GESTALT
JURNAL DESAIN KOMUNIKASI VISUAL

Vol. 8, No. 2, November 2026
DOI: https://doi.org/10.33005/gestalt.v8i2.734
ISSN (Cetak): 2657-1641
ISSN (Online): 2685-0311

MBGuard: UI/UX Design of a Mobile Application for the Early Detection of Food Suitability for Consumption in the MBG Program

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ARTICLE INFO

Article history:

Received: 31 July 2026

Accepted: 7 October 2026

Published: 1 November 2026

Keywords: *Food Suitability Detection; Design Thinking; UI/UX; Free Nutritious Meal; Usability*

ABSTRACT

This article examines the UI/UX design of a mobile application that helps Person-in-Charge (PIC) teachers detect, objectively and preventively, whether food served in Indonesia's Free Nutritious Meal Program (Makan Bergizi Gratis, MBG) is suitable for consumption. The problem addressed is the weak early detection of food suitability at the school level, as indicated by food poisoning incidents, while PIC teachers, as the last line of defense, still rely on subjective judgment without systematic tools. This study employed Practice-Based Research combined with the Design Thinking framework (Empathize, Define, Ideate, Prototype, Test). Data were collected through field observations at an affected school and interviews with MBG PIC teachers, an MBG Kitchen Head (a Sarjana Penggerak Pembangunan Indonesia, or SPPI, graduate), and a clinical nutrition specialist. The findings, namely detection parameters (visual appearance, aroma, texture, taste, and holding-time limit), were translated into the MBGuard prototype, which offers four features: AI-Based Hybrid Suitability Detection, Food Suitability Guide, History, and Report to the Nutrition Fulfillment Service Unit (Satuan Pelayanan Pemenuhan Gizi, SPPG). The mean System Usability Scale (SUS) score of 79 indicates that the prototype has good usability and is acceptable to MBG PIC teachers as a decision-support companion. This study did not test the accuracy of the food suitability recommendations generated by the application.

How to Cite:

Habibullah, M.F., Syarief, A. (2026). MBGuard: UI/UX Design of a Mobile Application for the Early Detection of Food Suitability for Consumption in the MBG Program. *GESTALT: JURNAL DESAIN KOMUNIKASI VISUAL*, *8*(2), 135-152. https://doi.org/10.33005/gestalt.v8i2.734

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Commented [MOU1]: This article tries to address the increasingly common issue of food poisoning related to the MBG program. The proposed design is good and can be implemented. However, there are several points that need to be discussed regarding this mobile application:

1.The authors should also explain the supporting hardware and software systems, including what platforms or technologies are used.
2.How do the authors determine that the amount of data is sufficient for this predictive AI model to achieve an acceptable level of accuracy and meet the required feasibility standards?

There are several additional comments regarding the writing, as follows:

1.Please explain the full meaning of the abbreviation SPPI.
2.Figure 4. User Persona is not clearly readable and should be improved.

INTRODUCTION

Access to nutritious food that is fit for consumption is one of the main foundations supporting the health and development of school-age children (Taufiq El Haque et al., 2023). Public health studies have shown that the availability of safe, high-quality food contributes significantly to improving students' nutritional status, immunity, and cognitive abilities, whereas limited access to food fit for consumption remains a problem in many regions owing to economic factors, food distribution, and weak food quality control (Desiani & Syafiq, 2025). Underlying the question of whether food is fit for consumption are serious risks, including microbiological contamination, chemical residues, and the degradation of nutritional quality caused by improper storage and processing (Kurnia & Nugrahani, 2022; Sugiyanto et al., 2024); these risks have a greater impact on children, whose immune systems are not yet fully mature (Ratnayani et al., 2021).

In response to child nutrition problems, the Indonesian government launched the Free Nutritious Meal (*Makan Bergizi Gratis*, MBG) Program as a national policy aimed at improving schoolchildren's access to nutritious and safe food (Lendra et al., 2025), with the target of reaching millions of students across various levels of education and reducing malnutrition and stunting rates (Karomah et al., 2024). The main challenge in implementing MBG lies not only in reaching the targeted number of beneficiaries but also in maintaining the consistent quality and safety of the food served, given the massive scale of distribution and the varying infrastructure conditions across regions (Agustini, 2025; Haryono et al., 2024). In practice, the implementation of MBG has been marred by food poisoning cases in several regions (Agustini, 2025; Qomarrullah et al., 2025), which have not only caused acute health effects but have also eroded public trust in the government program (Sinaga & Syarief, 2025). This phenomenon indicates that mechanisms for identifying and detecting food unfit for consumption at an early stage have not been functioning optimally at the school level, where existing identification processes still rely heavily on subjective experience and visual assessments that are not always accurate (Karomah et al., 2024).

Meanwhile, the high penetration of smartphones in Indonesia and the ease with which people of all age groups use mobile applications make this technology an effective medium for delivering information and supporting decision-making (Dillah et al., 2024; Mulyawan & Sharif, 2022). Previous studies have demonstrated the strengths of highly accurate artificial intelligence (AI)-based visual detection in general food safety contexts, such as detecting the freshness of food ingredients using augmented reality and machine learning (Xuan et al., 2024), monitoring food handlers' hygiene compliance (Manalo & Almarza, 2025), image recognition-based platforms for identifying product packaging (Park et al., 2024), and food safety application prototypes developed with a Design Thinking approach (Fong et al., 2026). However, a review of these studies reveals a consistent gap: the solutions developed remain fragmented by specific function, and none has been designed specifically for the context of mass food distribution in educational settings involving non-expert users with limited knowledge of nutrition and food.

Based on this gap, this study focuses on the UI/UX design of a mobile application that can help MBG Person-in-Charge (PIC) teachers, who serve as the last line of defense in determining whether food at school is fit for consumption, to carry out early detection of food suitability for consumption in a more objective, structured, and user-friendly manner. This study aims to: (1) design the UI/UX of a mobile application for the early detection of food suitability that meets user needs in the implementation of the MBG Program; and (2)

evaluate the usability of the design using the System Usability Scale (SUS) to measure its acceptance and ease of use among MBG PIC teachers. As a supporting step in the design process, this study also formulated parameters for the early detection of food suitability based on field data; however, these parameters are positioned as design inputs rather than as the ultimate objective of the study. The outputs of this study are a high-fidelity interactive prototype and the results of testing with the System Usability Scale (SUS).

It should be emphasized that the output of this study is a UI/UX prototype whose usability has been evaluated, not a food safety detection system whose accuracy has been validated.

RESEARCH METHOD

This study adopted a Practice-Based Research (PBR) approach, in which new knowledge is generated through direct engagement in practice, and the artifacts produced through that practice serve both as evidence and as the main contribution to new knowledge (Candy & Edmonds, 2018). In this study, the authors acted as both academics and design practitioners who were actively involved in the design process, so that the creation of the design artifact, namely the MBGuard application prototype, was not merely an output but also an integral part of the investigation itself. This approach was chosen because the problem under study is contextual and cannot be resolved through passive observation alone; rather, it requires the researchers' direct involvement in exploring, designing, and evaluating solutions iteratively within their real context of use.

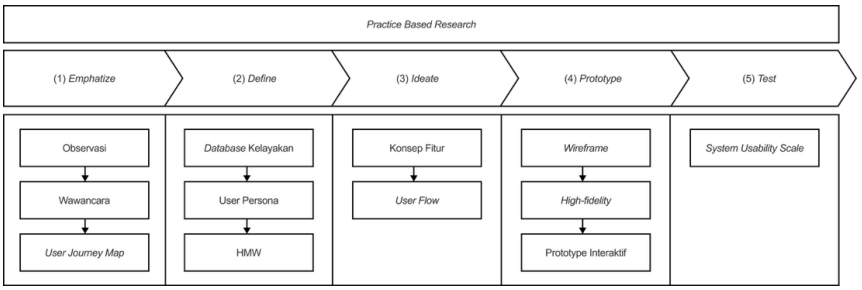


Figure 1. Research Framework Diagram
(Source: Authors, 2026)

PBR was then combined with the Design Thinking framework, a human-centered approach that places users at the center of understanding problems, formulating solutions, and evaluating design outcomes iteratively (Sangsuwan et al., 2025). The two approaches were combined strategically: PBR guides how the researchers generate knowledge (through design practice and artifacts), whereas Design Thinking systematically guides the design process, from understanding users to testing solutions. A human-centered design approach was chosen because the success of a digital system is determined not solely by technological sophistication but by how well the design fits the characteristics, capabilities, and context of use of its end users (Natalia et al., 2022). The framework was applied through five main stages, as shown in Figure 1.

Empathize

The Empathize stage was carried out through three sequential activities: observation,

interviews, and the development of a user journey map. Direct observation was conducted during meal-serving hours at a public junior high school in West Bandung Regency, which was selected purposively because it had been affected by a food poisoning incident in October 2025, in order to observe the actual flow of receiving, checking, and distributing MBG meals in the field. The observation results were then explored in greater depth through interviews with three groups of informants: MBG PIC teachers at the same school, as the target users; a *Sarjana Penggerak Pembangunan Indonesia* (SPPI; literally, "Graduate Drivers of Indonesian Development") graduate serving as the MBG Kitchen Head, to explore the technical aspects of quality control on the kitchen side; and a clinical nutrition specialist, to validate the food suitability indicators scientifically and to provide input on the system. All data from the observation and the interviews with MBG PIC teachers were then synthesized into a user journey map to chart the experience flow, touchpoints, emotions, and design intervention opportunities of MBG PIC teachers throughout the food-checking process (Pumpurs, 2022).

Define

The Define stage produced three main outputs in sequence: a suitability database, a user persona, and How Might We (HMW) questions. First, data from the Empathize stage were synthesized to compile a database of parameters for the early detection of food suitability, which reached data saturation across three sources: MBG PIC teachers, the SPPI kitchen head, and the nutrition specialist. Second, the same findings were used to develop a user persona representing the characteristics, motivations, and barriers of MBG PIC teachers as the application's primary users (ten Klooster et al., 2022). Third, based on this database and persona, How Might We questions were formulated as opportunity-oriented and solution-neutral guides for the design direction (Veflen & Gonera, 2023), to be addressed in the Ideate stage.

Ideate

The Ideate stage translated the How Might We questions into solution designs through two sequential steps: developing feature concepts and creating a user flow. Feature concepts were developed through divergent idea exploration and then filtered convergently on the basis of feasibility, relevance to user needs, and potential impact on the identified problems (Fong et al., 2026). The selected feature concepts were then translated into a user flow that details user interactions from one screen to the next in completing each application usage scenario.

Prototype

The Prototype stage converted the results of the Ideate stage into testable visual artifacts through three sequential steps: wireframes, high-fidelity design, and an interactive prototype. Wireframes were created in a low-fidelity format to quickly validate the layout structure and information hierarchy before being developed into a high-fidelity design that realistically represents the look and interaction of the final product (Sangsuwan et al., 2025). The validated wireframes were then developed into high-fidelity interface designs by applying a design system that consistently covers color, typography, iconography, illustration, and a component library across all screens. In the final step of the Prototype stage, all high-fidelity screens were linked into an interactive prototype using Figma and Figma Mirror, so that navigation between screens could be

simulated to resemble the experience of using the actual application.

Test

The Test stage is the empirical validation stage, carried out by testing the interactive prototype produced in the Prototype stage with the System Usability Scale (SUS). SUS was chosen as the measurement instrument because it captures users' subjective perceptions of a system's ease of use and converts them into a standardized quantitative score that is reliable across devices and testing contexts (Lorincz et al., 2026). The test involved 10 MBG PIC teachers as participants, selected using criteria relevant to the research context; this number is consistent with common practice in usability testing in similar studies (Handayani & Adelin, 2019). Each participant first completed ten task scenarios using the prototype on a smartphone via Figma Mirror and then filled out the SUS questionnaire, which consists of 10 standard statements rated on a 1-to-5 Likert scale, as presented in Table 1.

Table 1 Ten Statements of the System Usability Scale (SUS) Questionnaire

No.	Statement	Type
1	I think that I would like to use this system frequently.	Positive
2	I found the system unnecessarily complex.	Negative
3	I thought the system was easy to use.	Positive
4	I think that I would need the support of a technical person to be able to use this system.	Negative
5	I found the various functions in this system were well integrated.	Positive
6	I thought there was too much inconsistency in this system.	Negative
7	I would imagine that most people would learn to use this system very quickly.	Positive
8	I found the system very cumbersome to use.	Negative
9	I felt very confident using the system.	Positive
10	I needed to learn a lot of things before I could get going with this system.	Negative

Each respondent's SUS score was calculated by converting the scores of positive statements (n−1) and negative statements (5−n), summing all contribution scores, and multiplying the total by 2.5 to obtain the final score for each respondent, following the SUS calculation formula commonly used in usability studies (Lorincz et al., 2026). The final scores of all respondents were then averaged to obtain the overall usability score of the MBGuard prototype, which was subsequently interpreted using four standard SUS aspects: acceptability, adjective rating, grade, and Net Promoter Score (NPS) (Handayani & Adelin, 2019).

DISCUSSION

This section presents the research results systematically, following the five stages of the Design Thinking framework that was applied: Empathize, Define, Ideate, Prototype,

and Test. This structure was chosen because each Design Thinking stage produces outputs that serve as inputs for the next stage, allowing the links among field findings, design decisions, and evaluation results to be traced coherently and transparently. This stage-based presentation also shows how each design decision is rooted in the empirical data collected rather than in the designers' assumptions alone, in line with the principle of Practice-Based Research, which treats the process of creating artifacts as an integral part of the scientific investigation itself (Candy & Edmonds, 2018). Accordingly, the discussion presented here is not merely a description of the final results but a comprehensive reconstruction of the design thinking process, from understanding the user context to empirically validating the resulting prototype.

Empathize

Field observations showed that the food-checking process at the school already had a basic framework in the form of an organoleptic test form from the Nutrition Fulfillment Service Unit (*Satuan Pelayanan Pemenuhan Gizi*, SPPG), covering five assessment components (color, aroma, texture, taste, and doneness). In practice, however, suitability decisions still relied heavily on the instincts and personal experience of MBG PIC teachers, so the evaluation process was dominated by experiential judgment, which could lead to inconsistent decisions. During the observation period, foreign-body contamination in the form of larvae in the rice and vegetables was found and was detected only at the school level, indicating weaknesses in the upstream (kitchen) control layer. Another important finding was the emergence of a psychological dimension in decision-making: MBG PIC teachers appeared hesitant to decide on food suitability because of the psychological burden following the previous poisoning incident.

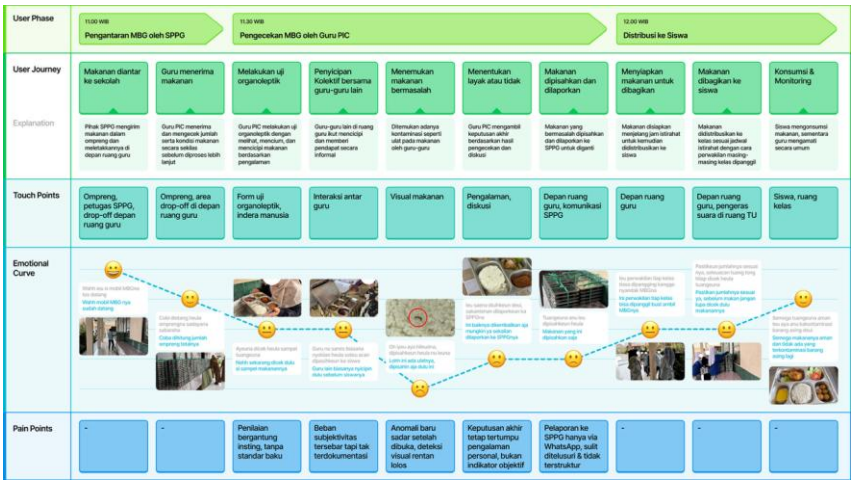


Figure 2. User Journey Map
(Source: Authors, 2026)

Based on the observation results, the user journey map shown in Figure 2 was developed from the analysis of the observation stage and maps three phases of daily

activity: the delivery of MBG meals by the SPPG, checking by the MBG PIC teacher, and distribution to students. This method was chosen for its ability to visualize the user's process end to end while identifying critical points that require design intervention. The emotion curve shows a sharp decline when foreign-body contamination is found in a food sample and a gradual recovery after it is reported to the SPPG. The main pain points are instinct-based assessment without standard criteria, undocumented subjectivity, and anomalies that are noticed only after the sample has been unpacked.

Furthermore, the interviews with the three groups of informants (MBG PIC teachers, the SPPI kitchen head, and the nutrition specialist) yielded several consistent key findings: (1) an excessively long holding time between cooking and consumption is the main trigger of poisoning risk; (2) organoleptic testing (visual appearance, aroma, taste, and doneness) is still performed in a self-taught manner without objective tools; (3) a documented reporting system is needed, given that anomalies have so far been reported to the SPPG only via WhatsApp, which is difficult to trace; and (4) MBG PIC teachers are ready to adopt digital technology, given that they are already familiar with platforms such as Google Classroom and e-Kinerja.

Define

The synthesis of findings from the Empathize stage produced parameters for the early detection of food suitability covering five dimensions: (1) visual appearance (discoloration, mold or slime growth, and foreign-body contamination); (2) aroma (sour, rancid, fishy, or putrid odors); (3) texture (softness, chewiness, and stickiness); (4) taste (deviation from the original seasoning profile); and (5) holding time and storage temperature. These parameters were validated by the nutrition specialist, as the expert, during the interview. They serve as design inputs rather than as the final output of this study.



Figure 3. User Persona
(Source: Authors, 2026)

To complement the user journey map, a user persona was developed to represent the MBG PIC teacher as the primary user: a 40-year-old teacher with no formal background in nutrition but with reasonable technological literacy (e-Kinerja, Google Classroom), as shown in Figure 3. The persona serves as an archetypal representation of users that focuses the design on the specific needs of the audience, guides the prioritization of design decisions, and tests the design team's assumptions. Its main pain points include subjective assessment without standard criteria and the absence of a digital record; accordingly, its

main needs are a structured detection tool, documented reporting, and a reference guide on food suitability. This persona was used together with the user journey map as an empathic reference for prioritizing features in the Ideate stage.

The synthesized outputs, namely the parameter database and the user persona, then served as the basis for formulating a How Might We question, a technique for transforming findings and themes from the Empathize stage into opportunity-oriented, solution-neutral problem statements (Veflen & Gonera, 2023): "How might we design a concise and easy-to-use companion application that helps teachers detect early whether food is fit for consumption, as a preventive measure against poisoning risk, while helping to minimize the subjectivity of their assessments?" This question became the main reference for the subsequent Ideate and Prototype stages.

Ideate

Based on this design question, an application concept named MBGuard (an acronym of *Makan Bergizi* Guard) was formulated as a food safety decision companion, that is, a decision-support system that positions MBG PIC teachers as the final decision-makers, while the system serves as a structured framework that guides and documents the assessment process. This positioning is in line with the consensus among all informants that technology is not intended to replace human judgment entirely. The ideation process produced four main features through divergent idea exploration, which were then filtered convergently according to their relevance to the user pain points previously identified in the user journey map and user persona. This follows the ideation principle of design thinking, which emphasizes exploring as wide a range of alternative solutions as possible before converging on the ideas most feasible for implementation (Fong et al., 2026), as summarized in Table 2.

Table 2 Main Feature Concepts of the MBGuard Application

Feature	Main Function	Pain Point Addressed
AI-Based Hybrid Suitability Detection	Combines the user's manual assessment inputs (visual appearance, aroma, texture, and taste on a 1–5 scale) and serving-time data with AI analysis to generate a suitability recommendation.	Subjective and inconsistent assessments; lack of objective instruments in the field.
Food Suitability Guide	Provides a scientific and visual reference database for each food spoilage indicator, accessible at any time.	Limited references and knowledge among non-expert teachers for recognizing the characteristics of food unfit for consumption.
History	Automatically records the full history of inspection sessions, including the time, decision, parameters, and photo documentation.	Lack of structured historical documentation for evaluation and accountability.

Report to SPPG	Provides an integrated official reporting channel for sending anomaly findings directly to the SPPG monitoring panel, accompanied by photos, notes, time, and location.	Lack of a fast and well-targeted official reporting channel between the school and the kitchen.

The four features were then elaborated into a user flow that maps user interactions in detail for each usage scenario, as shown in Figure 4. The MBGuard user flow covers four critical scenarios identified directly from the pain points in the user journey map: (1) the hybrid suitability detection flow. Input: (a) a photo of the food sample; (b) the user's assessment of visual appearance, aroma, texture, and taste on a 1–5 scale; and (c) the serving time. Process: sequential assessment; if any of the visual, aroma, or texture parameters indicates an anomaly, the system displays a warning before the taste test, as advised by the nutrition specialist. The scores are combined with the holding time. Output: "Recommended for consumption" (*Disarankan untuk dikonsumsi*), "Recommended for immediate consumption" (*Disarankan segera dikonsumsi*), or "Re-inspection recommended" (*Disarankan diperiksa kembali*); (2) the Report to SPPG flow, an anomaly-reporting flow that links field findings directly to the kitchen monitoring panel and covers form completion, photo documentation, and submission confirmation; (3) the suitability guide flow, which provides access to food parameter references that can be opened at any time as guidance before or during the detection process; and (4) the history flow, which allows users to trace records of past inspection sessions and historical MBG menus.

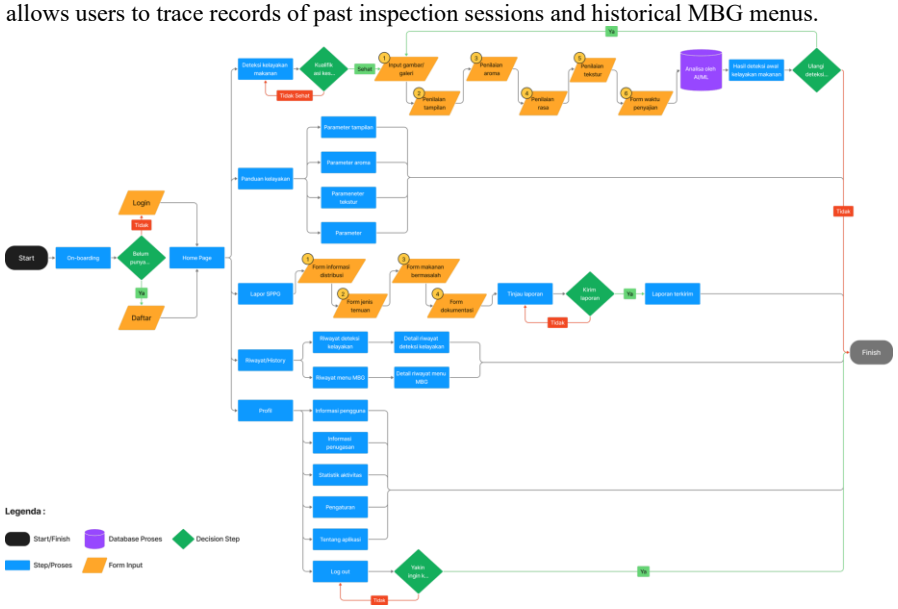


Figure 4. User Flow
(Source: Authors, 2026)

Each flow is designed with explicit conditional branching to accommodate the two scenarios that may arise in the field: a normal scenario, in which the food is declared

suitable, and an anomaly scenario, in which signs of problematic food are found. This branching design ensures that MBG PIC teachers always have a clear and unambiguous course of action in every condition, thereby minimizing the decision-making burden and preventing the distribution of unsuitable food as early as possible.

Prototype

The Prototype stage translated the concepts and features from the Ideate stage into an interactive interface design. The design process began with the creation of low-fidelity wireframes (Figure 5), which focused on element arrangement, navigation flow, and information hierarchy without attention to visual details such as color, typography, or icons. These wireframes served as an initial reference to ensure that each step in the food suitability detection cycle, from assessing the visual, aroma, and texture parameters to the final recommendation, was logically structured and easy for users to follow. A low-fidelity approach was chosen at this early stage because it allows the layout structure to be validated quickly before greater investments of time and resources are made in the visual design stage (Sangsuwan et al., 2025).

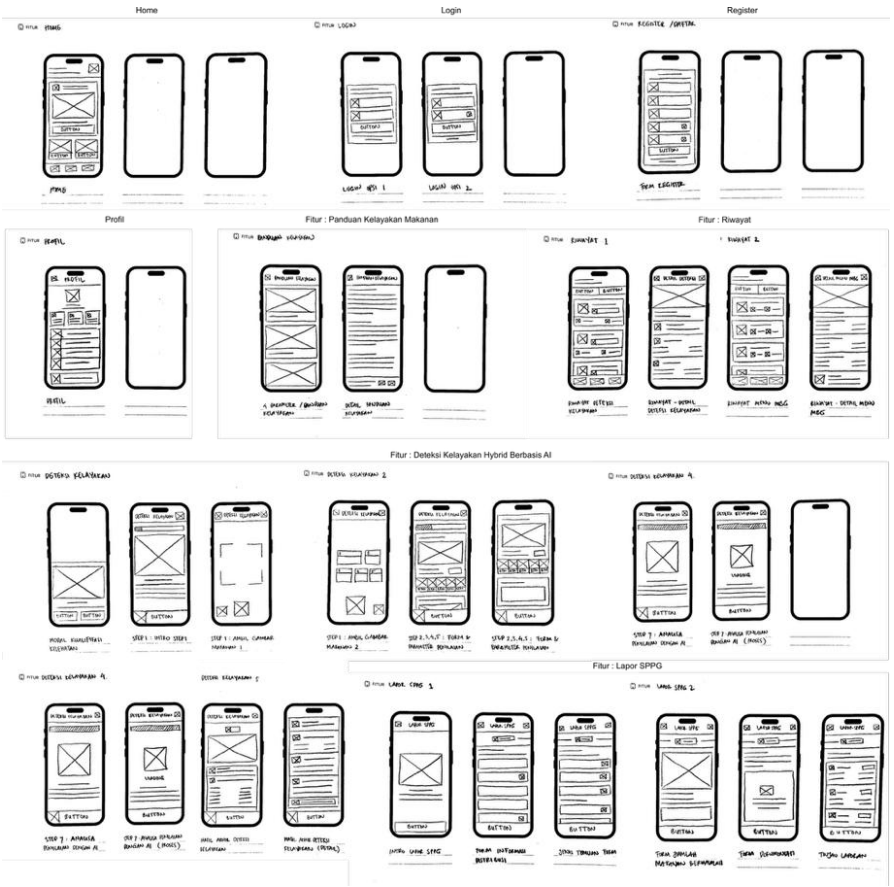


Figure 5. Wireframe Sketches
(Source: Authors, 2026)

Once the wireframe layout structure was deemed appropriate for the workflow needs of MBG PIC teachers, the design was developed into a high-fidelity prototype by adding visual elements, including a color system for suitability status indicators (suitable, needs attention, and unsuitable), typography, icons, and button interactions that resemble the final appearance of the application, as shown in Figure 6. This high-fidelity prototype represents the look and interaction of the final product more realistically, enabling a simulation of the user experience that approximates real conditions; it could therefore be used directly in usability testing sessions before the MBGuard application enters the technical development stage.

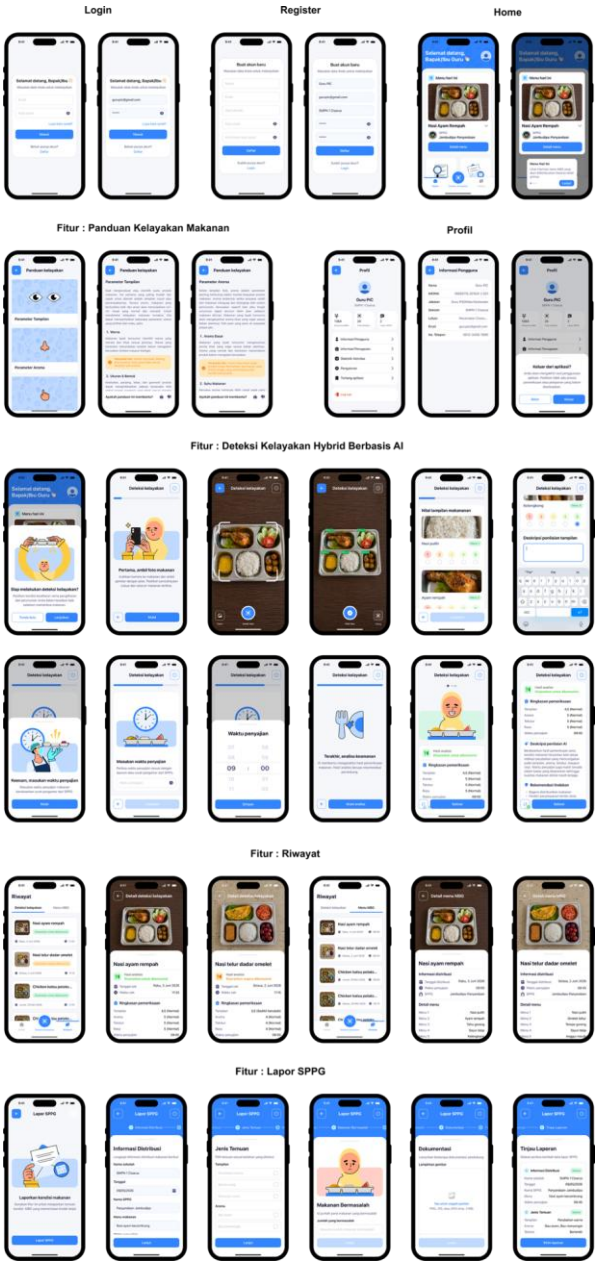


Figure 6. User Interface (High-Fidelity Prototype)
(Source: Authors, 2026)

A single MBGuard usage cycle proceeds as follows. When the food arrives, the MBG PIC teacher opens the application and starts a hybrid suitability detection session to assess the food sample sequentially on the visual, aroma, and texture parameters. If the score for any of these parameters indicates an anomaly, the system displays a warning before the user proceeds to the taste test, in line with the nutrition specialist's recommendation that failure at any one stage means that the food can be rejected immediately without being tasted. The system then processes all the scores together with the serving-time data to generate a final recommendation in one of three categories, "Recommended for consumption," "Recommended for immediate consumption," or "Re-inspection recommended," which is explicitly presented as a recommendation aid rather than a final decision. The system does not measure the condition of the food directly; its output is a decision-support recommendation, not a food safety test result. The accuracy of the recommendations has not been validated against laboratory testing in this study. If a confirmed anomaly is found, the MBG PIC teacher can immediately access the Report to SPPG feature to document the finding and send a report to the kitchen.

In this study, MBGuard is at the high-fidelity interactive prototype stage. The prototype was designed and linked in Figma and then tested on an iOS smartphone provided by the researchers, which participants used to run the prototype via Figma Mirror. A functional application has not yet been developed at this stage.

Test

The MBGuard prototype was tested with 10 participants serving as MBG PIC teachers. Each participant was asked to complete a series of ten task scenarios representing the full flow of application use, from creating an account and performing early food suitability detection using the visual, aroma, and texture parameters to accessing the inspection history and the feature for reporting to the SPPG. After completing all the task scenarios, each participant was asked to fill out the System Usability Scale (SUS) questionnaire as an evaluation instrument to measure the usability of the tested prototype.

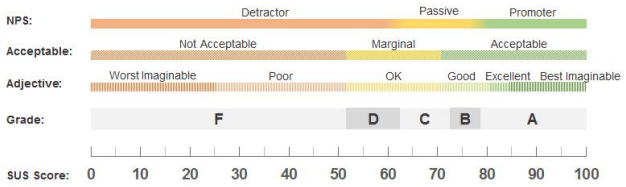


Figure 7. SUS Final Score Scale
(Source: Authors, 2026)

The SUS scores obtained were interpreted using the conversion scales developed by Bangor et al. (2009) and Sauro and Lewis (2016), which map the numerical score range of 0 to 100 onto several interrelated assessment categories, as shown in Figure 7. These scales comprise four interpretive dimensions: Grade (letter grades from A to F), Adjective Rating (an adjective scale ranging from Worst Imaginable, Poor, OK, Good, and Excellent to Best Imaginable), Acceptability Range (Not Acceptable, Marginal, and Acceptable), and correlation with the Net Promoter Score, or NPS (Detractor, Passive, and Promoter). On these scales, scores below 51 are generally categorized as Grade F with an acceptability

level of Not Acceptable, whereas scores from 51 to 71 are categorized as Grades D to C with an acceptability level of Marginal. Scores from 71 to 80.3 are categorized as Grade B with an adjective rating of Good to Excellent, whereas scores above 80.3 are categorized as Grade A with an adjective rating of Excellent to Best Imaginable and an acceptability level of Acceptable. This interpretation scale served as the reference for interpreting the processed SUS scores in this study, so that the scores obtained from respondents are not only presented as raw numbers but can also be interpreted qualitatively in terms of the usability of the MBGuard prototype.

Table 3 Final SUS Score Results

Final SUS Score	***Grade Scale***	***Adjective Rating***	***Acceptability Range***	***Net Promoter Score***
79	B	*Good*	*Acceptable*	*Promoter*

As shown in Table 3, the mean System Usability Scale (SUS) score of the MBGuard prototype was 79, which yields consistently positive results across the four standard SUS interpretation frameworks: the score is classified as "Acceptable" on the acceptability range, corresponds to the adjective "Good" on the adjective rating scale and to Grade B on the grade scale, and lies at the threshold of the lower promoter zone on the Net Promoter Score (NPS) correlation. These four aspects reinforce one another and indicate that the score not only falls within a statistically acceptable category but also reflects good user satisfaction and acceptance, while exceeding the general industry benchmark average for digital products. This shows that the MBGuard prototype has reached a sufficiently mature level of usability for use by MBG PIC teachers.

The findings of this study reinforce the position of visual and sensory detection as the first layer of a preventive approach in food quality control systems, in line with previous studies demonstrating the strengths of AI- and smartphone camera-based approaches to the initial screening of food quality. However, unlike those studies, which generally focus on a single specific detection function (e.g., freshness detection, hand hygiene, or packaging verification), MBGuard integrates four dimensions of organoleptic assessment with holding-time data in a single unified interface, while also providing reporting and documentation channels within a single application ecosystem. This approach directly addresses the gap of functional fragmentation identified in previous studies, particularly in the context of mass food distribution in school settings with non-expert users.

Positioning MBGuard as a decision-support companion rather than a replacement for human judgment is also an ethically and practically important design decision. Given the inherent limitations of visual technology in detecting chemical or microbiological hazards at very early stages, which are invisible to the naked eye, a design that keeps the final decision in the hands of MBG PIC teachers also strengthens accountability and user trust in the system. The SUS score categorized as "Good" indicates that this hybrid approach, combining technology and human judgment, is well accepted by the target users, although there is still room for improvement, particularly in onboarding and feature introduction for new users.

Sensory assessment remains subjective even when it is converted into structured scores; MBGuard only improves the consistency and documentation of assessments rather

than making them objective. Moreover, food can look, smell, and taste normal even when it contains microbiological or chemical hazards. Therefore, a "suitable" result in MBGuard must not be interpreted as a guarantee of food safety. The application is positioned as an initial screening aid; the final decision and responsibility remain with MBG PIC teachers together with the SPPG, and the application's results do not replace quality control and food safety testing in the kitchen and the laboratory.

CONCLUSION & RECOMMENDATIONS

This study achieved its two stated objectives. Regarding the first objective, the UI/UX design of the MBGuard mobile application was shown to help MBG PIC teachers carry out early detection of food suitability for consumption in the Free Nutritious Meal Program in a more objective, structured, and user-friendly manner. The application integrates four main features, namely AI-Based Hybrid Suitability Detection, Food Suitability Guide, History, and Report to SPPG, which together replace the instinct-based assessment previously used by MBG PIC teachers with a structured, documented identification mechanism grounded in scientifically valid food suitability parameters. The design consistently positions the application as a decision-support companion rather than a replacement for human judgment, given the limitations of visual technology in detecting hazards that are invisible to the naked eye.

Regarding the second objective, System Usability Scale testing with 10 MBG PIC teachers yielded a mean score of 79, categorized as "Acceptable," with an adjective rating of "Good" and Grade B. This score confirms that the UI/UX design of MBGuard is acceptable, intuitive, and capable of meeting the functional needs of MBG PIC teachers as an early warning system that supports the prevention of the distribution of food unfit for consumption in school settings. Nevertheless, there is room for improvement, particularly in onboarding and feature introduction for new users, which is an important consideration for the further development of this application.

The SUS score measures perceived ease of use and cannot be used to conclude that the application's recommendations are accurate. Further validation is planned through (1) testing the agreement of the recommendations with expert assessments and laboratory tests (microbiological and/or chemical) on MBG food samples; (2) testing the consistency of assessments across PIC teachers; and (3) a limited field trial before wide-scale implementation. The UI/UX design of MBGuard produced a structured and easy-to-use prototype that helps MBG PIC teachers conduct initial assessments of food suitability for consumption. This study evaluated the usability of the prototype, not its detection accuracy.

In addition, this study offers several notes for future research. Based on the findings and testing conducted, further development of MBGuard can focus on four main aspects: (1) continuously exploring the needs of MBG PIC teachers to deliver innovative features that are more effective in the field; (2) expanding the target users to those serving other MBG beneficiary groups, such as *Posyandu* (integrated community health post) staff; (3) using inspection history data to train predictive AI models capable of detecting recurring spoilage patterns; and (4) automatically evaluating the quality trends of food providers.

This study limits its scope to UI/UX design and the usability evaluation of the prototype. The "AI" component of the Hybrid Suitability Detection feature was formulated at the interaction design level; the predictive model has not yet been trained or tested for accuracy, so data sufficiency and model accuracy cannot yet be assessed. Further development will require (1) collecting a dataset of photos and sensory assessments of various MBG menus, labeled for suitability by experts and/or through laboratory testing;

(2) determining the sample size based on performance targets; and (3) evaluating the model in terms of accuracy, sensitivity, and specificity, particularly false negatives (unsuitable food classified as suitable).

ACKNOWLEDGMENTS

The authors would like to express their deepest gratitude to everyone who contributed to this study, particularly the entire community of the partner school for their willingness to host and facilitate the field observations; the Kitchen Head of the partner SPPG for sharing information and insights into the process of providing nutritious meals; the clinical nutrition specialist from the partner clinic for scientific input and perspectives on nutrition and food safety; and the MBG PIC teachers who served as respondents in the application testing for their time and valuable feedback in refining MBGuard. The support and cooperation of all these parties were invaluable to the smooth progress and completion of this study.

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