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# Diabetics Complications Management System (DIACOM)

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***Abstract*— This paper presents the design and evaluation of DIACOM, a patient-centered mobile application that is designed for the management of diabetes complications. The system specifically benefits adults with chronic type 2 diabetes by enabling daily monitoring of important signs, medication administration, and identification of initial warning signs of organ damage. DIACOM prioritizes simplicity for older adults with possibly restricted technical backgrounds, relying on intuitive interfaces, flexible choices, and visual formats to enhance participation and online inclusion. Prototyping of designs, requirements analysis, and user testing were conducted to maximize app performance—ensuring accurate data collection, prompt reminders, and information exchange with health professionals. The study points to the value of tailored digital interventions for the improvement of patient self-management, facilitation of timely intervention, and possibly reducing diabetes-related healthcare costs. Further improvement is recommended to incorporate privacy features as well as inherent expert support to optimize user experience as well as health outcomes.**

***Keywords—Diabetes, chronic disease, mobile application, vital signs, user experience, complications, elderly users.***

## 1. INTRODUCTION

Chronic diseases are health related illnesses that are long lasting in its effect. They stay with a patient for several years and don't heal or go away. These conditions are often associated with non-communicable diseases. They are difficult to deal with; most times, patients have to learn to live with them because there is no permanent solution to cure the condition. Common chronic diseases include diabetes, functional gastrointestinal, disorder, eczema, arthritis, asthma, cancer, chronic obstructive pulmonary disease, Lyme disease. Diabetes is a chronic disease that occurs when the blood sugar is not used up as a result of insufficient insulin produced or ineffective use of insulin by the body. It is indicated by persistence high blood glucose also known as blood sugar. Diabetes can be managing through lifestyle modification, drugs or both. Larger percentage of people living with diabetes manage the condition with drugs which they will have to take for a long term. People living with diabetes after many years develop other diseases which are called complications. Diabetes complication are long-term effects of diabetes that develop gradually, which can lead to serious damage if they go unchecked and untreated. Complications can either arise from consistent high blood glucose levels can especially on the hemoglobin called glycated hemoglobin HbA1c or from long term use of antidiabetic drugs, causing serious damage of the heart, blood vessels, eye, kidney, and brain. These complications are also chronic diseases and need to be managed for long term as well. Diabetes complications pose worries and burden on diabetes people, making their management more complex. However, since these complications are developing over a period of time, the onset of manifestation can be delayed or prevented through regular checkup and early treatment. Complexity in diabetes management is not only a burden to the patient but also to families, society and economy. This early detection of damage to body organs will not only help health practitioners to give necessary interventions to prevent situations getting worse, also help people living with diabetes to live longer in good condition as well as reduce economic budget spending on diabetes management.

### Problem Statement

In response to the inevitable burden of diabetes arising from long term treatment, early detection of the signs and symptoms of damaging body organs is critical, because they help point at issues that required attention in the body so that necessary actions for treatment can be taken. This is of utmost benefit to people living with diabetes because of quick intervention to this silent gradual. organ damage reduces the number of diseases managed along with cost in managing such disease. Targeting technology to help monitor early onset of diabetes complications reduces number of bed admissions both in hospitals and care homes in managing diabetes complications. This application will not only be of great benefit to the patient but also to the families, society and economy.

## 2. ANALYSIS OF THE PROBLEM

At the beginning of this project, people or team this project will be involved were identified and grouped according to their levels of participation, interest, and influence in the project also determining how best to involve and communicate with each of these

stakeholder groups. This is important to **gain early alignment among stakeholders and to help address conflicts or issues early on.**

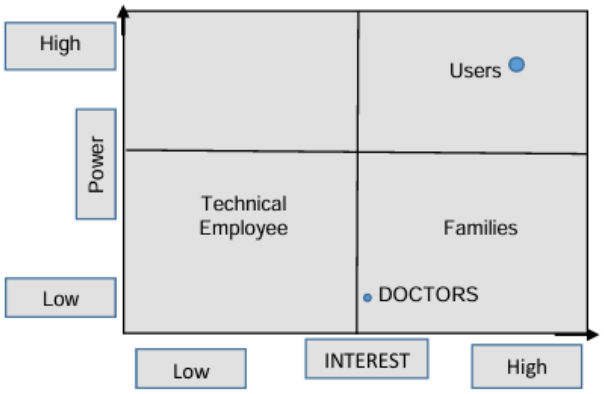



*Figure 1. Shows the mapping of the stakeholders according based on interest and influence on design.*

The most important stakeholders identified diabetes complication app are:

**The users of the product:** which will be people that have been diagnosed and managing diabetes for a long period of time minimum of two years. This category of people has high interest in the app and will be influencing the app design since the design is built for them to help address their health challenge. They are the center of the design, so they participate to co-design the app to make sure the app design is functional and usable by diabetes people.

**Families of the users:** Diabetes, being a long-term disease, is co- managed with families. Patients are not the only ones burdened by diabetes complications, their families are also affected emotionally and monetarily, so they get involved in managing the disease. They are interested in the app, but they do not influence designing the app.

**Doctors:** They are involved in managing the patient health conditions for better outcomes. Patient vital signs and HbA1c mean generated from the app can help predict upcoming complications which can be of benefit to help them make a better clinical decision of treatment. As useful as this may be, they have little or no influence on design making. Because they have many ways to get data that can be used.

**Career Home:** career organizations may show interest in using it to better track their patient health status, but they don't have influence in design.

**Technical Employee:** they have low influencing power and low interest but are involved in making the app outlook.

## Requirements

This section gives a clearer picture of the Objectives, perspectives, features, of the application. One of the major reasons for a clear product requirement to Make sure the final app meets your quality expectations. The requirement that will be discussed in this section is business and system requirement.

### Business Requirements

Cost of Managing diabetes is expensive managing diabetes complications. People living with diabetes are not the only ones that bear this cost, also it is a burden to their relatives, society and economy. Studies show that almost 80% of NHS budget spent on diabetes is for treating complications. This app aims to reduce the cost of managing diabetes complications. Money spent on increase hospital admission as a result of complications, can be diverted to more useful projects.

This mobile application allows patients to record their daily vital signs like, blood pressure, blood sugar and HBA1c and gets the statistic of data over a period of eight weeks. The user also records the drugs used in managing the condition, the dose of usage and how long the user has been on the drug. The mobile application displays possible complications that may arise as a result of long-term use of the drug, while the user records their symptoms, these symptoms are screened through series of questions to detect the symptom related to complications. In compares to other existing mobile app for diabetes management, this app is more engaging which makes is interesting to users to keep using it. It enables users to customize features like sound, unit of measurement, to their own choice, and allow notification when things go wrong like abnormal vital signs reading. Users are allowing us to share their data with their health providers. Downloading this application is free to encourage more users.

### Service Requirement

This entitles the functionality of the application in achieving its objective. Users of this applications are older adults, who are largely technologically disadvantaged, to encourage digital inclusion the application design is clear and easy to learn.

- The performance of every feature in the app is accurate; ♣ The data generate to calculate the mean value of HBA1c used to predict complications are precise. ♣ The questions to predict the onset of specific organ damage are valid. ♣ The menus and button of this application response promptly.

- Ease of use: the application is easy to understand and use because; ♣ The icons and labels are clear. ♣ Applicable Pictures are used for better understanding and reduce time reading too many text

- Proper navigation: moving between the screens is fast and has necessary link between them.

- Design Layout is appropriate by ensuring the arrangement and size of buttons, icons, and content on the screen are suitable.

- Visual appearance is pleasant; there is good use of color across screen and seamless graph.

- Educative: The app provides information about the drug, diabetes complications which is comprehensive but concise and drawn from reliable source. This information is correct, relevant to the conditions and well written.

- Mobile application works offline.

Users of the System

In designing an app for diabetes complications, consideration is given to the direct user. The primary users of this mobile application are people living with diabetes. Depending on the types of diabetes type 1 or type 2, diabetes affects both young and old, and the management of this disease condition maybe by lifestyle, organic or drugs. This application is targeted at people managing type 2 with drugs and have been consistently using their drugs daily over a period of 2years. People the falls in this category are adults. The persona used for this analysis is described below:

Emma is 55 years' woman living in Glasgow Road, she has two daughters and four grandchildren. She is from a family of four, her had diabetes when he was alive, but he died of heart attack at the age 73. She has one of her sisters been diagnosed of diabetes. She retired as head of administrator in a food factory where she had worked for 30 years. Emma was first diagnosed of diabetes in in 2015 using metformin for treatment, but she did not find it easy taking drugs, so she finds it difficult to adhered to her medication. In 2017 she became seriously ill and was recommended metformin and rosiglitazone. She has been on this medication consistently for five years. Presently she is having sleepless night because she is not happy about the health of her younger sister who has been taken to care home to be managed because she has kidney disease. Remembering how her dad died and her sister present condition she is worried she might also have heart attack or kidney disease. Presently she is having severe pain in her back. She constantly put a check on blood sugar every day and constantly book appointments with her doctor. During her days as an admin, she eats lots of her company fast food products and lives a sedentary life because of the nature of her job. Emma is not technologically incline but she manages to use a cell phone for the purpose of receiving calls.

Using this persona for an example, she reviews some challenges diabetes are facing, which must be put into consideration when designing a mobile application for people in this category. Emma, a diabetes woman, is presently living in fear, which has begun to affect her life; she could no longer sleep well, she constantly visits the clinic, she is not working anymore but her cost of treatment has increased. She has little knowledge about computers, and adherence to medication is a challenge. Designing a mobile application that is easy to learn with notification reminding her to take her medication, and helping detect on set of complications for quick response will help address her challenges.

Context of use

This means taking advantage of the user's situation, preference and attitude to design an application that provides the best possible experience. This gives the designer direction for the design and layout. The mobile application will help the user to know when something is going wrong in any part of her organ by screening her symptoms through series of questions. This understanding of the reason for her symptoms will help the user to seek necessary medical condition in prevention further problem, hence reduce her worries. The mobile applications allow data sharing of the user's statistics with the doctor; this will reduce her frequent visit to the clinic because the doctor will be able to access her vital readings to make clinical judgement.

Task analysis and use cases

This section highlights what the user needs to do with the app in order to achieve their goal and the feature the application has to solve the user challenges. This helps to improve the efficiency of the app.

**0.** To detect diabetes complication.
**1.** Enter your personal details
**2.** Enter your medication details
**3.** Daily check
  **3.1** check your blood pressure using BP monitoring and record the value
  **3.2** Check your blood sugar using home device and record the value
  **3.3** check your HBA1c through home device and record the value
**4.**
  **4.1** find the mean of HBA1c
  **4.2** plot a graph of blood pressure
  **4.3** plot a graph of blood sugar
**5.** share with doctor
**6.** Record your symptoms
**7.** Check more information of your medication
**8.** Know more about effect of diabetes on body organs

**Plan: 1&2** is done at initial starting of the app. **3** is done daily, **4** is done at the back of the screen but result can be virtualizing at statistic menu, **5** is optional, **6** occasionally when the need arises, **7&8** done at the user will

User's journeys

In other to describe more on how the application work in achieving user goal and the role the user play, user journey is illustrated. The further demonstrates how the task is divided into smaller units of tasks to achieve the big goal. The app works in three main categories: vital sign Reading, Notification, symptom check. The journey begins Vital sign Reading, this involves taking clinical measurements clinical measurements which that indicate the state essential body functions, the vital sign relating to the user's condition are blood pressure, blood sugar, and HBA1c. the system use this values to plot a graph for blood pressure and blood sugar while it calculate the mean of HBA1c over a period of 8 weeks. The system gives notification when there is abnormal reading in reference to the standard allow. The user then checks for possible symptoms to ensure no damage to the body.

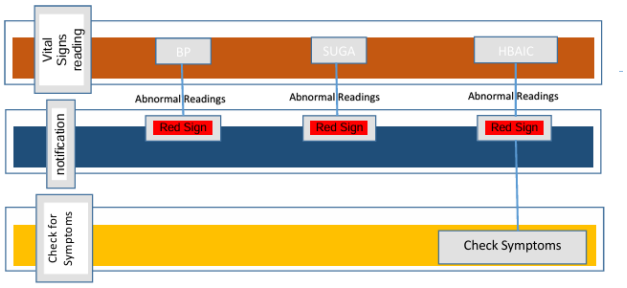



*Figure 2: Shows user journey.*

## 3. REQUIREMENTS ANALYSIS

This process involves describing the expectations of the users for an application that is to be designed. In this chapter the two-requirement analysis conducted are functional and nonfunctional analysis which this chapter will be providing a clear description to. These requirements are represented in the table below. The table structures the requirements accordingly:

- ID: numbering of features
- Requirement: required feature
- MOSCOW: used to prioritize requirements according to importance.
- Description: a clearer description of what the feature does
- Source: inspiration source for the feature

Functional requirements:

This analyses what the app must do. Showing all the features that meet the goal of design.

| FUNCTIONAL REQUIREMENTS | | | | |
|---|---|---|---|---|
| ID | M,S,C | REQUIREMENT | DESCRIPTION | SOURCE |
| 1* | M | Drop down box Select drug | Enable user to input her medical history | Literature review |
| 2 | M | Input bar to Type drugs | Ease of entering medication history | Persona |
| 3 | M | Record vital signs | Record blood pressure, glucose level and HBA1c | Literature review |
| 3 | S | Monitoring vital signs | Graphical representation of changes | Literature review |
| 4 | C | Monitoring HBA1c | Calculate the mean value of HBA1c over a period of 8 weeks | Literature review |
| 5 | M | Symptom check | Screen symptoms for any complication | Literature review |
| 6 | C | Side effect of drug | It gives more information about the drug | Literature review |
| 7 | C | Info and knowledge | Provides more knowledge on diabetes complication | Literature review |
| 8 | M | Notification | Give red alert when reading value is abnormal | persona |
| 9 | S | Setting | User can customize to their choice | persona |

*Table 1: Functional requirements prioritized for diabetes complication app*

Key: M = must have S =should have C = could have

*= feature no longer exist, because users were finding it difficult to select the type of drug they are using thereby discouraging them from using it.

Nonfunctional requirement

This analyses what the mobile application should do. Understanding all necessary features that make the app complete, which don't really address the problem.

| NON-FUNCTIONAL REQUIREMENTS | | | | |
|---|---|---|---|---|
| ID | **M,S,C** | REQUIREMENT | DECRIPTION | SOURCE |
| 1 | **S** | Mobile application works offline | Should be able to use without connection to internet | Persona |
| 2 | M | Pleasant visual appearance | Colour blend of blue and green | Persona |
| 3 | M | Ease of usage | Using icons and labels | Literature review |
| 4 | S | Pictorial representations | Indicate emotional expression | Literature, persona |
| 5 | M | Navigation | moving between the screen is fast and has necessary link between them. | Literature review |
| 6 | C | Menus and button | The menus and button of this application response promptly. | Literature review |
| 7 | M | Design Layout | Must be appropriate by ensuring the arrangement and size of buttons, icons, and content on the screen are suitable. | Literature review |

*Table 2: Non-Functional requirements prioritized for diabetes complication app*

Key: M = must have S =should have C = could have

## 4. DESIGN APPROACH AND PROTOTYPING

This chapter will be discussing the design approach and process taking to develop DiaCom prototype. This entitles overview of all the stages carried out, design steps taking and descriptions of the low and high-fidelity prototypes. The design approach has eight stages which are described in detail below.

Problem identification and scope of design

The major challenge of diabetes management is complications that arise after a long-term treatment. These complications are inevitable and become a burden to the patient, career and society because majority of diabetes cost of management are spent on the complications which make diabetes treatment more complex. Although these complications are inevitable because of the constant rise and fall of blood glucose, further damage and prevention can be possible if quick medical attention is given at the initial presentation of the complication. To ensure this close monitoring of glycated Hemoglobin (HBA1c) and presentation of symptoms and signs is of great necessity. Getting the value of HBA1c over a period of 8 weeks, along with reoccurring symptoms as a result of medication use can help health practitioners to predict upcoming complications and take clinical actions. Designing a mobile application to achieve this reduces the complexity of diabetes management. Study has shown that for a better outcome of chronic

disease management, the patient must be the center of focus, where they play an active role, because they are more concerned about the result of management. This is the major reason the mobile application is built around the patient's need, and they are the main user of the app.

Scope of design: this defines all the features that will enable the system to achieve its goal.

The table below shows the scope of design, what should be outside or in the design.

| SCOPE OF DESIGN | |
|---|---|
| In scope | Outside scope |
| Accessible to patient | Accessible to health professionals |
| Calculating blood sugar and HBA1c reading | Carbohydrate calculator |
| Users are managing of diabetes over 2 years | New diagnosed diabetes |
| User to enter their medication used | User to enter food calories |
| Information about drugs and diabetes effects on the body | Information about food to reduce blood sugar |
| Users screening symptoms | Users screening high carbohydrate food |
| Sharing data with health practitioner | |
| Application fully accessible with no cost | |

*Table 3: Show scope of design*

Stakeholders analysis: identifying the people that influence and have interest in the design. People living with diabetes are a major stakeholder that has high interest and high influence in design. The mobile application is designed for them, and they are the users of this system. Other stakeholders are families of the patient and the health professional, they are likewise interested in the application but not as much as the user and they don't influence the design process. The technical designers also are stakeholders involved in putting design in shape, have little influence on design layout.

Creating Persona

This involves generating different user types that might use DIACOM mobile app. In making design decisions, the need, interest and behavior of the persona were put into consideration. The user for testing the design was a woman suffering diabetes for over 5 years.

Identifying requirement

This illustrates what the app must do to solve the challenge. This requirement is grouped into functional and nonfunctional, and the majority of the requirements are obtained from literature review, although some are generated from the user after the testing the prototype and some of the requirements were changed to suit the user needs, one of such is medication selection. In order to screen the user symptoms based on medication, the user needs to input their drug, the type of input use initially was for the user to select their drug from a list of drugs available on the app. The user was finding difficult to identify their drugs from the list, causing delay. Although the user was just going to add medication once but the time taking to do this was already discouraging the user, so it was changed to typing her medication which was much easier.

Low fidelity

The next stage was creating an outline of the idea by drawing some sketches of how the design will appear/ look like, and how the screen will flow. This helps to find potential drawbacks within the design earlier, allowing to eliminate bad design. There is tendency for people to lose interest in the application or design reason that the model template might not in any way proximal to the real functionality the application intends to reveal the populace, and these could be one of the major demerits faced when creating solution-oriented application. Based on the above challenge the low fidelity design will not be able to achieve the design goal. Though some might find it easy to interact, however the larger populace or interest group might not connect to the design which might call for a high-fidelity prototype. The low-fidelity prototype method used for this design is Paper Sketch. The mobile application was designed to have 3 major screens:

The first screen is meant to capture these below:

1. User vital signs readings

2. Medication history

3. Information about the drug.

The Second Screen Captures:

1. Information about the effect of diabetics on body organ.

The Third Screen Displays:

1. The meaning of HBA1c

2. The Graphical representation of blood Glucose

The figure below shows a scanned sketch of the 3 major screens and four other views screens

ADVANTAGE AND DISADVANTAGE OF LOW FIDELITY PROTOTYPE

The advantages of Low fidelity prototypes used for the design are:

1. It cost less at developmental stage.

2. It gives room for evaluating many design options and ideas.

3. It gives a clearer picture of how the screens connect.

4. No technical constraint that can affect the creative process.

The disadvantage of Low fidelity prototype used for the design are:

1. It is difficult to check errors that occur with this type of design prototype.

2. Navigation across each screen is limited there making the flow uninteresting.

3. It does not give room for accurate specification detailing.

4. It no longer useful after the necessarily requirements are accomplished.

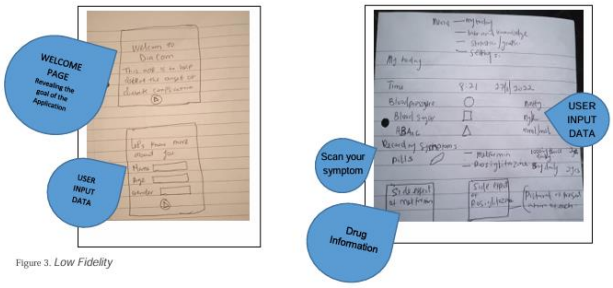



Figure 3. *Low Fidelity*

High Fidelity

The high-fidelity prototype is a more detailed prototype than low fidelity earlier described, it is interactive with several functions which makes it close to the final product. It is used for evaluation testing.

ADVANTAGE AND DISADVANTAGE OF HIGH-FIDELITY PROTOTYPE

The advantages of High-fidelity prototypes used for the design are:

1. This prototype has detailed functions and it's fully interactive, thereby users are encouraged to use it for testing.

2. It is suitable for testing and evaluation because it gives a feel of reality of the design.

3. It will eventually help in the marketing effort.

4. It clearly illustrates the navigations within the application.

The disadvantages of High-fidelity prototypes used for the design are:

1. Relatively to low fidelity prototype used above It is quite expensive to develop because it requires technical skills to put the design and requirement together.

2. A lot of time is put into creating a high-fidelity prototype because of the design knowledge required which might not be readily available.

3. Considering the functional and nonfunctional requirement gathering for an application development, high fidelity prototype is not effective, because they are not easy to change

4. Due to the fact that they are close to finished products, user might not be willing to comment on the design flaws during testing and evaluation.

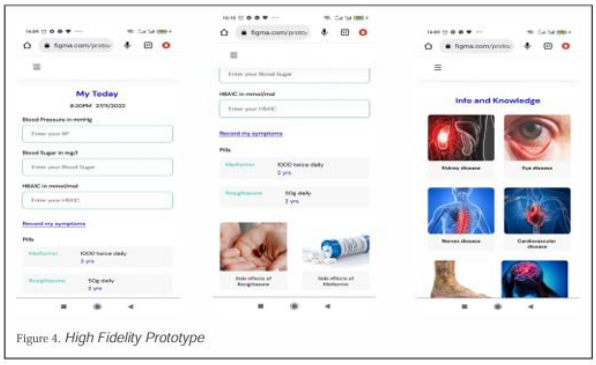



Figure 4. *High Fidelity Prototype*

## 5. EVALUATION

This chapter is about how evaluation is carried out. For this process high fidelity prototype was used and was tested with a diabetes woman.

Aims and objectives of evaluation:

1. It is established that the users of this app will be older adults, usually not technologically inclined, therefore it is necessary to test if they find it easy to understand and use, and to also get any difficulty that may discourage them from adopting the design. Therefore, the evaluation was particular about if the user will correctly select the medication they use, and how they were able to assess their symptoms.

2. The evaluation carried out was carried out by diabetes women. In other to achieve this an invitation letter was sent to two diabetes women. In the letter sent to them, I identify with myself, state what the evaluation is all about, how it will be done, how long this test will take and the benefit of it and finally ask if they will be interested in participating in such. I got their consent over the phone.

3. This evaluation was a small lab model, a consent form was given to the users, at the beginning of the test. Then a face-to-face explanation of the procedure was done. The users were the left to use the prototype for 10mins, while I observe the reaction.

(address)

Dear _____

Letter of Invitation to Participate in Mobile Application Evaluation

I am a post graduate student of university of Strathclyde, studying MSC Digital Health System.

I am interested in the wellness of diabetes people and I am inviting you to part take in small lab study on a diabetes mobile application.

The application aims to prevent diabetes complications arising from drug use. The study is to know if the user find it easy to correctly identify and select the type of anti-diabetics drugs they are using.

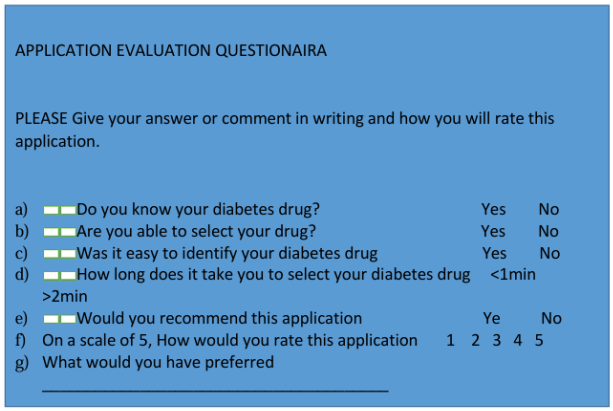
I hope to use the information from this evaluation to better improve on the application so that it can be user friendly.

Your participation in this evaluation is completely voluntary and will be helpful, every information provided will be confidential so I am expecting to use the application and give feedback, the duration for this test is 10mins. Feel free to contact me @sileol.adeniyi@uni.strath.ac.uk if you have any questions.

Sincerely

Funmilayo

Msc DHS



APPLICATION EVALUATION QUESTIONAIRA

PLEASE Give your answer or comment in writing and how you will rate this application.

a) Do you know your diabetes drug? Yes No
b) Are you able to select your drug? Yes No
c) Was it easy to identify your diabetes drug Yes No
d) How long does it take you to select your diabetes drug <1min >2min
e) Would you recommend this application Ye No
f) On a scale of 5, How would you rate this application 1 2 3 4 5
g) What would you have preferred

Method

The evaluation of the DIACOM smartphone application was conducted using a small-scale laboratory-based usability test with the primary target group of the app, which were older people with type 2 diabetes. Those who were likely to participate were invited prior to implementation by means of formal letters and telephone calls outlining study goals, protocols, and arrangements for confidentiality. Informed verbal and written consent were sought prior to participation.

Two female participants with long-term diabetes experience, fitting the target persona profile, were invited to take part in the trial. The evaluation was face-to-face, beginning with a description of the procedures and goals of the study in conversation. Participants were asked to interact with the high-fidelity version of the app for a set period of 10 minutes. Users also conducted significant tasks during this time such as entering personal and medical data, performing vital signs, assigning and choosing their diabetes medication, and navigating different aspects of the app related to symptom monitoring.

The responses, actions, and problems of the participants were observed directly. After use, there was a standardized questionnaire carried out to find subjective feedback. The questionnaire included closed, binary (Yes/No) questions regarding identification of drugs, drug selection, and ease of use, in addition to Likert-scale rating for overall app experience. Open questions enabled users to provide qualitative recommendations. All data were collected anonymously and stored confidentially.

Integrated observation and self-report data guided interface refinement, selection workflow, and message clarity, with recommendations based on actual-user behavior.

Results and Findings

After 10 minutes, both of them had 50% understanding of what the application is about but none of them correctly selected their drug, one was able to get a drug selected, while the other person does not understand what it is. Users were able to enter their name, age, blood pressure. One of the users said it texts were not clear enough, both they both said they understand how to use it.

## 6. CONCLUSION AND FUTURE WORK

Considering the evaluation result, the idea of these applications worth fully developed for further work and implementation. To further this design for implementation, there are some features that could be added which are.

- Login screen to provide some level of privacy for the users
- Alert sound for abnormal reading
- Chatting screen with medical expert.

In conclusion, The DIACOM mobile system fills a core gap in the management of diabetes complications through user centered design and digital inclusivity for older people. By incremental requirement analysis, prototyping, and direct user testing, the system has the potential to simplify recording important signs, promote medication compliance, and facilitate early detection of negative health events. Findings of the usability test highlight how intuitive interfaces, customizable features by the user, and robust notification systems can lead to greater user engagement, especially among less techno savvy users. The outcome calls for further development of DIACOM and its proposed feature enhancements such as privacy protection and incorporated expert guidance. Overall, the software could be a key player in improved long-term diabetes outcomes, simplified care, and lower costs for diabetes complication-managing patients and caregivers.

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