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OPTIMIZATION OF 'GULAKUPEDIA' APPLICATION INTERFACE USING A GOLDEN RATIO APPROACH

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ABSTRACT

The rising number of diabetes mellitus cases in Indonesia has increased the need for mobile health (mHealth) solutions that help people independently monitor their daily sugar intake. The Gulakupedia application was developed for this purpose; however, an initial evaluation involving 31 users produced a System Usability Scale (SUS) score of 67.18, classified as marginal, indicating that the application's interface was not yet optimal in terms of visual comfort and ease of use. This study aims to optimize the Gulakupedia interface design by applying the Golden Ratio principle through a Fibonacci sequence approach as a reference for layout proportion, spacing between elements, and the size of visual components. The development followed the Design Science Methodology (DSM), consisting of problem identification, design using Figma, implementation using Flutter, demonstration, evaluation, and communication of results, supported by a Design Thinking approach during the design stage. The evaluation involved 31 respondents using the SUS, User Experience Questionnaire (UEQ), and a user acceptance questionnaire. The results show an increase in the SUS score to 75.97 (Good category, Acceptable range). All UEQ dimensions obtained positive values above 0.8, with five dimensions in the Good category and one dimension (Perspicuity) in the Above Average category. The overall user acceptance rating averaged 4.48 out of 5. These findings indicate that applying the Golden Ratio through the Fibonacci sequence contributes positively to improving the usability and user experience of an mHealth application interface.

I. INTRODUCTION

Diabetes mellitus is one of the chronic diseases posing a serious threat to global public health. The World Health Organization reported that around 8.5% of the world's adult population had diabetes in 2014, and the disease caused approximately 1.5 million deaths in 2019 [1]. Diabetes also increases the risk of complications such as kidney failure, vision impairment, and heart disease, which reduce patients' quality of life [2]. In Indonesia, diabetes prevalence rose from 6.2% in 2019 to 10.8% in 2021, with an estimated 20.4 million cases in 2024, or about 11.3% of the adult population [3], placing Indonesia among the ten countries with the highest number of diabetes cases in the world.

Mobile health (mHealth) is one of the widely developed approaches to support diabetes management. The use of mHealth applications has been shown to reduce average HbA1c levels by 0.54% in type 2 diabetes patients and 0.63% in type 1 patients compared with conventional methods [4], and to improve adherence to blood glucose monitoring through interactive visual educational features [5]. However, the effectiveness of mHealth applications is not determined solely by functional features but also by the quality of interface design; many users still struggle with data input, icon comprehension, and reading visual reports, which reduces long-term user engagement [6].

Gulakupedia is an mHealth application developed to help the public monitor their daily sugar consumption. It is equipped with features such as automatic daily sugar target determination of 25 grams based on WHO recommendations, consumption logging, food barcode scanning, and daily/weekly consumption visualization. Despite its useful

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functionality, an initial evaluation involving 31 participants produced a SUS score of 67.18, which, according to standard SUS interpretation, falls within the Marginal range and has not yet reached the Acceptable category, indicating that the application's interface had only reached a basic level of functionality and required further improvement.

One approach to improving the visual quality of an interface is the application of the Golden Ratio principle ($\varphi \approx 1.618$), which has been empirically shown to be consistently selected as the most aesthetically pleasing proportion across various visual stimuli and to facilitate cognitive perceptual processing [7]. The Golden Ratio exhibits self-similarity and is an irrational number that is the most difficult to approximate with a rational number, theoretically providing optimal visual stability [8]. In digital interfaces, this principle is commonly applied in practice through a Fibonacci sequence approach to determine the proportions of visual elements [9], since directly applying the 1.618 ratio mathematically is considered less flexible for implementation on mobile device screens.

Related studies have demonstrated the benefits of this mathematical aesthetic approach in various contexts. Applying the Golden Ratio to the layout and typography of a website homepage has been shown to produce a more symmetrical and comfortable appearance [10], applying the Supergolden Ratio to the UI design of a trouble ticket application resulted in excellent UEQ scores for attractiveness, efficiency, and dependability [11], and a mixed-method analysis showed that the systematic application of the Golden Ratio increases user engagement, interaction speed, and visual satisfaction [12]. Meanwhile, a combined SUS and UEQ evaluation of the WeBarangay e-Government system [13] and the Threads application [14] demonstrated the effectiveness of both instruments in providing a quantitative picture of user satisfaction, although without applying a visual aesthetic principle such as the Golden Ratio.

Prior studies on the interface design of digital health applications have mostly focused on functional aspects such as data logging or medical monitoring [15], while mathematical aesthetic principles such as the Golden Ratio have rarely been examined specifically or combined systematically with usability and user experience evaluation in the context of mobile health applications. This study addresses that gap by optimizing the Gulakupedia interface using a Fibonacci sequence approach as a reference for visual element proportions, then evaluating its impact using the SUS [16], [17] and UEQ [18], [19] instruments, along with a user acceptance analysis.

The research problems addressed in this study are: (1) how to optimize the Gulakupedia interface to be more responsive and interactive; (2) how the application of the Golden Ratio can improve the visual balance of UI elements; and (3) to what extent the resulting design increases user engagement in monitoring daily sugar consumption. The objective of this study is to optimize the Gulakupedia user experience through a Golden Ratio-based interface design and to evaluate its effect on the application's usability and user experience, with a scope limited to readability, visual comfort, ease of navigation, and user interaction, without assessing clinical aspects or the medical impact of the application.

II. METHOD

This study uses the Design Science Methodology (DSM) approach, which consists of six stages: problem identification, defining the objectives of a solution, design and development, demonstration, evaluation, and communication of results [20]. The design stage was supported by a Design Thinking approach comprising Empathize, Define, Ideate, Prototype, and Test, to ensure that the resulting solution was human-centered [21].

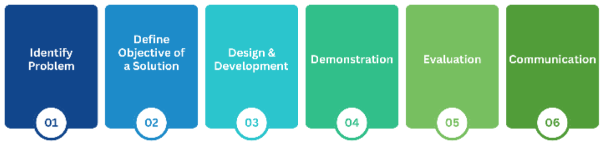

Figure 1. Design Science Methodology

A. Problem Identification and Solution Objectives

The main problem identified was the Gulakupedia application's initial SUS score of 67.18 (Marginal category), indicating that the interface was not yet optimal in terms of visual comfort and ease of navigation. The solution objective was formulated as optimizing the interface using the Golden Ratio principle through a Fibonacci sequence approach to produce a balanced, harmonious, and easily understood appearance, without altering the application's core functionality.

B. Design and Implementation

Formally, two quantities a and b (with $a > b > 0$) follow the Golden Ratio when $(a + b) / a = a / b = \varphi \approx 1.618$. The Fibonacci sequence, defined recursively as $F(n) = F(n-1) + F(n-2)$ with $F(1) = F(2) = 1$, approximates φ increasingly closely as n grows, and was therefore adopted in this study as a practical, implementation-friendly substitute for the exact irrational ratio [8], [9].

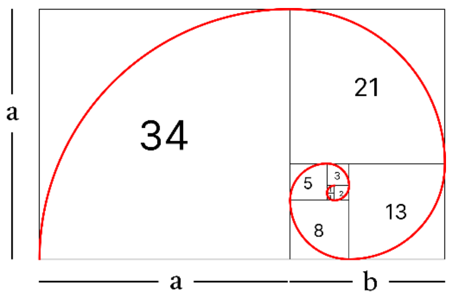

Figure 2. Illustration of the Golden Ratio of the Fibonacci Spiral Proportion

Design was carried out in stages. The first stage was wireframing, used to establish the navigation structure and interaction flow without considering visual aspects, covering the authentication page, the main flow for logging intake, information detail pages, and the profile page. The second stage was a high-fidelity prototype developed using Figma [22], in which Fibonacci sequence values were applied as a reference for padding, margin, icon and button sizes, and the balance between white space and the main content area. The Golden Ratio principle was specifically not applied to typography sizing, since initial testing showed that the resulting contrast in font size impaired readability on mobile screens; the text hierarchy in this study instead follows a modular type scale based on Material Design guidelines.

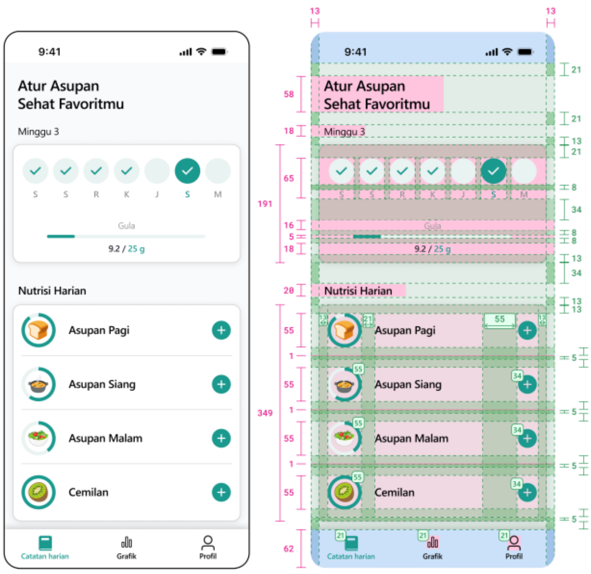

Figure 3. Examples of the Application of the Golden Ratio

The resulting high-fidelity prototype was then implemented as a mobile application using the Flutter framework and the Dart programming language [23], [24], chosen for their support of widget-based, responsive interface development with near-native performance from a single codebase. The Golden Ratio was applied across four aspects of the interface: (1) layout proportion, in which primary information areas such as sugar consumption and visualization charts were given more dominant space than supporting elements; (2) spacing and white space following the Fibonacci sequence to maintain visual consistency; (3) visual hierarchy, in which daily sugar consumption values and primary action buttons were made more prominent through size and position; and (4) balance of visual composition, so that the display would not appear lopsided on one side. These four aspects were consistently applied across all main pages of the application, including authentication and initial data entry, home and intake logging, recapitulation and nutrition detail, and profile and account settings.

C. Participants and Evaluation Instruments

The evaluation involved 31 general users who tried the optimized version of the Gulakupedia application, distributed through a third-party platform (APKPure), and then completed three instruments via Google Form: (1) the System Usability Scale (SUS), (2) the User Experience Questionnaire (UEQ), and (3) a user feedback questionnaire. The comparison with the initial evaluation results is a between-stage comparison on an equivalent general-user population, with some respondents participating in both evaluation stages, rather than a repeated-measures test on identical respondents.

The SUS consists of 10 alternating positive and negative statements on a 1-5 Likert scale. The contribution score for each item is calculated as Xi = Response Score − 1 for odd-numbered (positive) statements and Xi = 5 − Response Score for even-numbered (negative) statements, all contribution scores are summed and multiplied by 2.5 to obtain a final score on a 0-100 scale [16], [17], which is then interpreted based on adjective rating, acceptability range, and quartile range [16].

The UEQ consists of 26 bipolar word-pair items on a −3 to +3 scale, divided into six dimensions: Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, and Novelty [18]. Each dimension's score is calculated as the mean of all items within that dimension; a value above 0.8 indicates a positive evaluation, −0.8 to 0.8 a neutral evaluation, and below −0.8 a negative evaluation, which is then compared against UEQ benchmark data to obtain a quality category of Excellent, Good, Above Average, Below Average, or Bad [19], [25].

The user feedback questionnaire collected an overall rating (1-5), the most-liked features, and development suggestions, which were analyzed descriptively to complement the quantitative SUS and UEQ data. All data were processed using Microsoft Excel.

D. Materials and Tools

The hardware and software used to design, implement, and evaluate the optimized Gulakupedia application are summarized in Table 2. Design work was carried out in Figma [22], implementation used Flutter and Dart [23], [24] within Visual Studio Code, and testing combined an Android emulator with a physical Android device. Questionnaire data were collected through Google Form and analyzed in Microsoft Excel, while the application itself was distributed to respondents through the third-party platform APKPure.

Table 1. Hardware and Software Used

Component	Specification / Tool
Processor	Intel Core i5-12450H
GPU / RAM / Storage	NVIDIA GeForce RTX 2050 (4GB) / 24 GB / 2 TB

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Test device	Android smartphone (Android 10); Android Emulator
Operating system	Windows 11
Design tool	Figma
Development	Flutter, Dart, Visual Studio Code
Data collection & analysis	Google Form, Microsoft Excel
Distribution platform	APKPure

III. RESULTS AND DISCUSSION

A. Interface Implementation

The optimized Gulakupedia interface was implemented using Flutter and Dart across four main groups of screens, described below.

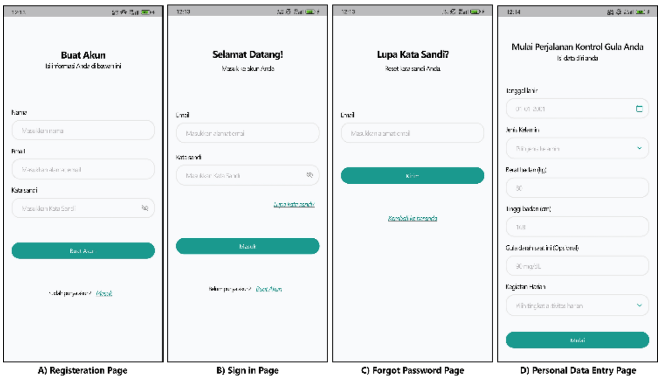

Figure 4. Authentication and Personal Data Entry Screens

Authentication and initial data entry. This group consists of an account registration screen (name, email, and password fields), a login screen, a forgot-password screen, and an initial data entry screen shown right after sign-up. On the initial data entry screen, users provide their date of birth, gender, weight, height, current blood sugar level, and daily activity level, which the application uses to personalize the daily sugar consumption target. Visually, these screens use vertically stacked form fields, a single green primary action button, and generous white space to keep the flow simple for first-time users.

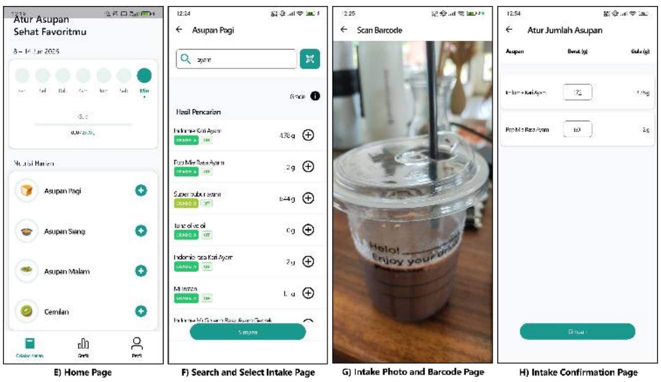

Figure 5. Home Page and Daily Intake Logging Screens

Home and intake logging. The home screen displays the current week's period, a daily progress indicator, and the amount of sugar consumed relative to the daily limit, letting users check their status at a glance. Below it, four intake categories - breakfast, lunch, dinner, and snacks - are each provided with an add button. Selecting a category opens a food search screen with a search field, a barcode-scan button, a results list, and each food's sugar grade and content; users may search manually or scan a product barcode as a faster alternative. After a food item is selected, an intake-confirmation screen lets the user set the consumed weight in grams and shows the resulting sugar value, with the save button placed at the bottom of the screen for easy reach.

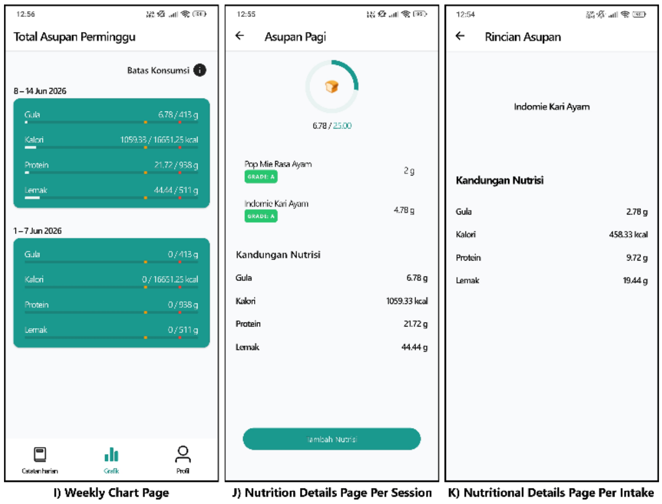

Figure 6. Recapitulation and Nutrition Detail Screens

Recapitulation and nutrition detail. The recapitulation screen presents weekly totals for sugar, calories, protein, and fat, each shown as a progress indicator against the corresponding daily limit. A per-category detail screen (e.g., breakfast) lists the specific foods logged, the total sugar consumed, and a nutrient summary using a circular progress display, while a per-food detail screen presents the sugar, calorie, protein, and fat content of a single item in a simple, clearly spaced layout.

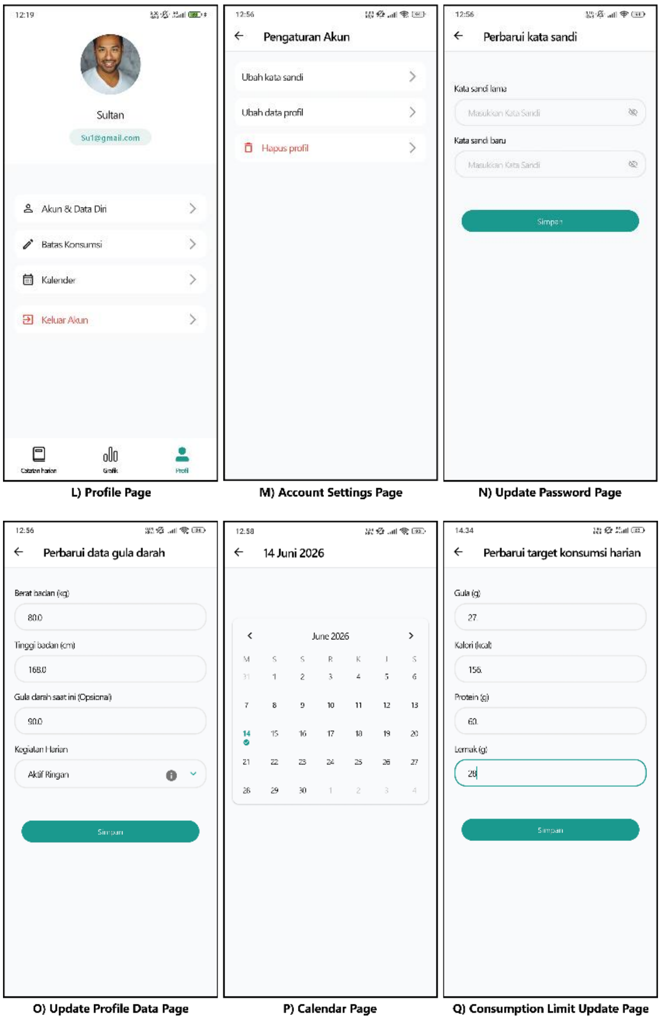

Figure 7. Profile and Account Settings Page

Profile and account settings. The profile screen shows the user's photo, name, and email, together with menu entries for account and personal data, consumption limits, a calendar view, and logout. From the account settings menu, users can update their password through a two-field form (old and new password), edit their personal data (weight, height, blood sugar, and activity level), or delete their profile. A separate screen allows users to adjust their daily consumption targets for sugar, calories, protein, and fat according to personal needs or medical advice.

Across all four groups, layout proportions, spacing between elements, sizes of interactive components, and white-space balance were arranged according to Fibonacci sequence values, resulting in a layout that is more proportional and focused, more consistent in spacing, clearer in visual hierarchy, and more stable in overall composition compared with the previous version.

B. *Usability Analysis Result (SUS)*

SUS testing with 31 respondents on the optimized interface produced a mean score of 75.97 (median 77.5, standard deviation ≈ 14.1, range 42.5-100), which according to Bangor et al.'s interpretation falls into the Good category and the Acceptable range [16]. Compared with the initial evaluation score of 67.18 (Marginal category), this represents an increase of 8.79 points following the Golden Ratio-based interface optimization, as summarized in Table 1.

Table 1. Comparison of SUS Scores Before and After Optimization

Evaluation Stage	SUS Score	Category
Before optimization	67.18	Marginal
After optimization	75.97	Good / Acceptable

This improvement indicates that a more proportional and structured interface design helps users understand the application flow, increases interaction efficiency, and eases navigation between features, consistent with findings that Golden Ratio proportions can correct layout imbalance and strengthen a sense of symmetry in interface design [10].

C. *User Experience Analysis Results (UEQ)*

UEQ testing with 31 respondents showed that all six dimensions obtained positive mean values above 0.8 (overall mean ≈ 1.63), as detailed in Table 2.

Table 2. UEQ Benchmark Calculation Results and Categories

Dimension	Mean Value	Category
Attractiveness	1.796	Good
Perspicuity	1.718	Above Average
Efficiency	1.685	Good
Dependability	1.516	Good
Stimulation	1.669	Good
Novelty	1.371	Good

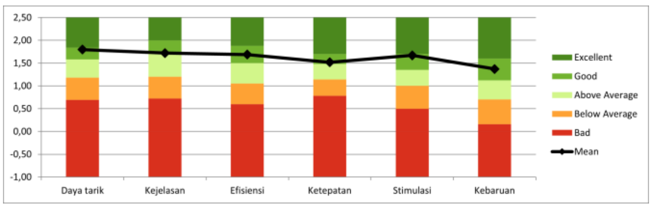

Figure 8. UEQ Six-Dimension Benchmark Chart

The Attractiveness dimension obtained the highest value (1.796), indicating an overall positive impression of the application's appearance; this result is consistent with studies showing that the Golden Ratio is consistently chosen as the most aesthetically pleasing proportion across various visual stimuli [7]. The Perspicuity dimension (1.718) falls into the Above Average category, indicating that the application is reasonably easy to understand, although there remains room for improvement in label clarity and feature guidance. The Novelty dimension obtained the lowest value (1.371), consistent with a pattern observed in other studies where the novelty aspect tends to score lower than other dimensions [11], [13], representing an opportunity for further development, for example through more distinctive visual elements or interactive features.

D. User Acceptance Analysis

The overall rating of Gulakupedia as an mHealth platform averaged 4.48 out of 5 (16 respondents gave a score of 4 and 15 respondents gave a score of 5, with no scores below 4), consistent with the highest Attractiveness value obtained in the UEQ. Table 3 summarizes the features most appreciated by respondents.

Table 3. Most-Liked Features Reported by Respondents

Feature Category	Respondents
Sugar consumption monitoring and logging	11
Nutrition information and sugar grading	5
Weekly visualization chart	4
Interface appearance and color composition	3
Intake quantity adjustment	2
Food search	2
Other features	4

Table 4 summarizes the development suggestions submitted by respondents.

Table 4. Development Suggestions Reported by Respondents

Suggestion Theme	Respondents
More food data variety	6
Improved food search feature	4
Integration with other services (Google account, AI, health apps)	4
Additional features (password recovery, reminders, educational articles)	4
Dark mode	3
Minor visual refinement (icon colors, polish)	2
Application already good / no suggestion	8

Several respondents specifically highlighted the interface appearance as neat and visually comfortable, while one respondent noted that the application still felt somewhat complex immediately after installation, suggesting that first-time onboarding could be further simplified.

Overall, the consistency between the increased SUS score, positive values across all UEQ dimensions, and high user acceptance reinforces the conclusion that Golden Ratio-based interface optimization through the Fibonacci sequence contributes positively to the usability and user experience of an mHealth application, consistent with findings in other application domains [11], [12], [14].

IV. CONCLUSION

The application of the Golden Ratio principle through a Fibonacci sequence approach was successfully used to optimize the interface of the Gulakupedia application, covering layout proportion, spacing between elements, component sizing, and white space balance, without being applied to typography in order to preserve readability. Evaluation with 31 respondents showed an increase in the SUS score from 67.18 (Marginal) to 75.97 (Good/Acceptable), all six UEQ dimensions scored positively above 0.8 with five dimensions in the Good category and one dimension (Perspicuity) in the Above Average category, and user acceptance averaged 4.48 out of 5. These findings indicate that a Golden Ratio-based mathematical aesthetic approach can be an effective and easily implementable strategy for improving the usability and user experience of an mHealth application.

From a practical standpoint, these findings suggest that mHealth developers facing similar interface-related usability complaints can adopt Fibonacci-based proportioning as a low-cost, framework-agnostic redesign strategy that primarily concerns layout, spacing, and component sizing rather than new functionality. This is particularly relevant given that many reported mHealth usability issues stem from input difficulty, icon ambiguity, and visual report readability rather than missing features [6], suggesting that visual-proportion interventions such as the Golden Ratio can directly address a documented class of user complaints without the cost of a full feature rebuild. From an academic standpoint, this study extends prior Golden Ratio literature - previously applied mainly to websites, internal tools, and e-Government systems [10]-[13] - into the mobile health domain, providing one of the first quantitative usability/UX evaluations of a Fibonacci-based redesign specifically for a diabetes self-management application. These results are also consistent with the broader push toward digital health innovation across Indonesia and Southeast Asia, where usable, well-designed mobile interfaces are viewed as a practical enabler of technology adoption in resource-constrained healthcare settings [27].

Future research is recommended to involve a larger and more diverse group of respondents, including users with specific medical conditions; to apply a before-after evaluation design on identical respondents accompanied by statistical testing to more convincingly demonstrate the causal effect of the Golden Ratio; and to explore combining the Golden Ratio with other design principles to improve the Novelty dimension, which obtained the lowest score in this study.

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