Journal of Intelligent Decision Support System (IDSS) 9 (2) (2026), pp. 89-98

Published by: Institute of Computer Science (IOCS)

Journal of Intelligent Decision Support System (IDSS)

Journal homepage: www.idss.iocspublisher.org

NutriSee: A Rule-Based Mobile Application for Personalized Dietary Planning Using Indonesian Food Composition Data

Ryan Christian Fabian Rattu[1], Salvius Paulus Lengkong[2], Salaki Reynaldo Joshua[3]

[123] *Informatics Engineering Study Program, Faculty of Engineering, Universitas Sam Ratulangi, Manado, Indonesia*

Article Info

Article history:

Received May 30, 2026
Revised Jun 18, 2026
Accepted Jun 29, 2026

Keywords:

Body Mass Index;
Flutter;
Menu Recommendation;
Mobile Application;
Rule-Based System.

ABSTRACT

Nutritional problems in Indonesia show a concerning trend, with adult overweight and obesity prevalences reaching 14.4% and 23.4% (2023 Indonesian Health Survey). However, existing mobile nutrition applications commonly rely on static macronutrient ratios, lack transparent decision-making mechanisms, and do not incorporate localized Indonesian food composition data, limiting their practical relevance for Indonesian users. This study aims to develop NutriSee, a mobile application for determining dietary patterns based on Body Mass Index (BMI) classification. The application was built using the Rapid Application Development (RAD) method, Flutter framework, and Firebase Firestore. The system implements BMI calculation (WHO Asia-Pacific standards) alongside Basal Metabolic Rate and Total Daily Energy Expenditure calculations utilizing the Mifflin-St Jeor equation. A rule-based system generates five daily meal recommendations based on users' caloric and macronutrient targets, using the Indonesian Food Composition Table (TKPI 2020) database. Black Box Testing with Boundary Value Analysis and Equivalence Partitioning passed all 33 scenarios. User Acceptance Testing involving 30 respondents yielded "Very Good" acceptance rates of 89.33% for functionality and 84.40% for usability. These findings indicate that NutriSee functions effectively and remains accessible for practical use, enabling Indonesian adults to independently plan and manage their daily dietary intake based on localized food composition data.

Corresponding Author:

Ryan Christian Fabian Rattu,
Informatics Engineering Study Program,
Universitas Sam Ratulangi,
Jl. Kampus UNSRAT Bahu, Kleak, Kec. Malalayang, Kota Manado, Sulawesi Utara, 95115, Indonesia.
Email: ryanrattu026@student.unsrat.ac.id

Introduction

At the global level, the World Health Organization reported in 2022 that approximately 2.5 billion adults were overweight, including 890 million classified as obese, a figure more than double that recorded in 1990 (World Health Organization, 2025). Nutritional problems in Indonesia show a complex and concerning trend across all age groups. According to the 2023 Indonesian Health Survey (Survei Kesehatan Indonesia/SKI), undernutrition was also present in younger populations, and the prevalence of overweight and obesity among adults over the age of 18 was 14.4% and 23.4%, respectively (Kementerian Kesehatan Republik Indonesia, 2023). This phenomenon of double burden of malnutrition reflects a fundamental shift in dietary patterns and lifestyle among the Indonesian population. Research by (Syauqy et al., 2020) further confirms that daily dietary choices, particularly

high consumption of processed foods, fried foods, and sugary beverages, are positively associated with the increased of Body Mass Index (BMI) and waist circumference, reinforcing the need for practical nutritional guidance tools.

The advancement of mobile technology has demonstrated considerable potential in addressing nutritional challenges. A systematic review by (Scarry et al., 2022) found that 60% of examined studies reported improvements in diet quality through the use of mobile applications, with the most notable behavioral changes being increased fruit and vegetable intake. Despite this potential, existing mobile nutrition applications exhibit recurring limitations in supporting personalized and locally relevant nutritional planning needs of Indonesian adults.

In addition to the growing body of literature on mobile nutrition interventions, the development of NutriSee is also supported by a series of previous studies conducted by the authors in the fields of nutritional monitoring, mobile health, and digital healthcare systems. Previous research introduced Health to Eat, a smart plate system integrating artificial intelligence, computer vision, food recognition, food classification, and weight measurement technologies to support automated nutritional assessment and dietary monitoring through food identification and nutrient estimation (Joshua, Shin, et al., 2023). The study demonstrated the potential of intelligent technologies in assisting users to better understand food composition and nutritional intake.

Therefore, NutriSee represents a continuation research efforts toward the development of intelligent and accessible digital nutrition solutions that support healthier dietary decision-making among the adult population.

To address these limitations, this study aims to develop NutriSee, a mobile-based application designed to determine personalized dietary patterns based on BMI classifications. The application incorporates BMI calculations based on the WHO Asia-Pacific standards, alongside Basal Metabolic Rate (BMR) and Total Daily Energy Expenditure (TDEE) using the Mifflin-St Jeor equation (Mifflin et al., 1990). Furthermore, a Rule-Based System is applied to generate structured daily meal recommendations divided into five meal sessions, following the energy distribution guidelines (Melani et al., 2022). To ensure local relevance, nutritional data are sourced directly from the Tabel Komposisi Pangan Indonesia (TKPI) 2020.

The selection of a Rule-Based System over Machine Learning was aligned with the study objectives. Nutritional recommendations, including BMI classification, calorie estimation, and macronutrient distribution, are based on established nutritional guidelines and can be implemented through explicit rules without predictive model training. Additionally, a rule-based approach offers greater transparency and interpretability, enabling users to understand how recommendations are generated.

Based on the identified gaps, this study addresses the following research question: How can a mobile-based Rule-Based System be developed and evaluated to provide personalized daily meal recommendations for Indonesian adults using local food composition data?

NutriSee is theoretically anchored in the integration of several well-established scientific paradigms. The application utilizes a Rule-Based System, a knowledge-driven methodology that relies on conditional "if-then" logic to formulate decisions. This circumvents the computational demands typically associated with machine learning models while demonstrating proven efficacy in nutritional decision-support environments (Çelik Ertuğrul et al., 2021; Shandi et al., 2021; Swarna et al., 2023). For anthropometric evaluation, the platform employs the BMI. BMI continues to be the predominant metric for assessing nutritional health and stratifying the risk of chronic illnesses (Khanna et al., 2022), making it highly suitable for tracking individual progress within personalized diet interventions (Y. Wu et al., 2024).

Furthermore, the system uses the Mifflin-St Jeor equation to estimate resting energy expenditure due to its higher accuracy than the Harris-Benedict model across normoweight and obese populations. Macronutrient allocation follows the World Health Organization framework, recommending 10–15% protein, 15–30% fat, and 45–75% carbohydrates (World Health Organization, 2026). Finally, the application's meal scheduling structure is based on previous studies regarding metabolic health, dietary quality, and meal timing. This structure emphasizes the importance of breakfast and incorporates strategically timed meal sessions and snacks to support healthier dietary

patterns (Almoraie et al., 2021; Bermingham et al., 2024; Lopez-minguez et al., 2019; Qorirah & Rahayu, 2024).

This study is expected to develop a functional mobile application tailored to Indonesian users to support adults in understanding their nutritional status and planning personalized healthy diets. Theoretically, NutriSee contributes by implementing a Rule-Based System for personal nutrition management, integrating standardized nutritional calculations into a mobile platform, and utilizing TKPI data within a recommendation system. System quality and usability are evaluated through Black Box Testing using Boundary Value Analysis (BVA) and Equivalence Partitioning (EP), along with User Acceptance Testing (UAT), to assess functional validity and user acceptance.

Method

This study applies the Rapid Application Development (RAD) method with an iterative development approach in the development of NutriSee, a mobile application for determining dietary patterns based on BMI classification. RAD is part of the Software Development Life Cycle (SDLC) and was introduced as an alternative to the traditional Waterfall model. According to (Dennis et al., 2012), RAD emphasizes faster system development through the use of specialized tools and techniques that accelerate the analysis, design, and implementation processes, allowing users to evaluate the system in shorter development cycles.

RAD was selected because it was developed to address the limitations of waterfall approaches by enabling faster development cycles and earlier user evaluation. Through iterative development, users can provide feedback on early versions of the system and contribute to subsequent refinements. This approach aligns with the needs of this study, which involved continuous adjustments based on supervisor input and user feedback during development

The development process consisted of three stages: Planning, Analysis, System Version Iterations as described in Figure 1.

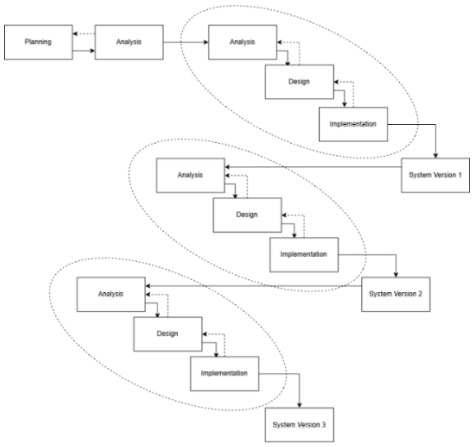


Figure 1. Rapid Application Development Iterative Development

Figure 1 shows the development process consisted of three stages: Planning, Analysis, and System Version Iterations. Software testing was conducted at the end of the system version iteration.

The Planning stage identified the system's functional and non-functional requirements. Functional requirements included user input for age, sex, height, weight, activity level, and macronutrient preferences; BMI calculation based on WHO Asia-Pacific standards in equation(1); BMR in equation(2) and equation(3), and TDEE calculation using the Mifflin-St Jeor equation in equation(4), menu recommendation generation through a Rule-Based System, and food database management through a web admin interface. Non-functional requirements included usability, responsiveness, and real-time cloud data management through Firebase Firestore.

$$BMI = Weight\ (kg) \div Height\ (m)^2 \quad (1)$$

$$BMR\ male = (10 \times Weight) + (6.25 \times Height) - (5 \times Age) + 5 \quad (2)$$
$$BMR\ female = (10 \times Weight) + (6.25 \times Height) - (5 \times Age) - 161 \quad (3)$$
$$TDEE = BMR \times Activity\ Level \quad (4)$$

Table 1. Activity Level for TDEE

Activity Level	Factor
Sedentary	1.2
Lightly Active	1.375
Moderately Active	1.5
Very Active	1.725
Extra Active	1.9

The Analysis stage translated the requirements into system architecture, database structures, interface designs, and workflow models represented through Use Case Diagrams and Activity Diagrams. The Firebase Firestore database consisted of two primary collections: makanan and users. The makanan collection stored Indonesian food composition data sourced from the TKPI 2020, including energy, carbohydrate, protein, fat, category, preparation condition, and image data. Only cooked, processed, or ready-to-consume foods were used for recommendations. The food composition database used in NutriSee is sourced exclusively from the Tabel Komposisi Pangan Indonesia (TKPI) 2020, an official reference published by the Indonesian Ministry of Health (Kementerian Kesehatan Republik Indonesia, 2020). TKPI 2020 represents an updated and expanded version of the previous TKPI 2009, incorporating additional food items and revised nutritional values to better reflect current Indonesian food consumption patterns. The users collection stored user profile data and included subcollections for BMI and TDEE calculation history, macronutrient preferences, and daily menu recommendations. The operational flow of the proposed rule-based system is illustrated in Figure 2.

PROCEDURE GenerateMenuRecommendation(...)
1. Calculate BMI, BMI category, BMR, and TDEE
2. Determine daily calorie target based on diet_goal
3. Distribute calories into 5 meal sessions:
Breakfast 20%, Morning Snack 10%, Lunch 30%, Afternoon Snack 10%, Dinner 30%
4. For Breakfast, Lunch, and Dinner:
a. Retrieve food_pool from TKPI 2020
b. Filter allergens, edible conditions, and blacklist keywords
c. Group foods into carbohydrate, protein, vegetable, and fruit categories
d. Build food combinations
e. Select exact calorie match; if none exists, use best fallback
5. For Morning Snack and Afternoon Snack:
a. Retrieve high-quality snack
b. Filter allergens
c. Select exact match; if none exists, use ±15% tolerance; if still none, choose closest item
6. Save the generated menu to Firestore
7. RETURN daily_menu
END PROCEDURE

Figure 2. Menu Recommendation Pseudocode

The algorithm first computes BMI, BMR, and TDEE, then distributes calories across five meal sessions, applies food filtering and allergen constraints, and finally stores the generated menu in Firestore.

The System Version stage served as the iterative phase of the RAD development process. In each iteration, the system passed through the Analysis, Design, and Implementation stages before being evaluated by the thesis supervisors for further improvement. System Version 1 focused on developing the core functionalities of the application, while the following versions introduced additional feature enhancements and system refinements based on evaluation outcomes and updated

system requirements. Daily caloric needs were determined based on TDEE (Gerdes et al., 2022). For users with weight loss goals, the system applied a calorie deficit approach (X. Wu et al., 2024), while a surplus was used for weight gain objectives (Fauziah, 2025).

System evaluation was carried out using Black Box Testing and UAT. Black Box Testing was used to examine system functionality without focusing on the internal structure of the program code (A. P. Putra et al., 2020). The testing process applied BVA to evaluate numerical input limits such as age, height, weight, and total macronutrient ratios, following the approaches proposed by (Myers et al., 2012) and (Pressman, 2010). In addition, EP was conducted to test valid and invalid input categories across the main system functionalities (Mahrozi & Yaqin, 2024). A testing scenario was classified as PASS when the output matched the expected result.

User Acceptance Testing (UAT) involved 30 respondents. Data collection was conducted through a five-point Likert scale questionnaire distributed using Google Forms (Aliyah et al., 2025). The evaluation focused on two main aspects, namely system functionality and interface usability and ease of use. The acceptance percentage for each questionnaire item was calculated by dividing the average respondent score by the maximum Likert scale value and then multiplying the result by 100%. Furthermore, the evaluation results were interpreted using five assessment categories ranging from Very Poor to Very Good (Hermansah et al., 2025).

Results and Discussions

The RAD development process resulted in four System Versions developed iteratively throughout the research. System Version 1 implemented the core functionalities of the application, including three-session meal recommendations and the web-based admin management system. System Version 2 expanded the recommendation mechanism into five meal sessions and introduced additional features such as food swapping with automatic gram adjustment and daily menu storage. System Version 3 added an activity level explanation table on the user input page to assist users in selecting appropriate activity categories for TDEE calculation. System Version 4 added the allergy filter Figure 3 shows the BMI and TDEE result page and diet goal selection interface used before menu generation.

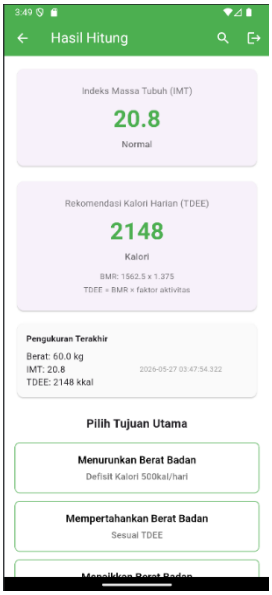


Figure 3. BMI and TDEE calculation result with Diet Goal Selection Screen

After all iterations were completed, the system was evaluated using Black Box Testing with BVA and EP. BVA was performed to evaluate the validation of numerical input limits, including age, height, weight, and total macronutrient ratios. The results of the BVA testing are presented in Table .

All tested boundary scenarios obtained PASS results, indicating that the system was able to properly handle both valid and invalid input ranges.

Table 1. Black Box Testing Results - Boundary Value Analysis

Variable	Tested Boundary Conditions	Expected Results	Result
Age	Lower invalid (17), lower valid (18), upper valid (75), upper invalid (76)	System rejects invalid inputs and processes valid entries	PASS 4/4 TC
Height	Lower invalid (49), lower valid (50), upper valid (250), upper invalid (251)	System rejects invalid inputs and processes valid entries	PASS 4/4 TC
Weight	Lower invalid (0), lower valid (1), upper valid (300), upper invalid (301)	System rejects invalid inputs and processes valid entries	PASS 4/4 TC
Macronutrient ratio	Invalid total (99%), valid total (100%), invalid total (101%)	System rejects invalid totals and updates menu on 100%	PASS 3/3 TC

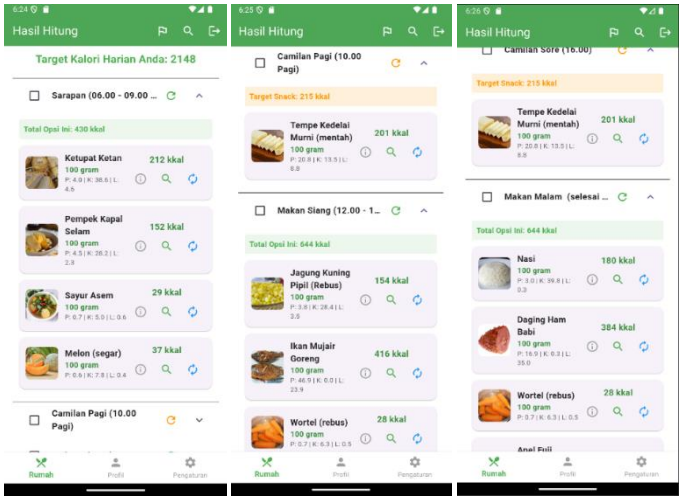
Equivalence Partitioning (EP) was conducted to evaluate the functional features of the mobile application and the admin website. The results of the EP testing are presented in Table 2. The mobile application was able to handle authentication, nutritional calculations, menu recommendation generation, macronutrient customization, and food search features properly. Meanwhile, the admin website successfully performed CRUD operations, and login.

Table 2. Black Box Testing Results - Equivalence Partitioning

Feature	Scenario Tested	Expected Results	Result
Authentication	Valid and invalid login and registration	System grants access to valid accounts and rejects invalid ones with error messages	PASS 5/5 TC
Nutritional calculation	BMI, BMR, and TDEE calculation	System processes inputs and displays correct calculated energy metrics	PASS 2/2 TC
Menu recommendation	Diet goal selection and five-session menu generation	System maps diet goals and populates appropriate menu schedules	PASS 2/2 TC
Macronutrient customization	Ratio adjustment totaling 100%	System updates recommendations for valid 100% total and rejects invalid totals	PASS 1/1 TC
Food search	Keyword search and category filtering	System displays relevant records matching queries or returns no matching results	PASS 3/3 TC
Admin CRUD	Data management (create, read, update, delete) and field validations	System successfully updates the database and triggers validation for empty fields	PASS 5/5 TC

All 33 tested scenarios across BVA and EP achieved PASS results. The BVA results confirm correct enforcement of input boundaries for age, height, weight, and macronutrient ratios, while the EP results show that core functionalities including authentication, nutritional calculations, menu generation, and admin CRUD operation sperformed according to requirements. These findings demonstrate functional correctness across valid and invalid input classes, consistent with Pressman's (2010) testing criterion.

Figure 4 shows the daily menu recommendation on the mobile interface across five meal sessions, which also includes a food swap feature. If users do not want to consume the recommended food, they can replace it with another food based on the calorie value of the previous recommendation.



(a) (b) (c)

Figure 4. (a), (b), (c) Daily Menu Recommendation Screen

Figure 5 shows the admin dashboard used to manage the food database through CRUD operations.

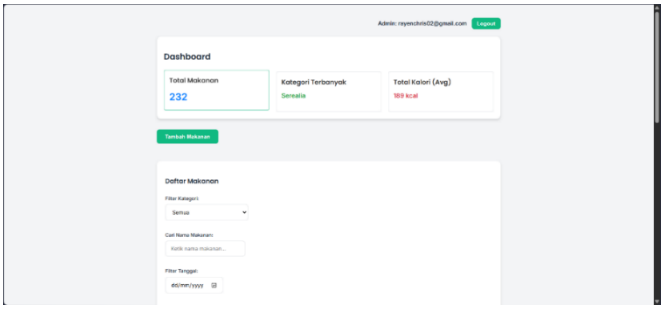


Figure 5. Admin Website Dashboard

User Acceptance Testing (UAT) was conducted involving 30 respondents using a five-point Likert scale questionnaire distributed through Google Forms (Aliyah et al., 2025). The evaluation covered two variables: system functionality and interface usability and ease of use. Table 3 presents the evaluation results for the system functionality variable. This variable obtained an average score of 89.33%, which falls into the "Very Good" category. The highest score was achieved by the registration and login process with a value of 92.67%, while the food search feature obtained the lowest score at 86.67%. Despite this, all evaluated indicators were still categorized as "Very Good."

Table 3. UAT Score for System Functionality Variable

Code	Total Score	Mean Score	Percentage	Variable Avg (%)
A1	139	4,63	92,67%	89,33%
A2	132	4,40	88%	
A3	133	4,43	88,67%	
A4	137	4,57	91,33%	
A5	133	4,43	88,67%	
A6	130	4,33	86,67%	

Table 4. UAT Score for Interface and Ease of Use Variable

Code	Total Score	Mean Score	Percentage	Variable Avg (%)
B1	117	3,90	78%	84,40%
B2	126	4,20	84%	
B3	126	4,20	84%	
B4	130	4,33	86,67%	

B5	134	4,47	89,33%

Table 4 presents the evaluation results for the interface and ease of use variable. The variable obtained an average score of 84.40%, which is categorized as "Very Good" (Hermansah et al., 2025). The highest score was achieved by the overall user satisfaction indicator with a value of 89.33%, while the visual appearance of the interface received the lowest score at 78.00%. This result indicates that the visual design of the application still has room for improvement.

In combination with the PASS results obtained from Black Box Testing, the findings demonstrate that NutriSee operates properly and can assist users in dietary planning through standard nutritional calculations and Indonesian food composition data.

The functional accuracy of the recommendation mechanism was evaluated through Black Box Testing, which verified that the system correctly computes BMI, BMR, and TDEE values, and generates menu recommendations within the defined calorie targets for all 33 tested scenarios. However, this study acknowledges that Black Box Testing evaluates computational correctness rather than nutritional adequacy in practice. A more comprehensive accuracy evaluation such as verifying whether the aggregate nutritional composition of generated menus aligns with users' actual daily macronutrient targets was not conducted in this study and represents a direction for future work.

The higher acceptance rate for system functionality 89.33% compared to interface and ease of use 84.40% suggests that users found the application's core features particularly the BMI, BMR, and TDEE calculation to be reliable and useful. The relatively lower score for visual appearance 78.00% indicates that the interface design presents an area for future improvement, a finding aligned with the trust component analysis by (Joshua, Abbas, et al., 2023), which identified user interface design as a key factor in mobile health application acceptance. Nevertheless, both variables exceeded the 80% threshold and were categorized as Very Good, indicating that NutriSee was able to be a helper for diet planning.

NutriSee builds upon previous studies by integrating features that support more personalized and locally relevant dietary planning. Compared with (Agustina et al., 2022), NutriSee enables customizable macronutrient distributions based on individual nutritional targets. Unlike (Agustia & Abadi, 2024), NutriSee incorporates the Indonesian Food Composition Table (TKPI 2020) to improve relevance for Indonesian users. Compared with (Rizaldy et al., 2024), NutriSee provides structured daily meal planning across five meal sessions. Furthermore, compared with (Lengkong et al., 2026), NutriSee extends BMI-based assessment beyond classification alone by incorporating calorie estimation and structured daily meal planning, addressing the limitations identified in prior BMI application research. Additionally, NutriSee applies a Rule-Based recommendation process using predefined nutritional rules to support a structured recommendation workflow.

Conclusions

This study successfully developed NutriSee as a mobile-based tool for dietary planning based on Body Mass Index (BMI) classification using Flutter and Firebase Firestore. The system is able to calculate BMI according to WHO standards, as well as estimate Basal Metabolic Rate (BMR) and Total Daily Energy Expenditure (TDEE) using the Mifflin-St Jeor equation. In addition, the application can adjust daily caloric targets according to the user's dietary goals, including deficit, maintenance, and surplus.

Using a rule-based approach, NutriSee generates structured daily meal recommendations across five meal sessions with customizable macronutrient distributions. System evaluation through Black Box Testing (BVA and EP) showed 100% PASS results across 33 test cases, while User Acceptance Testing involving 30 respondents achieved scores of 89.33% for functionality and 84.40% for usability. Based on the results, the NutriSee application can be used as a supporting tool for dietary planning based on Indonesian local foods composition data.

The study contributes to mobile health and personalized nutrition by demonstrating that rule-based systems grounded in established nutritional guidelines can be effectively implemented within a mobile platform to support structured dietary planning. The integration of TKPI 2020 enhances contextual relevance by ensuring recommendations align with foods commonly consumed by Indonesian users.

However, the system does not evaluate long-term dietary outcomes such as weight change. Future work may expand the food database, integrate dietary tracking features, apply machine learning for adaptive recommendations, and conduct long-term or clinical validation studies.

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