Development of Android-based "Manis" application for diabetes mellitus management

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Abstract

Management of diabetes mellitus (DM) requires innovative approaches to improve patient engagement. Android-based applications have the potential to be effective tools for supporting diabetes management through the five pillars of management. This study employed a research and development approach, involving two groups of respondents: app users and a panel of experts. The survey involved 30 users who rated the app's ease of use, performance, and visual appearance using a 5-point Likert scale. Additionally, a focus group discussion with an expert panel consisting of health professionals and application developers was conducted to evaluate the features and potential of the application. The data were analyzed descriptively. The results showed positive feedback from the users. A total of 76.67% of the users stated that the application was easy to use, and 83.33% rated the installation very easy. Navigation scored 80% with easy-to-find features, whereas 83.33% reported that the app ran smoothly. The visual aspect was appreciated, with 86.67% liking this design. The menu layout and content presentation obtained scores of 80% and 76.67%. The panel of experts rated key features, such as blood sugar monitoring, with a score of 87-88%, but suggested improvements to the foot care guide. Android apps for DM management demonstrated positive results in terms of ease of use and visual design. Feature enhancements and tutorial additions are required to improve the user experience. Further research is needed to evaluate the impact of this application on diabetes management.

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Introduction

Most diabetes management applications focus on education and monitoring but lack interactive, personalized features tailored to patients' specific needs, such as diabetes severity, comorbidities, and lifestyle.[1-3] Many existing applications do not include an automatic reminder system to integrate notifications for holistic diabetes management. Digital literacy, especially among the elderly or individuals with lower educational levels, is another overlooked challenge. Furthermore, long-term effectiveness in improving quality of life and reducing complications or hospital readmissions remains limited.[4]

Indonesia is the only Southeast Asian country among the top 10 nations globally with the highest number of people diagnosed with Diabetes Mellitus (DM).[5] The prevalence of diabetes in Indonesia is a significant public health concern, with a projected increase from 9.19% in 2020 to 16.09% in 2045, potentially affecting 40.7 million individuals.[6] The risk factors associated with the prevalence of diabetes in Indonesia include age, family history, body mass index, and triglyceride levels.[7,8] Regency reported a prevalence of 11.9%, exceeding the national average of 8.5%. Diabetes-related complications contribute significantly to mortality, cardiovascular disease, macrovascular complications, and chronic hyperglycemia.[9,10] Rising readmission rates further highlight the need for better diabetes management.[11]

Effective diabetes management relies on five key pillars: healthy diet, regular exercise, stress management, blood sugar monitoring, and adherence to prescribed medications.[12,13] However, many

patients struggle with consistent implementation. Further prospective studies should evaluate the role of these services in terms of these five pillars.[14] A study indicated that Android-based applications offer accessibility, real-time monitoring, and reminders to support patients in managing their condition.[15] Apps positively affect patient knowledge, compliance, and quality of life.[16] However, existing applications often feature outdated information, usability challenges, and a lack of comprehensive notification systems.[17]

Affordability and user-friendliness are crucial for wider adoption, especially among those with limited digital literacy.[16,18] The "MANIS" app, designed for five-pillar diabetes management, incorporates simplified features to improve usability.[19] Addressing gaps in digital literacy and long-term effectiveness, this study seeks to develop an adaptive, inclusive, evidence-based application to enhance diabetes management. Key features include medication reminders, dietary guidance with calorie breakdown, and tools to manage hyperglycemia or hypoglycemia at home. The app aims to reduce hospital readmissions and improve the quality of life for diabetes patients. The objective of this study is to develop and evaluate an Android-based application with an automatic alarm system for managing the five pillars of DM, expected to increase patient compliance in independent disease management.

Materials and Methods

Study design

This study used a Research and Development (R&D) approach with a descriptive design. The method used was the ADDIE model (analysis, design, development, implementation, and evaluation), but only three stages were applied in this study: analysis, design, and development.

Population, sample, and sampling techniques

The study population consisted of inpatients or outpatients diagnosed with DM at Singasana Hospital, Tabanan Regency (Indonesia). Using the Slovin formula, the minimum sample size required was 30 DM-diagnosed individuals at Singasana Hospital who met the following inclusion criteria: i) doctor-diagnosed DM, ii) access to a compatible Android device, iii) written consent for the application trial, iv) willingness to follow research procedures, and v) ability to read and understand instructions in the application and research materials. Excluded were respondents with severe cognitive impairment or significant mental disorders, those with technical difficulties using the Android device or app, and those without technical support for device use.

Data collection

Data from user trials were collected through questionnaires measuring user satisfaction and app effectiveness. The questionnaire was administered to 30 respondents meeting inclusion criteria, including a DM diagnosis and access to an Android device. It evaluated aspects like navigation ease, app appearance, and how well the application assists users in managing the five pillars of DM management. Questionnaire and experts' assessment results were analyzed descriptively by calculating the frequency and percentage of each assessment item. This analysis aims to describe user satisfaction and application effectiveness levels and identify areas needing improvement. The results were used to formulate evidence-based recommendations for further development of an Android-based five-pillar management application for DM management.

Study analysis

A literature review and field study identified user problems and needs in DM management. This analysis includes understanding the management of five DM pillars: healthy diet, regular exercise, stress management, blood sugar monitoring, and prescription drug consumption. Initial data collection from patients, health workers, and experts mapped challenges and solutions in DM management, especially using application-based technology. After expert validation, the application was tested on DM patients through Focus Group Discussions (FGD) involving patients, doctors, nurses, and patients' families. A semi-structured guide was used. The FGD provided insights into the experience of using the application, specifically regarding ease of use, navigation, and benefits in supporting daily DM management. For descriptive statistics, we used frequency and percentage on the questionnaire, which employed a 5-point Likert scale. Qualitative data from the FGD were analyzed thematically to explore user insights into the app's usability and potential improvements.

Results

Table 1 presents the assessments from two material experts, scoring 86.67% (52/60) and 88.33% (53/60). The app excelled in blood sugar monitoring and hyperglycemia treatment recommendations and received the highest scores. However, areas such as foot care and educational guides scored lower (4/5), indicating room for improvement. The second expert noted strengths in hypoglycemia and hyperglycemia treatment, foot care recommendations, and medication settings, with some features improving to 5/5. This suggests that the app has become more comprehensive and better at addressing user needs, while still having areas for further enhancement.

Table 2 shows that media experts rated the diabetes management app highly, with feasibility scores of 92.9% and 95.3%, respectively. Praised for its ease of use and installation, the app featured an intuitive design. Visual presentation was strong, especially regarding text and image clarity, although color and typeface improvements were suggested. Media integration effectively enhances content comprehension, although navigation responsiveness requires refinement. The flexibility of an app for anytime access is a key benefit. The scores improved from 86.67% to 95.3%, placing it in the highest feasibility category (85%-100%), demonstrating continuous enhancement.

Table 3 reveals that user feedback was largely positive, with 76.67% finding the app easy to use and 83.33% rating the installation as very easy. While 73.33% found downloading not difficult, improvements were required. Navigation was rated well, with 80% easily finding features and 83.33% reporting a smooth operation. The visual design received strong feedback (86.67%), although the color selection (73.33%) could be refined. The app effectively supported diabetes management, with 86.67% stating that it helped monitor blood sugar, 83.33% finding it useful for foot condition checks, and 83.33% benefiting from overall diabetes management support.

Qualitative results from internal medicine specialists and expert nurses agreed that the foot examination screening feature in

the app was very easy to use. The app's interface is designed in an intuitive manner, making it easy for users to perform regular checks without any difficulty. This user-friendly design facilitates the screening process, which is essential for regular monitoring of foot health in patients with diabetes.

The results of this study are supported by the following quotes:

"The foot examination screening feature is very easy to use. The app's interface is intuitive, simplifying routine checks." (I1)

"This design is helpful for the screening process, which is crucial for monitoring diabetic foot health." (I2)

Clear and easy-to-follow foot care guide:

"The guide is easy to follow, helping users care for their feet properly." (I1)
"Additional details for special cases, like infections, would enhance its usefulness in complex conditions." (I2)

Facilitating blood sugar monitoring:

"The monitoring feature is easy to use, allowing regular tracking." (I1)
"A simple process ensures compliance in sugar level monitoring." (I2)

Notifications align with clinical recommendations:

"Notifications follow clinical guidelines, ensuring timely monitoring reminders." (I1) "Standardized notifications help patients maintain healthy sugar levels." (I2)

Clear and updated recommendations:

"The treatment and prevention recommendations are easy to understand and align with the latest theories." (I1)
"The app follows current clinical guidelines, ensuring consistency." (I2)
"Updating information with new research is recommended." (I2)

Governance-pillar educational content is structured and easy to comprehend:

"The app presents clear and well-structured educational content." (I1)
"This accessibility is crucial for patient knowledge application." (I2)

Users can independently calculate their calorie needs:

"The calorie calculator allows users to make their own calculations." (I1)
"An automatic calorie calculator would further improve usability." (I2)

Food intake recommendations based on quantity, type, and schedule:

"The diet plan follows structured guidelines on quantity, type, and schedule." (I1)
"Clear guidance on meal timing and composition is valuable." (I2)

Appropriate and feasible physical exercise recommendations:

"The recommended exercises are easy to do and suit user needs." (I1)
"Adding variety to the exercises could enhance user complian-

Table 1. Results of the first and second material expert assessments on the development of management of the five pillars of diabetes mellitus management through Android-based applications.

Item	Statement	Score	
	Foot examination	**Expert 1**	**Expert 2**
1	Easy-to-use foot screening	5	4
2	The foot care guide provided is easy to do	4	4
	Blood sugar monitoring		
3	Blood sugar monitoring is easy to do	4	5
4	Blood sugar monitoring notifications given in accordance with recommendations	5	4
5	The recommendations for treatment and prevention of hypoglycemia given are easy to understand and in accordance with the latest theories	4	5
6	The recommendations for treatment and prevention of hyperglycemia given are easy to understand and in accordance with the latest theories	5	4
	Pillars of governance		
7	The education provided is easy to understand	4	4
8	Foot care recommendations are easy to do and in accordance with the latest theories	4	5
9	Calculating calorie needs can be done independently	5	4
10	The composition of the feed given corresponds to 3 h	4	4
11	The physical exercise provided can be easily done and as needed	4	5
12	Regulate the use of medication according to the recommendations	4	5
	Total score	52	53
	Eligibility proportion	86.67	88.33

ce." (I2)

Guidelines for appropriate medication adherence:

"The app helps patients follow prescribed medication schedules." (I1)
"This is crucial for correct dosage and treatment adherence." (I2)

Expert Media evaluation of usability and navigation:

"Installation and operation are simple, ensuring smooth initial use." (E1)
"Users can easily access functions, contributing to a positive experience." (E2)

Visually appealing and user-friendly design:

"Neat menu layout and high-quality visuals enhance usability." (E1)
"While some improvements are needed, the layout remains professional and balanced." (E2)

Efficient media integration:

"Images support the presented materials well." (E1)
"Navigation speed needs some improvement, but overall, integration is effective." (E2)

Promotion of user engagement and accessibility:

"The app encourages patient curiosity about diabetes management." (E1)
"Its flexibility allows for convenient daily diabetes management." (E2)

Discussion

The development and initial evaluation of the MANIS Android-based application demonstrated a high level of feasibility and user satisfaction for supporting the five pillars of DM management. This study aligns with previous research that emphasizes the critical role of mobile health (mHealth) interventions in chronic disease management, particularly diabetes, through improved self-monitoring, education, and adherence support mechanisms.[1]

User assessments of Android-based diabetes management applications indicate a positive reception. Most users found the app easy to use and install, with minimal downloading challenges. The application was rated highly for its functionality, features that were easily accessible, and reported smooth operation. Visual design was also well received, with users finding it attractive, although improvements in color selection and text-image neatness were suggested. Additionally, the users had no difficulty reading the text and found relevant images. These findings corroborate the existing literature that emphasizes the importance of user-centered design in enhancing digital health engagement.[20] Focusing on user-centered design, digital health interventions for DM can be more effective, user-friendly, and supportive of long-term self-management and health outcomes.

The findings showed that expert evaluations highlighted the app's overall usability and effectiveness; foot screening features were user-friendly, blood sugar monitoring was simple, education on hypoglycemia and hyperglycemia was well-received, and the governance pillar was rated positively for aligning with guidelines; the calorie calculation feature was helpful, physical exercise features were effective, and medication management was functional. However, enhancements like visual aids, customizable notifications, interactive educational content, personalized meal planning, diverse exercise options, and integrated medication support features were recommended to optimize user engagement and diabetes

Table 2. Results of the first and second media expert assessments on the management development of the five pillars of diabetes mellitus management through Android-based applications.

Item	Statement	Score	
	Foot examination	**Expert 1**	**Expert 2**
1	Easy-to-use foot screening	5	4
2	The foot care guide provided is easy to do	4	4
	Blood sugar monitoring		
3	Blood sugar monitoring is easy to do	4	5
4	Blood sugar monitoring notifications given in accordance with recommendations	5	4
5	The recommendations for treatment and prevention of hypoglycaemia given are easy to understand and in accordance with the latest theories	4	5
6	The recommendations for treatment and prevention of hyperglycaemia given are easy to understand and		
	in accordance with the latest theories	5	4
	Pillars of governance		
7	The education provided is easy to understand	4	4
8	Foot care recommendations are easy to do and in accordance with the latest theories	4	5
9	Calculating calorie needs can be done independently	5	4
10	The composition of the feed given corresponds to 3 h	4	4
11	The physical exercise provided can be easily done and as needed	4	5
12	Regulate the use of medication according to the recommendations	4	5
	Total score	52	53
	Eligibility proportion	86.67	88.33

self-management. Similar to previous studies, static educational content has been found to limit user engagement. Experts have emphasized the need for infographics, videos, and real-life case examples to improve knowledge retention and motivation in chronic disease management.[21,22] Incorporating expert recommendations into future versions of the application can significantly enhance its utility not only for patient self-management but also for health professionals delivering telemonitoring or remote education. The findings indicated that healthcare professionals recognized the application's potential to improve patient engagement and routine health monitoring. Integration with electronic medical records is recommended for better access to patient data. However, challenges such as limited patient technological literacy and concerns about data privacy remain. This aligns with prior research showing that privacy concerns are a barrier to the adoption of healthcare technology.[23] Experts have emphasized the need for interactive educational features consistent with the recommendations on chronic disease management.[24] Material experts assessed the application with a feasibility rating of 88.6%, endorsing its efficacy in diabetes management.[12] Media experts provided a feasibility score of 87%, highlighting ease of use and visual appeal.[19]

Regarding benefits, the app significantly aided users in foot examinations, blood sugar monitoring, and governance pillar implementations. This increases diabetes awareness and facilitates overall diabetes management. The app's accessibility was highly rated, supporting Nielsen's Usability Theory,[25] which underscores ease of use and navigation as critical for adoption. These findings align with studies showing that intuitive interfaces enhance user experience,[26,27] while another study highlights the impact of visual design on user interaction.[28] Although color schemes and content neatness received lower ratings, previous research confirms that aesthetics influence user experience.[24,29]

Thus, media integration is a critical factor. Button responsiveness and media quality impact user experience,[30] aligning with Adu *et al.*, who emphasize media integration for user engagement.[31] The app's flexibility in supporting diabetes management corresponds to research demonstrating that flexible health apps improve adherence and disease control.[32,33] However, concerns regarding technology support and information relevance highlight the need for integrated medical guidance and online consultations.[34] The overall positive performance was validated by a survey of 30 respondents, indicating that intuitive design and features, such as diet and medication reminders, help users manage diabetes effectively.[26,35] The app aligns with the principles of Self-Management Support (SMS)[36] and Nielsen's usability principles.[37-39] The primary limitations of this study include restricted testing, as the app remains under researcher control, potentially affecting the evaluation results. Additionally, public trials have not been conducted, which limits insights into broader user acceptance.

Conclusions

The Android-based diabetes management app demonstrated strong feasibility, with expert evaluations rating key features at 87-88%. Blood sugar monitoring and treatment recommendations were well received, although foot care guidance and educational content require improvement. Media aspects scored highly (92-95%) owing to usability and visual appeal. User ratings confirmed the app's effectiveness, with 76.67% finding it easy to use and 86.67% appreciating its visual design, although color adjustments were suggested. Developers should enhance tutorials, reminders, and guidance features, while users should utilize these tools fully

Table 3. Results of user assessments on each item of the management development of the five pillars of diabetes mellitus management through Android-based applications.

Item	Statement	Score					Percentage (%)
		1	2	3	4	5	
1	I find it easy to use this app	0	2	5	10	13	76.67
2	Installation of this application is very easy	0	1	4	11	14	83.33
3	Downloading this app is not difficult	0	2	6	8	14	73.33
4	I can find all the features I need easily	0	1	5	9	15	80
5	The app runs smoothly without a hitch	0	1	4	12	13	83.33
6	The design of this app is very attractive	0	0	4	10	16	86.67
7	The menu layout on this application is well organized	0	1	5	9	15	80
8	The text and images in this app are presented neatly	0	1	6	11	12	76.67
9	The colors in this app are pleasing to the eye	0	1	7	9	13	73.33
10	The typeface used is easy to read	0	0	5	10	15	83.33
11	I had no trouble reading the text in this app	0	0	4	12	14	86.67
12	The images in this application are in accordance with the content conveyed	0	2	5	10	13	76.67
13	The buttons in this app respond quickly when touched	0	1	6	10	13	76.67
14	The images shown support the information provided	0	1	6	9	14	76.67
15	This app helps me check the condition of my legs	0	0	5	12	13	83.33
16	This app helps me monitor my blood sugar	0	0	4	10	16	86.67
17	This app helps me with the implementation of the governance pillar	0	1	5	9	15	80
18	This app makes me more interested in understanding diabetes	0	1	7	9	13	73.33
19	This app helps me in managing diabetes better	0	0	5	10	15	83.33
20	I can use this app anytime and anywhere	0	0	4	12	14	86.67

to achieve better compliance. Future research should focus on broader patient trials, long-term impact assessments, and demographic-specific needs to refine app functionality. Continuous development is necessary for the further implementation and evaluation of this approach.

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