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# Rehabilitation of Data Web APP Design and Usability Evaluation for Elderly Users

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## ABSTRACT

As nations face aging populations, elderly individuals often resist seeking medical care, negatively impacting their physical and mental well-being. Current telemedicine solutions often present unfriendly interfaces, exacerbating seniors' difficulties comprehending these technologies. To address these challenges, we developed a web-based application enabling elderly users to access rehabilitation data on mobile devices, gain insights into their rehabilitation training, and obtain medical guidance. Our methodology combined semi-structured interviews with seniors, on-site observations, and expert consultations to understand user requirements. We then conducted usability task experiments to assess key usability metrics, such as satisfaction, efficiency, and error rates. Finally, we employed a usability questionnaire and semi-structured interviews to evaluate the application's usability and seniors' motivation. Analyzing the completion of five predetermined tasks and the results of the MAUQ questionnaire, our findings demonstrated good overall usability for elderly users, with an average score of 5.20 per question. Using an independent sample T-test, we found that although the total questionnaire score remained unaffected by respondents' education level, significant differences arose concerning ease of use and satisfaction among respondents with distinct educational backgrounds. Our study highlights that the web application enhances older adults' willingness to use mobile devices for rehabilitation. By integrating the application into geriatric rehabilitation training, healthcare providers can facilitate a deeper understanding of seniors' conditions, increase motivation for rehabilitation, and streamline the process, making it accessible, digital, and visually engaging.

**Keywords:** Web app, Usability, Seniors, Interface design

## INTRODUCTION

Amid the evolution of economic landscapes and shifts in population age structures, numerous nations are transitioning towards an aging society. The increasing significance of healthcare resources and the challenges posed by their uneven distribution warrant attention. Diminishing skeletal muscle mass and functionality represent quintessential attributes of human aging, engendering restricted mobility, disability, and mortality (Shlisky et al., 2017). Experts term the loss of muscle mass and strength associated with aging

**Figure 1:** Current status of rehabilitation treatment.

| Development Company | Product Name | Product Diagram | Product Function |
|---|---|---|---|
| aiFree | Intelligence Health Partner |  | The new type of rehabilitation service enables the recovered patients to recover at home, and professionals can remotely arrange the most suitable rehabilitation course through the system |
| LongGood | PAPAMAMA |  | Provide comprehensive rehabilitation training for patients with nerve damage such as stroke and Parkinson's disease, and after orthopedic surgery. |
| Conzian | KNEESUp |  | Provide a more complete home rehabilitation program for patients with knee surgery, ligament reconstruction and lower limb injuries. |

**Figure 2:** Products developed by Telehealth Medical.

as sarcopenia. (Fielding et al., 2011), which encompasses muscle degradation attributable to diminished activity, malnutrition, or disease among older individuals.

Effectively addressing sarcopenia necessitates implementing regulated dietary regimens and incorporating exercise and rehabilitation, with synergistic outcomes achievable through a combination of both approaches (Kakehi et al., 2022). Concerning rehabilitation, most patients currently undergo consistent and repetitive motor training, albeit older adults often exhibit a decreased willingness to persist with such regimens (see Figure 1). The COVID-19 pandemic has further catalyzed the emergence of intelligent medicine as a contemporary medical paradigm (see Figure 2). By leveraging artificial intelligence, healthcare professionals can optimize the management of patients afflicted with chronic conditions, provide precise treatment recommendations for critical illnesses, and mitigate medical errors (Miller & Brown, 2018).

Consequently, numerous enterprises are striving to develop products that facilitate telemedicine services. However, the physical constraints experienced by elderly individuals often pose difficulties or challenges when attempting to read and operate these technologies, leading to a diminished inclination among seniors to embrace novel technological products. As a result, this study applies the "Intelligence Health Partner," developed by aiFree Technology, to design a user interface tailored to this demographic. This interface enables real-time access to rehabilitation training medical records. It conducts a test experiment on its usability for seniors aged 65–80, assessing the user satisfaction and efficiency of the software. This study evaluates user

satisfaction and efficiency while refining the interface design. The findings of this study will serve as a valuable reference for the future development of applications catering to the needs of the elders.

## LITERATURE REVIEW

### Seniors and New Technology

In the wake of recent advancements in sophisticated products, various technological solutions have emerged to accommodate the growing trend of aging societies, furnishing elderly individuals with intelligent software and hardware to enable self-sufficient lifestyles. Nevertheless, seniors' use of mobile devices, e-readers, and tablets exhibits marked disparities contingent on their age. As delineated by a study conducted by the Pew Research Center, older adults may confront the subsequent impediments and obstacles when endeavoring to harness these cutting-edge technologies (Smith, 2014):

- The physical challenges of using the new technologies
- Skepticism about the benefits of the new technologies
- Difficulty learning to use the new technologies

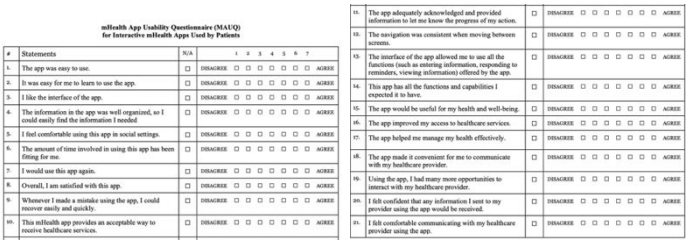
Research suggests that the advent of information and communication technologies can reduce social isolation and improve health and activity participation among older adults (Baker et al., 2018).

### Mobile Health

Mobile health has been talked about a lot in recent years as one of the components of e-health, which typically uses mobile communication devices (e.g., cell phones, tablets, etc.) and wearable devices (e.g., smart watches, smart glasses, etc.) to deliver health services, information, and data collection—generating a new, convenient and novel healthcare system. It has been a driving force in healthcare over the past decades, from healthcare delivery to low-cost tools for effective disease diagnosis, prediction, monitoring, and management (Iyawa et al., 2019). Thus, experts define it as using mobile computing and communication technologies in healthcare and public health. (Free et al., 2010). In the recent COVID-19 epidemic, mobile and zero-touch health care has gone from experimental to routine. Mobile medicine has been very effective at this time, allowing many people to use their mobile devices to see a doctor anywhere without traveling. In terms of long-term care, mobile health can save on service costs and reduce the overuse of medical resources. However, as intelligent technologies increasingly provide data for healthcare, the industry must address cross-platform data integration, systematic data governance, and empathetic privacy protection.

### Usability Evaluation

The primary purpose of conducting usability testing and evaluating a product is to assess whether it meets the user's needs and operation. Nielsen argues that usability is not just a single assessment but is measured using



**mHealth App Usability Questionnaire (MAUQ) for Interactive mHealth Apps Used by Patients**

| # | Statements | N/A | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | The app was easy to use. | ☐ | DISAGREE | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | AGREE |
| 2. | It was easy for me to learn to use the app. | ☐ | DISAGREE | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | AGREE |
| 3. | I like the interface of the app. | ☐ | DISAGREE | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | AGREE |
| 4. | The information in the app was well organized, so I could easily find the information I needed. | ☐ | DISAGREE | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | AGREE |
| 5. | I feel comfortable using this app in social settings. | ☐ | DISAGREE | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | AGREE |
| 6. | The amount of time involved in using this app has been fitting for me. | ☐ | DISAGREE | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | AGREE |
| 7. | I would use this app again. | ☐ | DISAGREE | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | AGREE |
| 8. | Overall, I am satisfied with this app. | ☐ | DISAGREE | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | AGREE |
| 9. | Whenever I made a mistake using the app, I could recover easily and quickly. | ☐ | DISAGREE | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | AGREE |
| 10. | This mHealth app provides an acceptable way to receive healthcare services. | ☐ | DISAGREE | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | AGREE |
| 11. | The app adequately acknowledged and provided information to let me know the progress of my action. | ☐ | DISAGREE | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | AGREE |
| 12. | The navigation was consistent when moving between screens. | ☐ | DISAGREE | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | AGREE |
| 13. | The interface of the app allowed me to use all the functions (such as entering information, responding to reminders, viewing information) offered by the app. | ☐ | DISAGREE | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | AGREE |
| 14. | This app has all the functions and capabilities I expected it to have. | ☐ | DISAGREE | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | AGREE |
| 15. | The app would be useful for my health and well-being. | ☐ | DISAGREE | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | AGREE |
| 16. | The app improved my access to healthcare services. | ☐ | DISAGREE | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | AGREE |
| 17. | The app helped me manage my health effectively. | ☐ | DISAGREE | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | AGREE |
| 18. | The app made it convenient for me to communicate with my healthcare provider. | ☐ | DISAGREE | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | AGREE |
| 19. | Using the app, I had many more opportunities to interact with my healthcare provider. | ☐ | DISAGREE | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | AGREE |
| 20. | I felt confident that any information I sent to my provider using the app would be received. | ☐ | DISAGREE | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | AGREE |
| 21. | I felt comfortable communicating with my healthcare provider using the app. | ☐ | DISAGREE | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | AGREE |

**Figure 3:** MAUQ questionnaires (Adapted from Zhou et al., 2019).

five attributes (Nielsen, 1996): 1. learnability, 2. efficiency, 3. memorability, 4. error rate, and 5. satisfaction. Qualitative interviews ask respondents for more information about their thoughts, while quantitative usability assessment questionnaires administer data from validation studies. The three most commonly used questionnaires in mobile health service utilization are the System Utilization Scale (SUS), Overall Assessment of Utilization Questionnaire (PSSUQ), and Computer Systems Usability Questionnaire (CSUQ) (Hajesmaeel-Gohari et al., 2022). Zhou et al. developed the Mobile Medical Application Usability Questionnaire (MAUQ) by combining the SUS and PSSUQ. The application in this study will refer to the MAUQ questionnaire with the type of interaction and the patient as the target user (see Figure 3) because it interacts with physicians, and the target users are patients and their family members (Zhou et al., 2019).

## RESEARCH METHOD

This investigation seeks to furnish elderly individuals with an application that expedites them to access their recuperation data upon engaging the rehabilitation apparatus. Through a comprehensive usability appraisal, we shall discern the prerequisites of the elders when interacting with the application and refine the interface accordingly. Our objective is to propose an optimally tailored interface design for elderly users to peruse the data effectively. We have divided this segment into three distinct sections: (1) User Requirements Analysis, (2) Interface Design and Development, and (3) Usability Evaluation Experiment Planning and Test Content. Figure 4 below depicts each phase.

### User Requirements Research

The participants in this study comprise 65 to 80 years old elders. Consequently, we interviewed elderly individuals undergoing rehabilitation to discern potential issues related to the user interface and their functional needs in accessing their physiological rehabilitation data. We performed on-site observations of existing rehabilitation environments (refer to Figure 5) and engaged in expert consultations to better understand the current rehabilitation process. The methods therapists employ for record-keeping, patient-therapist interactions, and electronic records' efficacy for patients and healthcare providers. Our findings can be summarized: (1) Rehabilitation physicians tailor rehabilitation plans according to the patient's condition

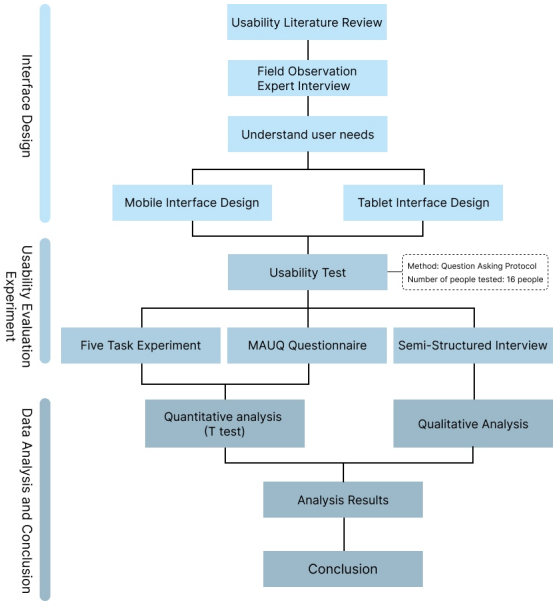



**Figure 4:** Research project flow chart.

**Figure 5:** Current status of the rehabilitation area.

and needs. (2) Paper records are currently maintained alongside the patient. (3) Therapists communicate the scheduled activities and their respective durations to patients before commencing the rehabilitation program, instructing patients to undertake the rehabilitation independently. (4) There is a lack of data that facilitates accurate recording of each movement by therapists, enables patients to access rehabilitation information at their convenience, and mitigates the risks associated with paper loss, rehabilitation oversight, and real-time progress monitoring.

After the expert consultations, we engaged five seniors aged 65 to 80 and convalescing from illness to partake in semi-structured interviews concerning their prevailing visual preferences and functional requisites. The discourse centered around the proclivities, challenges, and necessities associated with the current data visualization interface. The data application furnished to the participants facilitated discerning which interface presentations were effortlessly legible and operable for the elderly demographic.


**Figure 6:** Application wireframe.


**Figure 7:** Application interface design.

## Interface Design

This study aims to develop a web application facilitating real-time access to physiological data on internet-enabled devices. We create a user-friendly interface using responsive web design and adhering to Gandy's seven web design elements. Target devices include tablets and mobile phones, with a functional layout based on Shitkova's typographic specifications. The wireframe (Figure 6) reflects these specifications. From semi-structured interviews, we incorporate user needs and preferences to design the app's features and interface, catering to seniors' operational preferences and functional requirements (Figure 7). The following are the main functions established for this application:

1. Rehabilitation Schedule: Dates, data, and future rehabilitation planning details.
2. Training Intensity: Physician-recommended frequency and resistance levels for various exercises, accompanied by a progress chart depicting exercise frequency and resistance.
3. Achievement Record: Accumulate exercise repetitions to earn badges and rewards, fostering rehabilitation motivation.
4. Physician Communication Portal: In real-time discussions with doctors through a dedicated chat room.
5. Personal Profile: Patient's details and rehabilitation progress.
6. Customer Support: Contact information for assistance with system-related inquiries.

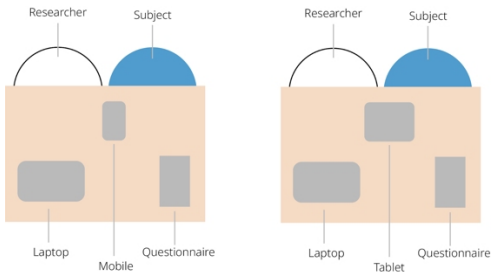



**Figure 8:** Location plan of the experimental site.

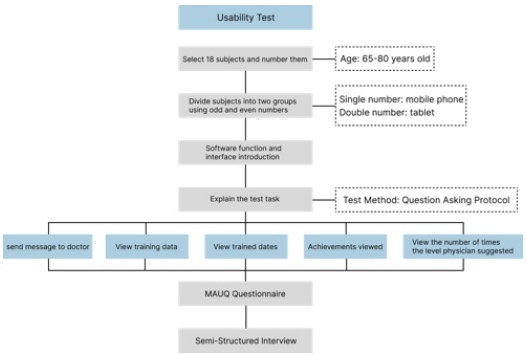



**Figure 9:** Flowchart of rehabilitation data application testing.

## Usability Test

This investigation aimed to assess the usability of an application interface tailored to accommodate the requirements of elderly individuals. We enlisted a cohort of 18 participants, aged between 65 and 80 years, for the study. We divided the experiment into two distinct groups, with one group focusing on tablet interfaces and the other on mobile interfaces. The experimental design was delineated as depicted in Figure 8.

In this investigation, we employed an iPad 6 as the tablet model and an iPhone 8 Plus as the experimental apparatus, documenting the participants' duration, error rate, and touch error rate. The participants were instructed to accomplish five predetermined tasks, as demonstrated in the operational illustration (refer to Figure 9): 1. transmitting a message to the physician, 2. examining the cumulative training time on a specific date, 3. verifying the training date, 4. determining the number of requisite achievements, and 5. ascertaining the number of recommendations provided by the doctor for a particular level. We administered the MAUQ questionnaire upon task completion.

This study employed the interactive, patient-targeted user version of the Mobile Medical Application Usability Questionnaire (MAUQ) proposed by Zhou et al. in 2019. A seven-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree), assessed the significance of usability.

**Table 1.** MAUQ interaction, patient version questionnaire questions.

| |
|---|
| Q1. This application is easy to use |
| Q2. It is easy for me to learn to use this application |
| Q3. I like the interface of the application |
| Q4. The information provided in the app is well organized so that I can easily find the information I need |
| Q5. I can use the app comfortably in public places |
| Q6. It does not take me too much time to use the app |
| Q7. I would use this app again |
| Q8. I am satisfied with the app as a whole |
| Q9. Whenever I make a mistake with this app, I can fix it easily and quickly |
| Q10. The way the app provides health care services is easy for me to accept |
| Q11. The app gives enough feedback and information to let me know where I am in my steps |
| Q12. Web site browsing is consistent when I slide the screen |
| Q13. The application's interface allows me to use all the functions it provides (e.g., entering messages, viewing information) |
| Q14. The application has the functionality and processing power I expect |
| Q15. The app is useful for my health and well-being |
| Q16. The app improves my access to medical services |
| Q17. The app helps me to help manage my health more effectively |
| Q18. The app makes it easier for me to communicate with health care professionals |
| Q19. I have more opportunities to communicate with health care professionals by using this app |
| Q20. I believe that health care professionals receive any messages I send using the app |
| Q21. I feel comfortable using this app to communicate with health care professionals |

We computed the score as the mean value of each inquiry, and a higher mean value approaching 7 indicated superior usability. To facilitate the usability evaluation, screen, and audio recordings were utilized throughout the experiment, enabling observation of the subjects' interface interactions.

## RESULT

The quantitative investigation of this study encompassed task completion duration, task completion error frequency, contact error prevalence, and the MAUQ scale rating. We scrutinized qualitative information through semi-structured questionnaires and observational records. Data analysis will be executed utilizing SPSS software. Independent sample t-tests will be employed to ascertain whether disparate factors considerably influence task performance for distinct cohorts of elderly individuals. The significance threshold was established at 5% ($p<0.05$).

### Usability Test Results

A cohort of 18 participants, 13 females and 5 males, was enlisted for this investigation to evaluate the usability of the Web App devised for documenting rehabilitation data. The subjects' ages spanned from 65 to 80 years, with

| Test Procedure (Tablet) | Number of people completed(No.) | Completion rate (%) | Average time to complete (sec) | Misclick Rate (%) |
|---|---|---|---|---|
| Task 1: Send a message to the doctor. | 6 | 66.7% | 36.6 | 17% |
| Task 2: View training data. | 8 | 88.9% | 35.9 | 25% |
| Task 3: View the trained date. | 9 | 100% | 12.8 | 27% |
| Task 4: How many times to check the achievements. | 9 | 100% | 4 | 20% |
| Task 5: View the number of doctor recommendations for a specific level | 8 | 88.9% | 29 | 31% |

**Figure 10:** Tablet five task test results.

| Test Procedure (Mobile) | Number of people completed(No.) | Completion rate (%) | Average time to complete (sec) | Misclick Rate (%) |
|---|---|---|---|---|
| Task 1: Send a message to the doctor. | 8 | 88.9% | 37.7 | 5.5% |
| Task 2: View training data. | 4 | 44.4% | 44.2 | 25% |
| Task 3: View the trained date. | 9 | 100% | 23.1 | 22% |
| Task 4: How many times to check the achievements. | 8 | 88.9% | 10.7 | 5% |
| Task 5: View the number of doctor recommendations for a specific level | 7 | 77.8% | 36.2 | 7% |

**Figure 11:** Mobile five task test results.

a mean age of 71.8 years. The average educational attainment amounted to 10 years (SD = 3.55).

We collated the indicators documented during the usability assessment (refer to Figures 10 and 11) and examined the completion of the five predetermined tasks. For Task 1, the data reveals that 6 out of 9 participants accomplished the task via the anticipated trajectory. Among tablet users, 66.7% completed the task, averaging 36.6 seconds, with a 17% error rate; conversely, 88.9% of smartphone users achieved completion, averaging 37.7 seconds and a 5.5% error rate (see Figure 12). The heat map depicting user interactions and interface pathways highlights the sequence and locations of clicks during the operational process.

We employed a consistent methodology to examine the quintet of user tasks, concentrating on those exhibiting diminished completion rates, elevated error frequencies, and lengthy completion durations. Interviews were conducted to ascertain the underlying causes and optimize and ameliorate these aspects functionally. The following illustration presents the click heat map delineating the interface trajectory for the quartet of tasks (refer to Figure 13).

In conclusion, most users could proficiently and seamlessly execute the five designated tasks by adhering to the anticipated trajectory. Nevertheless, specific interfaces necessitate an expanded click area, resulting in a heightened


**Figure 12:** "Task 1" interface path click on the heat map.


**Figure 13:** Another four task interface paths click on the heat map.

frequency of erroneous clicks. After the usability evaluation, the web application interface tailored for the elders exhibited minor shortcomings, including diminutive font size impeding legibility and occasionally undersized buttons compromising precise clicking. Concurrently, the interviewees extolled the application's friendly and considerate approach to digitizing rehabilitation data and its subtle and pragmatic interface design.

## MAUQ Questionnaire Results

Upon completing the usability evaluation, participants were given the MAUQ questionnaire, assessing usability in user-friendliness, information organization, and system utility. The custom-designed interface achieved an average score of 5.20 per question, reflecting good usability for elderly users. All of the elderly respondents agreed that the application improved healthcare accessibility enabled effortless communication with medical staff, and supported users in managing their well-being.

Within the MAUQ questionnaire, the average score for the ease of use and satisfaction segment amounted to 41.66. At the same time, the system information arrangement yielded a mean score of 31.05, and the system

**Group Statistics**

| | Q4Education | N | Mean | Std.Deviation | Std.Error Mean |
|---|---|---|---|---|---|
| Total | Below junior high school | 10 | 182.90 | 31.876 | 10.080 |
| | Junior high school or above | 8 | 168.75 | 25.252 | 8.928 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 95% Confidence Interval of the Difference | |
| | | F | Sig. | t | df | Sig.(2-tailed) | Mean Difference | Std.Error Difference | Lower | Upper |
| Total | Equal variances assumed | .562 | .464 | 1.023 | 16 | .322 | 14.150 | 13.834 | -15.176 | 43.476 |
| | Equal variances not assumed | | | 1.051 | 16 | .309 | 14.150 | 13.645 | -14.395 | 42.695 |

**Figure 14:** Independent sample t-tests for the results of MAUQ.

**Group Statistics**

| | Q4Education | N | Mean | Std.Deviation | Std.Error Mean |
|---|---|---|---|---|---|
| Total | Below junior high school | 10 | 42.80 | 10.130 | 3.203 |
| | Junior high school or above | 8 | 40.25 | 5.523 | 1.953 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 95% Confidence Interval of the Difference | |
| | | F | Sig. | t | df | Sig.(2-tailed) | Mean Difference | Std.Error Difference | Lower | Upper |
| Total | Equal variances assumed | 4.676 | .046 | .638 | 16 | .533 | 2.550 | 3.999 | -5.927 | 11.027 |
| | Equal variances not assumed | | | .680 | 14.378 | .507 | 2.550 | 3.752 | -5.477 | 10.577 |

**Figure 15:** Independent sample t-tests for the ease of use and satisfaction score of MAUQ.

usefulness segment scored a mean of 36.5. Additionally, this investigation explored the potential influence of educational background on the tested interface. As a result, we classified the participants into two groups based on their educational attainment, specifically their completion of junior high school. Independent sample t-tests scrutinized the scores across various sections to discern whether significant discrepancies existed in task completion time relative to education level (refer to Figure 14).

The outcomes of the t-test analysis of the cumulative MAUQ scores revealed a significance exceeding 0.05 at 0.464, indicating no discernible distinction in the total MAUQ scores among respondents based on their educational backgrounds (refer to Figure 15). Nevertheless, when evaluating the three dimensions of the MAUQ scores individually through t-tests, no substantial disparities emerged regarding system information organization and utility. However, the significance in ease of use and satisfaction registered at 0.046, suggesting a variation among participants with diverse educational levels. We construe this finding to imply that respondents with higher levels of education possess a more comprehensive understanding of the application's usage. Furthermore, we deduce that more educated individuals grasp the application's content and find it relatively effortless to acquire proficiency in its utilization (see Figure 15).

## CONCLUSION

In this study, we designed a data interface for elders and assessed the outcomes for usability. The MAUQ questionnaire explored facets of user

experience during the engagement. Field observations and expert dialogues identified user needs. Responsive Web Design was employed in creating the web application. We conducted a usability test and evaluated the questionnaire results using qualitative and quantitative approaches. We conducted independent sample t-tests to determine if factors influenced the operation of the software by elder cohorts.

The findings will refine the interface design and serve as a benchmark for subsequent application development for the elders. The Web APP interface, designed by the Institute, may integrate into rehabilitation training processes, enabling elders to comprehend their conditions and augment motivation for rehabilitation. We aim to mitigate elders' challenges by adopting new technology, streamlining the rehabilitation process, and making it data-driven and visually intuitive.

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