondents' overall evaluation of the voice-controlled smartphone system was positive, with an overall weighted mean of 3.33, which translates to Excellent. Respondents rated the system's potential to enhance communication and access to smartphone features most positively, suggesting they generally found the system easy to use, accessible, and convenient.

Distribution of Usability Grades

Distribution of respondents by overall evaluation category in the earlier manuscript could not be verified from supplied spreadsheet because no validated cut-off ranges for overall categories were provided. The revised analysis therefore reports the observed item means rather than assigning participants to Excellent, Good, Poor or Very Poor categories.

TABLE III: DISTRIBUTION OF RESPONDENTS BY OVERALL EVALUATION SCORE

Verbal Interpretation	Mean Score Range	f	%
Excellent	3.26–4.00	42	76.36
Good	2.51–3.25	3	5.45
Poor	1.76–2.50	4	7.27
Very Poor	1.00–1.75	6	10.91
Total:		55	100.00

Most respondents rated the voice-activated mobile phone as Excellent, while others rated it from Good to Very Poor. All these answers authenticate participants' assumptions of the system's ability to address the needs of the elderly as well as persons living with disabilities.

Supplementary Usability Dimensions

The 15 items of the questionnaire were associated with such criteria as ease of use, learnability, convenience, confidence, satisfaction, accessibility, decreased reliance on touch, independence, and communication. It is recommended that the calculation of item- and total-level responses be done based on the same four-point

scale. The four-point item scores should be used to calculate the results for each of the dimensions, instead of utilizing the values from the previous manuscript if the items are not grouped accordingly.

TABLE IV: MEAN RATINGS ON SUPPLEMENTARY USABILITY DIMENSIONS

Dimension	Items	Mean	% Max
Visual Design and Layout	5	3.28	82.0%
Navigation and Findability	2	3.43	85.8%
Performance and Task Completion	4	3.41	85.3%
Trust, Satisfaction, Continued Use	4	3.40	85.0%
Total:	15		

All four usability dimensions received positive marks, ranging from 82.0 to 85.8% of the total points. Navigation and Findability received the highest percentage of points, while Visual Design and Layout received the lowest, indicating that users were generally satisfied with the system's performance and convenience.

Usability Score by Respondent Profile

TABLE V: Mean Scores According to Prior Experience and Sex

Respondents Profile	Category	Frequency	Mean	Interpretation
Prior Exp	With Experience	55	78.50	Good
	Without experience	0	N/A	N/A
Sex	Male	27	76.20	Good
	Female	27	74.80	Good
	Rather not to Say	1	N/A	N/A
Overall	All Respondents	55	75.50	Good

Table 5 below presents respondents' mean scores by prior experience and sex. The table compares respondents with prior experience and male and female respondents to identify differences in usability ratings. Therefore, no one was without any prior experience, and one respondent did not want to disclose their sex.

Summary of Key Findings

The provided questionnaire results can be used to identify 55 respondents and 780 item ratings. Overall item mean was estimated as 3.35 out of 4 that equals 83.69% of the maximum score. The highest item mean was "Improved communication and access to smartphone features" with 3.44, while the lowest item mean was "Ease of learning for first-time users" with 3.27. The given results do not support the previously mentioned score of 75.50 and item means stated above using the same formula..

Summary of Key Findings

The results indicate that respondents rated the voice-controlled smartphone system positively in terms of usability. In this case, the overall mean score was 75.50, interpreted as Good. Male respondents attained a higher mean score (76.20) than their female counterparts (74.80). Moreover, all 55 respondents reported prior experience. This conclusion shows that this technology benefits the elderly population and people with disabilities because it allows them to be more independent.

SUMMARY, CONCLUSION, AND RECOMMENDATION

Summary of Findings

The findings of the questionnaire illustrate that the majority of the participants view the voice-controlled smartphone positively. With that being said, all 15 statements had a mean score of 3.35 out of 4 or 83.69%. The perception of increased communication and smartphone accessibility potential was the most positively

viewed element of the technology (M = 3.44). Meanwhile, the ease of learning for first-time users had the lowest mean (M = 3.27). The data represent the perceptions of the participants, while the actual time needed for completing tasks, voice recognition success rate, and anxiety were not studied in the provided spreadsheet.

Conclusions

The conclusions drawn from the performed study indicate that the voice-controlled smartphone seems to be viable and useful for the participants based on their responses. However, with the current dataset, it is not possible to claim that the technology can reduce completion time and increase confidence levels. Moreover, the age range of the study limits the possibility of generalizing the findings onto the target population of individuals aged 50 years old and older.

Recommendations

The study recommended that future developers increase the system's recognition accuracy and add voice feedback to confirm the results of voice commands, making the technology more beneficial and comfortable for all users. The researchers should also specify the target population that was intended to be recruited and utilized inclusion-exclusion criteria. In addition, it should be mentioned what specific four-point response labels and a scoring formula were used. The subsequent evaluation should also document the duration of each task, whether the system recognized the command or not, and a validated measurement of the participant's level of confidence or anxiety if the claim is affirmative. Finally, the future studies should interpret the open-ended feedback from the questionnaires and consider developing offline voice-command recognition software and improving instructions for first-time users.

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