Together Application-Health Diary App for Caregivers of Alzheimer's Patients

Eng.Nada Hamad Alqarameen
The University of Sheffield, United Kingdom.

ABSTRACT

Alzheimer's patients are experiencing a continuous increase around the world, highlighting the challenge of ensuring consistent quality of care for all patients. This project is studying the daily care needs of Alzheimer's patients and medical care providers. It aims to address this challenge by creating a mobile application to follow up on the daily health developments of Alzheimer's patients and record them through care providers. The care aims of this project is to highlight the development of a mobile app, which based on scientific and medical sources, aims to help Alzheimer's disease care providers to render their services in a modern, easy, and effective way. This app is also designed to help save time, money, and effort. As a result, this project has several specific objectives it seeks to achieve including the design, facilitation of use, quality improvement, and support services for care providers and doctors.

1. Introduction

More than 50 million people are affected by progressive neurocognitive disorders such as Alzheimer's disease and related dementias (AD/RD). This number is particularly significant as projections indicate that it could surge to 152 million by 2050 [1]. AD/RD patients face numerous challenges affecting their social, emotional, physical, and cognitive well-being [1]. Many AD/RD patients develop behavioral and psychological symptoms of dementia (BPSD), including aggression, agitation, wandering, and hallucinations, which are considered significantly challenging [2]. Additionally, a considerable portion of AD/RD patients are elderly adults, exacerbating the vulnerability of this group, particularly when they also experience other aging-related health issues.

The prevalence data of AD/RD and its impact on patients, caregivers, and their families highlight the crucial need for developing effective, dynamic, and efficient care approaches [3]. Providing care to AD/RD patients is complex and often leads to compromised health, depression, and burden for caregivers who offer daily support and care. The caregiving burden faced by caregivers is positively correlated with the level of dependence of RD patients [4]. Therefore, a well-designed self-care support mechanism that addresses the core needs of care recipients can significantly reduce caregivers' burden. Interventions or innovations aimed at promoting self-care among AD/RD patients can play a pivotal role in reducing caregivers' burden levels while enhancing their health and well-being [5].

New technologies nand innovations in the Information Technology (IT) sector have sought to disrupt the care provision processes and bolster the healthcare industry. IT inventions have helped shape data collection, analytics, and interpretation to improve care provision and patient outcomes [6]. Technology has also sought to re-shape care provision among AD/RD patients through the development of targeted and customised mobile applications (apps) designed to help patients, caregivers, and their families in improving self-care among AD/RD patients, reducing the caregiving burden, and enhancing the quality of the relationship between the patients with their family members and caregivers [7].

Apps running on mobile phone technology have increasingly become ubiquitous globally. Contemporary mobile phone-based health apps are re-shaping the healthcare industry. For example, these apps are transforming the ways how patients access care, interact with caregivers, and thus promote improved health outcomes [8]. These apps are occupying a crucial position in the reform process of healthcare delivery systems. Data collected from the healthcare sector demonstrates that an increase in mobile app usage can lead to massive improvements in health outcomes and care quality and thus reduce disparity and inequity in access to high-quality healthcare services [9]. The development of a mobile application specifically targeting AD patients is a promising approach for addressing the inherent challenges facing this cohort in accessing high-quality care, improving self-care and patient autonomy, reducing the care burden on caregivers, and facilitating better relations with patient families. As a result, such an app is likely to be a valuable healthcare resource [10]. Acceptability and usability of apps is crucial to AD patients. Previously conducted studies establish that healthcare-targeted technology for elderly patients should focus on the personalisation of the design and address the poor readability problem encountered in using technology [11]. With the proliferation of health apps in the industry, there is a need to focus on effectiveness, efficiency, acceptability, applicability, and ease-of-use, especially among AD patients. This project

aims to address these crucial aspects by examining the development of a mobile application used in the daily care provision to AD patients.

1.1 Aims and Objectives

The care aims of this project is to design and develop a mobile app, which, based on scientific and medical sources, aims to help Alzheimer's disease care providers to render their services in a modern, easy, and effective way; this app is also designed to help save time, money, and effort.

As a result, this project has several specific objectives it seeks to achieve including the design, facilitation of use, quality improvement, and support services for care providers and doctors. The specific objectives of the project include:

(1) Designing a low-cost and easy-to-use application to address of all day-to-day needs and quality of life aspects of Alzheimer's disease patients.

(2) Facilitating the role of care providers and eliminating disparities in the level and quality of care provided to Alzheimer's disease patients.

(3) Improving the quality, dignity, and cost-effectiveness of care provision to Alzheimer's disease patients.

(4) Enhancing doctors' abilities to analyse, follow-up on, and monitor Alzheimer's disease patients in real time.

1.2 Organization

The remainder of this paper is divided into five sections. Section 2 comprises the literature review, which critically examines previously conducted studies focusing on the development of mobile app and care provision for AD patients. Section 3 presents the proposed mobile application, highlighting the requirements and analysis of app development, the design process, and implementation. Section 4 shows the results. Section 5 provides a concise conclusion and outlines future work.

2. Literature Review

This section presents existing use of mobile applications as the core technologies in the daily care provision to Alzheimer's disease patients. It also seeks to explore different technologies (applications) employed in mental healthcare provision, their potency, and specifically examine the technology-driven methods used in caring for Alzheimer's disease patients. This topic is important because of the prevailing proliferation of technology in the market and the current drive to speed up technological integration in the overall healthcare sector and specifically in mental healthcare provision.

According to Gupta et al. [12], mobile applications are used in daily care for Alzheimer's disease patients by assisting them in carrying out routine activities through timely notifications. These applications also facilitate daily care provision by allowing family members to retrieve the GPS locations of the patient using Geo-tagging. Additionally, the mobile application provides photographs to help patients remember their family members, while music is employed to stimulate positive moods.

Imtiaz et al. [13] proposed a mobile multimedia solution designed to develop reminiscence and music therapies to prevent the occurrence of behavioural and psychological symptoms of dementia among Alzheimer's disease patients. The mobile applications were employed on a daily basis to address Alzheimer's disease problems, such as irritability, agitation, and apathy by adopting both music and reminiscence therapies.

Maynard et al. [14] designed a CARE-Well (Care Assessment, Resources, and Education) mobile application for Alzheimer's disease patients. The application comprised of six sections that shaped the day-to-day use of the technology; these include self-assessment of stress and care recipient behaviour problems, goal diary, psycho-education, online message forum, managing behaviour problems, and video library. This mobile application provided information and interaction to manage the behaviour and conduct of Alzheimer's disease patients. It also allowed for psycho-education, online messaging and networking, and direct interaction with caregivers.

Chávez et al. [15] designed a mobile application called Alzheed, which was mainly used to monitor individuals with Alzheimer's disease. This application was established to be remote, mobile and wearable. This way, it collected patient data and sent it to caregivers in real time. Alzheed collected information like behavioural data (wandering, aggression, drowsiness, and apathy), performance in physical and cognitive therapies, clinical and health related data, and attitudes and crises (like delusions, anger, anxiety, and mood swings).

Werner et al. [16] primarily targeted caregivers, providing continuous data entry, an interactive approach to addressing emerging challenges, an easy-to-use interface, and a direct link to Alzheimer's disease patients and their families. This study employed the Mobile App Rating Scale (MARS) framework to evaluate 23 applications across 5 dimensions (functionality, engagement, aesthetics, subjective quality, and information). The research also employed computed descriptive statistics. The findings indicate that recent years have experienced a surge in the development of mobile applications designed to address symptoms and challenges facing ADRD patients.

Sindi et al. [17] utilized the CAIDE (Cardiovascular Risk Factors, Aging, and Incidents of Dementia) dementia risk score to explore the role of technology in mitigating dementia risk among Alzheimer's disease patients. The findings suggest that the adoption of technologies improved data collection and provided actionable information, thereby facilitating care provision and response time, and ultimately enhancing the role of caregivers.

3. Proposed Mobile Application

This section will delve into the requirements and analysis of our proposed mobile application, including its technology stack and tools. We will also discuss the design and implementation process in detail.

3.1 Requirement and Analysis

The form list comprises the purpose and function driving this project (Table 1). This list is portrayed in the form of the levels of priority of the core requirements.

As illustrated in Figure 1, the system begins with the splash screen, which allows the users to either log in or create a new account. When creating a new account, the requirements include a phone number and user's name to enable the unique identification for each user. Once these requirements are provided, clicking on the "enter" button triggers the need for a verification code, which is sent to the user via the provided phone number; the code is used to confirm the identity of the individual signing up. A successful verification process means that the user is given the opportunity to log into the app, with the preferred recognition feature (either a fingerprint or facial identification) employed.

The login process is simple and involves the user entering the phone number or user name and varying their identity via a short message sent to their phones. Alternatively, the verification process can also be carried out through facial or fingerprint methods.

The next step in this process is the appearance of the app's user interface, which allows for the navigation of the app to different icons and the exploration and utilisation of different functionalities targeted at the patient or the healthcare staff. In this case, the user is allowed to choose the date of the day on which he/she will follow up with the patient. Subsequently, all the services offered by the app are displayed; these include activities, daily routine, mental and physical status, medication, reports, inquiries and communication; these are examined below.

Medication Section – This section allows the display of different medicines approved by the healthcare industry (companies approved to operate in the industry) in Britain and America. Some of these organisations include the National Institute of Health (NIH) [18], Mayo Clinic [19], Stanford Healthcare [20], Alzheimer's Association [21], and Drugs.com [22]. This section provides different options of drugs to address various aspects affecting AD patients. For example, various drugs are recommended for addressing various physical and psychological changes to a patient; some of these shifts are potentially dangerous to the healthcare staff, the patient, or their family members. Therefore, this application displays the 10 approved and most widely used drugs for AD patients; these include Aducanumab (Aduhelm), Citalopram (elexa), Fluoxetine (Prozac), Sertaline (Zoloft), Alprazolam (Niravam, Xanax), Buspirone (Buspar), Lorazepam (Ativan), Oxazepam (Serax), Namenda, and Aricept. The medicines section also allows the user of the app to specify how the patient took the drug; this highlights whether the patient took the medicine individually or with the help of another person, a family member, or a medical care provider. The icon also allows for the recording of the name of the individual involved in aiding the patient to take their medication.

Activities – This icon comprises activities recommended for AD patients, which are proposed by organisations, such as the National Health Service (NHS) [23], Alzheimer's Association [24], and Alzheimer's Society [25]. Some of the commonly recommended activities include watching TV, walking, socialisation (including visits of family and friends or using telephones), reading, shopping, and playing with pets and grandchildren. Other activities recommended to AD patients include physical exercises (yoga and gym), playing music, arts and crafts, playing mind games, and taking part in spiritual activities. The icon also offers the possibility of recording more daily activities executed by AD patients and determining whether they completed these measures alone or with the help of a medical assistant, and noting the name of the individual involved.

Daily Routine – This icon allows users to note what a patient does during his/her day. All the 13 routines highlighted in this icon's list have been proposed by organisations like the Alzheimer's Association [26], Where You Live Matters [27] and Alzheimers.net [28]. Some of these routines include eating, using the toilet, bathing, getting dressed, preparing food and drinks, driving, and house works. Other recommended routines include personal care (wash, teeth brushing, hand and fingernails, combing), keeping

appointments, tracking medications, using technology (banking by internet, computer, applications), and cooking. With this icon, the user can either choose from the provided list or add a new routine (not on the list) performed by a patient; they have to note whether the patient completed the routine individually or with help, and, thus, record the name of the person involved in helping the AD patient.

Mental and Physical Status – This icon allows the user to record the mental and physical symptoms and condition of the patient. This enables real-time monitoring of the patient's wellbeing and the impact of any interventions.

Reports – This icon enables the issuance of graphical or written reports regarding all the records of a patient during a specific period (year, month, or day). These reports are crucial in monitoring the progression of the patient's health and response to interventions.

Inquiries and Communication–Communication with patients, family members, and healthcare personnel is crucial. This icon encourages users to communicate with patients, their family members, or other patients and pose inquiries or share new beneficial things (activities, drugs, or routines).

3.2 Technologies and Tools

The development process for the Android app in this project leveraged different tools and technologies based on their suitability to meet the overarching objectives. Some of these technologies and tools that were employed include the following:

● Android platform – this is mainly a development tool.

● Java – this is the main programming language employed in this project. Android studio support for development was also used.

● Firebase – this is software designed for application development and is backed by Google. The platform allows developers to design web IOS and Android applications. Apart from these tools and technologies, the alteration and adjustments were made based on the required update of the application.

3.3 Design

This section leverages the emulator tool in the Android Studio program to explain user interfaces in the developed mobile app; in this case, this review highlights the features the user can encounter when utilising the application for the first time. As shown in Figure 2, the application icon on the mobile. In designing the application's main interface, we opted for an image and emotional and encouraging phrase to welcome the user to the app as shown in Figure 3. This was designed to be interesting to attract users to the app.

As shown in Figure 4, pressing the 'Start' button allows the user to navigate two icons: the user account creation and the login buttons. This page appears as a condition for the user to access the app while retaining their privacy.

To create an account with the app, there are various requirements the user needs to meet before they can complete the process, as illustrated in Figure 5. Firstly, the age of the beneficiary needs to be registered. After this initial request, the user needs to enter the user name, e-mail, and password, which should contain 6 characters or more.

Selecting the daily patient information registration service, the app will move the interface to choose a date for the provision of care to the patient and record the development and progression of his/her health condition. Subsequently, the app moves the user to another interface where they can choose the type of care services they want to

follow up on or record, depending on a specific patient's condition and the care process adopted, as illustrated in Figure 6.

The mobile app also offers the medicines page, which highlights the record(s) of medicines that the patient has taken on a specific day, as illustrated in Figure 8. The recording is carried out by choosing from the approved list of medicines. Varying types of medicines on offer are influenced by the specific conditions of the patients. The app also allows the user to record whether the patient took the medicine without help (independently) or with the aid of a caregiver or family member. In cases where the patient was helped, the aid's name is recorded.

Up next on the app's interfaces is the Daily Routine Registration Page, as shown in Figure 8. This page presents the day-to-day habits that a normal individual performs, which allows for follow-ups on Alzheimer's disease patients and information on whether they have done any of the listed activities. These habits are recorded by the selection, and the app seeks to determine whether the patient has carried them out independently or with the assistance of a caregiver.

The Activities page, as shown in Figure 9, enables the user to record any activity executed by the Alzheimer's disease patient, and it can also reflect whether he/she (the patient) completed these activities independently with assistance.

The "Mental and Physical Status" page on the mobile app is crucial because it allows the recording of day-to-day changes in the patient while noting the time and manner of their occurrence, as shown in Figure 10. This page also establishes whether these observations were made by the patient or the caregiver. Overall, this page is essential to healthcare providers and doctors because it offers a robust trace of the psychological and physical development of Alzheimer's disease patients.

The report selection page in the Together application offers three options for the user: daily, monthly, and yearly, as shown in Figure 11.

4. Results

This project's core outcome (result) is a mobile application designed to execute daily medical follow-ups and offer services to medical care providers for Alzheimer's disease patients. The focus of this app is to improve the quality of care and life among Alzheimer's disease patients. However, it also focuses on facilitating the core services provided by caregivers. The Together app was developed utilising Android and has been examined through manual and unit testing techniques followed by integration testing on an Android device and emulator. Subsequently, the app was launched for operation on an Android device to allow for further exploration, trouble-shooting, and feedback offering suggestions for further improvement and development.

The design of Together app focused on 15 requirements classified as both desirable and mandatory. Table 2 illustrates the core functional requirements achieved while also highlighting those that have not been achieved. In this case, all 11 mandatory requirements have been achieved. However, among optional requirements, none have been fulfilled in this app, as highlighted in Table 2. This dynamic was mainly because the mobile number was replaced during the process of creating a new account using an e-mail address, which was a part of the government's implementation procedures.

Therefore, the remaining optional requirements are undergoing implementation and development steps.

Unit testing allows a programmer to examine the components and units of an application to establish whether they are working as designed. This testing provides the first stage of evaluating software projects. Unit testing is an important part of the app development process, whether it is on the iOS or Android operating system. This approach allows programmers to find bugs and debug in the process at an early stage, which can save them time and finances. This project applied unit testing through three steps: LogInTesting, SignUpTesting and User Select Screen Testing.

LogInTesting

This step comprised four Testcases for the login, as shown in Table 3. This step was carried out to examine whether users enter their e-mail addresses and name when logging in.

SignUpTesting

This step included eight Testcases of the signup process, as shown in Table 3; it was carried out to examine whether users entered their e-mail address, name, and password that comprised six or more characters.

Integration and UI Testing

This section will primarily focus on testing groups of units together to detect any bugs between them. The emulator has been used for this testing. We tested the optional interface for users who forget their passwords, providing them with the option to reset them. Additionally, it reveals a warning that users receive when the email they enter is not found in the database (indicating a new or inaccurate email). The user can then proceed to reset the password.

5. Conclusion

The proposed mobile application has successfully achieved its objectives, which aimed to support the medical care and follow-up of Alzheimer's disease patients. During manual and unit testing, the application demonstrated its capability to meet project requirements, particularly in terms of being a low-cost and user-friendly platform. Our application contributes significantly to improving the quality of care and life for Alzheimer's patients. Additionally, the application's successful implementation and meeting of all mandatory specifications highlight its reliability and effectiveness. Its robust security features, including user account creation and login, ensure data protection and confidentiality, thereby reinforcing trust and cost-effectiveness in patient care. Moreover, the app can help medical experts to analyze and monitor patients in real-time, facilitating follow-ups and providing valuable insights for better care management.

Further research should be done on the topic in relation to advancing the operations of the developed application. Besides the need to evaluate the ways of adding the functionalities that were not successfully implemented, there is a requirement to improve the efficiency and effectiveness of application in the future operations. Some of the interesting elements are the improvement of communication and inquiries option to enable good productive interactivity for Alzheimer's patients with their caregivers.

Table 1.Functional Requirements

ID	Functional Requirement	Priority level
1	The Android application should focus on establishing daily follow-ups for medical care providers for Alzheimer's disease (AD) patients.	Mandatory
2	Different interfaces to optimise direct use by medical providers and physicians addressing medical conditions should be available.	Mandatory
3	Develop an easy to use interface comprising a platform to create new account and log in.	
5	Facial or fingerprint recognition should be alternatives to the logging-in process for patients and medical care providers.	Desirable
6	The date to be followed should remain my prerogative.	
7	The app's interface should display the user's name, the date of the day on which specific records/notes were taken, and the list of services provided to the app user.	Mandatory
8	A "Medications" icon / section should be available. Comprising a record of medicines that the patient has taken that day, a note of whether the patient took the medication individually or with the assistance of a family member, and medical care staff (as well as the name of the assistant).	Mandatory
9	A "Daily Routine" icon in the app is important. It contains a recording of the routine activities the patient carries out. The icon can also record whether the patient executes these activities individually or with the help of an assistant. New routines can be added to the icon with the help of a healthcare assistant.	Mandatory
10	An "Activities" icon should be developed and can comprise activities (scientific and medical ones) designed to be carried out by AD patients. The icon provides a platform to record the patients' execution of targeted activities. It also establishes whether patients do these activities individually, the medical assistants involved, and the names of individuals participating in this process.	Mandatory
11	A "Mental and Physical Status" icon on the app is important. The tab allows recording of different known physical and mental shifts in an AD patient. This icon also allows the possibility of specifying the occurrence of these changes and whether they were flagged by patients, a medical assistant, or any other individual. The involved individual's name can be noted.	Mandatory
12	A "Reports" icon is useful on the app by enabling the user to develop daily, monthly, or annual reports highlighting all the patient records during the chosen period.	Mandatory
13	Users or beneficiaries should have the option of reading data in a graphical form and they should be afforded artificial intelligence platforms to predict the developments or projections of the patient's status.	Desirable
14	It was crucial to develop an icon called "Inquiries and Communication" designed to enable users to directly and immediately message patients, medical assistants, or other users to get answers regarding specific issues with their health or share activities or positive news.	Desirable
15	The user can log out of the application.	

Table 2. LoginTesting Cases and Results

Testcase	Result
Username=valid, Password =valid	Passed
Username=null, Password =null	Passed
Username=valid, Password =null	Passed
Username=null, Password =valid	Passed

Table 3. SignupTesting Cases and Results

| Testcase	Result
Username=valid Email=valid Password =valid	Passed
Username=null Email=null Password =null	Passed
Username=null Email=valid Password =valid	Passed
Username=valid Email=null Password =valid	Passed
Username=valid Email=valid Password =null	Passed
Username=valid Email=null Password =null	Passed
Username=null Email=valid Password =null	Passed
Username=null Email=null Password =valid	Passed
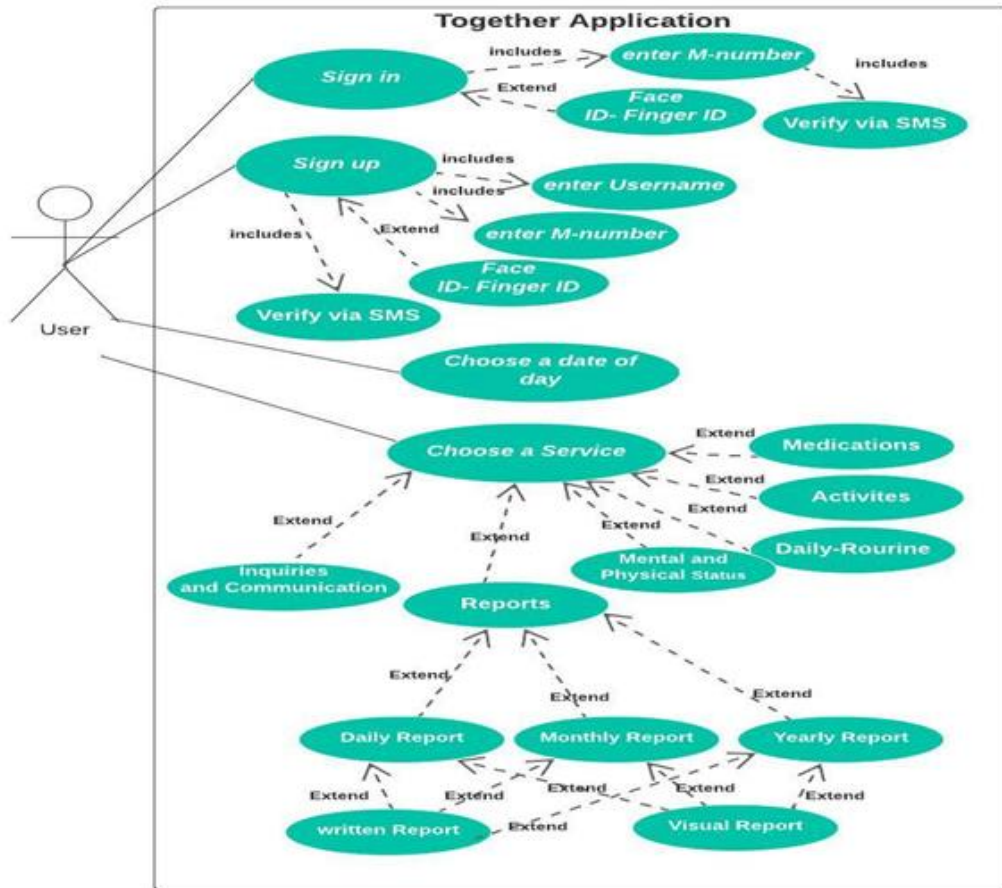
Figure 1. System's Use Case
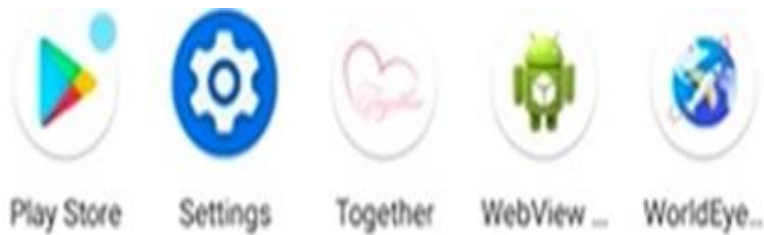
Figure 2. A Picture of the Application Icon through an Android Phone.

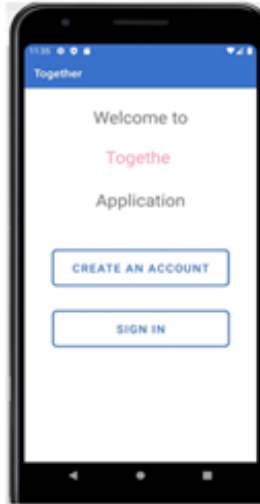**Figure 3. The Main User Interface When Opening the Application**
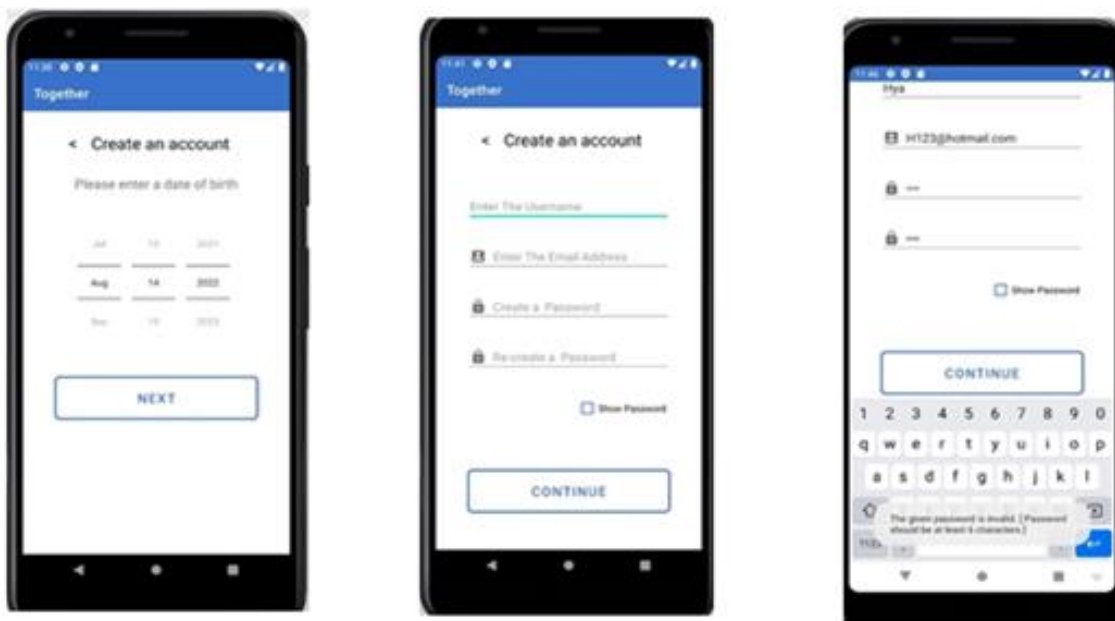
Figure 4. Create a New Account or Login Page

Figure 5.Application Sign-up Page

Figure 6. Interface for Choosing Types of Registered Care
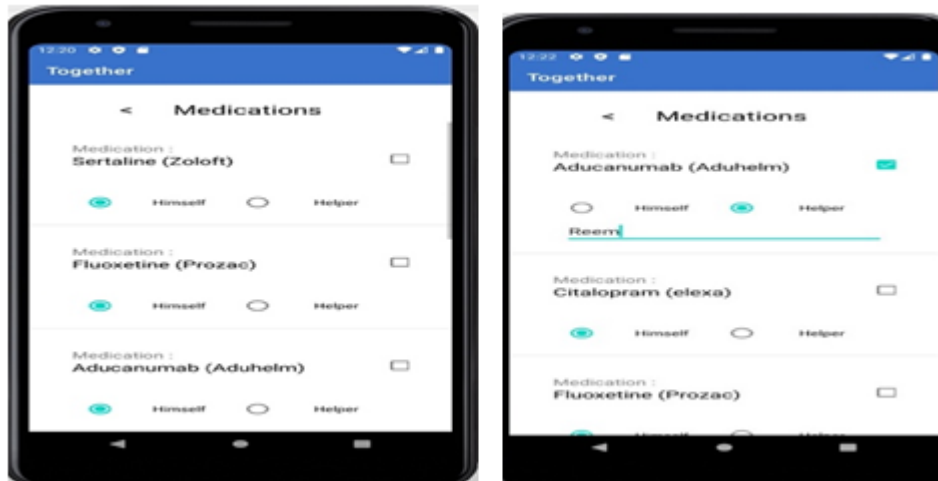
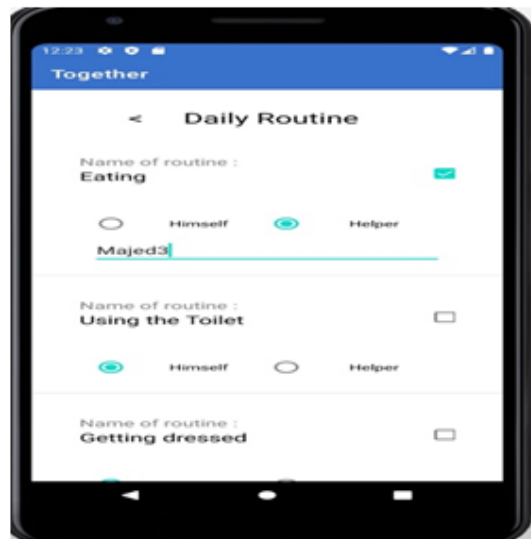**Figure 7. Medications Registration Page**

Figure 8. Daily Routine Registration Page

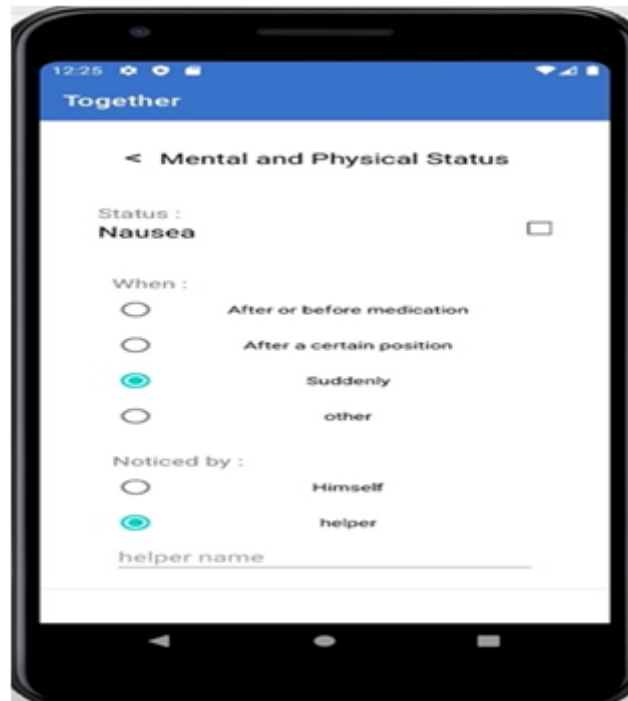**Figure 9. Activities Registration Page**

Figure 10. Mental and Physical Registration Page

Figure 11. Report Type Selection Page

References

[1]Guo, Y., Yang, F., Hu, F., Li, W., Ruggiano, N. and Lee, H.Y., 2020. Existing mobile phone apps for self-care management of people with Alzheimer disease and related dementias: systematic analysis. JMIR aging, 3(1), p.e15290.

[2]Werner, N.E., Brown, J.C., Loganathar, P. and Holden, R.J., 2022. Quality of Mobile Apps for Care Partners of People With Alzheimer Disease and Related Dementias: Mobile App Rating Scale Evaluation. JMIR mHealth and uHealth, 10(3), p.e33863.

[3]Ruggiano, N., Brown, E.L., Roberts, L., Suarez, C.V.F., Luo, Y., Hao, Z. and Hristidis, V., 2021. Chatbots to support people with dementia and their caregivers: systematic review of functions and quality. Journal of Medical Internet Research, 23(6), p.e25006.

[4]Choi, S.K., Yelton, B., Ezeanya, V.K., Kannaley, K. and Friedman, D.B., 2020. Review of the content and quality of mobile applications about Alzheimer's disease and related dementias. Journal of Applied Gerontology, 39(6), pp.601-608.

[5]Engelsma, T., Jaspers, M.W. and Peute, L.W., 2021. Considerate mHealth design for older adults with Alzheimer's disease and related dementias (ADRD): A scoping review on usability barriers and design suggestions. International Journal of Medical Informatics, 152, p.104494.

[6]Wozney, L., de Souza, L.M.F., Kervin, E., Queluz, F., McGrath, P.J. and Keefe, J., 2018. Commercially available mobile apps for caregivers of people with Alzheimer disease or other related dementias: systematic search. JMIR aging, 1(2), p.e12274.

[7]Martínez-Alcalá, C.I., Pliego-Pastrana, P., Rosales-Lagarde, A., Lopez-Noguerola, J.S. and Molina-Trinidad, E.M., 2016. Information and communication technologies in the care of the elderly: systematic review of applications aimed at patients with dementia and caregivers. JMIR rehabilitation and assistive technologies, 3(1), p.e5226.

[8]Zanwar, P., Heyn, P.C., McGrew, G. and Raji, M., 2018, October. Assistive technology megatrends to support persons with alzheimer's disease and related dementias age in habitat: challenges for usability, engineering and public policy. In Proceedings of the Workshop on Human-Habitat for Health (H3): Human-Habitat Multimodal Interaction for Promoting Health and Well-Being in the Internet of Things Era (pp. 1-9).

[9]Iribarren, S., Stonbraker, S., Suero-Tejeda, N., Granja, M., Luchsinger, J.A., Mittelman, M., Bakken, S. and Lucero, R., 2019. Information, communication, and online tool needs of Hispanic family caregivers of individuals with Alzheimer's disease and related dementias. Informatics for Health and Social Care, 44(2), pp.115-134.

[10]Boutilier, J.J., Loganathar, P., Linden, A., Scheer, E., Noejovich, S., Elliott, C., Zuraw, M. and Werner, N.E., 2022. A Web-Based Platform (CareVirtue) to Support Caregivers of People Living With Alzheimer Disease and Related Dementias: Mixed Methods Feasibility Study. JMIR aging, 5(3), p.e36975.

[11]Neal, D., van den Berg, F., Planting, C., Ettema, T., Dijkstra, K., Finnema, E. and Dröes, R.M., 2021. Can use of digital technologies by people with dementia improve self-management and social participation? A systematic review of effect studies. Journal of clinical medicine, 10(4), p.604.

[12]Gupta, G., Gupta, A., Jaiswal, V. and Ansari, M.D., 2018, December. A review and analysis of mobile health applications for Alzheimer's patients and caregivers. In 2018 Fifth International Conference on Parallel, Distributed and Grid Computing (PDGC) (pp. 171-175). IEEE.

[13]Imtiaz, D., Khan, A. and Seelye, A., 2018. A mobile multimedia reminiscence therapy application to reduce behavioral and psychological symptoms in persons with Alzheimer's. Journal of healthcare engineering, 2018.

[14]Maynard, T.R., Chapman, K.R., Sadhu, S., Frink, T., Mankodiya, K., Davis, J.D., Uebelacker, L., Ott, B.R. and Tremont, G., 2021. Beta test of a mobile health application for dementia caregivers. Alzheimer's & Dementia, 17, p. e056312.

[15]Chávez, A., Borrego, G., Gutierrez-Garcia, J.O. and Rodríguez, L.F., 2019. Design and evaluation of a mobile application for monitoring patients with Alzheimer's disease: A day center case study. International journal of medical informatics, 131, p. 103972.

[16]Werner, N.E., Campbell, N.L., Boustani, M., Ganci, A. and Holden, R.J., 2022. Helping the Helpers–A research protocol for user-centred technology to aid caregiver management of medications for people with Alzheimer's disease and related dementias. Research in Social and Administrative Pharmacy.

[17]Sindi, S., Calov, E., Fokkens, J., Ngandu, T., Soininen, H., Tuomilehto, J. and Kivipelto, M., 2015. The CAIDE dementia risk score app: the development of an evidence-based mobile application to predict the risk of dementia. Alzheimer's & Dementia: Diagnosis, Assessment & Disease Monitoring, 1(3), pp. 328-333.

[18]National Institute on Aging (NIA). (n.d.). How Alzheimer's Disease Is Treated. Retrieved from https://www.nia.nih.gov/health/how-alzheimers-disease-treated.

[19]Mayo Clinic. (n.d.). Alzheimer's Disease. Retrieved from https://www.mayoclinic.org/diseases-conditions/alzheimers-disease/in depth/alzheimers/art-20048103.

[20]Stanford Health Care. (n.d.). Alzheimer'sDisease Treatments - Medications. Retrieved from https://stanfordhealthcare.org/medical-conditions/brain-and-nerves/alzheimers-disease/treatments/ medications.html.

[21]Alzheimer's Association. (n.d.). Medications for Memory. Retrieved from https://www.alz.org/alzheimers-dementia/treatments/medications-for-memory.

[22]Drugs.com. (n.d.). Alzheimer's Disease. Retrieved from https://www.drugs.com/condition/alzheimer-s-disease.html.

[23]National Health Service (NHS). (n.d.). Dementia Activities. Retrieved from https://www.nhs.uk/conditions/ dementia/activities/.

[24]Alzheimer's Association. (n.d.). Activities for Kids and Teens. Retrieved from https://www.alz.org/help-support/ resources/ kids-teens/50-activities.

[25]Alzheimer's Society UK. (n.d.). Activity Ideas for Dementia.Retrieved from https://www.alzheimers.org.uk/get-support/staying-independent/activity-ideas-dementia.

[26]Alzheimer's Association. (n.d.). Daily Care Plan. Retrieved from https://www.alz.org/helpsupport/ caregiving/ daily-care/daily-care-plan.

[27]Where You Live Matters. (n.d.). Importance of Routines for Dementia. Retrieved from https://www. Where youlivematters.org/importance-of-routines-for-dementia/.

[28]Alzheimer's.net. (n.d.). Checklist and Daily Care Plan for Dementia.Retrieved from https://www.alzheimers.net/ checklist -and-daily-care-plan-for-dementia.