

The Study on the User Experiences of the M-Health Application "Swayam Diabetes Care" on Android Devices, Qualitative Testing of Its Usefulness and Utility for Self-Care Management of Type 2 Diabetes at Home Settings.

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Abstract

The Swayam Diabetes Care mobile application was developed to facilitate self-care management for those with type 2 diabetes in an urbanhome setting. This Android-based mobile application was designed to keep the user at the center of its design functionality and features. The development of Swayam Diabetes Care prioritized a user-centric approach, and qualitative sequential research was conducted with a sample size of n=18 participants. This study involved in-depth interviews and evaluated the initial version of the Swayam Diabetes Care application. The qualitative sequential study also received input from a sample of n=55 participants on the SUS globally tested tool on the usability and utility assessment of this application. For complete self-care management, the application was filled by n=250+ users. This application encompassed several aspects such as maintaining a daily diary, monitoring nutrition intake and food consumption, engaging in regular exercise, adhering to prescribed medication regimens, and utilizing information on nutrition informatics available with the app. The aim was to enhance adherence to self-care activities related to self-care management. This study aims to identify the key characteristics that users consider relevant in the self-care management application "Swayam Diabetes Care." To evaluate the program, they employed the well-recognized System Usability Scale (SUS) tool for the evaluation of the usability of this application. This article presents findings from a study that utilized qualitative research methodology, specifically in-depth interviews (IDIs), to gather data from a sample of 18 participants. Out of the total sample size n=18, 10 individuals identified as male, accounting for 55% of the participants, while 8 individuals identified as female, constituting 45% of the participants. The participants, who had an average age of 50 years (standard deviation = 14), were individually interviewed utilizing the IDI technique. Among the sample of n=18 participants, most respondents, exceeding 40%, reported having type 2 diabetes for a duration of fewer than five years. Additionally, eight participants, representing 35% of the sample, reported having the condition for a period ranging from five to ten years. Furthermore, three respondents, constituting 20% of the sample, reported having type 2 diabetes for more than ten years. Three themes were found in qualitative research based on the analysis of the interview data. The study resulted in the identification of three overarching qualitative themes and the impact of different diabetic self-management features, individuals' requirements, preferences, and expectations, and elements that influence users' degree of engagement with the designed application, highlighting the need for personalized features rather than generic features of the m-health application.

Key Words: Users center design, Human-centered designed application, Self-care management, T2DM, Human-centered designs, self-care-oriented mobile apps

Introduction

The focal points of this study are the design principles that prioritize the needs and preferences of users, particularly in the context of self-care management for individuals with Type 2 Diabetes Mellitus (T2DM). Specifically, the research focuses on the development of human-centered designed applications that aim to enhance self-care practices. These applications are meant to be user-friendly and tailored to the specific needs of individuals with T2DM, to promote effective self-care management.[1].Based on a study conducted by Cho et al. (2018), it is projected that type 2 diabetes (T2D), the predominant form of diabetes, will have a global prevalence of 693 million individuals by the year 2045. Research has demonstrated that the adoption and upkeep of diabetes self-management behaviors, including consistent monitoring of blood glucose levels, adherence to a nutritious diet, participation in physical exercise, and appropriate utilization of prescribed medications, can significantly improve outcomes related to diabetes, reduce the occurrence of complications, and enhance overall quality of life [1].The current study has identified a significant research gap about the need for more studies that examine the experiences of individuals and adherence to self-care management and care at home in type 2 diabetes (T2D). The significance of diabetes self-management education and ongoing assistance cannot be emphasized in the one-to-one approach to education maintenance of self-care practices [2]. However, the implementation of face-to-face educational programs is constrained due to resource accessibility, and availability, mobile penetration in the urban context is a great opportunity for self-care management using the mhealth application. According to the study conducted by Scheibe et al. (2015), several factors, including treatment, self-care management attitudes, and existing knowledge, exert an influence on the wants and desires of individuals diagnosed with type 2 diabetes (T2D). For instance, individuals who have recently been diagnosed with diabetes may express a preference for mobile applications that include educational content on the subject [6]. In contrast, those with a greater degree of familiarity with managing and

living with diabetes express dissatisfaction with rudimentary instructional materials and express a need for more sophisticated knowledge and supplementary resources. The user did not provide any text to rewrite. Individuals with a longer duration of diabetes are more inclined to utilize technology to enhance their self-care management practices. Conversely, individuals with a shorter duration of diabetes rely on diabetes self-care management tools to establish their daily routines [5].

The Swayam Diabetes application therefore was designed to facilitate the self-care management of individuals with diabetes by providing features such as monitoring and reminders for daily routines. Additionally, it has a daily diary function that allows users to record and track their food intake and nutritional information. The findings and perspectives derived from the qualitative study were utilized in the development of the Swayam Diabetes Care application, which prioritizes user-centered design principles. The app's usability and utility characteristics were assessed by qualitative techniques on a sample of n=55 individuals, utilizing the System Usability Scale (SUS) as a worldwide instrument. Participants were asked to score the app on a 10-point scale. The qualitative assessment of the System Usability Scale (SUS) indicates that users see health applications designed for their use as valuable, user-friendly, and beneficial. Consequently, the utility and usability aspects of these applications receive scores over 80 on the scale.

Study on mHealth app Swayam diabetes care on self-care management

The primary aim of this study is to examine the utilization patterns of the "Swayam Diabetes App" among individuals diagnosed with diabetes. Specifically, the study seeks to identify the features that users prefer for self-care management of type 2 diabetes, as well as the essential routines for everyday life that contribute to improved disease management within the home environment. The present investigation adopts a qualitative research approach, The primary objective of users is to use a user-centered approach in comprehending the

viewpoints, characteristics, requirements, and preferences of individuals about their utilization of diabetic self-management via mobile health (m-health) platforms. According to the second source, the user did not provide any text to rewrite. Qualitative in-depth interviews are a research method that involves conducting detailed

and comprehensive interviews with participants to get rich and detailed data. The study employed a qualitative-quantitative sequential design, incorporating 18 in-depth interviews and the initial iteration of the Swayam Diabetes Care application [2].

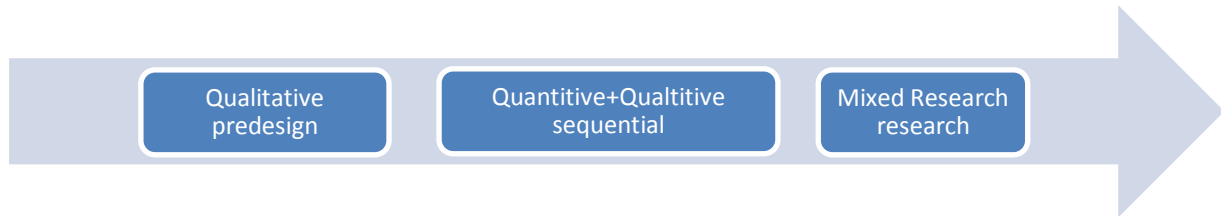


Figure 1: Source Abhijeet P Sinha healthSelf-care management of type 2 diabetes at urban home settings (integrated diabetes system) patent published.

The study conducted a qualitative sequential analysis to gather feedback from a sample size of n=55 users. The focus of the study was on integrated self-care management and the Swayam Diabetes Care application. The application included various features such as a daily diary, nutrition tracking, exercise monitoring, medication intake tracking, and nutrition informatics. These features aimed to enhance adherence to self-care activities and improve self-care management. According to the second source, the objective of this study is to ascertain the key elements that users see as significant and pertinent for the self-care management application "Swayam Diabetes Care." The evaluation of this health app was conducted by employing the SUS tool, which is well-recognized and utilized for app testing purposes. The objective of this study is to examine the utilization patterns of the Swayam Diabetes app on mobile devices among individuals with diabetes in their

day-to-day routines over an extended duration. Additionally, the system endeavors to ascertain the users' attributes, requirements, and inclinations about their utilization of the diabetic self-management program.

Description of the Intervention

The Swayam Diabetes Care application was developed to facilitate self-care management for those diagnosed with type 2 diabetes, with a particular emphasis on patient-centric design principles. The mobile application operates on the Android platform. Swayam Diabetes Care was developed with a strong focus on user-centric design principles. Qualitative sequential research was conducted, with a sample size of 18 participants. The study included in-depth interviews to gather data, focusing on the initial iteration of the Swayam Diabetes Care application [3,4]

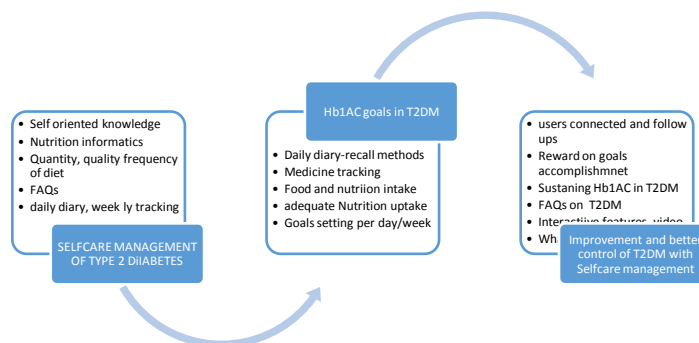


Figure 2: Source Abhijeet P Sinha, Swayam diabetes care HCD design integrated diabetes management system.

In Figure 2, the SWAYAM Diabetes Care m-health application showcases the many options available to users for testing purposes. The study included qualitative sequential methodology and gathered feedback from a sample of n=55 individuals about their comprehensive self-care management practices. This encompassed several aspects such as maintaining a daily diary, monitoring nutrition and food choices, engaging in regular exercise, adhering to medication schedules, and utilizing nutrition informatics tools. The aim was to enhance adherence to self-care activities and improve overall self-care management. The objective of conducting a usability test on the self-care management application "Swayam Diabetes Care" was to ascertain the perceived significance of various features among users. The evaluation of this health app was conducted utilizing the extensively validated System Usability Scale (SUS) instrument. Mixed-methods research uses both quantitative and qualitative methodologies. This study used a mixed research design [2] [4] [7],

using both observational methods and a sequential approach. Mixed methods research may effectively address both the "what?" and "why?" aspects of diabetes, encompassing its fundamental nature and its interconnections.

Self-care in an urban home setting

This study design primarily emphasizes a sequential mixed research approach, using both qualitative and quantitative methodologies [2]. This study employs a mixed research design, wherein both qualitative and quantitative methods are utilized as distinct approaches. The data collected from each component is afterward combined to validate the research results [2]. The study implemented the practice of informed consent and adhered to data protection rules by the study protocol [2]. The user did not provide any text to rewrite. The user's text does not provide any information or context to rewrite academically.

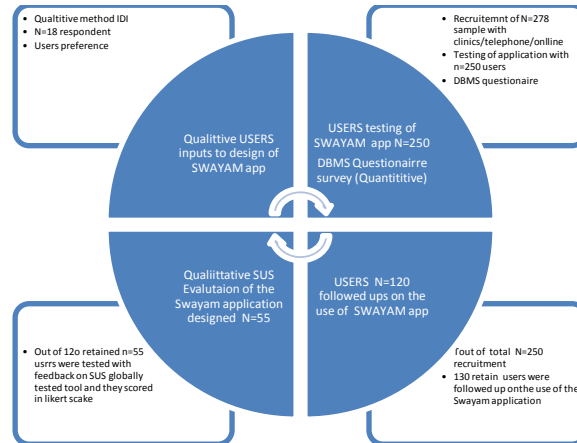


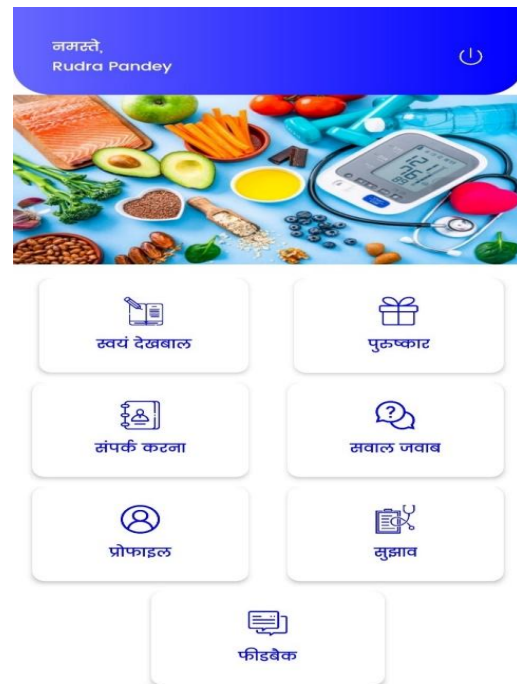
Figure 3. Overall design SWAYAM Diabetes health care for type 2 management at urban home setting (smartphone android users)

Process of gathering information or data

Written informed consent was obtained by all respondents in the local Hindi language. Participants in the study were informed of withdrawal at any point in time and without justifying any reason their reasons for doing so participants were provided with a written consent form in Hindi that outlined

the details of the investigation [2]. Subsequently, they were requested to provide written consent and the consent was read and signed off at the outset of the study. Data on participant characteristics were obtained through a self-administered questionnaire DBMS in the local language Hindi. Additionally, the survey data collection was done for in-depth interviews as part

of their research methodology. The individual in question served for a total of n=18 In-depth interviews that were conducted to attain this saturation point. 18 respondents who were interviewed using IDIs were an average of 50 years old (SD = 14). Ten of them were Male (55%) and eight of them were women (45%). Out of n=18 respondents more than (40%) of them had type 2 diabetes for less than five years, eight (35%) for five to ten years, and three (25%) for more than ten years. Hb1AC not known by users-70% and Hb1AC reported by recall-30% (Table1). Daily diary filled by 55% of users for the pretesting of the questions [4]



प्रतिभागी द्वारा घोषणा

1. मैं इस बात की पुष्टि करता/करती हूँ कि मैंने शोध के जांचकर्ताओं के साथ इस अध्ययन के उद्देश्यों और इसके परिणाम पर चर्चा की है। मुझे इस अध्ययन के संबंध में सवाल करने का समय और अवसर दिया गया था।
2. मैं समझता/समझती हूँ कि वो मेरे और मेरे परिवार के संबंध में जानकारी एकत्र करेंगे और ज़रूरत पड़ने पर आगे कार्यवाही की जाएगी।
3. मैं समझता/समझती हूँ कि मेरी व्यक्तिगत पहचान का खुलासा किए बिना मेरे स्वास्थ्य के बारे में जानकारी एकत्र करने के लिए मेरी केस फाइल के प्रासंगिक अनुभागों को देखा जा सकता है।
4. मुझे पता है कि द्रव के सैंपल या शारीरिक द्रव को मेरे आवश्यक उपचार के लिए एकत्रित किया जाता है, न कि केवल शोध के लिए।
5. एकत्रित द्रव को जांच होने तक अपकेन्द्रित और संग्रहीत किया जायेगा। अप्रयुक्त द्रव को सुरक्षा के दिशानिर्देशों के अनुसार फेंक दिया जायेगा।
7. अध्ययन का परिणाम जानने के लिए मुझे भविष्य में शोधकर्ताओं से संपर्क करने का अधिकार है।
8. मैं इस अध्ययन से उत्पन्न होने वाले किसी भी डेटा या परिणामों के प्रयोग को प्रतिबंधित न करने की सहमति प्रदान करता/करती हूँ, बशर्ते कि ऐसा प्रयोग केवल अध्ययन से संबंधित वैज्ञानिक उद्देश्य (उद्देश्यों) के लिए हो।

सिस्टम उपयोगिता मापन

निर्देश: निम्नलिखित कथनों में से प्रत्येक के लिए, उस एक बॉक्स पर निशान लगाएं जो आज मोबाइल एप्लिकेशन के लिए आपकी प्रतिक्रियाओं के बारे में सबसे अच्छे से बताता है।

- 1-मुझे लगता है, मैं इस मोबाइल एप्लिकेशन का बार-बार प्रयोग करना चाहूंगा/चाहूंगी।
 पूरी तरह असहमत पूरी तरह सहमत
- 2-मुझे यह मोबाइल एप्लिकेशन बेकार में काफी जटिल लगती।
 पूरी तरह असहमत पूरी तरह सहमत
- 3-मुझे यह मोबाइल एप्लिकेशन प्रयोग में आसान लगती।
 पूरी तरह असहमत पूरी तरह सहमत
- 4-मुझे लगता है, मुझे यह मोबाइल एप्लिकेशन प्रयोग करने के लिए मदद की ज़रूरत पड़ेगी।
 पूरी तरह असहमत पूरी तरह सहमत
- 5-मुझे लगता है, इस मोबाइल एप्लिकेशन की विभिन्न कार्यक्षमताओं को अच्छे से जोड़ा गया है।
 पूरी तरह असहमत पूरी तरह सहमत
- 6-मुझे इस मोबाइल एप्लिकेशन में बहुत ज़्यादा असंगति लगती।
 पूरी तरह असहमत पूरी तरह सहमत
- 7-मैं सोच सकता/सकती हूँ कि ज़्यादातर लोग इस मोबाइल एप्लिकेशन को ख़तर नैनी से प्रयोग करना सीख सकते।

प्रदत्त

Table 1: Demographic and clinical characteristics of the participant convenience sample Urban household android users [1]

Total sample
(N=18)

Gender: Male		10 (55%)		
Female		8 (45%)		
Age, years		50±10		
Socio-economic status	BPL	3(21%)		
	Above BPL	15 (35%)		
	Own mobile(android)	18(100%)		
Education,highest level:	Matric	3 (19%)		
	Intermediate	8 (41%)		
	Graduate/Post-graduate	7 (39%)		
Diabetes duration,years		5±7		
Working		75%		
Non-working		25%		
HbA1c:unknown		70%		
HbA1c self-reported %(mmol/mol)		30%		
Registration	Currently	Swayam	100%	1
Diabetes management	app(s)for	self-care		
Yes			55%	
Daily diary filled (daily/ weekly)				

Data interpretation and analysis.

The unprocessed interview data was transferred into NVIVO software for coding and analysis. The process of thematic analysis was conducted by a structured approach consisting of six distinct steps. These steps were guided by predetermined objectives that were identified in the aims of the study.

The steps included: 1) becoming familiar with the given set of information; 2) identifying initial codes and constructing a coding framework; 3) identifying potential themes; 4) aligning the identified themes with the supporting data; 5) defining and assigning names to the themes; and 6) extracting pertinent themes and generating a comprehensive description of the findings [6][8].

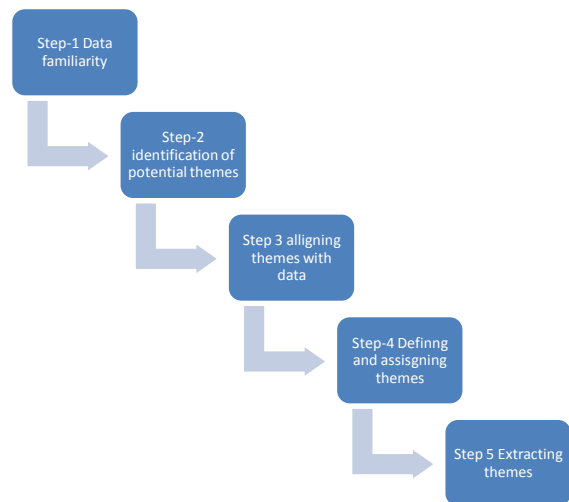


Figure 4: Steps in qualitative investigation and data analysis

Results and Findings

A total of eighteen individuals diagnosed with Type 2 Diabetes (T2D) and access to smartphoneAndroid users were subjected to in-depth interviews. The participants had an average

age of 60 years, with a standard deviation of 14 years. Among the participants, 42% were female. Table 4 provides a comprehensive overview of supplementary participant attributes. The interview participants in the SWAYAM Diabetes care intervention arm exhibited characteristics such as being older, having higher levels of education, possessing a lower baseline HbA1c, and using the app twice as frequently compared to other participants. The average time of the interviews was 90 minutes, with a range of 60 to 90 minutes. The data analysis resulted in the identification of three overarching themes: 1) the impact of different diabetic self-management

techniques on individuals' requirements, preferences, and expectations; and 2) the many elements that influence users' degree of engagement with the application, highlighting the need of personalized approaches rather than a generalized one and 3) how the users can learn from other users about nutrition, daily routine, and applications to answer questions and queries[2][6] The aforementioned sub-themes are delineated and elaborated upon in the subsequent sections, with a concise summary provided in below figure no 5.

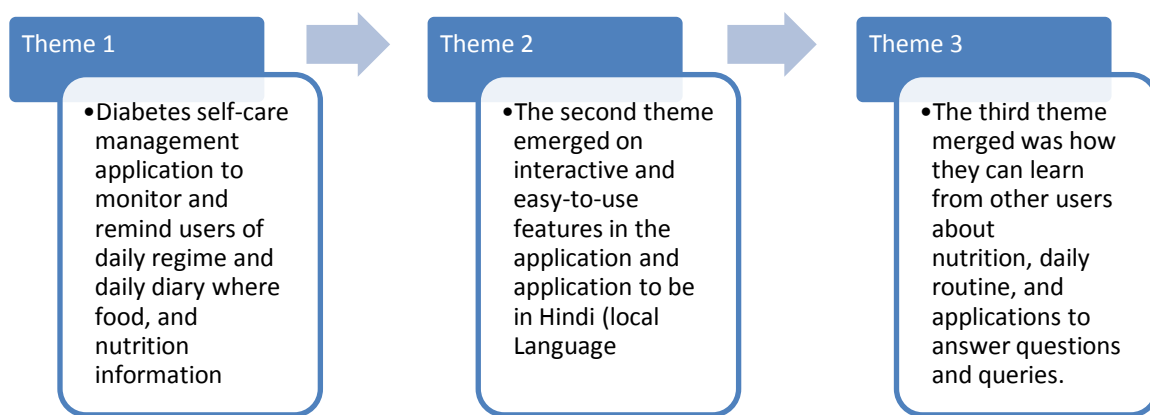


Figure 5: The qualitative themes input to design the user-centered (HCD) Swayam Diabetes Care application.

Theme 1: Diabetes self-care management application to monitor and remind users of daily regime and daily diary where food, and nutrition information. This subject elucidates the diverse range of self-management techniques and their impact on individuals' choices for mobile applications. Respondents and users exhibited varying degrees of autonomy, motivation, and efficacy when describing their diabetes management and knowledge before utilizing the Swayam Diabetes Care app. Out of the total sample size of 18 participants, around 66.6% (n=12) reported that self-care management can be beneficial and consistent to self-care management throughout their lives using mobile. The users preferred, for instance, the use of a daily diary, reminder, food, nutrition, and exercise regime to be part of users choice and inherent motivation if the updated information and knowledge about diabetes A prevalent attribute among the participants was their extensive reliance on

cellphones for a wide range of tasks, coupled with their prior use of health applications to facilitate the attainment of their health-related objectives. In contrast, the remaining n=6 individuals tended towards an externally directed approach and did not actively pursue independent knowledge. [6] However, they exhibited a preference for seeking diabetes-related information from health experts and diabetic associations, and mobile is the preferred platform and they preferred videos and YouTube to be there for new information and knowledge. N=13 72% said WhatsApp features can be useful to be integrated into the application. Due to their failure to actively pursue diabetes-related knowledge upon diagnosis, they expressed a sense of being profoundly disoriented initially, as they lamented the lack of guidance provided by healthcare professionals. When participants were asked N=14, 80% discussed their experiences using the SWAYAM Diabetes app, distinct variations emerged among individuals who exhibited self-

care management features are better compared to other applications as it is easy and in Hindi local language those with an externally directed self-management style, with regards to their requirements, inclinations, and anticipations.

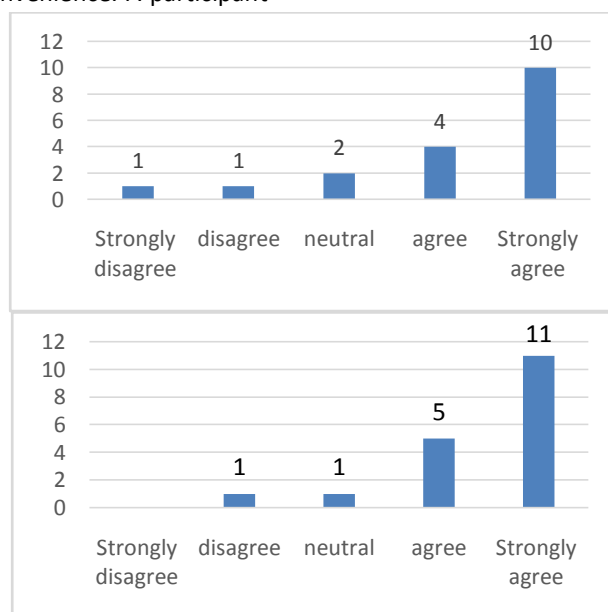
Theme 2: The second theme emerged on interactive and easy-to-use features in the application and the application to be in Hindi (local Language). The individuals expressed their perspectives on the desired features of a diabetes support application, emphasizing the importance of incorporating their existing knowledge and expertise in diabetes management. They emphasized the need for the app to provide information, FAQs, and nutrition local information allowing them to make informed decisions regarding their care. N=13 72% expressed local food, nutrition information, and Hindi content and videos would be helpful for them to understand as a result, a crucial factor considered was the enhancement of decision-making processes through the provision of a seamless mechanism to monitor diverse health-related data sources.

Theme 3: The third theme merged was how they can learn from other users about nutrition, daily routine, and applications to answer questions and queries. N=14 66.66% of users' primary objective in utilizing an application was solely to acquire knowledge. The provision of readily available information eliminates the need for an active search, thus enhancing convenience. A participant

expressed that they would not have engaged in the act of searching due to their inclination towards laziness. Furthermore, participants highlighted instances where they required additional motivation. They expressed a keen interest in delving into a diverse array of subjects, such as the technological advancements in diabetes management and the effects of sugar on muscle tissue. Ensuring the reliability of the information, akin to that found in Cochrane Reviews, was of utmost importance to them. Learning from another person, WhatsApp info, and video on how another person(peer) could improve conditions would stimulate, interactive quizzes, distinctive, and capable of enhancing their level of interest.

Qualitative Evaluation and Results of the SUS Evaluation (Feedback Survey)

The application was judged using the System Usability Scale (SUS), a tool that has been tested a lot around the world. SUS applications can be used to test any kind of system or software, like mobile apps, websites, digital kiosks, computers, and equipment [16]. Based on how well something works and how easy it is to use; it can be given an overall SUS number [17]. The users n=18 health application Swayam diabetes app on usability, ease of use score(graph1), and utility provide information on self-care management.[4]



The study design for SUS tools used qualitative methods to find out how well nutrition and mobile health informatics interventions work for self-care and care at home for type 2 diabetes. The study used FGDs, IDIs, in-depth interviews, and SUS tool tests to collect data. To look at the results, how useful the app is, and how easy it is to use for self-care control of type 2 diabetes at home. The 10-item System Usability Scale (SUS) is simple. SUS is a Likert scale. The SUS form was used to test n=55 people. The overall SUS score for this application's usefulness and ease of use is shown in the table below. $X = 5$, which is the total number of points

for all questions with an odd number. When you add up the points for all questions with an even number, you get $Y = 25$, or 25. Score for SUS = 2.5 times $(X+Y)$. $X = 16.6 + Y + 17.1 = 33.7 * 2.5 = 84.25$ Total score is an A and a great score. SUS Users find health apps that are meant to be useful, easy to use, and helpful. This is shown by the fact that utility and usability scores are higher than 80 on the scale [4]

Conclusion

Patients and users are more likely to be ready for self-management and to use m-Health for self-management of disease if they seem to have some control over their illness. Integrated self-care management of type 2 diabetes using an application with a human-centered design that is made for and by the patient and will help patients handle their care at home. The quality of the app needs to have several features, such as a self-diary where daily entries can be made about diet, exercise, and medicines. Questions for judging oneself DBMS built in, with built-in tools like rewards, setting goals, chat with FAQs and a WhatsApp group. The human-centered design of the m-health application Swayam Diabetes would bring an integrative approach to self-care management to the Chronic Care Model (CCM) in Type 2 diabetes and its management in a home setting. It would also help patients with comorbidities, such as those who have high blood pressure, cardiovascular disease, and diabetes. The m-Health interventions such as Swayam Diabetes Care would help people stick to their self-care management plans. In the future, this application could include a nutrition informatics

module that focuses on local foods as region-specific using AI tools.

Acknowledgments

The only authors and coauthors who worked on this manuscript were the writers, who were given credit for their work.

Authors' Contributions

All the coauthors supported the planning of the study, the creation of the questionnaire, and the writing of the manuscript. They have also all given their permission for the manuscript to be published.

Conflict of Interest

Nothing Declared

Acronyms explained-

- AI- Artificial Intelligence
- Diabetes-management system DBMS
- SWAYAM diabetes care -health diabetes application by lead author
- Human-centered design-HCD-
- Master of Business Administration MBA
- Master's in public health-MPH
- Doctor in Philosophy- PhD
- Dehradun Institute of technology, university Dehradun, India DIT
- Standard Deviation SD
- Scoping review-SCR
- System Usability Scale SUS Global tool
- Focus group discussion Focus group Discussions.
- In-depth interviews IDIs

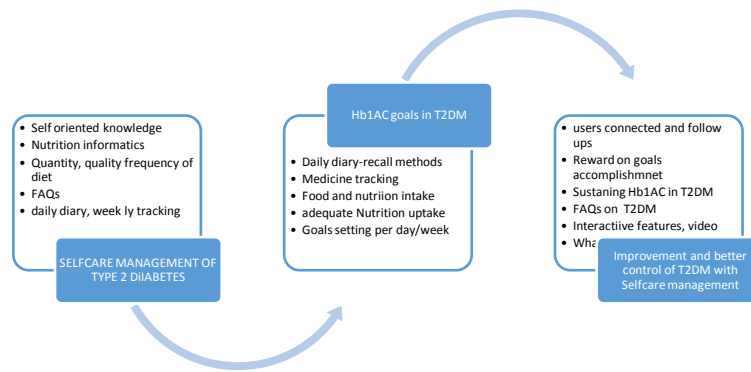
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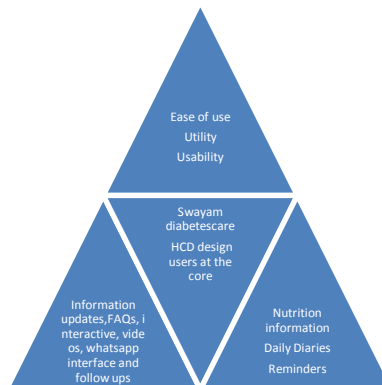
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Annexure 1.

- 1.1 *Figure 1: Source Abhijeet P Sinha healthSelf-care management of type 2 diabetes at urban home settings (integrated diabetes system) patent published.*



1.2 Figure Source Abhijeet P Sinha, Swayam diabetes care HCD design integrated diabetes management system, Patent published.



Annexure 2

Table 1: Demographic and clinical characteristics

		Total sample
		(N=18)
Gender: Male		10 (55%)
Female		8 (45%)
Age, years		50±10
Socio-economic status	BPL	3(21%)
	Above BPL	15 (35%)
	Own mobile(android)	18(100%)
Education, highest level:	Matric	3 (19%)
	Intermediate	8 (41%)
	Graduate/Post-graduate	7 (39%)
Diabetes duration, years		5±7
Working		75%
Non-working		25%
HbA1c: unknown		70%
HbA1c self-reported %(mmol/mol)		30%
Registration Currently Swayam Diabetes app(s) for self-care management	Yes	100% 1
Daily diary filled (daily/ weekly)		55%