College of Health Sciences

School of Pharmacy

Department of Social and Administrative Pharmacy

Designing a Mobile Application-based Tool to Support Diabetic Patients' Self-Management in the Context of a Tertiary Care Setting in Ethiopia

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A Thesis Submitted to the Department of Social and Administrative Pharmacy, School of Pharmacy, College of Health Sciences, Addis Ababa University for Partial Fulfillment of the Requirements for a Master of Science Degree in Pharmacoepidemiology and Social Pharmacy.

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This is to certify that the thesis prepared by Semayawit Bahiru Bezabih entitled: Designing a Mobile Application-based Tool to Support Diabetic Patients Self-management in the Context of a Tertiary Care Setting in Ethiopia and submitted in partial fulfillment of the requirements for the degree of Master of Science Degree in Pharmacoepidemiology and Social Pharmacy complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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ABSTRACT

Title: Designing a Mobile Application-based Tool to Support Diabetic Patients Self-management in the Context of a Tertiary Care Setting in Ethiopia

By: Semayawit Bahiru

Background: Diabetes mellitus (DM), a prevalent Non-communicable disease (NCD), requires consistent self-management to prevent complications. Mobile health (mHealth) tools have shown promise in supporting chronic disease management. Ethiopia's expanding mobile infrastructure presents an opportunity to enhance DM self-management, reduce complications, and improve the quality of care.

Objectives: This study aimed to co-design a digital tool to improve DM self–management by engaging diabetic patients and healthcare providers through a design thinking approach.

Methods: Using a design science research methodology, the tool was iteratively co-designed with healthcare providers and patients through the stages of design thinking sessions.

Results: Three key findings emerged in developing a digital tool for diabetes self-management at Tikur Anbessa Specialized Hospital (TASH): the need for user-centered design, improved continuity of care, and accessible health education. The user-centered design addressed the specific needs of healthcare workers (focusing on medical management) and patients (focusing on emotional and lifestyle support), resulting in features like personalized alarms, record-keeping, and an accessible interface. Alignment with TASH's electronic medical record system was found to be a critical issue to ensure continuity of care and streamline queue management. Finally, gaps in the way a health education is being delivered, which was addressed in the designed mobile application through facilitating access to resources and empowering patients to actively engage in their care through their mobile phone.

Conclusion: This study demonstrates the role of a co-design approach in healthcare service design, uniting stakeholders interest to create a valuable tool for diabetes self-management that addresses concerns from healthcare providers and patients.

Keywords: design thinking, diabetes mellitus, digital health, self-management, user-centered design, low-resource healthcare

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LIST OF ABBREVIATIONS /ACRONYMS

ADA	American Diabetes Association
CBHI	Community-Based Health Insurance
DM	Diabetes Miletus
DSR	Design Science Research
DT	Design Thinking
EMR	Electronic Medical Record
FGD	Focus Group Discussion
FIP	International Pharmaceutical Federation
GSMA	Global System For Mobile Communications Association
HCI	Human-Computer Iteration
HCW	Healthcare Worker
HIMS	Hospital Information Management Systems
ICT	Information Communication Technology
IDF	International Diabetes Federation
IPDM	Integrated Personalized Diabetes Management
IS	Information Systems
ISR	Information Systems Research
IVR	Interactive Voice Response
mHealth	Mobile Health
MM	Medication Management
NCD	Non-Communicable Disease
PI	Principal Investigator
QMS	Queue Management Systems
SMS	Short Message Service
SSA	Sub-Saharan Africa
TAM	Technology Acceptance Model
TASH	Tikur Anbessa Specialized Hospital
UCD	Use Centered Design
UI	User Interface
USA	United States Of America
VCD	Video Compact Disc
WHO	World Health Organization

1. INTRODUCTION

1.1. Background

Humanity is suffering from the causes and consequences of non-communicable diseases (NCDs) all over the world. The latest studies still show that NCDs are the global leading causes of death, which is responsible for more than 43 million deaths in the year 2021 equivalent to three-quarters of all non–pandemic–related deaths globally. Responsible for more fatalities than all other reasons combined, and they strike hardest on the low- and middle-income populations. In Ethiopia, NCD is the leading cause of death in Ethiopia with an estimated rate of 554 (95% UI: 502-605) per 100,000 population (World Health Organization [WHO] 2016; Shiferaw et al. 2018). Having the hardest hit in Ethiopia and other developing countries, chronic diseases impose heavy burdens and costs on the health industry in many countries. The cost increases with poor medication adherence, associated with increased re-hospitalization, morbidity, mortality, and increased healthcare costs. The burden of the health care cost of non-communicable diseases on society could be devastating for the infant economies in which less developed countries partake.

People suffering from chronic NCDs are forced to struggle with several difficulties in daily medication management on their own. They are overburdened by the agony of problems connected to both their medication regimen and their regular medication (self-) management (Haslbeck and Schaeffer 2009). Among NCDs, Diabetes Mellitus (DM) is the primary cause of co-morbidity and death as indicated above. Hence, clients are suffering from taking several medications at a time or beginning a new regimen, experiencing the medication and its outcomes and side effects, or even dealing with concerns about medication safety and efficacy. There is a need for NCDs, especially DM clients, to track their symptoms during and or after their medications to achieve the goals of the treatment. This calls for a reliable and easy-to-use medication management (MM) tool that possibly has patient involvement to become important

(Tabi et al. 2019). E-health and telemonitoring are necessary because of the continuum nature and frequent need for ongoing monitoring in chronic disease management. Which uses technological instruments to attain preferable treatment outcomes (Hamine et al. 2015).

Hence, the purpose of the study was to co-design with DM patients and healthcare workers who are interested in having a digital tool and develop prototypes that are deemed useful by the actual users of the tool, fully engaging them in their own DM self-management.

1.2. Statement of the Problem

As scientific efforts have not come up with curative medications for diabetes mellitus, suitable self-management contributes to delaying or controlling its complications. Nevertheless, broken self-management by diabetic patients adds to the disease burden (Petersen and Hempler 2017; McLaughlin et al. 2019). Components of self-management include diabetes education; healthy eating, physical activity, medication, and device usage; monitoring and using patient-generated data to adjust behavior and medication doses; preventing, detecting, and treating acute and chronic complications; coping with psychosocial issues; and problem-solving (Veazie et al. 2018).

Patients often struggle with self-management due to the overwhelming amount of data and the necessity for frequent clinical consultations that can be achieved through digital health technologies (Ye, 2023). Digital tools can enhance patient engagement through peer support and training, ultimately improving self-efficacy and treatment satisfaction, and addressing the critical gap in effective diabetes management strategies by offering convenient access, tailored content, and behavior change techniques (Alexander et al., 2023; Amante et al., 2024).

Digital health tool for diabetes self-management could be adopted from other setups and fulfill this gap in the context of Ethiopia. Even though According to studies and available technical

innovations, the uptake of digital solutions for managing type 2 diabetes mellitus (T2DM) remains low, primarily because these solutions often focus on clinical factors rather than aligning with patients' real-world needs and experiences (Persson et al., 2023).

This disconnect highlights the necessity for user-centered digital tools that empower patients to manage their condition effectively and adapt to their evolving needs over time (Persson et al., 2023). Co-design techniques like Design thinking have the potential to enhance patient experiences, improve clinical outcomes, and refine medical programs (McLaughlin et al., 2019). With the growing technology capacity, delivering the final product to a wide audience with minimal effort is now achievable, significantly benefiting large populations, especially in resource-limited settings.

This collaborative process helped create a user-friendly and contextually relevant solution that aligns with the unique challenges and requirements of diabetes management at Tikur Anbessa Specialized Hospital (TASH). Addressing this gap would not only improve the quality of life for diabetic patients but also contribute to the overall efficiency and effectiveness of diabetes management at TASH.

1.3. Significance of the Study

Diabetes is a chronic illness that requires continuing medical care and ongoing patient self-management education and support to reduce the risk of long-term disability and prevent complications. Self-management refers to “tasks that an individual must undertake to live well with one or more chronic conditions. These tasks include gaining confidence to deal with medical management, role management, and emotional management (El-Gayar et al. 2013). Self-monitoring might contribute to management in two ways; firstly, it might improve glycemic control by reinforcing beneficial self-management behaviors and compliance with medication; Secondly, the process of monitoring and the immediate feedback it provides on

glycemic control might affect patients' experience and determine attitudes toward their diabetes and satisfaction with treatment (O'Kane et al. 2008). Providing self-management services to patients at TASH requires an in-depth understanding of the context and needs of the institution. This experience with the design method and final output supports replication of the service for other NCDs within TASH and other setups with similar settings.

Design Science Research (DSR), also known as Constructive Research, is a methodological approach concerned with devising artifacts that serve human purposes. This is a form of scientific knowledge production that involves the development of innovative constructions, intended to solve problems faced in the real world, and simultaneously contributes (Dresch et al. 2015). Design considerations and tests of the idea/insights forwarded in different stages of the development of mobile applications to support diabetic patients' self-management with a design thinking approach. Previously, the role of design considerations has been poorly utilized to make informed decisions before deploying a digital tool. This study helped to improve the gap in the body of knowledge in design science applications in M-health systems. The tools/apps of this study will directly benefit patients with DM. The researcher, the system designers, the programmers, and the E-health system will benefit from this process to improve the health services provided to DM patients. DM patients will easily manage self-care, health service providers can access individual data for further planning and strategic service provisions, and all the health systems improve their service quality. It will also help to predict potential causes of DM complications and service management that seek improvement.

2. LITERATURE REVIEW

2.1. Diabetes Miletus

NCDs are linked to socioeconomic development, with mortality rates varying across different development stages (Wang and Wang 2020). However, the continuing rise in the burden of NCDs is a key global health agenda since NCDs cause more deaths than all other causes combined. Though determining the impact of NCD is imperative to developing the existing healthcare systems and monitoring the program's effectiveness, organized data is still lacking in Ethiopia (Girum et al. 2020; Peng et al. 2016). According to The Society for Endocrinology Metabolism and Diabetes of South Africa (2017), DM is a metabolic disorder with heterogeneous etiologies, which is characterized by chronic hyperglycemia and disturbances of carbohydrate, fat, and protein metabolism resulting from defects in insulin secretion, insulin action, or both.

2.2. Global and Regional Prevalence

In 2021, there were 529 million (95% UI 500–564) people of all ages, worldwide, living with diabetes (Ong et al., 2023). As per the International Diabetes Federation (IDF), the anticipated 589 million adults aged 20–79 years had diabetes in 2024. It is forecasted that the number will rise to 853 million in 2050 in a projection done in 2024.

In sub-Saharan Africa, the burden of DM among adults aged 20–79 years was estimated to be 10.8 million with four countries alone: South Africa, Nigeria, Democratic Republic of Congo, and Ethiopia; accounting for about 60% of all adults living with DM in the region (Yunka et al. 2020). A study done in the urban and rural settings of Ethiopia shows a five-year trend. Type 2 diabetes increased for both urban (6.9 to 14.0 per 1000 adult urban residents) and rural (4.0 to 9.5 per 1000 adult rural residents). Even though the ratio of type 1 is much lower than that of type 2; type 1 diabetes showed an increment for both urban (1.0 to 2.2 per 1000 adult

urban residents) and rural (1.2 to 2.6 per 1000 adult rural residents) parts of Ethiopia (Gebremedhin et al. 2020).

By 2017, the projected national diabetes prevalence among individuals aged 20-79 was estimated to be 5.2% in Ethiopia, translating into 2.6 million DM cases in the country (International Diabetes Federation, 2017). Alarmingly the percentage of undiagnosed DM in Africa (66.7%) is almost two times higher than that of industrialized countries, which is 37% (Ogurtsova et al. 2017).

2.3. Challenges in Diabetes Diagnosis and Awareness

Economic improvement in Ethiopia has been changing the citizens' dietary patterns, which implies urbanization, improvement in food intake types and frequencies, and reduced physical activity, mainly in the current decades. These fast changes have led to the surfacing of NCDs such as diabetes mellitus (Wolde et al. 2020). In Sub-Saharan Africa (SSA), the problems caused by DM are even more awful as diabetes will have to share limited resources with infectious diseases and malnutrition (Yunka et al. 2020).

Diabetes remains underdiagnosed in many regions, the World Health Organization (WHO) projected that diabetes will be the seventh leading cause of fatality by 2030. Sadly, more than half (50.1%) of people with DM are unaware of their status and most of them (84.3%) were found in low and middle-income countries. Individuals with type 1 diabetes present with acute symptoms of diabetes and markedly elevated blood glucose levels which is a diagnosis criteria for the diagnosis of diabetes in non-pregnant adults is on a routine screening. Type 2 diabetes is not diagnosed until complications appear, and approximately one-third of all people with diabetes may be undiagnosed. Although the burden of diabetes is well known, the natural history is well characterized, and there is good evidence for benefit from treating cases diagnosed in the context of usual clinical care (ElSayed et al., 2025)

In Africa, nearly 60% of all people living with diabetes were undiagnosed. Early detection of unrecognized DM and its risk factors in the community is critical to minimize the trouble of diabetes mellitus and related complications (Yunka et al. 2020). The occurrence of unacknowledged diabetes mellitus amongst adults in Jimma town was comparatively high. Male sex, advanced age, physical inactivity, and central obesity (high waist circumference) were found to be predictors of unacknowledged diabetes mellitus. Thus, awareness creation activities targeting adults should be devised regarding regular physical activity and maintaining normal body weight. Additionally, screening for diabetes mellitus should be promoted for early detection, prevention, and treatment (Yunka et al. 2020).

Patients' perceptions of diabetes also influence self-management. Many diabetes mellitus patients consider diabetes mellitus to be a disease that affects patients in different levels, some are affected hard, and some are not. A diabetes mellitus patient was assisted by her husband and he said, my wife is in 'diabetes light'. He was describing the absence of perceived impact on the illness of diabetes that reduced the caution of the need for self-management, which possibly affected their inspiration to partake in diabetes education (Petersen and Hempler 2017). this highlights the importance of tailored awareness campaigns focusing on risk perceptions and behavioral change.

2.4. Diabetes Treatment and Self-Management

Management of diabetes varies depending on the type and severity of diabetes. Ranges of interventions from different sources exist to improve diabetes outcomes. Clinicians, patients, researchers, and other interested persons in the components of diabetes care propose standards of care, treatment goals, and tools to evaluate the quality of care entities like the "American Diabetes Association" and "WHO" are at the forefront (Charleer et al. 2020). For type 2 diabetes patients, management is often initially focused on lifestyle changes (diet and physical activity) and may include the use of oral hypoglycemic medications. Sometimes type 2 diabetes

patients use insulin in addition to or in place of other medications to obtain optimal glycemic control (Veazie et al. 2018). Effective diabetes management is essential for preventing complications and improving patients' quality of life.

Chronic diseases such as heart disease, cancer, and diabetes are permanent, leave residual disability, require long periods of supervision, observation, and care (Choi et al. 2020). For decades, diabetes self-management has been considered a cornerstone of diabetes care and is believed to play an important role in preventing micro and macro vascular complications (El-Gayar et al. 2013).

Health practitioners encourage patients with diabetes to develop many self-care behaviors. Thus, the purpose of the education is for the disease to be managed by the patient and to improve the quality of life. To reduce the complications of diabetes, some studies emphasize that healthcare workers should not merely provide knowledge to people, but take into account the perception of the risk as a central concept for understanding healthy behaviors and making changes in behavior (Shabibi et al. 2017).

Barriers to Effective Self-Management

Regardless of the emphasis on self-management, several challenges hinder optimal diabetes control. In study done in South Africa identified poor patient self-control regarding lifestyle modifications, inadequate patient-provider and family partnerships, and emotional challenges such as post-diagnosis grief as a key psychosocial barriers (Masupe et al., 2022). Barriers such as cultural insensitivity, socioeconomic inequalities, and lack of tailored interventions hinder attendance and engagement of patients (Hadjiconstantinou et al., 2021).

Knowledge and skills deficiency are still mentioned despite the effort. Many individuals with diabetes lack the skills to manage stress, plan exercise to avoid hypoglycemia, and interpret blood glucose patterns. Furthermore, Self-efficacy in coping with stress and adjusting

medications or diet to maintain ideal blood glucose levels is often minimal (Adu et al., 2019).

In low-resource settings, there are significant resource limitations, such as financial constraints affecting access to necessary supplies, and physical resource shortages, including accessible exercise facilities and diabetes clinics, which hinder effective self-care (Kalra, 2009).

The challenges of implementing evidence-based treatment guidelines, particularly in low- and middle-income countries, further complicate DM management. Health personnel and patients face obstacles due to overburdened health facilities, the dual burden of infectious and non-communicable diseases, and the inadequate training in pedagogy and adult learning principles of healthcare workers (Puoane and Tsolekile, 2021; Kalra, 2009).

Effective self-management education and support programs, as well as policies that facilitate active patient involvement, which are often lacking, hinder optimal diabetes management and patient empowerment (Puoane and Tsolekile, 2021). Community-based solutions and dedicated multidisciplinary healthcare teams are crucial to address these gaps effectively. (Masupe et al., 2022). Only if these solutions are conducted without disregarding the existing barriers such as stigma, socio-economic and cultural influences, communication gaps between providers and patients, and a disconnect between healthcare services and patients' lived experiences that could further exacerbate the obstructing factors at hand (Masupe et al., 2022).

When designing diabetes self-management education and support programs, the gap primarily lies in the accessibility and effectiveness for under-represented groups, including minority ethnic groups. Hence, obstacles such as cultural insensitivity, socioeconomic inequalities, and lack of tailored interventions hinder attendance and engagement (Hadjiconstantinou et al., 2021; Piccinino et al., 2017).

Diabetes is a critical health condition for the aging population; at least 15% of patients over the age of 65 years comprise diabetes. The number of older persons with diabetes can be expected to grow rapidly over the coming decades (American Diabetes Association 2003; Charleer et al., 2020; WHO 1994).

Among the elderly, diabetes self-management is complicated by age-related conditions and co-existing diseases. Older adults exhibit diverse clinical, functional, and psychosocial characteristics that make self-management challenging. This heterogeneity underscores the need for an individualized, multi-faceted approach to diabetes management. Tailored self-management behaviors and continuous education are essential to mitigating complications in elderly diabetes patients (Casegas, 2024).

Digital health solutions, while promising, may exacerbate health inequalities if not designed inclusively, leaving many individuals without adequate support for effective self-management. (Hadjiconstantinou et al., 2021). In Scotland, gaps in diabetes self-management were particularly evident in the pre-digital era. Limited access to resources, insufficient personalized support, and a lack of integration of digital health solutions hindered patient engagement and education. Digital initiatives have been highlighted as necessary to address these deficiencies and enhance self-management support for individuals with diabetes (Laura Rooney, 2016). Advances in smartphone technology and wireless networks have resulted in increased adoption and enhanced capability, leading to opportunities for improved diabetes self-management (El-Gayar et al. 2013).

Recent evidence has indicated that digital self-management interventions may enhance self-management behaviours and capabilities in individuals with Type 2 diabetes. However, many studies in this area have shown low quality, suggesting a need for further research with larger sample sizes and robust designs to optimize these interventions for different populations.

(Mehraeen et al., 2021)

2.5. Digital Self-Management Tools

Digital self-management tools for diabetes primarily aim to enhance patient engagement and improve health outcomes through various technological interventions.

Health monitoring tools include devices and applications that allow patients to track their health metrics effectively. Continuous glucose monitoring (CGM) sensors are a prominent example, providing real-time data on blood glucose levels, which is crucial for diabetes management (Agency for Healthcare Research and Quality, 2018). Additionally, mobile applications can facilitate the recording of blood glucose levels, dietary intake, and physical activity, enabling users to visualize trends and make informed decisions about their health (Grammatikopoulou et al., 2021).

Health education platforms are designed to inform patients about diabetes management strategies and promote healthy behaviors. These can include websites, mobile apps, and interactive modules that cover topics such as nutrition, physical activity, medication adherence, and coping strategies. The effectiveness of these platforms often relies on their ability to engage users and adapt content to individual needs, which can enhance users' understanding and management of their condition (LeSeure et al., 2024).

Follow-up and support systems provide ongoing interaction between patients and healthcare providers. Digital platforms may include messaging features that allow for communication with healthcare professionals, reminders for medication, or scheduled appointments. Such systems help to ensure that patients stay on track with their management plans and receive timely support when needed(Jeffrey et al., 2019).

Design activities play a pivotal role in numerous applied disciplines, encompassing health informatics. They are especially pertinent and indispensable in the creation of mobile health (mHealth) technology that ensures safety, utility, and efficacy for its end-users mHealth technology is comprised of hardware, software, and human interfaces that are mutable and adaptable. Consequently, it presents several exceptional and demanding design issues, which necessitate novel and inventive concepts (Huckvale et al. 2015).

In diabetes care, innovative design is essential for effective self-management. Thoughtfully developed digital tools can enhance patient engagement, yet uptake remains low due to poor alignment with real-life needs. At Tikur Anbessa Specialized Hospital, employing user-centered design principles, such as design thinking, can create scalable, context-specific solutions that improve outcomes in resource-limited settings.

2.6. Design Science Research

Design science research (DSR) is a methodology that prioritizes the user and presents itself as a viable alternative for the design, development, and implementation of health services, specifically within the realm of eHealth. Notably, the DSR has been embraced as a service design methodology across diverse settings, including those within the healthcare industry (Gregório et al. 2021). That aims to create innovative artifacts to solve problems and improve environments. To establish clear and consistent guidelines for conducting, evaluating, and presenting high-quality qualitative design science research (Hevner Alan 2007). we adapted Hevner's (2004) framework(figure 1) which provides guidelines for evaluating and developing representations of Information Systems (IS) problems, solutions, and solution processes, which can be applied in practical settings to improve the design and implementation of information systems (Hevner et al. 2004; Farao et al. 2020).

- **The Relevance Cycle** in which we seek to understand the environment of the end-user by determining requirements through a series of interactions (e.g., focus groups, interviews) with stakeholders;
- **The Rigor Cycle**, in which evaluation of theories and artifacts contribute to the design science and application domain knowledge base; and
- **The Design Cycle** in which artifacts are produced and evaluated.

The Information Systems Research (ISR) framework is advantageous in user-centered m-Health app design, however, its multi-stage approach is time-consuming and costly, and there is a need for a definitive design approach in the design cycle (Schnall et al. 2016).

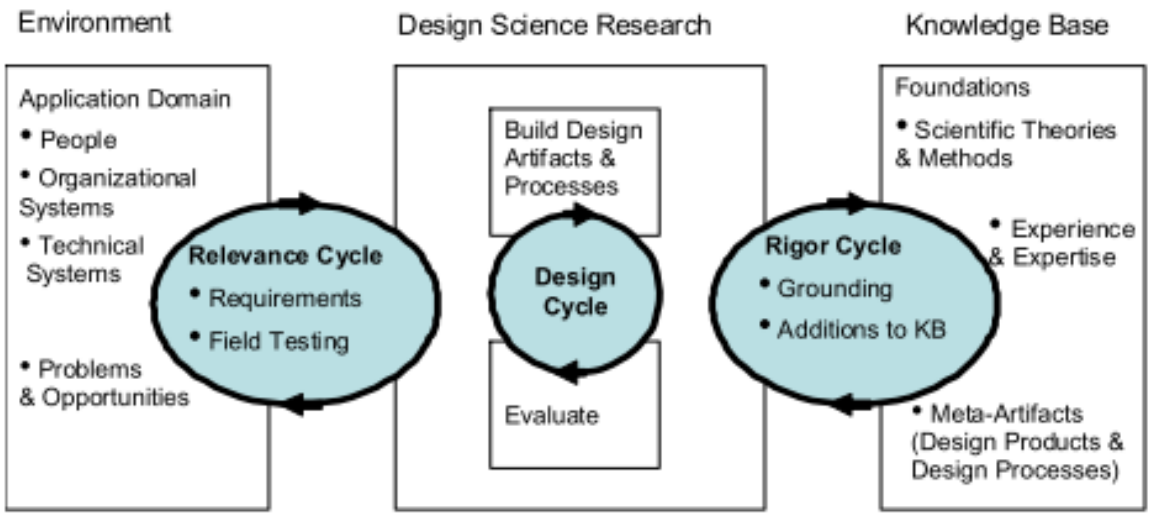

Figure 1. Design Science Research Cycles (Hevner et al. 2004)

The design cycle lacks emphasis on the involvement of researchers during technical development, and there is a disconnect between technical requirements and feasibility in the field, as well as inadequate evaluation of knowledge rigor; furthermore, prioritizing business objectives over understanding the context in which a product works may lead to short-term effectiveness but long-term unsustainability. Because of these limitations, we integrated design thinking, as proposed earlier by Farao et al, 2020 resulting in a more holistic approach

to the design of mobile health technologies. For this purpose, we chose a design-thinking model to fill the gap observed.

Design Thinking

According to Chomutare et al. (2013), design thinking is described as a method of solving problems that answer patient concerns. It is very useful in undertaking intricate problems that are ill defined or unfamiliar, by considering the human needs involved, reframing the problem in human-centric ways, engaging in brainstorming sessions to generate numerous ideas, and utilizing a hands-on approach in the prototyping and testing phases, one can effectively employ the five stages of design thinking (DT). This method enables individuals to tackle complex problems that arise in various contexts by:

Empathizing: Understanding the human needs involved

Defining: Re-framing and defining the problem in human-centric ways

Ideating: Creating many ideas in ideation sessions

Prototyping: Adopting a hands-on approach in prototyping

Testing: Developing a prototype or solution to the problem.

Though mobile applications and social media have breakthroughs as central facets of the Internet, their role in healthcare is still not well recognized. We present design artifacts, stimulated by influential technology concepts, from a study of social media as part of the diabetes mHealth application (Chomutare et al. 2013).

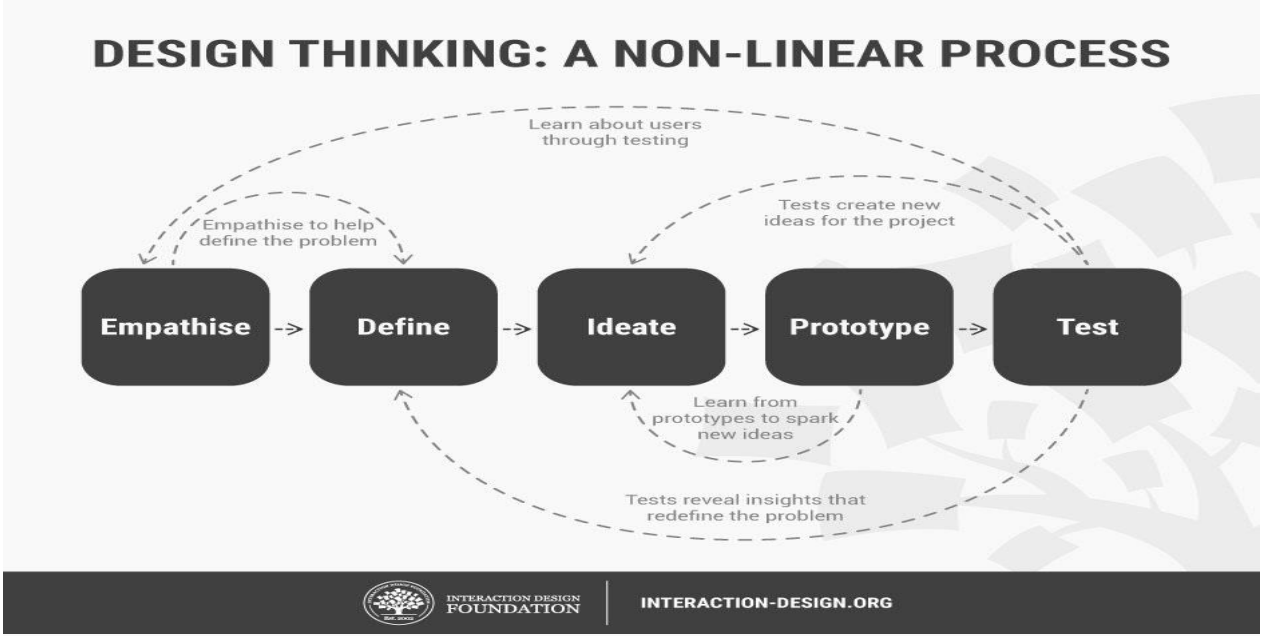

Figure 2 Design Thinking phase Source: www. Author/Copyright holder: Teo Yu Siang and Interaction Design Foundation. Copyright license: CC BY-NC-SA 3.0

Combined Framework

As it is proposed by (Farao et al. 2020) in this study we adopted the combined framework (annexed in this document) to achieve better results. This study was designed in a way that allows all of the involved parties to have a say on the final product. In addition, to include design considerations and pain points of diabetes patients being served at TASH and the healthcare team, working to accomplish this service at the clinic.

3. OBJECTIVES

3.1. General Objective

To explore the design considerations and design a mobile application-based digital tool to support diabetic patient's self-management in the context of a tertiary hospital in Ethiopia

3.2. Specific Objectives

1. To explore diabetic patients' perspectives on designing a tool for self-management
2. To explore the design considerations of health professionals when designing a supportive application for diabetic patients.
3. To design a mobile application-based digital tool using the insights from patients and health professionals

4. SCOPE OF THE STUDY

This study focused on gathering essential design considerations to create a digital tool that better supports diabetic patients in managing their condition, in alignment with clinical goals identified by healthcare professionals. By engaging with both diabetic patients and healthcare providers, the study aimed to develop a digital application that reflects the patients' preferences and needs, enhancing their involvement in self-management and ongoing health monitoring. The app design incorporated feedback from patients and healthcare professionals, and several insights and features were tested to evaluate their effectiveness.

The primary focus was on patients' willingness to use digital tools for managing their diabetes, particularly in areas of self-management and medication adherence. The study specifically involved diabetic patients who are on regular medication and who participate in the monthly health education sessions at Tikur Anbessa Specialized Hospital. Through this engagement, the study assessed both patients' interest in using digital tools for medication management and potential challenges that could limit adoption.

The proposed digital tool aims to address the specific needs and concerns of individuals living with diabetes, ultimately improving health outcomes and quality of life. Insights from this study may also serve as valuable input for government and policymakers in designing NCD-related programs and policies. Additionally, this tool could form the foundation for further research into the use of technology in supporting the self-management of non-communicable diseases.

5. METHODOLOGY

5.1. Study Setting and Study Period

This research was conducted at the Tikur Anbessa Specialized Hospital (TASH) endocrinology clinic in Addis Ababa, Ethiopia, from December 2022 until May 2023. The hospital receives approximately 400,000 patients referred from across Ethiopia annually. It is the largest teaching hospital in Ethiopia and provides tertiary-level referral treatment with 24-hour emergency services. It also has different specialty clinics that provide follow-up services. The Diabetic clinic is the largest referral clinic for DM in the country, and provides services for more than 300 people per week. Currently, there are more than 7000 diabetes mellitus patients on follow-up in the clinic (Seid et al., 2021).

5.2. Study Design

A qualitative study design was conducted using a combined framework of Design Science Research and Design thinking procedures to co-design a digital tool that incorporates the concerns of healthcare workers and diabetic patients.

5.2.1. Combined Framework

As it is proposed by (Farao et al. 2020) in this study, we adopted the combined framework (annexed in this document) to achieve better results. This study was designed in a way that allows all of the involved parties to have a say on the final product. In addition, included design considerations and pain points of diabetes patients being served at TASH and the healthcare team working to accomplish this service at the clinic.

5.3. Study Participants

In this study, patients and healthcare workers (HCWs) were used as participants. The HCWs were engaged from the TASH endocrinology clinic based on the activities of the clinic. Participants with DM were recruited for this research through a presentation done at TASH on the monthly patient education session that is organized by the Ethiopian Diabetic Association

with the collaboration of the clinic at the hospital. The primary criterion was the diagnosis of type 2 diabetes. To ensure representation we selected individuals with different statuses (patients who are newly diagnosed, who have lived with the condition for a long time, on oral/ injectable medication, and patients with complications from DM) and variety in terms of age, gender, and educational background. This sampling technique is both convenience sampling (approaching patients present at the monthly sessions) and purposive sampling (patients from different characteristics were selected).

We conducted seven key informant interviews with the HCWs and used the insights from these interviews to inform the design thinking session we held with twelve patients. This session was conducted at TASH on the day of the monthly session to increase attendance and minimize the burden on participants.

5.3.1 Inclusion/Exclusion Criteria

A. Patients

Inclusion Criteria:

- Diagnosed with type 2 diabetes
- Attending monthly diabetic education sessions at TASH
- Receiving follow-up care at TASH
- Diverse in:
    - Duration of diagnosis (newly diagnosed or long-term)
    - Type of treatment (oral or injectable)
    - Presence of complications
    - Age, gender, and educational background

Exclusion Criteria:

- Not diagnosed with type 2 diabetes
- Not attending the education sessions
- Receiving diabetes follow-up care outside of TASH

B. Healthcare Workers (HCWs)

Inclusion Criteria:

- Working in the TASH endocrinology clinic
- Involved in diabetes-related activities
- Willing to participate in key informant interviews

Exclusion Criteria:

- Not affiliated with the TASH endocrinology clinic
- Unwilling to participate

5.4. Data Collection Instrument, Procedure, and Analysis Used

In-depth interviews (IDIs) with healthcare workers (HCWs) and the focus group discussion (FGD) with patients were conducted across different phases of the study, guided by a combined framework that integrates the Design Thinking process with the Implementation Science Research (ISR) cycle. The IDIs, each lasting approximately 30 minutes, were held in a designated room at the Endocrinology Clinic of Tikur Anbessa Specialized Hospital (TASH). FGDs, lasting about two hours, took place on the third floor of the TASH administrative building, where patient education sessions are also regularly conducted. The FGD was conducted in Amharic, the widely spoken language in Addis Ababa, to ensure participants could express themselves comfortably. A designated note-taker recorded detailed field notes, and all sessions were audio-recorded for accuracy. While a detailed summary of the IDI and FGD contents is presented in the following subsection, this section provides an overview of the settings

Sample size determination for patient participants was guided by the principles of generative qualitative research, which aims to gain a deep, contextual understanding rather than statistical generalization. In this context, data saturation the point at which no new insights emerge, was the key criterion. Patients were purposively selected to ensure diversity in duration of illness, treatment types (oral/injectable), age, gender, and the presence of complications.

A total of twelve (12) patients participated in the design thinking sessions. This aligns with best practices in participatory design, which typically recommends 10–12 participants per segment to ensure a rich, inclusive co-creation process. Unlike quantitative research, the focus here was not on representativeness, but rather on achieving rich, actionable insights to inform

user-centered healthcare solutions.

A. Phase one

C. Empathize (DT1)

The first phase focused on HCW and the service provision that is being rendered at TASH. This phase was informed with an in-depth interview done with professionals serving the clinic; and open observation of the clinic on the specific days the clinic serves diabetes patients. This helped the principal investigator (PI) to fully understand and empathize with the context and develop insights that were used in the interview and subsequent stages. The interview guide was designed to explore and get an exhaustive understanding of patients' interactions with healthcare workers in the specific setting using open-ended questions for brainstorming on the topic and encouraging the participants to express their views within the framework of questions. (Mack et al. 2005) Later a thematic analysis was done using Open Code 4.03.

D. Define (DT1)

This stage follows the previous one and helps us to thematically analyze the data we collected from HCW and make sense of it. Insights were developed through the synthesis of information, which is later used in the design stage. This analysis informed us of issues that need to be addressed in phase **two** where we hold a design thinking session with diabetes patients.

E. Ideate (DT1)

At this stage, we used a decision matrix to evaluate and prioritize the list of possible intervention ideas suggested by healthcare workers (HCWs). The matrix considered criteria such as feasibility, potential impact, ease of implementation, and relevance to the local context. Each idea was assessed and scored against these criteria to identify the most practical and high impact options. The most plausible and patient-friendly ideas were selected to be presented in phase two for feedback from diabetic patients, thereby informing the iterative design process.

Additionally, key insights from the HCWs were synthesized into "How might we…" questions, which served as a foundation for the final design stage.

F. Prototypes (DT1)

Here, we developed question scripts that were used to describe possible intervention ideas the HCW suggested. This was used to test the idea forwarded by HCW and see what patients think about the ideas.

G. Test (DT1)

Using the scripts we developed in the previous (prototype) stage the final stage of phase one was concluded. This test session was done consequently with the phase two (empathize) session that was held with diabetes patients. The test was done using the questions based on the scripts at the end of the empathy session with the patients. In order not to distract patients from their preferences with leading questions or with the scripts developed as a result of the key informant interviews previously done with HCWs. The comments and insights from this are taken into account when doing the final phase two design.

B. Phase two

H. Empathize (DT2)

We held a design thinking session with patients recruited and asked about major pain points they face when dealing with diabetes disease self-management and related to follow-up services they get at the hospital. To identify needs and challenges patients face. The PI and an experienced design thinking session expert from the industry led this session that allowed the session to touch upon the issue from different perspectives.

I. Define (DT2)

This stage follows the previous one and helps us to thematically analyze the data we collected from the diabetic patients and make sense of it. Insights and 'How might we ...' Questions

were developed through the synthesis of information for later use. This analysis informed us of major issues that need to be addressed with the final design.

J. Ideate (DT2)

At this stage, we collected solution concepts from the design team by clearly following the insights that were not addressed previously. This allowed the team to formulate new design questions and later use the decision criteria to help choose which question to design. With this, it was decided to focus on institution-related questions that can complement the currently existing system at TASH.

K. Prototypes (DT2)

Using the questions we chose, we designed a concept wireframe that will later be used in follow-up studies we plan to do.

L. Test (DT2)

The major benefit of this model is that there is always room to grow, assess the result, and redesign every solution; what is presented as a solution today will eventually become a pain point. Even though this stage is not part of this study, this will be conducted once the mobile application is developed. The plan includes refining the prototypes and solutions by learning more about users' preferences and what is easy for them to use to result in maximum usage and, at large, better control over their disease condition.

Table 1: Overview of Aim, Method used, and Output for Phase one (1)

IST	Design Thinking phase	Subject	No of participants	Aim	Method	Data used	Needed insights
Relevance	Empathize (DT1)	Setting	N/A	• To gain insight into the working procedure and identify service-related questions	Open Observation	• Field Notes	• Current working process • Inform service-related probing questions.
		HCW	7	• To identify the challenges HCWs face in providing service. • Idea for improvement HCWs view on digital tools for self-management	Interview Semi-structured individual interviews	• Empathy map Audio recording/ • Transcribed	• Define the perceived needs of patients, • Insight of HCW • Digital tool use readiness and limitation)
		Patients	60+	• To identify patients (based on inclusion criteria)	Presentation project and sign-up session.	List of participants	• Potential participants for the FGD
	Define (DT1)	PI	N/A	• Develop an understanding of the context • Synthesize and select a limited set of perceived **NEEDS** • INSIGHTS will be developed through the synthesis of information	Analysis	• User needs and challenges (Themes)	• User requirement (Service-related, patient's needs) • Create insight statements (theme)
Design	Ideate (DT1)	PI	N/A	• List to be used for the design stage		• how might we questions	• List of questions
				• Use intervention ideas collected (brain dump from HCW interview) • Use the framework to prioritize and choose possible Ideas for intervention.	Analysis	• Framework	• Metrix
	Prototypes (DT1)	PI	N/A	• Design a Storyboard to use for testing	Script	• Script	• Prototype
Rigor	Test (DT1)	Patients (FGD)	12	• Collect insight from users		• Use a storyboard	• Collect insight for iteration

Table 2: Overview of Aim, Method Used, and Output for each Phase two

IST	Design thinking phase	Subject	No of participants	Aim	Method	Needed insights
Relevance	Empathize	Patients (FGD)	12	• Identify user needs and challenges • Develop insights	• FGD(design thinking session)	• Seek to understand • Empathy by asking about "needs for self-management of diabetes" • Experience
	Define	PI	12	• Clustering insights	• Analyses	• Identify Major NEEDS to address
Design	Ideate	Design team	Design team	Idea Generation • ASK (how might we ….?) • Separating the generation of ideas from the evaluation of ideas	• FGD (design thinking session)	• Solution concepts. • multiple ideas forwarded
		Design team	Design team	• designate voting criteria to choose which idea to move forward can it be integrated with i-care and can it function on a simple Application	• FGD(design thinking session)	• Prototypes
	Prototype	Software Programmer	Development partner	• Develop a wireframe prototype	• Design • Software development (user-friendly prototype)	• Wireframe (Figma) • Minimum Viable Product
Rigor	Test	Develop a framework for evaluation	5	• To refine prototypes and solutions • To learn more about users. • To refine the prototype.	• Test Task completion	• think-aloud questioning recordings for each of the scenarios

5.5. Data Collectors

The principal investigator, pharmacists, and other design thinking facilitators collected data. All of the data collectors including the PI were trained and certified to conduct design thinking sessions with ample experience in conducting such sessions efficiently in a way that fosters in-depth discussions. The in-depth interviews and FGD were collected by the PI, a trained professional on how to conduct in-depth interviews with HCWs. All of the data collection processes employed semi-structured questions and scripts designed to fulfill the aim of the study.

5.6. Data Analysis

Before analysis, audio recordings underwent verbatim transcription and proofread by another experienced researcher for quality and accuracy and to evaluate the audio and transcribed file. A detailed description of the context in which the research was performed and how this shaped the findings at every step was actively recorded throughout all phases of this study. Thematic analysis was deployed and we provided detailed descriptions with the use of quotes to make it clear how we arrived at the result.

5.7. Trustworthiness of study

In the context of this study, we employed a systematic approach to enhance rigor at every stage of the research process. The PI) has a personal connection to this study, as her mother is living with diabetes. This experience has motivated the PI's interest in exploring digital tools to support diabetes management. While this connection offers valuable insight and empathy, the PI acknowledges the potential for bias and has taken steps such as ongoing reflection and peer feedback to ensure objectivity and maintain the integrity of the research.

The PI who was familiar with this research focus led the design thinking session. To ensure credibility, the author utilized purposeful sampling with maximum variation of participant's background and FGD were conducted in settings preferred by the study participants. Data were read, re-read, coded by the PI, and reviewed. Efforts were made to maintain the original meanings when interpreting the data.

Detailed and transparent information was provided to participants to establish trust. Findings were discussed among the team. An exhaustive audit trail was maintained documenting all research steps and procedures, including data collection, analysis, and interpretation. Detailed field notes,

audio recordings, and memos were maintained to monitor decisions taken during data analysis and to ensure transparency regarding the researchers' reflexivity and possible biases. Additionally, regular debriefing sessions were conducted with the advisor and co-advisor. These sessions entailed discussions on emerging themes, interpretations, and potential biases, thereby offering an external viewpoint and confirming the neutrality of our findings. We adhered to a well-defined research protocol, outlining the study's objectives, methods, and analytical techniques. Any deviations from the protocol were documented and justified. To enhance the transferability of our findings, we provided a detailed description of the research context, participants, and data collection methods. Thick description techniques in reporting our findings provide rich and detailed narratives that capture the complexity of the matter under study.

5.8. Ethical Consideration

Ethical approval was obtained from the ethics review committee of the school of pharmacy (ERB/SoP/75.23/11/2022), and an official letter of support was obtained from the Department of Pharmaceutics and Social Pharmacy. A letter of support was provided to all parties involved including the Department of Internal Medicine, Ethiopian diabetes association, and individual participants to get their approval for data collection. Informed consent was requested from study participant to confirm their willingness to participate after explaining the purpose of the study, and its benefit. Participants were assured about the confidentiality of their information obtained in the study by excluding any personal identifier in the data collection form and Participants were informed of the right to refuse or terminate at any point of the interview. To ensure data security, all data were stored in password-protected files and locked cabinets, accessible only to the research team. Data were encrypted and anonymized to protect confidentiality and prevent unauthorized access.

5.9. Operational Definitions

Self-Management: Patient-driven activities for managing medical treatment, role responsibilities, and emotional well-being in chronic disease care.

Mobile Health (mHealth): Healthcare services delivered via mobile devices, such as smartphones, to support patient health management.

E-Health: Digital healthcare applications or websites accessible through various digital devices to support health and wellness.

Design Thinking: A problem-solving methodology focused on user-centered, solution-based approaches, often involving rapid prototyping and iterative feedback.

User-Centered Design: A design approach prioritizing the user's needs, preferences, and accessibility for a more effective, relevant product.

Continuity of Care: Ongoing, coordinated healthcare services that provide consistent treatment over time.

Health Education: Information provided to patients to improve their understanding of their condition, treatments, and self-care practices.

Medication Management: The organized administration of medications, ensuring adherence to prescribed treatment regimens.

Electronic Medical Record (EMR) System: A digital system that stores and manages patients' health records within a healthcare facility.

Co-Design: A collaborative design process involving direct input from end-users to ensure the product meets real needs.

Design Considerations: Essential insights and requirements identified to guide the design team in creating a contextually relevant product.

6. RESULTS

6.1. PHASE ONE

M. Empathize (DT1)

A thematic analysis was conducted using the Open Code 4.03 platform and the interpretation of the result was organized under four major thematic areas; design consideration for Service rendered at TASH, Patients' perceived needs and challenges, and, Digitalization factors. All of our participants are service providers from TASH and

Table 3: Demographic data (for Health Care workers)

Profession	Physician	2
	Clinical pharmacist (MSc.)	1
	Nurse	2
	Pharmacist	1
	Druggist	1
Gender	Female	3
	Male	4

Table 4: Demographic data (for patients)

Age	Average	56.78 SD=9.2
Gender	Female	4
	Male	5

Theme 1.1: Design Consideration: Service rendered at TASH

Subtheme 1: Renovation and Service Improvements:

TASH's Diabetic Center was renovated in July 2022 introducing key changes, including the I-Care electronic medical record system, which replaced manual patient cards and reduced previous struggles with record keeping. However, patients must still visit the clinic in person and wait in long queues for their scheduled follow-ups. Although the clinic has implemented a prioritization system for elderly patients, those who are visually impaired, and those with mobility challenges which is announced at the start of the mass education to reduce dispute, the physical queuing system still causes disputes and delays.

"…they bring their card with them and then will walk in based on queue. Based on visible things we give priority to some. Priority is given to the visually impaired, for those who can't walk well, and elders." Nurse A

Subtheme 2: Patient Load and Service Delays

The clinic serves 100 to 120 patients daily, leading to long wait times and delays in service. Patients often arrive as early as 6 AM and remain at the hospital the entire day. The high patient load affects service delivery across departments, particularly at the pharmacy, where overcrowding prevents detailed consultations and increases the likelihood of misinformation.

"…one of the major issues is patient load. This will lead to long queue and not allow us to provide service as soon as they get here… "Clinical Pharmacist

The clinic offers complementary services such as free dental and foot care, which are critical for diabetic patients. However, eye care services have been suspended due to broken equipment, forcing patients to seek these services elsewhere.

Subtheme 3: Laboratory and Diagnostic Service Challenges

Laboratory services remain a significant challenge for patients. Either they must arrive with test results or have the tests conducted at the center within specific time windows, which often causes stress. If tests are unavailable within TASH, patients must return on another day or seek costly private alternatives. The sustainability of certain laboratory services also remains a concern, with frequent gaps in the availability of these routine tests within the facility.

"…tests are not available and expensive when it is available. The ones with Community Based Health Insurance (CBHI) will get the service. The service at TASH is not sustainable; certain laboratory services are not constantly provided…" Physician A

Subtheme 4: Medication Accessibility and Pharmacy Challenges

Medication access is a recurring issue, particularly for Community Based Health Insurance (CBHI) users, who are limited to a two-month supply and must make additional visits before their scheduled follow-ups to obtain refills. Limited medication availability at the pharmacy adds to the burden, and overcrowding hinders communication between pharmacists and patients. Patients often misunderstand instructions due to the rushed environment.

"Because of patient load, the information they get from the pharmacy is not enough. Because it is crowded the information that is shared with one will be used by another…" Clinical Pharmacist

Subtheme 5: Follow-Up Frequency and Continuity of Care

Routine follow-ups, scheduled twice a year, are the primary reason patients visit the clinic. However, this schedule is insufficient for effective diabetes management. Patients often perceive follow-ups as primarily for medication refills rather than comprehensive evaluations. Furthermore, the rotation of residents every three weeks disrupts continuity of care, requiring patients to repeatedly explain their history to new providers. Despite these challenges, healthcare workers encourage patients to visit outside of their scheduled appointments if they have concerns.

"…routine follow-up cases are seen by residents, assigned at the clinic only for three consecutive weeks at a time." Physician B

Subtheme 6: Health Education and Awareness

Health education is provided to patients through mass sessions and one-on-one consultations. These sessions cover lifestyle modifications, nutrition, exercise, medication use, and recognizing complications. However, the high patient load limits the depth of these interactions, and patients may misinterpret or forget the information provided.

"…We provide health education … We give health education about the disease so that they understand it…" – Nurse B

Theme 1.2: perceived needs and challenges of patients,

Subtheme 1: Knowledge vs. Practice

As mentioned by key informants, most individuals have a good knowledge base when it comes to diabetes. However, there are significant challenges when it comes to practicing the advice they receive. The fact that diabetes is a chronic condition often burdens patients, with the anticipation of future complications like kidney or eye deterioration acting as a barrier to preventive actions. Patients struggle to work toward goals that feel distant, which emphasizes the need for motivation, social support, and financial assistance.

"For issues like stroke, one can be careful not to get sick again because of the experience. When we talk about eye and kidney deterioration that is in the future. It is hard for them to work for something in the future. This needs motivation, social support, and finance…" Physician B

Subtheme 2: Comorbidities and Medication Adherence

Patients visiting TASH often have comorbidities and complicated cases, requiring them to take multiple medications for treatment and prevention. Most of these patients are elderly and forgetful, but memory issues related to medication and health education adherence also affect younger patients. HCWs noted that patients often struggle to follow dosage adjustments. To reduce these errors, patients are asked to bring their medications to follow-up visits, and insulin users are required to demonstrate the correct dose measurement in front of healthcare workers for verification and guidance.

> "…They might miss the information provided to them. There is a problem when it comes to remembering the information and following it after getting home …" Clinical Pharmacist

Subtheme 3: Symptom Identification and Interpretation

Recognizing symptoms and taking the appropriate course of action is another concern. Patients often use symptom severity as evidence of their health status, which may differ significantly from laboratory test results that provide a three-month trend of their diabetes control. In addition, some patients confuse hypoglycemia symptoms with hyperglycemia symptoms, leading to incorrect responses to their condition...

"…Some of the patients don't differentiate the hypoglycemia symptoms from hyperglycemia ones. They confuse them and give a wrong response…" Physician A

Subtheme 4: Challenges in Lifestyle Modification

Exercise Misinterpretation: Exercise is an essential aspect of lifestyle modification but is often misunderstood by patients. Many equate the walking they do as part of their daily routine, such as running errands, with purposeful exercise. HCWs emphasized the need to communicate more measurable and descriptive goals, such as walking briskly for 30 minutes a day, five days a week, to ensure patients understand the expectations clearly...

"… They think a simple walk is an exercise they engage in as part of their daily routine. We, on the other hand, need them to walk for at least 30 minutes a day, 5 days a week walking faster gradually increasing breathing rate and heart rate. This is the kind of descriptive terms we need to use for them to understand better…. "Physician A

Dietary Challenges: Patients also face challenges when it comes to food and nutrition advice. Many feel that the guidance provided is too rigid and does not consider their socioeconomic realities or access to diverse food options. HCWs stressed the importance of tailoring advice to empower patients with practical solutions while remaining sensitive to their financial limitations. Flexibility and empathy in dietary recommendations are critical to ensuring adherence and fostering trust.

"We need to know our patients capacity if it was us who were told to stop we wouldn't do it. We have to be lenient. …we cannot tell them to stop everything as if they have a choice...they use whatever they have in their house. It is not right to tell them to include a variety of food types when they can only afford one type. For example, if they can only make pasta, then we should tell them to eat little of that and add vegetables with it …we cannot just tell them not to eat pasta. …. "Physician A

Theme 1.3: digitalization ideas

All of our participants were asked to mention the type of digital tools that they would suggest for a tool to support patients in diabetes self –management. Below is the compiled list of proposed features.

Subtheme 1: Telemedicine Platform

Participants emphasized the importance of a telemedicine feature that allows patients to access counseling, education, and remote physician consultations without needing to visit the clinic physically. This platform would also provide patients with a personal profile where they can access and record laboratory results, ensuring that critical information is available anytime and anywhere.

Subtheme 2: Medication Adherence and Management Support

Part of the clinical outcome is highly affected by adherence to medication provided not only for diabetes but also for the comorbidities these patients have. Along with management for preventive medications, they take. A way to alarm them with the possibility to record all medications taken,

type of medication (including the type, dosage, and timing.), and Space to record and track potential side effects experienced.

"If it doesn't have an alarm there is no point "Physician A

Subtheme 3: Symptom Tracking and Management

Symptom management which helps patient list and record what kind of symptoms they have; including the information about when and for how long it lasted and measures they took .It was suggested that it should also include access guidance on how to respond to varying symptom severity levels..

"..Hypoglycemia harms them. We need to make them aware of its management and that certain medications have side effects … "Clinical Pharmacist

Subtheme 4: Lifestyle Modification and Non-Pharmacological Support

Lifestyle modification is a cornerstone of diabetes management. Participants highlighted the need for functionalities that support non-pharmacological management, particularly in:

- **Nutrition and Food Management:** Guidance on dietary choices tailored to individual patient's needs, along with flexibility to accommodate financial or resource limitations.
- **Exercise:** Clear and objective recommendations about the type and duration of exercise, with the ability to track and log exercise sessions.

"Diabetic management's one part is lifestyle management or non-pharmacological management ..." clinical pharmacist

Participants stressed that the tool should provide personalized, measurable, and achievable goals for lifestyle changes to help patients integrate them effectively into their routines.

Theme 1.4: Digitalization factors.

While the possibilities of digital tools for diabetes self-management excited healthcare workers (HCWs), they strongly highlighted several barriers to implementation. These challenges reflect their understanding of the patients' needs and Ethiopia's' evolving technological environment.

Subtheme 1: Patient Characteristics and Acceptance

One of the key concerns was that older patients, who make up the majority at the center, might not readily accept digital tools. HCWs expressed that patients might struggle with using technology or feel hesitant to adopt it. However, they also noted that caregivers could play an essential role in supporting patients who face such challenges.

> "...if they can read and understand or if there is a family member that can read for them …they can help them understand it and it can also be used by the caregiver for easy access to information ..." clinical pharmacist

Subtheme 2: Literacy and Language Barriers

General literacy levels, coupled with digital literacy gaps, were seen as significant barriers. Patients' ability to use digital tools effectively may be hindered by limited reading and writing skills, particularly for older individuals. Language diversity also needs to be considered to ensure the tools are accessible to patients from various regions and backgrounds.

> "..The other thing is language …we need to understand patients background of language …if we want to get to patients to use the platform… "Clinical pharmacist

Subtheme 3: Economic and Technological Accessibility

The economic and technological capacity of patients was another major concern. Many individuals come from rural or remote areas where there is limited access to electricity and smartphones. However, HCWs also recognized that some patients, particularly those in urban areas or with better financial means, could benefit significantly from these tools

> "…what kind of technology are we using and the capacity of it matters ... if we are using smartphones... how many of the patients can access it or have one in their family …we can't be sure of that 100% of the time. Technology accessibility is or could be a limitation...Yet most people will benefit from the technology…" Physician A

Subtheme 4: Usability and Simplicity of Tools

Even for patients who own smartphones, the complexity of digital tools could deter their use. HCWs emphasized that the tools must be simple, intuitive, and user-friendly, especially for older

individuals who might only use phones for basic functions like making or receiving calls. The tools should provide clear guidance and direction to make them easier to navigate.

"It should be easy to use …they are older. I see this in my mom too. She uses her phone to call or receive one. There is the impression that phones are only for making calls. To be used beyond this it should be simple and easy to use though..." Physician A

N. Define (DT1)

Based on the previous stage insights were developed to inform the design sessions that were done in the second phase of this study. Below are the major insights that were found organized in two aspects user requirement that is service and patient need related and further grouped to allow focused and target questions in the different aspects to be answered with the design stage.

Insight: service related

General Service	The clinic is overloaded
	Patients visit the clinic every 6 month
	Patients have to come early in the morning to be served and get in the queue.
	Some patients get priority based on their condition
	Patients can visit the clinic if they have any concerns before the scheduled date
Follow Up	Patients are expected to come with a laboratory result.
	Patients have to come with their medication to show that they are using the right medication
	Patients can't remember every symptom they had throughout the months.
	Patients don't give enough information about their experience unless they are prompted to
	Physicians don't have enough time to spend with patients
	There is a concern that patients are only getting a refill service rather than a follow-up
Laboratory Test Related	Laboratory test is being done in specific time frame and patients need to be aware of that.
	There are laboratory tests that are not found at TASH
	Patients are not aware of where to get these tests from and how much it would cost them.

Health Education	Health education is provided at the clinic in person at specific hours.
	HCW should give personalized advice to patients (in cognizant of economic status and patient behavior)
Pharmacy Service	There isn't ample time to give medication-related advice at the pharmacy
	Patients get confused as to which instruction is given to them or another patient
	Medications are not available at the pharmacy and they have to physically come to check the availability
	Even though they are scheduled to come every 6 month they are provided with medications that lasts them only 2 months.
Insight: patient's needs:	
	Patients know what they need to do to control the illness, yet they have a hard time practicing it
	Patients struggle with anticipating comorbidity and possible complications of the illness.
	Patients have other conditions they are managing too
	Patients are forgetful and forget the instructions they are given
	Patients have a hard time when measuring insulin and differentiating the pills
	Patients struggle to adhere to medication instructions
	Patients struggle to differentiate the cause of the symptoms and how to respond to it
	Patients misinterpret vague advice like "exercise "
	Patients need objective measurements to stay put with the lifestyle modifications they want to practice
	Patients don't respond well to stringent advice
	Patients need to feel empowered to make the right decisions.
Insights: digitalization	
	The tool needs to be in the Language patients understand
	Should support different languages
	Easy to use
	Simple not complicated
	Should incorporate guidance on how to use the tool and direction
	There should be a way to address individuals with basic phones

O. Ideate (DT1)

Based on the insights from the define stage, which allowed us to cluster the insight; we found two major groups and also what we should consider on the system when designing the digital tool. As stated in the method section, this when we formulated questions to be addressed in the final design stage. The list of questions we developed is based on the insights and needs assessment.

- **"HOW MIGHT WE MAKE THE SERVICE PROVIDED AT TASH A PLEASANT EXPERIENCE FOR PATIENTS?"**
- **"HOW MIGHT WE MAKE THE FOLLOW-UP SESSIONS MORE INFORMATIVE AND SATISFACTORY? "**
- **"HOW MIGHT WE SUPPORT PATIENTS IN RECORDING SYMPTOMS AND TAKING THE RIGHT COURSE OF ACTION? "**
- **"HOW MIGHT WE SUPPORT PATIENTS TO BE ADHERENT TO MEDICATION INSTRUCTIONS THEY ARE GIVEN?"**
- **"HOW MIGHT WE SUPPORT PATIENTS TO HAVE PERSONALIZED LIFESTYLE MODIFICATION TOOLS THAT CAN OBJECTIVELY MEASURE THEIR PROGRESS? "**

We used the design suggestions HCWs identified on THEME 3 and chose the ones that could be tested through a short script. Which helped us to test the concept ideas with patients later on in the design session we had. Which are

- Having health education through a digital tool
- Keeping a Digital diary
- Having a specific alarm to remind you of when to take medications

P. Prototypes (DT1)

Script developed:

- What do you think about having diabetes-related health education through a digital tool?
- What do you think about recording your symptoms and glucose level on a digital tool?
- Would you like to have an alarm set for the medications you take?
- How about having an application specifically made for DM self-management?

The digital tools can be in the form of a text message that you regularly get or a phone call to your phone.

Q. Test (DT1)

To ensure patients' perspectives were included in the development process, feedback was collected from the same patient group that participated in Phase Two of the study. This allowed the participants to provide insights into the solutions suggested by HCWs without distraction from their priorities. The translated version of the probing script was used to facilitate discussions, and their responses were grouped into three themes: **Content**, **Medium Used**, and **Alarm and Record Keeping**.

Theme 2.1: Content

All of the respondents agreed upon the value of having diabetes-related education accessible to them through technology. They appreciated the idea of receiving relevant and important information, contrasting it with the often trivial or "nonsense" messages they receive on their phones. Participants also emphasized the potential to educate the public about diabetes, encouraging people to be tested. Those with years of experience managing diabetes found value in reminders and new information.

"We get unnecessary information through our phone most days we would prefer to be informed about crucial information related to the disease" **Age=62, Male**

Theme 2.2: medium used

Concerns were raised about the practicality of using technology. Many participants admitted they could only manage basic phone functions such as making and receiving calls. They felt the tool might be more useful for those comfortable with advanced phones.

When alternative communication mediums such as phone calls were suggested, there was a positive response, though the use of text messages raised concerns about language barriers. Video Compact Discs (VCDs) were also proposed as a medium, but Telegram and Interactive Voice Response (IVR) systems elicited the most enthusiasm, as participants found them potentially accessible even on basic phones.

"If these different ways like the ones you mentioned are available on a basic phone I can click and get the information." Female (Age = 67)

Theme 2.3: alarm and record keeping

Participants reacted positively to the idea of using alarms and record-keeping functions to manage their illness. Many shared that they already used alarms as a coping mechanism. However, they admitted that even with alarms, they sometimes forgot whether they had taken their medication.

The idea of keeping a record was also well-received, though participants expressed hesitation about showing their records to physicians. Fear of judgment or disappointment was a recurring theme.

"I take my machine with me to see the doctor but I am scared to show it to them …I don't want to be disappointed if he says I don't want to see it …" Male (Age = 62)

6.2. PHASE TWO

R. <u>Empathize (DT2)</u>

Similarly to Phase One, we used the Open Code 4.03 platform for thematic analysis, and the interpretation of the result was also organized under four major thematic areas; design consideration for Service rendered at TASH, Patients' needs and challenges, and, Digitalization factors.

Theme 3.1: Service rendered at TASH

Subtheme 1: Appointment and Medication Availability

Participants of the design thinking session were asked to comment on their experience when it comes to diabetes self-management. Service-related topics were issues that were brought up and were seconded by other participants. The fact that patients visit the clinic every 6 months was at the center of the complaint coupled with not having access to medication to last them that long.

They are forced to physically come back to the clinic to get medication now and then to check the availability.

"We are given a 6-month long appointment, and medication is not available for that long"

Female (Age = 48, 6 years with DM)

Subtheme 2: Processes and access of services

The majority of the participants are served under the CBHI, which allows them to take medication from this either pharmacy in the clinic or Kenema chain pharmacy, and they stressed the tiring amount of back-and-forth communication required with different offices located in different areas to be served under the insurance skim. This also stretched to the unavailability of laboratory tests at the hospital. As it was reported by the participants since, they cannot find all required laboratory tests they are forced to pay for the expensive tests out of pocket.

"My complaint is about the laboratory test we get outside the hospital. Our financial status is a problem. Getting these tests by paying 2000-3000 birr is hard for us"

Male (Age=57, 16 years with DM)

Subtheme 3: Communication and Support

An additional thing that was mentioned was the willingness of the staff to communicate and provide the necessary information rather than shutting down any questions and concerns. This was brought with great understanding for the HCW of the load of patients and their being tired yet the participants stressed that there could be improvement in that regard. It was also suggested to have a separate consultant besides the physician to assist them with medication and food-related questions and concerns. Female (Age = 37, 1 year and 7 months with DM)

"The doctors only see our results and give us medication for that … even when we ask to get tested for other concerns I have… I was told that it is not a concern for my age…I went to a private center because I have access" Female (Age = 48, 12 years with DM)

Theme 3.2: Patients' needs and challenges

Subtheme 1: Emotional Reactions to Diagnosis:

The design session also included the view of patients toward diabetes condition and all of them expressed their fear when they first heard about the condition and their extreme desire to try anything that gave them hope of a cure. This desire caused different reactions from all of them. The most prominent ones are the following. One of the participants abandoned the medication after 3 months of use and seeking a cure, which led her to be hospitalized and move to injectable

because of the sudden progress of the disease. Another had to be hospitalized when she heard the news. On the contrary, this fear caused others to lead a disciplined way of life with the same hope of being cured through time. Emotions like fear, hopelessness unrealistic desire to be cured, and willingness to try anything that promises it were noticed predominantly through the discussions.

"I felt like it was not better than HIV and soon something worse will happen to me and the disease doesn't have a cure" Male (Age = 57, 16 years with DM)

"…Knowing our status is good and taking the right medication and it is possible to be cured" Female (Age = 63, 20+ years with DM)

Subtheme 2: Public Perception and Stigma:

On top of this, the public perception of the disease highly affects them. Participants mentioned that they do not want to disclose that they have diabetes because of the stigma and unsolicited advice they get about medications and cures. In addition to this, it affects their participation in social events especially ones that involve food. It was said that it would be considered rude not to eat what is presented to them and balancing this with the food regimens they normally follow was forward as something they struggle with.

"… Regarding eating habits. It is tough with social life… "Male (Age = 62, 15 years with DM)

"…we suffer to make people happy in social gatherings" Male (Age = 60s, 15+ years with DM)

S. <u>Define (DT2)</u>

In this stage, we listed down all of the major and relevant insights we found from the previous stage. To Identify Major **Needs** to address these clustered insights helped us to generate the right questions for the next stages that were used to address the final design.

Insight: Service-related

General Service	• The clinic is overloaded • visit the clinic every 6 month • The service for CBHI users is not clear for patients.
Follow Up	• Patients feel hesitant to share their symptoms because of fear of rejection • patients want ample time to share their concerns • Patients want to get non-diabetes-related medical services and consultations.

Laboratory Test Related	• There are laboratory tests that are not found at TASH which are expensive
Pharmacy Service	• patients have to physically come to a pharmacy to check the availability of medication
Insight: patient's persona:	
	• they are in different emotional and motivation levels
	• very fearful of the condition and possible complication
	• very open to try anything as long as cure is promised
	• some become very adherent to what they are told with the hope of being cured
	• they don't want to disclose their condition to the public
	• they feel pressured by the community's unsolicited advice and comments
	• They have a hard time with social gatherings involving food.

T. **Ideate (DT2)**

At this stage, we coined the relevant "how might we …? "Questions based on the insights we gathered in the define stage of phase two. We majorly focused on new concerns that were not addressed in the previous stage and focused on patient-related concerns. Which were

- "HOW MIGHT WE MAKE THE SERVICE PROVIDED AT TASH RESPONSIVE TO PATIENTS' NEEDS?"
- "HOW MIGHT WE MAKE THE FOLLOW-UP SESSIONS MORE COMFORTABLE AND SATISFACTORY FOR PATIENTS? "
- "HOW MIGHT WE SUPPORT PATIENTS IN GETTING NECESSARY INFORMATION ABOUT TESTS AND MEDICATIONS REMOTELY? "
- "HOW MIGHT WE SUPPORT DIABETES SELF-MANAGEMENT FOR PATIENTS WITH DIFFERENT EMOTIONAL AND SUPPORT NEEDS? "

U. Prototypes (DT2)

Based on the concerns and design questions from the previous stage we focused on designing a wireframe for a platform that can solve information flow from the center and record keeping for patients. This platform needs to be tested before it can be implemented by the endocrinology center of TASH.

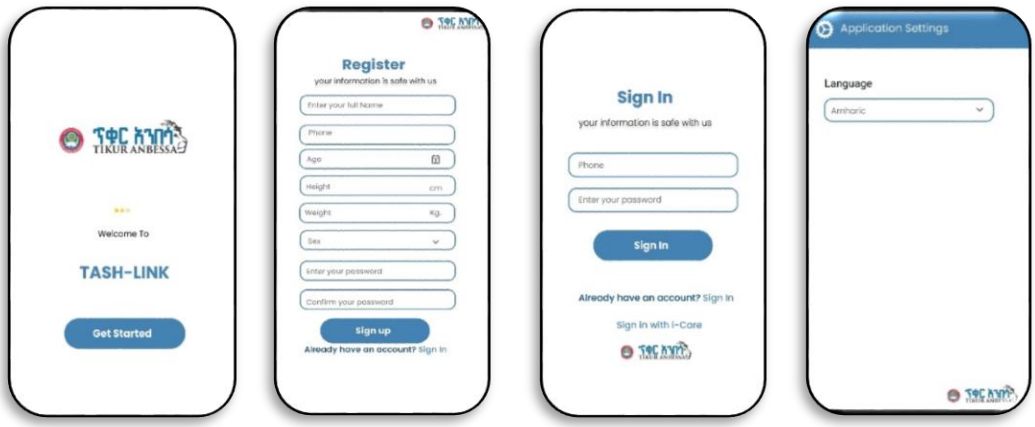

Figure 3. Front-page, Registration Page, sign-in page, and Language setting

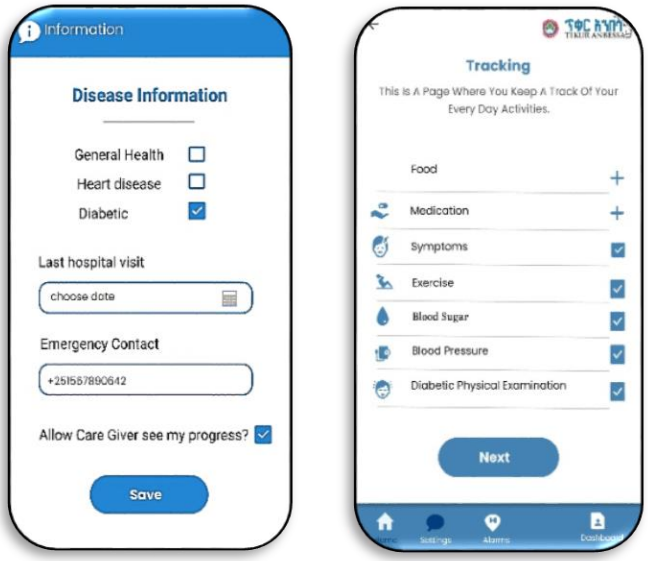

Figure 4. Tracking page

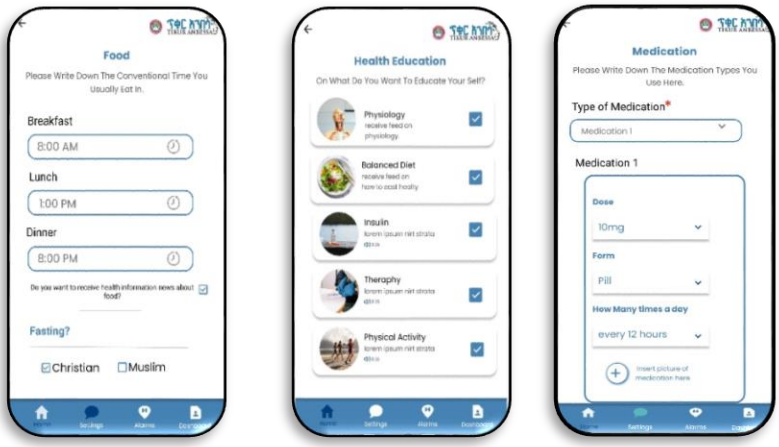

Figure 5. Food, Health education, and Medication setup

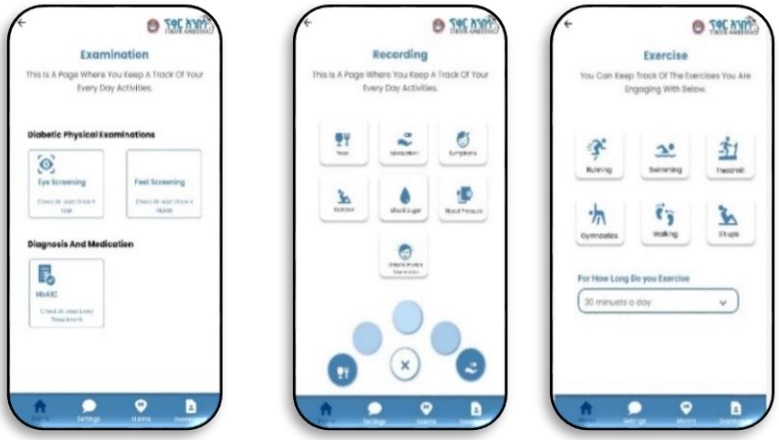

Figure 6. Recording page

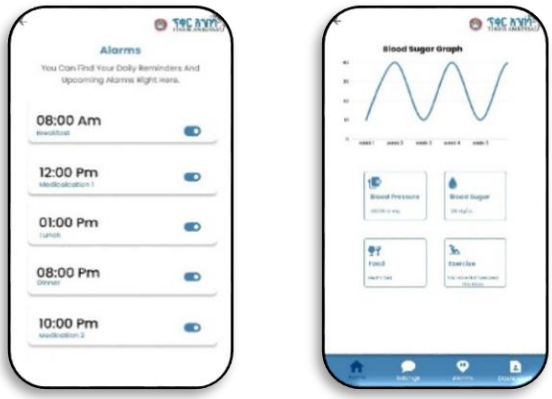

Figure 7. Reporting Page

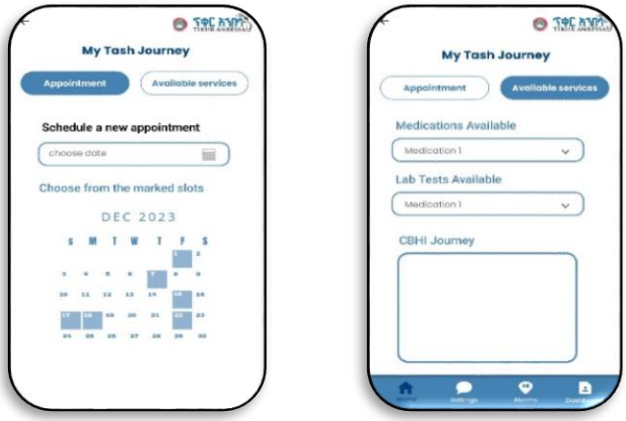

Figure 8. TASH Journey

V. Test (DT2)

Even though this study report pauses at this stage. The research will proceed and refine this prototype test the solution proposed and further do a usability test on the design once that research is acceptable design we hope to do an economical evaluation and clinical trial to quantify the impact it has.

7. DISCUSSION

Researchers working on digital health technologies like Stevens et al (2022) have advocated the utilization of technology to enhance healthcare effectiveness. However, transitioning from a mere product to a practical tool requires a methodological approach such as participatory design methodology and ISR framework (Schnall et al. 2016). This study involved patients and healthcare workers to gather insights, develop and test concepts, and prioritize questions for design solutions to address concerns from stakeholders; all while leveraging the existing systems of TASH. Using Hevner's (2004) framework, we outlined a methodical process for advancing the knowledge base on diabetes self-management while ensuring that our design solutions met the needs of the users.

In the design consideration and design development, we reported a systematic process we followed to meet the objectives we set out to answer. Thus, the first two specific objectives that deal with design considerations from patients and HCWs are discussed in the relevance cycle section that corresponds to results found on empathize and define stages from both phases. The design cycle and rigor cycles discuss specific objectives three (use insights to design digital tool concepts) and four (Test and iterate the concepts and present the final product design) respectively.

7.1. Relevance cycle

The relevance cycle in DSR refers to the iterative process that links the environment and the design phase, which we accomplished through the Empathize and Define stages with both patients and HCWs. From the HCWs, we identified four key themes: service-related issues, patient needs, digitalization concepts, and factors hindering the implementation of digital tools. In contrast, the FGDs with patients generated two major themes: patient needs and services rendered. The difference in the theme is noticed because of the role difference between patients and HCWs. The variation in themes reflects the role differences between HCWs and patients. This highlights the necessity for inclusive design frameworks, as noted by (Brankaert 2022), who coined the term “Warm Technology”; where co-design methods are used to ensure that digital tools are co-designed with target groups like dementia patients, enhancing their well-being and quality of life alongside HCWs.

Self-management of diabetes encompasses medical, role, and emotional management (Adams et al. 2004). In our study, HCWs focused primarily on medical and role management; encompassing activities directly related to disease and medication management, and emotional management was

the center of concern for the patients. Even though the HCWs seem to have enough information on disease-related struggles, the patients need to cope with; they often overlook the emotional and environmental factors affecting self-management. Further supporting the need for co-designing services.

I. Queue Management & Record-Keeping Systems

Service-related struggles identified in both phases of this study primarily revolved around challenges stemming from high patient load and poor queue management at TASH, a common issue in many low-resource healthcare systems. While i-Care system was introduced to assist with record management, it did little to address queue management effectively. This mirrors findings from a systematic review conducted in Nigeria's hospital emergency rooms, which concluded that queue-related frustrations could be alleviated by adopting queue management systems (QMS) and hospital information management systems (HIMS)(Sharon Ross and Venkatesh 2016). According to a study on issues related to a QMS used In Nigeria, the authors mentioned how this system aspires to reinvent the experience of waiting in line; replacing it with a practical and pleasurable experience (Baballe and Suleiman 2022). That shows the extent of innovative thinking. However, as with the i-Care system, other studies, such as those from Australia, demonstrate that while HIS are beneficial, they must be coupled with better staff allocation to reduce patient waiting times significantly (Kuek and Hakkennes 2020).

II. Follow-up and Record-Keeping

The lack of a robust record-keeping mechanism for patients results in forgetting important health information during the 4-6 month gaps between appointments. In the cases where patients improvised and used notes to keep a record, it is hard for them to voice or show their record affecting patient satisfaction. In a systematic review, "communication with the patient" has been considered a critical factor for researchers influencing patient satisfaction (Ferreira et al. 2023). To facilitate effective patient-centered care, patients must engage in comprehensive discussions regarding their self-care strategies, particularly concerning lifestyle management, with a practitioner who possesses the requisite time and willingness to listen attentively (Rees and Williams 2009). Digital tools like telemedicine have the potential to improve the communication

gap and have the potential to enhance patient empowerment through access to reliable information and monitoring systems, facilitating active involvement in healthcare (Fitzpatrick 2023).

In the context of TASH, besides the long follow-up time, the turnover of residents further exacerbates the discontinuity of care, causing discomfort for patients. Shortcomings related to Residency programs are not unique to Ethiopia. Similar challenges were found in a study conducted in a UK teaching hospital, where frequent resident rotations caused discontinuity in care and patient dissatisfaction (Ellman et al. 2016). This issue is particularly detrimental in chronic disease management, such as diabetes, where regular follow-up and stable patient-provider relationships are crucial for long-term disease control. In the USA "Bright Spots" clinics are tackling this using patient scheduling algorithms that prioritize continuity of care (Dubé et al. 2018) showcasing the immense power of technology in filling current healthcare gaps.

III. Access to Information

Furthermore, access to health education at TASH is highly restricted, requiring patients to attend sessions at specific times, a barrier to those who cannot arrive early. This coupled with the low retention of information reported by HCWs affects the impact of the health education provided. Requiring shift to more accessible methods. In a randomized controlled trial conducted in Bangladesh mHealth, education interventions outperformed traditional health education interventions in enhancing knowledge, adherence to self-management guidelines, and health outcomes for diabetic patients. In this study, mobile health education intervention also positively affects peripheral regions with the potential for replication in managing diabetes and other non-communicable diseases in LMICs (Banu et al. 2023). A similar mHealth solution could potentially be beneficial for TASH, where patients currently struggle to access health education. This platform can also be used to provide service-related information on time and allow remote inquiry about laboratory results or medication availability (Fitzpatrick 2023) improving health outcomes.

IV. Differentiating Information for Self-Management

In terms of diabetes self-management, this study found that although patients believe they have access to information, they struggle to differentiate accurate advice fitting to their unique

condition. The information needs of individuals with diabetes mellitus vary significantly across different subgroups, as highlighted by recent studies employing latent class analysis. This approach allows for identifying distinct patient profiles based on their specific information requirements and psychosocial characteristics, which can inform tailored interventions (Borgmann et al. 2020). At TASH, HCWs should stay cognizant of the different needs across and offer more personalized advice, allowing patients the flexibility to adapt management techniques that best suit their lifestyles. To facilitate this more Kalra et al. (2022) introduced the concept of Integrated Personalized Diabetes Management (iPDM) as a holistic, patient-centered model that personalizes diabetes care. This model aims to streamline therapy and improve outcomes by integrating technology with personalized strategies. A strategy that will allow Institutions like TASH to leverage technology to cater to the individual needs of patients.

V. Emotional Component of Diabetes Self-Management

The emotional component of diabetes self-management significantly influences adherence to self-management, as it was uncovered in this study. During design sessions, it became apparent that patients' emotional states influenced their decision-making processes. Acceptance and Commitment Therapy and Emotion-Focused Therapy were both effective in increasing treatment adherence among cardiac patients, highlighting the role of emotional support in chronic disease management (Aghel Masjedi et al. 2020). A systematic review done on digital counseling environments has demonstrated positive effects on anxiety, depression, and treatment adherence, indicating that innovative approaches can complement traditional methods (Paalimäki-Paakki et al. 2022). Such models could be explored in the context of TASH to enhance patient care outcomes.

VI. Social and Community Support

Finally, the influence of community and social life on diabetes management is a notable finding of this research. Social life plays a vital role in Ethiopian culture, and a lack of community understanding regarding diabetes can impede effective management. This resonates with studies from Ghana; this study explores how social factors affect diabetes self-management among

individuals with type 2 diabetes mellitus. It highlights the importance of understanding patients' perspectives on these influences. Similar to this study Participants shared narratives that revealed various social issues affecting their ability to manage diabetes effectively. These included economic challenges, social support systems, and cultural beliefs (Korsah and Agyeman-Yeboah 2023).TASH could benefit from such community-focused interventions, particularly through initiatives that target broader public awareness of diabetes and its management.

7.2. Design Cycle

When designing digital tools for chronic disease management, particularly diabetes, it is crucial to integrate them seamlessly into patients' daily lives to promote self-efficacy ((Yu et al. 2014)). In this study when designing the scripts and final design the team was cognizant of the burden this could cause and incorporated the TASH service and self-management into one platform as an extension of the clinic's service. This is essential because added burdens from new technologies can discourage consistent use. It was emphasized that poor integration of digital tools into clinical routines leads to decreased usage over time. Successful integration relies on system interoperability, intuitive user interface design, and collaboration between designers and users to minimize workflow stress (Welzel et al. 2023). The key to achieving seamless integration is through collaboration between the designers and the users of the tool. Engaging users in the design process ensures that the final product aligns with their daily needs and expectations (Brankaert 2022).

During the initial phase of this study, we used a script-based prototype to gather insights from HCWs. These insights were focused on patients' perspectives on various technologies for healthcare support. By presenting a range of digital tools, we sought to address the HCWs' skepticism regarding the usability and acceptance of new digital platforms. A multi-country Research Done in Nigeria, Uganda, and Zimbabwe echoes these concerns, where low digital literacy among patients was seen as a barrier to adopting e-health solutions (Nkhoma et al. 2021). Our study attempted to bridge this gap by exploring technologies that could accommodate patients with varying levels of digital literacy even though our last product is a mobile application. We have explored Ideas of using IVR and the use of VCDs was one thing that was discussed as a way to fill the gap in literacy. With the current rise of AI, we can minimize the struggle of dealing with a mobile application instead it will be replaced with a simple Voice command individuals will be

equipped to control and get the platform record to advise them on Diabetes self-management, and possibly give personalized plans to support this journey (Ayesh 2024). All these possibilities need extensive progress in not only having the technology but also the clinically sound reason and way to support the ecosystem (Istepanian et al. 2017). While allowing the paradigm to shift from "algorithmic" to "personalized" care to optimize treatment outcomes (Kalra et al. 2022).

Until the availability of these advanced technologies, making the use of available technologies is the path this team took. In this journey making the platform affordable and designed in a way that it is the extension of the services provided at TASH to minimize the financial burden. Making the platform culturally relevant was considered and is reflected in the consideration of religion to guide individuals on fasting sessions based on their religion. Similar approaches have been successful in a project done in the USA with participants identified as Hispanic or Mexican, who had less than a ninth-grade education. Under project Dulce which illustrates the feasibility of affordable digital adaptations of culturally relevant programs to enhance accessibility to diabetes and cardiovascular education and yield significant patient outcomes (Paul et al. 2021).

For the second phase of design, we developed a user interface (UI) using Figma, building on lessons learned from the first phase. We integrated the concept in a way that it is possible to seamlessly integrate with the existing electronic medical record (EMR) system at TASH, allowing data from the i-Care system to inform patients about hospital services, medication availability, and queue management. This approach aligns with findings from a study conducted in Sweden, giving patients access to their records, which is even more aggressive than what we have proposed here. It faced mixed feelings from professionals in primary care and concerns from professionals at the outpatient clinics (Wass and Vimarlund 2019).

The platform we designed also offers patients a way to record symptoms, medication, laboratory results, and home test results, which is critical for continuous self-management. As it was evidenced by, a systematic review conducted showed that self-monitoring tools within digital platforms could significantly improve patient outcomes, particularly in chronic disease management (Mushcab et al. 2015). In addition to the record-keeping features, our platform provides health education content accessible at any time, an element that studies in the United States have shown to enhance patient knowledge and adherence to treatment plans (Paul et al. 2021). Furthermore, our platform includes tools for exercise and food logging, which align with

findings from the USA, where individuals to decrease obesity used such tracking features and reported improved adherence to both diet and exercise regimens (Butryn et al. 2020).

Overall, our approach to co-design and the iterative development of a user-centered platform reflects best practices from similar projects globally. By involving users from the outset and integrating the platform with existing hospital systems, we aim to minimize the friction of new technology while enhancing patient self-management and satisfaction. These findings echo global best practices that emphasize user collaboration and system integration as key factors in the successful deployment of digital health solutions.

7.3. Rigor cycle

The rigor cycle of this study outlines the iterative processes undertaken to refine the design, emphasizing how each iteration contributed to the overall development of the digital tool. With the limited resources, we incorporated the element of testing ideas before the design phase. In design science research, such iterations not only improve the specific artifact but also enhance the domain knowledge base (Hevner et al. 2004). The approach we used of testing ideas and the involvement of different stakeholders aligns with findings from studies in Australia, which underscore the importance of iterative co-design in improving the applicability of digital health tools across different healthcare contexts (Woods et al. 2018).

During phase one of the test stage, three major themes emerged the usefulness of digital tools, the medium of use, and the importance of alarm and record-keeping functionalities. In our study, participants saw the value of technology, even though some expressed reservations about more advanced options.

During phase one of testing a diabetes self-management tool, three central themes emerged the perceived usefulness of digital tools, the preferred mediums of use, and the value of alarm and record-keeping functionalities. Participants recognized the utility of these tools for tracking and managing their health, though some voiced caution about complex features (Persson et al. 2023). The research underscores that usability and personalized information quality are essential to the adoption of such tools, particularly for those with diabetes who benefit from accessible, reliable digital health interventions (Larbi et al. 2021). Alarm and record-keeping features have been particularly impactful, as seen in studies where interventions like SMS reminders and tailored app alerts significantly improved medication adherence and engagement in self-care routines

(Georgieva et al. 2023). This structured functionality aligns with user needs for manageable, intuitive systems, supporting effective self-monitoring and timely adjustments in diabetes care.

The use of IVR emerged as a viable solution for participants with lower digital literacy. Studies indicate that IVR systems tailored for users with lower digital literacy can improve accessibility significantly. For instance, an IVR system in Burkina Faso provided health information in local languages, achieving a usability score of 78.75, highlighting the importance of language localization for low-literate users (Some et al. 2022). These findings suggest that localized, user-centered design can mitigate language barriers, enhancing engagement even among populations with lower technological proficiency. This finding suggests that such technologies could be adapted to suit the local needs of populations like the one in our study.

Participants also reported using other recording methods for home tests. Such as paper logs, rarely shared this information with their physicians. Patients are far more likely to continue with a self-management support program over time when it is based on a positive relationship with their HCW and when it is viewed as an extension of their care (Fisher and Dickinson 2011). Our findings underscore the need for HCWs to become more aware of and utilize the data that patients already collect.

Interestingly, despite the study group being deemed less technologically adept, their willingness to adopt digital tools was notable. Studies in South Africa, for example, reveal that while many patients view mHealth as beneficial, the high cost of mobile devices, internet access, and necessary glucose-monitoring tools limits accessibility (Petersen et al. 2020). Language barriers and low awareness of mHealth resources also persist, necessitating educational outreach that addresses local language and cultural contexts (Takenga et al. 2014). Similarly, in regions like Senegal and Uganda, financial constraints significantly affect diabetes care, highlighting the need for community-driven initiatives that provide affordable solutions and leverage traditional knowledge systems to foster understanding and adoption of health technologies (Bekele et al. 2020). These approaches demonstrate that strategic stakeholder partnerships and contextually appropriate designs can enhance diabetes management, even in resource-limited settings.

In summary, this work began as an idea and evolved into a design with significant potential to be adopted by institutions such as TASH. The insights gathered throughout the rigor cycle provided a deeper understanding of the holistic patient experience in diabetes self-management and healthcare services, contributing to the broader conversation on digital health innovation. Research

across various regions shows that digital health tools centered on patient needs can significantly enhance chronic disease management when tailored to local contexts. In resource-limited settings, such as Ethiopia, integrating culturally sensitive, patient-centric digital solutions is particularly effective for diabetes self-management, empowering patients with accessible and contextually relevant tools. Despite infrastructural and economic challenges, such interventions are shown to improve health outcomes by fostering sustained engagement and adherence to self-care practices (Manyazewal et al. 2021). Thus, implementing technological solutions with a patient-centered approach offers a promising pathway for enhancing diabetes care and promoting self-management in under-resourced settings.

8. STRENGTH AND LIMITATION

This study followed a systematic approach to design a digital tool based on insights gathered from diabetic patients and healthcare providers at TASH. By carefully documenting the challenges and pain points faced by patients and the healthcare system, we were able to ensure that the introduction of digital tools addressed these issues in a meaningful way. This approach allowed us to collect a comprehensive range of data on the services at TASH and the self-management needs of diabetic patients, which could also inform future improvements in the hospital's overall service delivery, even beyond the scope of the proposed digital tool.

However, the study does have limitations. Due to time and resource constraints, we were unable to conduct a usability test on the final design, which will be an essential step once additional resources are available. Additionally, the design is currently only available in English, and translating it into local languages to meet the needs of all patients was not feasible within the allocated timeframe. Finally, while the design presents a conceptual solution, it requires further resources and development to transform it into a fully functional application that can be implemented at TASH.

9. CONCLUSION

This study demonstrates the potential of digital tools to enhance the self-management of chronic health conditions, particularly diabetes, by aligning with the daily needs and routines of patients. Through the co-design process, we were able to ensure that the resulting tool reflects the preferences and pain points of both patients and healthcare providers, making it a valuable resource that complements existing healthcare practices without adding unnecessary complexity or burden. By integrating patient perspectives into the design, we highlighted the importance of creating tools that not only support medical management but also foster a sense of empowerment and control over one's health.

The insights gained from this study provide a deeper understanding of the challenges patients face in managing diabetes and offer valuable guidance for improving the design of digital health tools in similar settings. These findings are relevant not only to the development of tools for diabetes management but also for other NCDs and broader e-health applications. The lessons learned here can inform the work of digital health professionals, quality improvement experts, and developers seeking to create more effective and user-centered solutions.

For TASH, this platform can serve as a foundation for disseminating trusted health information to the community, thereby expanding its impact and promoting greater engagement in health management. Moreover, it opens the door for healthcare workers to leverage technology in delivering more efficient and accessible care. Ultimately, the design presented in this study reflects the key insights of our participants, offering a solution that directly addresses their concerns and needs, while demonstrating the promise of digital tools to improve chronic disease management in resource-limited settings.

10. RECOMMENDATIONS

Based on the findings and discussions from this study, the following recommendations are made to enhance both healthcare service delivery and the development of digital health tools provided for the key stakeholders:

Recommendations for Tikur Anbessa Specialized Hospital (TASH) Management:

1. **Improve Empathy and Care:** Train HCWs to provide more empathetic, patient-centered care.
2. **Enhance Service Continuity:** Address staff rotation and improve patient follow-up through integrated digital tools.
3. **Leverage Technology:** Use digital platforms to expand healthcare services and support remote care.
4. **Utilize Digital Health Education:** Use mobile/web platforms for accessible, reliable health education.

Recommendations for Digital Health Tool Developers:

1. **Use Co-Design Methods**: Involve both HCWs and patients in the design process to meet real needs.
2. **Test Concepts Early:** Validate assumptions with real users before finalizing designs**.**
3. **Simplify User Experience:** Design easy-to-use, intuitive tools for diverse patient populations.
4. **Include Local Language Support:** Translate the tool into local languages for better accessibility.

Recommendations for Researchers:

1. **Conduct Usability Testing:** Evaluate the digital tool's real-world effectiveness and integration.
2. **Assess Long-Term Impact:** Study the long-term effects on patient health outcomes and self-management.
3. **Expand Study Scope:** Involve a larger, more diverse sample for broader insights.
4. **Evaluate Barriers to Adoption:** Identify and address technological and socioeconomic barriers to adoption.

5. **Collaborate with Policymakers:** Work with policymakers to create frameworks for digital health integration.

Recommendations for Policymakers:

1. **Support Digital Health Integration:** Develop policies to encourage the use of digital tools in healthcare systems.
2. **Foster Public-Private Partnerships:** Promote collaborations to scale digital health solutions.
3. **Allocate Resources for Localization:** Ensure resources are available for localizing tools to meet national health needs.

Recommendations for Healthcare Workers (HCWs):

1. **Adopt Technology for Patient Engagement:** Integrate digital tools into daily practice for better patient support.
2. **Provide Ongoing Feedback:** Regularly provide feedback on digital tools to improve their effectiveness.

These recommendations aim to enhance the development and adoption of digital tools for chronic disease management, improving patient outcomes and healthcare service delivery**.**

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12. ANNEX

Annex I: Combined Framework Table: Design Thinking Modes with the Information Systems Research

Cycle in ISR	Mode/s of design thinking	Why do they integrate well
Relevance	Empathies	All DT modes and the ISR relevance cycle aim at theorizing the requirements for the artifact. Modes have end-user satisfaction and feedback as criteria, while cycles are less defined in this respect.
	Define	The collaboration of researcher and practitioner or end-user is emphasized in the modes of design thinking, particularly during the empathies mode.
		The lack of clarity of acceptance criteria in ISR can be addressed through end-user engagement and empathy, emphasized in DT.
Rigor	Test	The rigor cycle adds to the knowledge base which includes experiences and expertise, as well as existing artifacts and processes. Thus, testing, which includes engagement with end-users (who have relevant experience), and the evaluation of artifacts, suits the function of the rigor cycle.
		(Hevner Alan 2007) argues that theory is not enough and that different sources of information e.g. end-users and field testing, assist in providing rigor to the research.
		Testing can be used by researchers to evaluate the functionalities (and success) of an artifact. Testing can thus be seen as a requirement to meeting health objectives, instead of having the theoretical reasoning for why an artifact works competing for significance. By entering the end-user, one can use information gathered during testing as evidence of potential
Design	Ideate	The iterative nature of both DT and ISR accommodates the main function of the design cycle. The ideate and prototype modes of DT facilitate the creation of artifacts, a shared characteristic with the design cycle, but quickly and using few resources. The costly and time-consuming nature of ISR framework prototyping is thus alleviated
	Prototype	DT centers the end-user throughout the design process. This allows for the participation of practitioners during technical development, a collaboration the ISR does not specify.

Annex II: The Amharic and English version of Study Participants Informed Consent Form

Annex II.1: English version of informed consent

College of Health Sciences

School of Pharmacy

Department of Pharmaceutics and Social Pharmacy

"Design Considerations and Usability Test of a Mobile Application/ digital tool to Support Diabetic Patients Self-Management: A Design science research"

Semayawit Bahiru

Dear participant, Greetings!

Thank you very much for your time and kind permission to speak with me. My name is Semayawit Bahiru. I am a postgraduate student at Addis Ababa University, College of Health Sciences School of Pharmacy, Department of pharmaceutics and social pharmacy in the field of pharmacoepidemiology and social pharmacy. The title of my research is "**Design Considerations and Usability Test of a Mobile Application/Digital Tool to Support Diabetic Patients Self-Management: A Design Science Research**" which is Funded by Addis Ababa University. You are being asked to take part in this research that aims to assess design considerations of individuals living with diabetics to support them in self-managing their diseases using digital tools. This consent form contains information about the research stated above. To be sure that you are informed about being in this research, we are asking you to read this consent form.

Taking part in this study is voluntary

Your participation in the study is completely voluntary and you can refuse to answer any question at any time, for any reason, if you decide so. Any decision you make will not bring you any penalty or loss of benefits, and will not affect your relationship with the organization.

Please review the rest of this document for more details about this study and the things you should know before deciding whether to participate in this study.

Why is this study being done?

Diabetes self-management has been considered a cornerstone of diabetes care and is believed to play an important role in preventing micro and microvascular complications. The effort to bring in acceptable and useful solutions to support patients in their day-to-day activities of coping with the disease requires the user's involvement to facilitate and understand the needs

of the end-user and the health care worker to direct the design in a way it results in better clinical outcomes. You were selected as a possible participant because your presence in the clinic will inform the study and result in better design.

How many people will take part?

If you agree to participate, you will be one of the key informants from the DM clinic (DM center) of Tikur Anbessa Specialized Hospital, located in Addis Ababa, and a Minimum of 4 key informants will be selected from each profession which gives a total of 12 participants taking part in this research interview.

What will happen during the study?

If you agree to be in the study, I will take notes of your comments but it might be difficult to capture all of your comments. Hence, in order not to miss any of your comments, I need your permission to use a tape recorder.

How long will I be in the study?

The interview will take once and the proposed duration is about 30 to 60 minutes.

What are the risks of taking part in the study?

While participating in the study, the risks, and/or discomforts include:

- A risk of completing the interview is being uncomfortable answering the questions.
- No guarantee of decision made by policymakers based on the present study's conclusion,
    1. But we will try to complete a conclusion very precise to the truth we find.
- However, please do not hesitate to ask any uncomfortable or if you do not want to answer a particular question.

What are the potential benefits of taking part in the study?

We don't expect you to receive any benefit directly after taking part in this study, but we hope to learn things that will help policymakers in the future.

How will my information be protected?

Efforts will be made to keep your personal information confidential. We cannot guarantee absolute confidentiality. Thus, we assure you the information in the report does not identify you as the respondent. The information you provide me will be kept confidential it will be shared with the research team when needed only.

Will my information be used for research in the future?

Information collected from you for this study will never be used for future research studies or shared with other researchers for future research.

Will I be paid for participation?

You will not be paid for participating in this study.

Will it cost me anything to participate?

There is no cost to you for taking part in this study. You will not be responsible for these study-specific costs:

Can I withdraw from the study?

If you decide to participate in this study, you can change your mind and decide to leave the study at any time in the future.

Participant's consent

In consideration of all of the above, I give my consent to participate in this research study. I will be given a copy of this informed consent document to keep for my records. I agree to take part in this study.

Participant's Name:_____

Participant's Signature:_____**Date**:_____

Name of Person Obtaining Consent:_____

Signature of Person Obtaining Consent:_____**Date**:_____

Annex II.2: Amharic Version of Informed Consent

አዲስ አበባ ዩኒቨርሲቲ

ፋርማሲ ት/ ቤት

ተሳታፊዎችን ቃለ-መጠይቅ ማድረጊያ መመሪያ

ውድ ተሳታፊ፣ ሰላም!

በቅድሚያ ከዕርሶ ጋር ለመነጋገር ስለሰጡኝ ጊዜ እና መልካም ፈቃድ በጣም አመሰግናለሁ፡፡ እኔ ሰማያዊት ባሀሩ እባላለሁ፡ ፡ በአዲስ አበባ ዩኒቨርሲቲ ፋርማሲ ት/ቤት የሁለተኛ ድግሪ ተማሪ ስሆን፤ የመመረቂያ ጽሁፌን "**ለስኳር ህመምተኞች ራስን በራስ ለማከም የሚደገፍ የሞባይል መተግበሪያ/ዲጂታል መሳሪያ ዲዛይን እና የአጠቃቀም ሙከራ፡ የንድፍ ሳይንስ ጥናት**" ርዕስ በአዲስ አበባ ዩኒቨርሲቲ የገንዘብ ድጋፍ በመስራት ላይ እገኛለሁ፡፡ በዚህ ጥናት ይሣተፉ ዘንድ በአክብሮት እየጠየቅንዎ ነዉ፡፡ አጥኚ ሰዎች ጥናት የሚሰሩት በማሕበረሰቡ ዉስጥ ከስኳር ህመምተኞች ጋር የሚኖሩ ግለሰቦች ዲጂታል መሳሪያዎችን በመጠቀም ህመማቸውን እራሳቸውን እንዲቆጣጠሩ ለመርዳት የንድፍ ሀሳቦችን ለመገምገም እና ለሚፈጠሩ ተግዳሮቶች መልስ ለማግኘት እንዲረዳቸዉ ነዉ፡፡ ይህ የፈቃድ ቅጽ ከላይ ስለተገለጸው ምርምር መረጃ ይዟል። ይህን የስምምነት ቅጽ በጥንቃቄ እነዲያነቡት እንሰጥዎታለን፡፡ ይህን ካነበቡ በኋላ በዚህ ጥናት ለመሳተፍ ፈቃደኛ ስለመሆን አለመሆንዎ ያሳዉቁናል፡፡ ያልገባዎ ወይም ግልፅ ያለሆነ ነገር ካለ እባክዎ በየትኛዉም ሰዓት ይጠይቁን፡፡

በዚህ ጥናት ውስጥ ስለመሆንዎ መረጃ እንዳሎት እርግጠኛ ለመሆን፣ ይህን የስምምነት ቅጽ እንዲያነቡ እንጠይቅዎታለን።

ቀጥሎ ሙሉ ዝርዝር መረጃ አቅርበናል ማለትም ወሳኔ ከመወሰንዎ በፊት ማወቅ ያለብዎትን ነገሮች ያትታል፡፡ እባክዎትን በትኩረት ይመልከቱት

በዚህ ጥናት ላይ የሚሳተፉት በዕርሶ በጎ ፈቃድ ብቻ ነዉ

ዕርስዎ በዚህ ጥናት የሚሳተፉት ሙሉ በሙሉ በዕርስዎ ፈቃደኝነት ላይ ተመሰረተን ሲሆን ማንኛዉንም ጥያቄ በየትኛዉም ሰዓት፤ በምንም ምክንያት አለመመለስ ይችላሉ። ነገር ግን ለመሳተፍ የሚወስኑት ዉሳኔ በምንም ዓይነት መልኩ በዕርሶ ላይ ቅጣት፤ የሚያጡት ጥቅም ወይም ከመሥሪያ ቤትዎ ያሎትን ግንኙት ተፅዕኖ አያደርስርም፡፡

የጥናቱ ዓላማ ምንድነዉ?

የስኳር በሽታን ራስን በራስ ማከም ለስኳር በሽታ እንክብካቤ ዋና ተገቢ ተግባረ ተደርጎ የተወሰደ ሲሆን ጥቃቅን እና ማክሮ የደም ቧንቧ ችግሮችን በመከላከል ረገድ ትልቅ ሚና ይጫወታል ተብሎ ይታመናል። በዕለት ተዕለት ሕይወታቸው ውስጥ ታካሚዎችን ለመደገፍ በራሳቸውተቀባይነት ያለው እና ጠቃሚ መፍትሄዎችን ለማምጣት በሚደረገው ጥረት የተጠቃሚውን ተሳትፎ ለማመቻቸት ፤ ለዋና ተጠቃሚው እና ለጤና አጠባበቅ ሰራተኛው ንድፉን በተሻለ ክሊኒካዊ ውጤት በሚያስገኝ መንገድ ለመምራት የተጠቃሚውን ተሳትፎ ይጠይቃል፡፡ ዕርሶ ለዚህ ጥናት የታጩትበት ምክንያት በክሊኒኩ ያሎት የሥራ ኃላፊነት/ክፍል እኛ ለምንፈልገዉ መረጃ ጥሩ ምንጭ የሆናል ብለን ስላመንን ነዉ፡፡

ምን ያህል ሰዎች በዚህ ጥናት ይሳተፋሉ?

በዚህ ጥናት ለመሳተፍ ከወሰኑ ዕርስዎ ከጥቁር አንበሳ ሆስፒታል ከተለያየ የሙያ መስክ የተዉጣጡ ሰዎች አንዱ ይሆናሉ ማለት ነዉ፡፡ ከእያንዳንዱ የሙያ መስክ ቢያንስ 4 ሰዉ የሚሳተፍ ሲሆን በጠቀላላ ቢያንስ 12 ሰዉ በዚህ ጥናት ተሣታፊ ይሆናል ማለት ነዉ፡፡

በቃለ-መጠይቁ ወቅት ምን ይከወናል?

በዚህ ጥናት ለመሳተፍ ፈቃደኛ ከሆኑ በቃለ-መጠይቁ ወቅት በፍጥነት የምንነጋገረውን ሁሉ በማስታወሻ መዝግቦ ለማስቀረት ስለሚያስቸግር መቅረፀ-ድምፅ (ቴፕ-ሪከርደር) ብመጠቀም እንዲፈቀድልኝ በትህትና እጠይቃለሁ፡፡

<u>በዚህ ጥናት ለምን ያህል ጊዜ እቆያለሁ?</u>

ቃለ-መጠይቁ አንድ ጊዜ ብቻ የሚከወን ሲሆን ከጊዜዎት ደግሞ 30- 60 ደቂቃ አካባቢ የሚወስድ ይሆናል

<u>በዚህ ጥናት መሳተፍ ምን ዓይነት ስጋት ያመጣል?</u>

በዚህ ጥናት በሚሳተፉበት ወቅት ሊያጋጥዎ የሚችል ስጋት/ምቾት ማጣት የሚከተሉት ናቸዉ

- ለጥያቄዎቻችን መልስ ለመስጠት ምቾት ማጣት ወይም ጥያቄዎቹ ላያስደስቶት ይችላል፡፡.
- በዚህ ጥናት ማጠቃለያ ግኝት ላይ ተመስርቶ ፖሊሲ አዉጪዉን አካል ዉሳኔ ማወቅ አይቻልም
    1. ነገር ግን ዉሳኔዎቻቸዉ ተገቢ እንዲሆኑ የዚህ ጥናት ዉጤት መሬት ላለ እዉነት የተጠጋ እንዲሆን እንጥራለን፡፡
- ከጥያቄዎቻችን መሃል ያለተስማማዎት ያለ እንደሆነ ወይም ለጥያቄዉ መልስ መስጠት ካልፈለጉ እባክዎትን ለማሳወቅ ወደ ኋላ እንዳይሉ፡፡

<u>በዚህ ጥናት መሳተፌ ምን ዓይነት ጥቅም ላገኝ እችላለሁ?</u>

በዚህ ጥናት በመሳተፍዎ በቀጥታ የሚያገኙት ጥቅም የለም፡፡ ነገር ግን ይህ ጥናት ለፖሊሲ አዉጪ አካላት ግብዓት ሊሆን ይችላል፡

<u>የመረጃ ሚስጥራዊነት እንዴት ይጠበቃል?</u>

አሁን የምንነጋገርባቸው ነጥቦች ሁሉ ሙሉ በሙሉ በምስጢር ለሚጠበቅ አስቸጋሪ ቢሆንም ከምርምር ቡድኑ ውጭ ለማንም የማይገለጹ እና የማይሰጡ ይሆናሉ። ቃለ-መጠይቁን መሰረት በማድረግ የሚወጡ ሪፖርቶች/ዘገባዎችም የርስዎን ስም የማይጠቅሱ ይሆናሉ።

<u>እኔ የሰጠሁት መረጃ ወደ ፊት ለሌላ ጥናት ይሰጣልን?</u>

ከዕርሶ የምናገኘዉን መረጃ ለማንም እና ወደ ፊት ለሌላ ጥናት በፍፁም እንደማይሰጥ እናረጋግጣለን፡፡

<u>ለተሳትፎዬ የከፈለኛል ወይ?</u>

በዚህ ጥናት በመሳተፍዎ የሚያገኙት ክፍያ አይኖርም፡፡

<u>ለዚህ ጥናት ለመሳተፍ የማወጣዉ ወጪ ይኖራል ወይ?</u>

በዚህ ጥናት ለመሳተፍ ምንም ዓይነት ክፍያ አይጠየቁም፡፡ ለዚህ ጥናት ለሚወጣ ወጪም እንዲሁ ኃላፊነት አይወስዱም፡ ፡

<u>ከዚህ ጥናት መዉጣት እችላለሁ?</u>

በዚህ ጥናት ለመሳተፍ ከወሰኑ በኋላ ቃለ-መጠይቁ ወቅት ከጥናቱ ለመዉጣት ሀሳብዎን በቀየሩ ሰዓት መዉጣት ይችላሉ፡

<u>የተሳታፊ ስምምነት</u>

ከላይ የተቀመጡትን ሃሳብ በማገናዘብ፤ በዚህ ጥናት ለመሳተፍ ስምምኔትን አስቀምጣለሁ፡፡ የዚህን የስምምነት ሰነድ ቅጂ የሚሰጠኝ የሆናል፡፡

የተሳታፊ ስምምነት:_____

_____

የተሳታፊ ፊርማ:_____ _____ቀን:

_____ _____

የአጥኚዉ ስም:

_____

የአጥኚዉ ፊርማ:_ _____

_____ቀን:_____ ___

Annex III: Healthcare Workers Interview Guide Questions

Annex III.1. **English version of** Healthcare Workers Interview Guide Questions

College of Health Sciences

School of Pharmacy

Department of Pharmaceutics and Social Pharmacy

Healthcare workers interview Guide Questions (English version)

Instruction: the following Healthcare worker's interview Guide questions are intended to be used to collect in-depth information from Healthcare workers in the DM clinic about their expectations about self-management digital tools and current interactions. Code no: _____

Name of the Interviewer: _____

Date of interview: _____

Part 1: Key Informants Profile

1. Gender a. Male b. Female
2. Age :_____(in years)
3. Profession

   A. Pharmacist B. Physician C. Nurse D. Others specify: _____
4. Work experience :_____(in year)
5. Position: _____

Part 2: Physicians/Clinical Pharmacists Interview Questions

- In your opinion what is the best-expected outcome when treating patients with diabetes?
- What kind of diabetes complications do you look for on your routine follow-up?
  1. What kind of advice do you give patients to prevent this complication or to catch it early?
  2. What do you advise patients in regards to monitoring these complications so that they won't get worse?
- How do you assess the level of compliance from patients to the advice you give them?
  1. Why do you think some patients respond well and follow the advice and some don't?
  2. In your opinion what do you think will improve patient compliance?

- How do you think the current system is supporting patients to achieve their goals?
    1. What is lacking in the current system?
    2. In your view what can be done to improve their experience at the clinic?
- How are patients responding to the current clinic scenarios? What do they complain the most about?
- What is your opinion regarding the use of digital tools/phone applications to support diabetic patients?
    1. What do you think would hinder the use of digital tools?
    2. Do you think patients would find it useful?
- If so, what kind of information/features do you expect to be included in the digital tool?
    1. What kind of information should be available for the patients on the tool?
    2. Any features that can help you assess the patient's status? Compliance/adherence?
- From your point of view, are there any relevant aspects or questions that you feel should be addressed, but haven´t mentioned thus far?

Annex III.2. Amharic version of Healthcare Workers Interview Guide Questions

አዲስ አበባ ዩኒቨርሲቲ

ፋርማሲ ት/ ቤት

መመሪያ፡-የሚከተለው የጤና ባለሙያዎች ቃለ መጠይቅ መመሪያ ጥያቄዎች በዲያቢቲክ ክሊኒክ ውስጥ ካሉ ባለሙያዎች ስለራስ ህክምና አስተዳደር ዲጂታል መሳሪያዎች እና ስለ ወቅታዊ መስተጋብር የሚጠብቁትን ተግባር ላይ ጥልቅ መረጃ ለመሰብሰብ ጥቅም ላይ እንዲውሉ ታስበው የተዘጋጁ ናቸው።

ኮድ ቁጥር: _____

የጠያቂው ስም: _____

የቃለ መጠይቁ ቀን: _____

ክፍል 1፡ <u>ስለ ቃለመጠይቅ ሰጪው አጠቃሊይ መረጃ፡</u>

1. ጸታ 1. ወንድ 2. ሴት
2. ዕድሜ: :_____(አመት)
3. ሙያ

1. ፋርማሲስት 2. ሐኪም 3. ነርስ 4. ሌሎች ይገልጻሉ።: _____

4. የስራ ልምድ :_____(አመት)
5. የስራ ድርሻ: _____

ክፍል 2፡ <u>የቃለ-መጠይቅ መምሪያ</u>

- በእርሶ እይታ የስኳር በሽተኞች በሚታከምበት ጊዜ ጥሩ ወይም ይተሻለ ውጤት ነው ተብሎ ይሚታየው ምንድን ነው?
- በመደበኛ ከትትልዎ ላይ ምን ዓይነት የስኳር በሽታ ውስብስቦችን ይመለከታሉ?

ሀ. ለታካሚዎች ይህንን ውስብስብ ችግሮች ለመከላከል ወይም ቀደም ብሎ ለመያዝ ምን ዓይነት ምክር ይሰጣሉ?

ለ. ይህን ውስብስብ ሁኔታ እንዳይባባስ ክትትልን በተመለከተ ለታካሚዎች ምን ይመክራሉ?

- ለታካሚዎች የሚሰጧቸውን ምክሮች የመቀበሉን እና የመተግበሩን ደረጃ እንዴት ይገመግማሉ?

ሀ. ለምን ይመስላችኋል አንዳንድ ሕመምተኞች ጥሩ ምላሽ ይሰጣሉ እና ምክሩን ይከተላሉ እና አንዳንዶቹ ደግሞ አያደርጉም፡፡

ለ. በእርስዎ አስተያየት ታካሚዎች የተሰጣቸውን ምክር እንዲተገብሩ ምን ቢደረገ ያሻሽላል ብለው ያስባሉ?

- አሁን ያለው አሰራር ታካሚዎች አላማቸውን እንዲያሳኩ እንዴት እየደገፈ ነው ብለው ያስባሉ?

ሀ. አሁን ካለው አሰራር ምን የጎደለው ነገር አለ?

ለ. በእርስዎ እይታ በክሊኒኩ ያላቸውን ቆይታ ለማሻሻል ምን ሊደረግ ይችላል?

- ታካሚዎች አሁን ላለው የክሊኒኩ ሁኔታ ምን ምላሽ እየሰጡ ነው? በጣም የሚያማርሩት ነገር ምንድን ነው?
- የስኳር ህመምተኞችን ለመደገፍ የዲጂታል መሳሪያ/የስልክ አፕሊኬሽን መጠቀምን በተመለከተ የእርስዎ አስተያየት ምንድነው?

ሀ. የዲጂታል መሳሪያዎችን ለመጠቀም የሚያደናቅፍ ነገሮች ምን ይመስልዎታል?

ለ. ታካሚዎች ጠቃሚ ሆኖ ያገኙታል ብለው ያስባሉ?

- ከሆነ ምን አይነት መረጃ በዲጂታል መሳሪያው ውስጥ እንዲካተት ይጠቢቃሉ?

ሀ. በመሳሪያው ላይ ለታካሚዎች ምን ዓይነት መረጃ መገኘት አለበት?

ለ. የታካሚውን ሁኔታ ለመገምገም የሚረዱዎት እና በዲጂታል መሳሪያው ላይ እንዲገኝ የምፈልጉት መረጃ ምንድን ናቸው?

- በእርስዎ እይታ፣ መካተት አለባቸው የሚሏቸው፣ ነገር ግን እስካሁን ያልተጠቀሱ ጠቃሚ ጉዳዮች ወይም ጥያቄዎች አሉ?

Annex IV: Focus group discussion facilitator guide

College of Health Sciences

School of Pharmacy

Department of Pharmaceutics and Social Pharmacy

Focus group discussion facilitator guide Phase DT2

IST	**Design thinking phase**	**Needed insights**	Guide questions
Relevance	Empathize	• Identify user needs and challenges • Develop insights	• Icebreaker game • Ask • How are you coping with diabetes? • Is there a need for self-management of diabetes? • Major challenges you are facing when you are practicing diabetes self-management?
	Define	• Identify Major NEEDS to address	• Clustering insights
Rigor	Test	• **Idea Generation**	• What do you think about having diabetes-related health education through a digital tool? • What do you think about recording your symptoms and glucose level on a digital tool? • Would you like to have an alarm set for the medications you take? • How about having an application specifically made for this? • The digital tools can be in the form of a text message that you regularly get or a phone call to your phone.