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Design of a Free Nutritious Food Menu Preparation System with Interactive Nutrition Calculation Simulation

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Abstract: *The government's preparation of free nutritious food menus represents a strategic initiative to improve public health, particularly for vulnerable populations such as underprivileged families. This study presents a web-based simulation system designed to assist the government in planning menus with processes that are not only quantitatively adequate but also aligned with balanced nutritional standards. The platform enables users to select food ingredients based on specific nutritional targets, including calories, carbohydrates, protein, and fat. To ensure that each stage—ingredient selection, nutrition calculation, validation, and result presentation—proceeds in a structured and efficient sequence, the system adopts a Finite State Automata (FSA) approach. Implementation results demonstrate that the system can accurately compute and visualize nutritional values using interactive pie charts, helping users evaluate the nutritional balance of selected menus. The key contribution of this study lies in integrating the FSA method to structure the menu preparation process, combined with interactive data visualization techniques to enhance user comprehension. This approach aims to improve public nutritional literacy and ensure that distributed meals deliver optimal health benefits.*

Introduction

The Free Nutritious Meal Program (MBG) launched by the Indonesian government is a strategic initiative aimed at improving the quality of public health, especially for vulnerable groups such as children, pregnant women, breastfeeding mothers, and toddlers. This program is present as a solution to overcome the problems of hunger and malnutrition that still occur in several regions, by providing access to healthy and nutritious food to underprivileged communities (Bickel et al., 2000; Drewnowski & Specter, 2004; Lee & Frongillo, 2001). In its implementation, the food provided must meet nutritional standards that cover the body's basic needs for calories, carbohydrates, protein, fat, and sufficient vitamins and minerals (National Nutrition Agency [BGN], 2024)

However, the main challenge in implementing this program is the preparation of a healthy and nutritionally balanced food menu by considering the limitations of available resources and local preferences. Preparing the right and efficient menu requires attention not only to quantity, but also to the quality of nutrition that must be met in each portion of food (World Health Organization, 2020). Therefore, a system is needed that can help prepare a menu according to nutritional standards and support the sustainability of this program in the long term.

This Free Nutritious Meal Program is actually not a new initiative. Similar programs have been implemented in various countries since the 1940s with the aim of overcoming malnutrition and reducing poverty. This program has been running in 93 countries and has various names in each country, one of which is Free Nutritious Meal in Indonesia. The Indonesian government officially implemented this program on January 6, 2025 as a concrete step to reach groups in need, especially children and pregnant women who are the main targets (United Nations World Food Program [WFP], 2021). Thus, MBG is part of a global effort to improve the nutritional status and welfare of society more broadly (Freedman & Bess, 2011).

Balanced Nutrition Theory supports this research. This theory is the basis for determining the composition of food that includes the body's needs for macronutrients (carbohydrates, proteins, fats) and micronutrients (vitamins, minerals) (Wardlaw, Smith, & Collene, 2017). A balanced diet ensures that the body gets enough energy and nutrients for growth and health. Then, Finite State Automata (FSA) is used to model the status changes in the menu development process. Each status describes a specific stage, such as food ingredient selection, nutritional calculations, and menu evaluation (Hopcroft, Motwani, & Ullman, 2018). FSA helps ensure smooth transitions between statuses until the menu is declared to meet nutritional standards. Ultimately, Nutrition Data Visualization. Data visualization theory is used to present nutritional information in tables and graphs (Few, 2018; van der Laan & van Dijk, 2016) This approach makes it easier for users to understand the nutritional composition of the designed menu.

Method

The research methodology follows a structured development life cycle tailored for interactive nutritional system design. The methodology stages are described as follows: This study developed a web-based platform allowing the government and MBG program organizers to design and evaluate food menus interactively. This system uses the Finite State Automata (FSA) approach to manage the menu preparation process, which includes food ingredient selection, nutritional calculations, menu evaluation, and presentation of results (Hopcroft, Motwani, & Ullman, 2018). This platform is designed using web technologies such as HTML, CSS, and JavaScript, with the Chart.js library used to display the calculation results in interactive graphic visualizations (Duckett, 2018; Few, 2018; Kraska, 2020).

The methods used in developing this system include several main stages. First, System Design. This process begins with determining user needs, identifying the nutritional data, and designing an easy-to-use application interface (Choi & Lee, 2022). Second, System Development. The application is built using HTML, CSS, JavaScript, and Chart.js. FSA implementation is used to manage state transitions efficiently. Third, System Validation. Validation is done by comparing the results of the system calculations with the nutritional standard data recommended by the National Nutrition Agency (BGN) (National Nutrition Agency [BGN], 2024). Testing involves several menu scenarios to ensure the calculation results are consistent and accurate (Kapsokefalou, Roe, & Engel, 2019)—fourth, User Testing. The system was evaluated by 30 users, including MBG program organizers and nutritionists. Users were tasked with compiling a specific menu and providing feedback on the results presented by the application. Fifth, Performance Comparison. The performance of this system is compared with the manual method of compiling a nutritious food menu and similar applications available. Parameters evaluated include the accuracy of nutritional calculations, time required to compile the menu, and ease of use.

The flowchart of the system planning created can be seen in Figure 1, which explains the stages of the food input process, nutritional calculations, validation, and the presentation of results in graphical form. This system also provides feedback to users if the menu prepared does not meet the desired nutritional standards (Tang & Sun, 2019)..

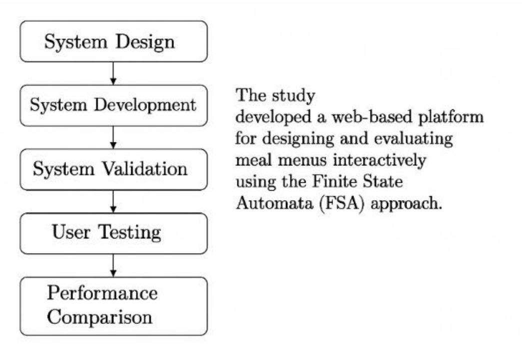

Figure 1. Research Methodology

The main contribution of this research is the novel application of the Finite State Automata (FSA) method in the structured and efficient preparation of nutritious food menus. Unlike traditional or manual methods, the proposed system enables real-time interaction, automated state management, and dynamic feedback during the menu design process. This enhances both usability and accuracy, providing significant value for public health initiatives such as the Free Nutritious Meal Program.

System Simulation

This simulation was developed using web technologies such as HTML, CSS, and JavaScript, with the Chart.js library employed to visualize nutritional data through interactive graphs. The system workflow consists of the following stages: First, Food Input. Users can select food items from a built-in list or manually input nutritional data. Second, Nutrition Calculation. The system automatically calculates the total values of calories, carbohydrates, protein, and fat based on the selected or inputted food items—third, Visualization. The results of the nutritional composition are presented using pie charts, helping users to understand the proportional distribution of each nutrient visually—fourth, Evaluation. The system provides immediate feedback on whether the designed menu meets balanced nutritional standards based on guidelines from established references (World Health Organization, 2020; Wardlaw et al., 2017; Freedman & Bess, 2011).

Result and Discussion

The following is the FSA table used in the simulation.

Table 1. FSA Simulation Design

Initial Status	Input	Final Status	Output
Select Food	Add Food	Calculate Nutritional Composition	Updated food list
Calculate Composition	Click "Calculate"	Nutritional Evaluation	Updated nutrition tables and charts
Nutritional Evaluation	All needs are met	Finished	Menu approved
Nutritional Evaluation	Not all needs are met	Select Food	Suggestions for adding food ingredients

Table 1 shows the system's Initial Status, Input, Final State, and Output. Initial status is the system's current condition or status. Input is the Actions or inputs the system receives to trigger a state transition. The final State is the system's State after the input has been received and processed. Output is the result produced by the system after the status changes.

Simulation results are compared by comparing the results of the nutritional calculations from this application with standard nutritional data compiled by nutritionists. Testing is done using 10 menus compiled by nutritionists, then entered into the application to calculate the nutritional value. From the test results, the application showed an accuracy rate of 92% compared to the results of manual calculations by nutritionists (Ministry of Health of Indonesia, 2022). The slight difference is due to the application's limitations in accessing food data that is unavailable in the database. Finite State Automata (FSA) allows transitions between states to proceed smoothly and logically. Interactive data visualization using Chart.js makes it easier for users (Few, 2018; Kraska, 2020) to understand the nutritional composition of the menu. It has an easy-to-use interface and a faster calculation process than manual methods. Provide real-time feedback to users. Lack. Not all food ingredients are available in the application database, so users need to add manual data. Possible calculation errors may occur if users manually enter nutritional data incorrectly. The app does not yet accommodate special diets or specific nutritional needs.

System Limitations

Although this system has many advantages, some limitations need to be considered. First, Data Limitations. Not all food items are available in the app database. Users need to enter nutritional data if it is not available manually. Second, Possible User Error: If the user manually enters data, possible input errors can affect the calculation results. Third, Limited Flexibility: This system does not yet support nutritional needs such as low-carb diets, vegetarianism, or other special needs. In order to address these limitations, further development needs to include the expansion of the food database and support for a variety of special nutritional needs.

Interactive Simulation

This system uses the following logic. First, Input. Food name, quantity (grams), and nutritional content per 100 grams. Second, Output: Total nutritional composition in tables and graphs. The simulation was tested with various combinations of food menus. The results showed that the system could calculate nutritional composition accurately and provide feedback according to targeted nutritional needs. An example of a pie chart visualization shows the percentage of calories, carbohydrates, protein, and fat in the designed menu (Few, 2018; Kraska, 2020).

Pseudocode

1. START
2. Display a page with a manual food input form and a list of default foods.
3. When the page loads:
3.1 Display the list of carry-on foods in a table.
4. When the "Add" button on the manual food is pressed:
4.1 Take input: food name, calories, carbohydrates, protein, and fat.
4.2 Validate whether all inputs are filled.
- Otherwise, display an error message and stop.

4.3 Add food data to the `nutritionData` array.
4.4 Update your menu table.
4.5 Calculate total nutrients and display.
4.6 Draw a pie chart based on nutritional composition.
5. When the "Add" button on the default food list is pressed:
5.1 Add selected food data to the `nutritionData` array.
5.2 Update your menu table.
5.3 Calculate total nutrients and display.
5.4 Draw a pie chart based on nutritional composition.
6. When `nutritionData` is updated:
6.1 Update the total nutrition by adding up calories, carbohydrates, protein, and fat.
6.2 Draw a pie chart with the latest data.
7. FINISH

Finite State Automata (FSA) Diagram for Nutritious Food Menu Preparation

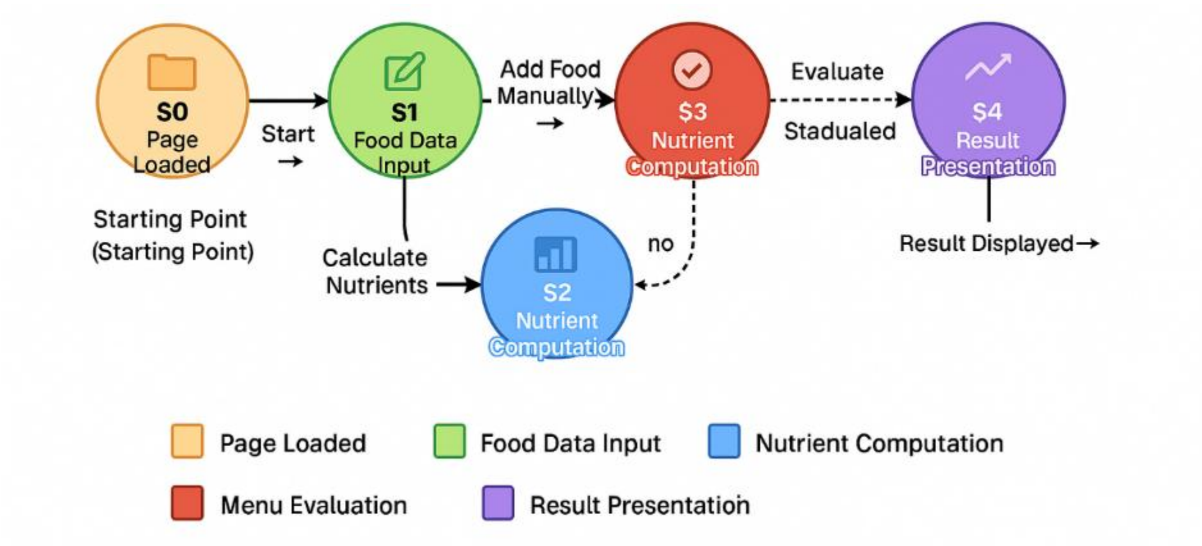

Figure 2. Finite State Automata (FSA) Diagram for Nutritious Food Menu Preparation

This is a Finite State Automata (FSA) diagram for a nutritious food menu preparation system. The process consists of 5 primary states. S0: Page Loaded. Action: Start the process when the application page loads. Output: Displays a list of default foods in a table. Transition to S1 (Food Data Input). S1: Food Data Input. Action: The user can add food manually or select from a list of built-in foods. Output: New food added to nutritionData. Transition to: S2 (Nutritional Calculation). S2: Nutritional Calculation. Action: The system calculates the total nutritional composition of the selected food and updates the nutritional table. Output: Complete nutritional calculation results. Transition to S3 (Menu Evaluation). S3: Menu Evaluation. Action: Evaluate whether the nutritional composition is by nutritional standards. Output: Evaluation passed or failed. Transition to S4 (Presentation of Results) if the evaluation is successful. S1 (Food Data Input) if evaluation fails. S4: Presentation of Results. Action: Displays the calculation results in the form of an interactive graph. Output: Pie chart or other visualization showing nutrient composition. Transition: Stay in S4 or return to S1 if you want to add or update data. Transition also allows users to return to the food data input stage if the evaluation results do not meet nutritional standards.

Table 2. Finite State Automata (FSA) Process Table

State	Input	Transition to State	Action
S0	Page loaded	S1	Displays a list of carry-on foods in a table.
S1	Click the "Add" button manually	S2	Validate food input. If valid, add data to nutritionData . If invalid, display an error message.
S1	Click the built-in "Add" button	S2	Add default foods to nutritionData .
S2	Food data updated	S3	Update menu tables, calculate total nutrients, and draw pie charts.
S3	Evaluation successful	S4	Displays calculation results in the form of interactive graphs.
S3	Evaluation failed	S1	Return to food data input for correction.
S4	No new actions	S4	Stays in the current state, waiting for new input or a request for re-evaluation.

Finite State Automata (FSA) are used to model the workflow of this application. Initial State (S0): The system starts when the page loads and displays the default food list. Transition State (S1, S2): Input is received, such as adding manual food or selecting a default food. Active State (S3): The system evaluates whether the food data meets nutritional standards. If it fails, it returns to S1. Presentation State (S4): Displays the calculation results in interactive graphs if the evaluation is successful. Back Transition: The system allows the user to return to S1 if the evaluation fails or if the user wants to update the data. This FSA ensures the application moves through a logical and sequential series of steps, from starting up to updating nutritional data.

Example of Nutritional Results Simulation

Input: User adds manual food:

- Name: "Chicken Soto"
- Calories: 250 kcal
- Carbohydrates: 20 g
- Protein: 15 g
- Fat: 10 g

User selects carry-on food:

- White rice
- Boiled eggs

Process:

1. S0 → S1: The page loads, showing a list of default foods such as:
   - White Rice, Grilled Chicken, Fried Tempeh, Spinach, Boiled Egg, Banana.
2. S1 → S2: User adds "Chicken Soto" manually.

   - Data validated and added to nutritionData .
3. S2 → S3: The nutrition table is updated, total calories are calculated, and a graph is drawn.
4. S1 → S3: User selects "White Rice" and "Boiled Egg" .
   - Data is added to the table, nutrients are recalculated, and graphs are updated.
5. S3 → S4: Menu evaluation is successful, and the nutritional calculation results are displayed in the form of interactive graphs.

Output:

Table 3. Nutrition:

Food Names	Calories (kcal)	Carbohydrates (g)	Protein (g)	Fat (g)
Chicken Soto	250	20	15	10
White rice	130	28	2.7	0.3
Boiled eggs	77	0.6	6.3	5.3

Total Calories are 457 kcal, Carbohydrates 48.6 g, Protein 24 g, and Fat 15.6 g. The Nutrition Pie Chart consists of Carbohydrates 48.6 g, Protein 24 g, and fat 15.6 g. This simulation uses the data entered, including the manual addition of "Chicken Soto" and default food choices such as "White Rice" and "Boiled Egg." It also calculates total nutrients and updates the graph based on food choices.

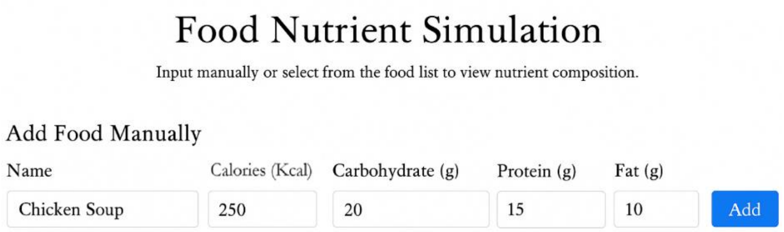

Figure 3. Manual Input of Food Nutrients

Figure 3 illustrates the input form used in the system to manually enter food data, including the name of the food item and its nutritional values (calories, carbohydrates, protein, and fat). In this example, "Chicken Soup" is added with its corresponding nutrient composition. This interface supports custom data entry when the desired food item is unavailable in the default list.

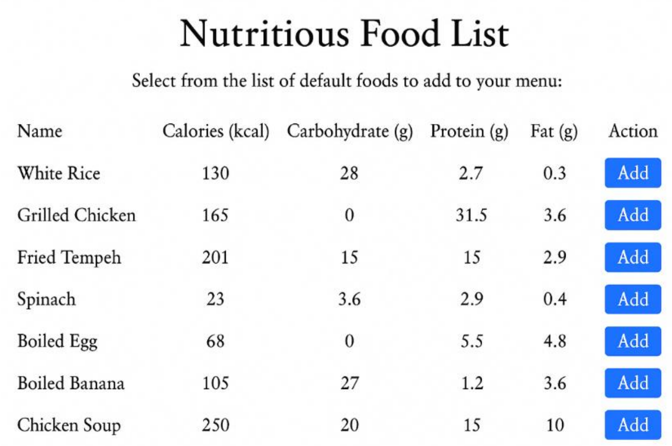

Figure 4. Menu and Nutrient Food List

Figure 4 displays the system's default list of food items, including their nutritional values for calories, carbohydrates, protein, and fat per serving. Users can select food items directly from this list to include in their menu by clicking the "Add" button in the Action column. The list is designed to simplify menu compilation by providing commonly consumed foods with predefined nutrient data, thus streamlining the process of nutritional simulation.

Your Menu

Name	Calories (kcal)	Carbohydrates (g)	Protein (g)	Fat (g)
Chicken Soto	250	20	15	10
Boiled Egg	77	0.6	6.3	5.3
White Rice	130	28	2.7	0.3

Total Calories: 457 kcal

Figure 5. Selected Menu List

This figure presents the food items selected by the user for the simulated menu, along with their respective nutritional values for calories, carbohydrates, protein, and fat. The table displays a cumulative overview of the nutrient composition based on user choices and summarizes total caloric intake. This feature helps users visualize the nutritional balance of their selected menu and supports informed decision-making in aligning with dietary goals.

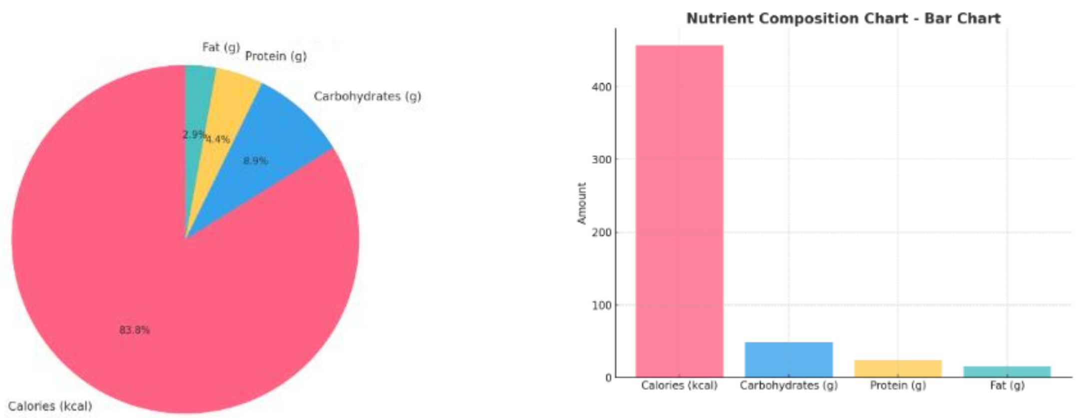

Figure 6. Pie and Bar Charts of Nutrient Composition in the Selected Menu

This figure illustrates the nutritional breakdown of the selected menu using two types of visualizations: a pie chart and a bar chart. The pie chart represents the percentage distribution of calories, carbohydrates, protein, and fat, highlighting their proportion in the menu. The bar chart displays the absolute values of each nutrient component to facilitate easy comparison. These visual tools enhance user understanding of nutrient balance and assist in evaluating whether the selected menu meets desired dietary guidelines.

Conclusion

The test results demonstrate that the developed system can calculate nutritional compositions with an accuracy rate of 92% compared to manual assessments conducted by professional nutritionists. Additionally, the system provides clear feedback to users when a designed menu does not meet the targeted nutritional standards. Implementing the Finite State Automata (FSA) method has proven effective in structuring the menu preparation process to ensure efficiency and logical workflow. Among the 30 users who tested the system—including MBG program organizers and nutritionists—85% expressed satisfaction with the application's user interface and ease of use. Then, the average time required to compile a menu using the system was 40% shorter than the manual method, underscoring its potential to enhance productivity. Further research can focus on the following aspects. Database Expansion: Integrate more food ingredients into the database to improve calculation accuracy. Innovative System Development: Using machine learning technology to provide menu recommendations based on user preferences and needs.

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