

A Preference-Based Dynamic Weighting TOPSIS Framework for Web-Based Menu Recommendation in Indonesia's Free Nutritious Meal Program

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ABSTRACT

The Free Nutritious Meal (MBG) Program requires a systematic menu selection process to consider multiple nutritional criteria and changing priorities. This study aims to develop a web-based decision support system for MBG menu selection using the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method with a dynamic weighting mechanism based on user preferences. Thirty menu alternatives were evaluated using five criteria: energy, protein, fat, carbohydrates, and dietary fiber. TOPSIS was applied to rank alternatives based on their relative closeness to the ideal solution. The results show that the system successfully performs all core functions and produces rankings consistent with manual calculations. Menu 4 achieved the highest preference score of 0.7215. The dynamic weighting mechanism allows changes in criterion priorities to generate adaptive recommendations. The developed system supports a more objective, consistent, and flexible menu selection process for the MBG Program.

1. Introduction

The Free Nutritious Meal (MBG) Program is a strategic government initiative designed to improve national nutritional status. Beyond addressing nutritional needs, the program aims to enhance the quality of human resources through the provision of nutritionally balanced meals [1]. The program is administered by the National Nutrition Agency (BGN) and is expected to contribute to improving nutritional status and strengthening human resources toward the realization of Golden Indonesia 2045 [2]. The formulation of nutritious meals should consider the *Angka Kecukupan Gizi* (AKG), Indonesia's national dietary adequacy standard, according to age groups and physiological conditions[3].

The success of Indonesia's Free Nutritious Meal (MBG) Program depends not only on the ability to distribute meals to beneficiaries but also on the ability of program administrators to select menus that appropriately meet nutritional requirements. Menu selection constitutes a complex decision-making problem because each menu alternative has different characteristics and needs to be evaluated across multiple aspects simultaneously. Previous research on school meal planning has demonstrated that menu selection may involve trade-offs among nutritional quality, cost, student consumption, and environmental impacts, indicating that menu selection cannot adequately rely on a single indicator [4]. In addition to nutritional content, menu acceptability among beneficiaries is an important aspect of school meal programs. A nutritionally appropriate menu may not necessarily be optimally consumed if it is not well accepted by students. A systematic review of school feeding programs showed that menu acceptability has been evaluated using various approaches, including hedonic scales, questionnaires, interviews, and measurements of food consumption and leftovers. These findings indicate the need for a systematic evaluation mechanism through which multiple menu alternatives can be consistently compared

based on predefined criteria. Multi-Criteria Decision Making (MCDM), including TOPSIS, can support this process by simultaneously ranking alternatives across multiple criteria [5].

TOPSIS is widely used to rank alternatives based on their proximity to the positive ideal solution and their distance from the negative ideal solution [6]. In the context of food selection, the integration of the Analytic Hierarchy Process (AHP) and TOPSIS has been applied to rank food packages by considering nutritional value and user preferences [7]. Furthermore, food recommendation systems have highlighted the importance of integrating nutritional requirements with user preferences to generate personalized and adaptive recommendations [8].

However, most existing decision support systems for food selection still employ predefined criteria and fixed weights established during the model design stage [7]. In contrast, recent advances in food recommender systems have shifted toward more personalized and adaptive recommendations by incorporating user preferences, health conditions, and individual nutritional requirements [8], [9]. Within the Free Nutritious Meal Program (MBG), menu planning must satisfy nutritional requirements across different age groups while also considering budget constraints, menu variety, ingredient availability, and local food characteristics [10]. Nevertheless, a gap remains between the use of fixed weighting schemes and the need for a flexible recommendation system capable of accommodating changes in the priority of nutritional criteria.

This study develops a decision support system that enables users to dynamically adjust the relative importance of nutritional criteria. Changes in criterion weights can influence the preference scores and ranking order generated by the TOPSIS method [11], [12]. The proposed system provides flexibility in prioritizing energy, protein, fat, carbohydrates, and dietary fiber without modifying the underlying TOPSIS

algorithm. This approach is consistent with the concept of adaptive decision support systems, which incorporate user needs and preferences into the decision-making process [13]. The main contribution of this study is the implementation of a dynamic weighting mechanism that enables the generation of multiple recommendation scenarios in response to changing user priorities [11] while supporting menu planning based on Indonesia's national nutritional standards [10]

This study aims to develop a web-based decision support system that applies the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) for menu selection in Indonesia's Free Nutritious Meal (MBG) Program. The proposed system allows users to dynamically adjust the weights of nutritional criteria according to their preferences and evaluates menu alternatives based on energy, protein, fat, carbohydrates, and dietary fiber. The system is subsequently validated through functional testing, and its computational results are compared with manual calculations to verify the accuracy of the TOPSIS implementation.

2. Research Methods

This study adopts a Research and Development (R&D) approach to develop a web-based application for evaluating and ranking menu alternatives in Indonesia's Free Nutritious Meal (MBG) Program. The application was developed using the Waterfall software development model, which consists of five sequential phases: requirements analysis, system design, implementation, testing, and maintenance. These phases are executed in a structured and systematic manner [14]. The Waterfall model was selected because the system requirements and core functionalities were clearly defined at the outset of the project, enabling a systematic and well-controlled development process.

The study utilized secondary data obtained from the Free Nutritious Meal (MBG) Program guidelines and the AKG issued by the Ministry of Health of the Republic of Indonesia. The

AKG specifies the recommended intake of energy, protein, fat, carbohydrates, dietary fiber, water, vitamins, and minerals for different population groups [3]. A total of 30 menu alternatives were evaluated based on five nutritional criteria: energy, protein, fat, carbohydrates, and dietary fiber. These criteria were selected based on the scope of nutritional data that was consistently available across all menu alternatives and used as the primary indicators in the decision matrix. Energy was used to represent the energy adequacy of each menu, whereas protein, fat, and carbohydrates represented the major macronutrient components. Dietary fiber was included as an additional indicator related to food composition. Although the AKG also includes other nutritional components, such as vitamins and minerals [3], these components were not incorporated into the initial model because the dataset for all 30 alternatives was focused on the five selected indicators. Therefore, the five criteria are not intended to represent all dimensions of nutritional adequacy in the MBG Program but rather define the scope of the nutritional evaluation used in the proposed system. The weights assigned to the five nutritional criteria can be dynamically adjusted by users through the system interface. This mechanism allows different weighting configurations to be applied before the TOPSIS calculation, enabling the resulting preference scores and menu rankings to reflect different user-defined priorities.

This study did not employ respondents intended to represent the Indonesian population. The nutritional values used in the ranking process were obtained from secondary data, whereas the criterion weights in the system can be adjusted by users through the application interface to represent different priority scenarios in the decision-making process. The intended users of the proposed system are SPPG/MBG kitchen administrators involved in menu evaluation and selection. Therefore, the criterion weights should not be interpreted as representing the preferences of all MBG

beneficiaries in Indonesia; rather, they serve as adjustable decision parameters that can be modified by system users according to their menu management priorities

The 30 menu alternatives represent meal combinations containing complete information on energy, protein, fat, carbohydrates, and dietary fiber required to construct the TOPSIS decision matrix. The alternatives were compiled within the scope of menus for junior and senior high school students with reference to the nutritional standards adopted in this study. They were included because all alternatives contained nutritional information that could be consistently evaluated using the five selected criteria. Accordingly, the dataset was used for system development and computational testing and was not intended to represent all menu variations implemented throughout Indonesia's MBG Program.

In determining the ranking of MBG menu alternatives, the TOPSIS procedure was performed sequentially. First, the decision matrix was constructed using the nutritional values of each menu alternative across the five evaluation criteria. Second, the decision matrix was normalized so that criterion values expressed on different scales could be compared. Third, the normalized matrix was multiplied by the corresponding criterion weights to obtain the weighted normalized decision matrix. Fourth, the positive ideal solution (A^+) and negative ideal solution (A^-) were determined based on the best and worst values for each criterion. Fifth, the separation distance of each alternative from the positive ideal solution (D^+) and the negative ideal solution (D^-) was calculated using Euclidean distance. Sixth, the relative closeness coefficient (C_i) was calculated based on the distances of each alternative from both ideal solutions. Finally, all menu alternatives were ranked in descending order according to their C_i values. The alternative with the highest C_i value was identified as the highest-priority menu alternative[6].

3. Results and Discussions

The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) has been widely applied to various food selection problems involving individuals with specific nutritional requirements or health conditions. Previous studies have employed TOPSIS to support menu selection for undernourished children [15], while other researchers have developed decision support systems for menu selection among individuals with obesity[16]. Similar approaches have also been applied to food selection for patients with hypertension by evaluating menu alternatives against predefined criteria [17]. In the context of child nutrition, TOPSIS has further been utilized to recommend complementary feeding menus based on infants' caloric requirements [18]. Collectively, these studies demonstrate that TOPSIS is an effective method for evaluating multiple nutritional indicators and systematically ranking food alternatives.

Despite these contributions, most existing studies focus on recommendations for individuals or specific patient groups and rely on predefined evaluation criteria and fixed weighting schemes. More recently, decision support systems have also been developed to support menu selection in Indonesia's Free Nutritious Meal (MBG) Program through web-based platforms. Nevertheless, there remains an opportunity to enhance these systems by enabling MBG administrators to dynamically adjust the relative importance of each nutritional criterion before the ranking process is performed.

This study develops a web-based decision support system to evaluate 30 menu alternatives based on five nutritional criteria: energy, protein, fat, carbohydrates, and dietary fiber. The primary contribution of this research is the implementation of a user preference-based dynamic weighting mechanism, which enables MBG administrators to specify the relative importance of each nutritional criterion through the system interface. Based on the user-defined weights, the system recalculates the relative

closeness coefficient and the ranking of menu alternatives using the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). Variations in criterion weights can influence the ranking results because they reflect the relative importance assigned to each nutritional criterion [12]. Consequently, the proposed approach allows the system to generate different menu recommendation scenarios that are aligned with the priorities and preferences of MBG administrators.

Requirements Planning

The first phase of the Waterfall development model involved requirements analysis, which was conducted to identify both the functional and non-functional requirements of the proposed system based on the business process and stakeholder needs. The functional requirements include the management of menu alternatives and nutritional information, menu ranking using the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), presentation of the recommended menu, and user management by the system administrator. The non-functional requirements encompass usability, data security, and computational efficiency. Business process analysis revealed that menu selection was previously performed manually and was therefore susceptible to subjective judgment, while verifying nutritional information was relatively time-consuming. Furthermore, menu selections that do not adequately reflect the preferences of the intended beneficiaries may contribute to increased food waste. Two primary system users were identified: the System Administrator and the SPPG/Kitchen Officer. The SPPG Manager acts as the decision-maker who uses the recommendation generated by the system for menu planning.

System Design

The system was designed based on the results of the requirements analysis, encompassing the system architecture, database structure, TOPSIS computational workflow,

and a web-based user interface. The proposed system adopts a three-tier architecture consisting of a presentation layer (front-end), a business logic layer that executes the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) algorithm, and a data layer responsible for storing menu data, nutritional criteria, and calculation results. This architecture was designed to automate the menu selection process, which had previously been performed manually and in an unstructured manner. The user interface was developed to ensure ease of use, allowing MBG Food Service Unit (SPPG/Kitchen) administrators to operate the system without requiring specialized technical expertise. Consequently, the proposed system is expected to generate menu recommendations that are more objective, efficient, measurable, and compliant with Indonesia's national nutritional standards (AKG), while supporting a more effective and systematic decision-making process.

Table 1. Stakeholder Roles and System Requirements

No	Stakeholder	Role in the System	System Requirements
1	System Administrator	Manages the overall system and its data.	Requires functionalities to manage user accounts, evaluation criteria, menu alternatives, and system configuration, including the execution of the menu evaluation process.

2	MBG Food Service Unit (SPPG/ Kitchen) Officer	Primary user responsible for the menu selection process.	Requires functionalities to input menu data and nutritional information and to view the recommended menu generated by the system.
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The proposed decision support system for Free Nutritious Meal (MBG) menu selection involves MBG Food Service Unit (SPPG) officers as the primary users responsible for managing menu data, nutritional criteria, and the evaluation process, while the SPPG Manager serves as the decision-maker who utilizes the recommendation results in menu planning. As the intended beneficiaries, students are indirectly represented in the recommendation process through the nutritional requirements corresponding to their age groups. Overall, the proposed system is expected to support a more objective, efficient, and evidence-based menu selection process while ensuring compliance with Indonesia's national nutritional standards (AKG).

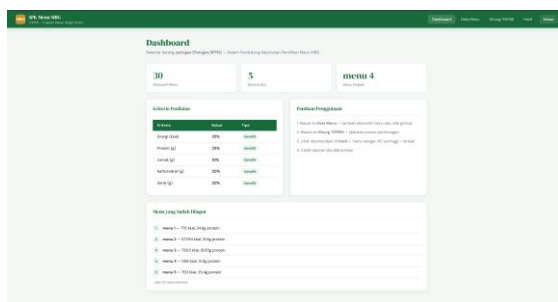


Figure 1. Dashboard of the Web-Based Decision Support System for MBG Menu Selection

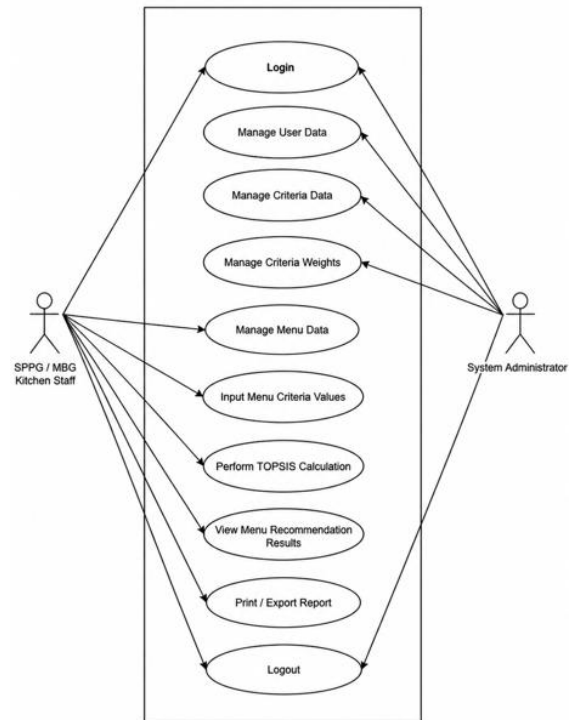


Figure 2. Use Case Diagram

The use case diagram illustrates the interactions between the System Administrator and the MBG Food Service Unit (SPPG/Kitchen) Officer. The System Administrator is responsible for managing user accounts, evaluation criteria, criterion weights, and system access control. Meanwhile, the SPPG Officer manages menu data, enters nutritional criterion values, executes the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) calculations, and accesses the recommended menu and generated reports. In addition, the activity diagram depicts the workflow of the proposed system, beginning with user authentication, followed by data management, TOPSIS computation, and the presentation of menu recommendations and reports. Together, these diagrams illustrate the structured interaction between users and the system, demonstrating how each functional component supports a more objective, efficient, and systematic menu selection process that aligns with user requirements and the implementation of the MBG Program.

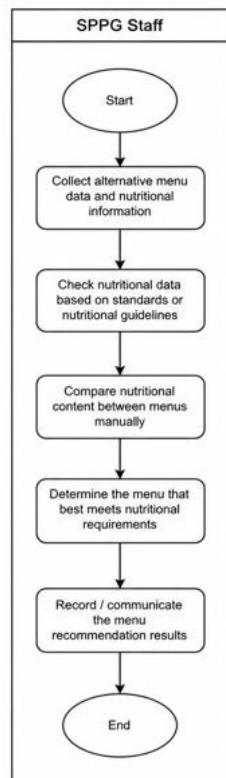


Figure 3. Activity Diagram of the Existing Business Process

The activity diagram illustrates the menu selection process prior to the implementation of the proposed decision support system. In the existing workflow, menu selection is performed manually by compiling menu alternatives and reviewing their nutritional content, including energy, protein, fat, carbohydrates, and dietary fiber. SPPG officers compare the nutritional values against established guidelines and internal considerations without relying on a structured decision-making method. The selected menu is subsequently documented or communicated to the relevant stakeholders. This manual process is time-consuming, lacks system integration, and may lead to inconsistent decision-making. The implementation of the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)-based decision support system transforms this workflow into a structured and automated process, enabling menu alternatives to be evaluated more efficiently, objectively, and consistently based on predefined nutritional criteria.

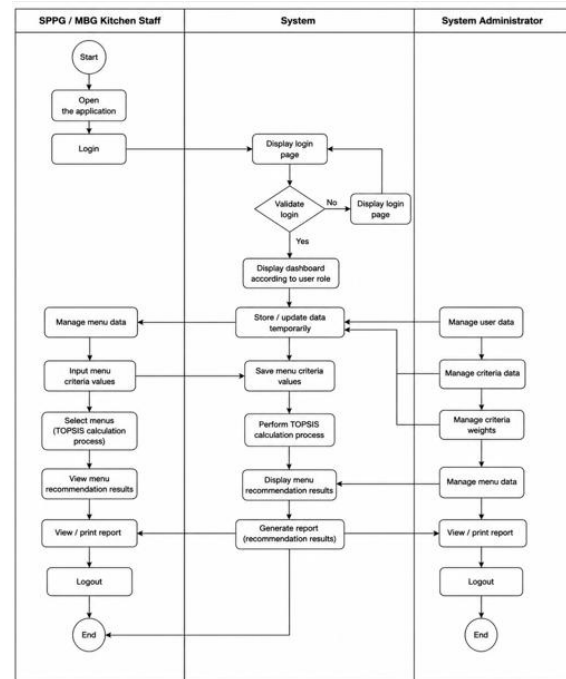


Figure 4. Activity Diagram of the Proposed Business Process

The business process for menu selection in Indonesia's Free Nutritious Meal (MBG) Program was significantly improved following the implementation of the proposed decision support system. Prior to system implementation, MBG Food Service Unit (SPPG/Kitchen) officers manually collected menu data and nutritional information before comparing menu alternatives based on the nutritional requirements of the intended beneficiaries. The documentation and evaluation processes relied heavily on the officers' judgment, making the workflow more time-consuming, less structured, and susceptible to inconsistent decision-making.

Following the implementation of the proposed system, the menu selection process is performed through an integrated web-based application. Users can authenticate, enter menu data and nutritional information, assign weights to the evaluation criteria, and execute the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) algorithm. The system then automatically performs decision matrix normalization, constructs the weighted normalized decision matrix, determines the positive and negative ideal solutions, and ranks

the menu alternatives based on their relative closeness coefficients. Finally, the alternative with the highest relative closeness coefficient is presented as the recommended menu.

The implementation of the proposed system transforms the Free Nutritious Meal (MBG) menu selection process from a manual evaluation approach into a TOPSIS-based decision-making process. Activities that were previously performed manually are now executed systematically and automatically by the system. The generated menu recommendations can be displayed, stored, and exported as reports, thereby facilitating the documentation and traceability of decision-making outcomes. Consequently, the proposed TOPSIS-based decision support system improves the efficiency, consistency, and objectivity of the menu evaluation and selection process by systematically assessing menu alternatives based on predefined nutritional criteria.

Implementation

During the implementation phase, the system design was translated into a web-based application capable of supporting the menu selection process for Indonesia's Free Nutritious Meal (MBG) Program. The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) algorithm was integrated into the application as the core decision-making engine for ranking menu alternatives. The application was developed with several key functional modules, including menu and nutritional criteria management, TOPSIS computation, menu recommendation generation, and user administration. The AKG issued by the Ministry of Health of the Republic of Indonesia serves as the reference standard for managing the nutritional values associated with each menu alternative. Through this implementation, menu data can be processed automatically by the system to generate ranked recommendations based on the relative closeness coefficient calculated using the TOPSIS method.

Testing

The system was evaluated in terms of both functional performance and the computational accuracy of the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) algorithm. Functional performance was assessed using black-box testing, in which a series of test scenarios was conducted to verify the functionality of each system feature. In addition, the computational accuracy of the TOPSIS implementation was validated by tracing each computational stage and comparing the system-generated results with manual calculations performed in Microsoft Excel. This evaluation approach ensured that the proposed system operated correctly from both the user perspective and the algorithmic implementation perspective.

A total of 21 test scenarios were successfully executed to evaluate the system's core functionalities, including user authentication, the dashboard, menu management, TOPSIS computation, ranking generation, and report generation. A total of 21 test scenarios were executed to evaluate the system's core functionalities, including user authentication, dashboard operation, menu management, TOPSIS computation, ranking generation, and report generation. The functional evaluation achieved an overall score of 84.9%, indicating that the major system functionalities operated according to the predefined test scenarios. The decision matrix module obtained the highest score (8.1). Meanwhile, each of the core TOPSIS procedures—including decision matrix normalization, weighted normalization, determination of the positive and negative ideal solutions, and calculation of the relative closeness coefficient (RC)—received a score of 4.5. These results indicate that all major system functionalities operated successfully and performed in accordance with the predefined testing scenarios.

The computational accuracy of the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) algorithm was verified by comparing the outputs generated by the

proposed system with those obtained from Microsoft Excel calculations. The comparison covered the normalized decision matrix, the weighted normalized decision matrix, the positive and negative ideal solutions, the separation distances for each alternative, and the relative closeness coefficient (RC). The two approaches produced identical computational patterns and the same ranking order of menu alternatives. Minor discrepancies were observed only in certain decimal places due to numerical rounding and had no effect on the final ranking results.

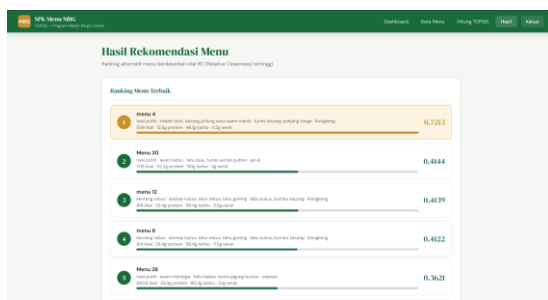


Figure 5. Menu Ranking Results Generated by the Web-Based Decision Support System

Table 2. Menu Ranking Results Obtained from Manual TOPSIS Calculations

Menu Alternative	D+	D–	C _i	Rank
4	0,04	0,11	0,7215	1
30	0,08	0,06	0,4144	2
6	0,09	0,06	0,4139	3
12	0,08	0,06	0,4139	3
28	0,09	0,05	0,3620	5
21	0,09	0,04	0,3330	6
5	0,09	0,05	0,3274	7
11	0,09	0,05	0,3274	8
27	0,09	0,04	0,3202	9
22	0,09	0,04	0,3191	10

As presented in Table 2, Menu 4 achieved the highest relative closeness coefficient (C_i) of 0.7215, with a separation distance from the positive ideal solution (D⁺) of 0.0456 and a separation distance from the negative ideal solution (D[–]) of 0.1181, thereby ranking first among all evaluated alternatives. As an

illustrative calculation, the relative closeness coefficient of Menu 4 was calculated using $(C_i = D_i^- / (D_i^+ + D_i^-))$, resulting in $(C_4 = 0.1181 / (0.0456 + 0.1181) = 0.7215)$. The relatively low D⁺ value indicates that Menu 4 is closer to the positive ideal solution, whereas the higher D[–] value indicates that the alternative is farther from the negative ideal solution. Therefore, a higher C_i value represents a higher priority in the TOPSIS ranking [6].

Menu 30 ranked second with a C_i value of 0.4144, while Menu 6 and Menu 12 obtained C_i values of 0.4139. The difference of 0.3071 between Menu 4 and Menu 30 indicates that, under the applied weighting configuration, Menu 4 exhibits greater proximity to the ideal solution than the other alternatives. This finding is consistent with previous applications of TOPSIS to food-menu selection, in which alternatives were prioritized according to their shortest distance from the positive ideal solution and greatest distance from the negative ideal solution [15]. Therefore, the present findings further support the use of TOPSIS as a menu-ranking mechanism, while extending its application through dynamic weighting to accommodate changes in user-defined criterion priorities.

Maintenance

The maintenance phase aims to ensure that the application remains aligned with operational requirements and evolving national nutritional policies. Maintenance activities include correcting system errors, updating the AKG references whenever revisions to the nutritional standards are issued by the Ministry of Health of the Republic of Indonesia, accommodating changing user requirements, and expanding the menu database to reflect the availability of local food resources. In addition, periodic system evaluations are necessary to ensure that the evaluation criteria, weighting mechanism, and application functionalities remain relevant and effective in supporting menu selection within the Free Nutritious Meal (MBG) Program.

4. Conclusion and Suggestions

This study successfully developed a web-based decision support system for menu selection in Indonesia's Free Nutritious Meal (MBG) Program using the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). The system evaluates 30 menu alternatives based on five nutritional criteria: energy, protein, fat, carbohydrates, and dietary fiber. Computational validation showed that the preference scores and ranking order generated by the system were consistent with the results obtained from manual calculations using Microsoft Excel, indicating that the TOPSIS algorithm was correctly implemented. Under the weighting configuration used in the evaluation, Menu 4 achieved the highest relative closeness coefficient (C_i) of 0.7215 and ranked first among the evaluated alternatives. In addition, the dynamic weighting mechanism allows users to adjust the relative importance of each criterion before the TOPSIS calculation is performed, enabling the system to evaluate menu alternatives under different criterion-priority scenarios.

This study has several limitations. First, the system was developed and validated using 30 menu alternatives; therefore, the resulting rankings are limited to the alternatives included in the study dataset and do not represent all menu variations implemented throughout Indonesia's MBG Program. Second, the menu evaluation was limited to five nutritional criteria—energy, protein, fat, carbohydrates, and dietary fiber—and did not incorporate other relevant factors such as micronutrients, menu cost, ingredient availability, food safety, and menu acceptability. Third, the study did not involve a representative sample of SPPG users or MBG beneficiaries. Consequently, the criterion weights used in the system represent user-defined priority scenarios and should not be generalized as representing the preferences of all SPPG administrators or MBG beneficiaries in Indonesia.

Future research should extend the proposed model by incorporating additional criteria, including menu cost, ingredient availability, micronutrients, food safety, beneficiary preferences, and menu acceptability, to provide a more comprehensive evaluation framework. Weight sensitivity analysis should also be conducted to evaluate the stability of menu rankings under changes in the relative importance of individual criteria. Furthermore, multi-objective optimization could be integrated to identify menu combinations while simultaneously considering multiple objectives and constraints. The use of actual operational data and direct implementation within Nutrition Fulfillment Service Units (SPPG) is also recommended to evaluate the effectiveness, scalability, and practical applicability of the proposed system under real-world MBG operational conditions.

5. References

- [1] Presiden Republik Indonesia, "Peraturan Presiden Republik Indonesia tentang Badan Gizi Nasional," *Pemerintah Pusat Republik Indonesia*, no. 211799, 2024, [Online]. Available: <https://peraturan.bpk.go.id/Details/295857/perpres-no-83-tahun-2024>
- [2] F. Shiddiq and G. N. Effendi, "Strategic Challenges and Optimization Strategies for Human Resource Development through Indonesia's Free Nutritious Meal Program," *Society*, vol. 13, no. 2, pp. 1037–1055, 2025, doi: 10.33019/society.v13i2.943.
- [3] Kementerian Kesehatan Republik Indonesia, "Angka Kecukupan Gizi Masyarakat Indonesia," *Permenkes Nomor 28 Tahun 2019*, vol. Nomor 65, no. 879, pp. 2004–2006, 2019.
- [4] A. L. Stern, S. Levine, S. A. Richardson, N. T. Blackstone, C. Economos, and T. S. Griffin, "Improving school lunch menus with multi-objective optimisation: Nutrition, cost, consumption and environmental impacts," *Public Health Nutr.*, vol. 26, no. 8, pp. 1715–1727, 2023, doi: 10.1017/S1368980023000927.



- [5] S. L. İpek and D. Göktürk, "Application of Multi-Criteria Decision Making Methods for Menu Selection," *Black Sea Journal of Engineering and Science*, vol. 7, no. 1, pp. 21–30, 2024, doi: 10.34248/bsengineering.1358895.
- [6] L. Lamrini, M. C. Abounaima, and M. Talibi Alaoui, "New distributed-topsis approach for multi-criteria decision-making problems in a big data context," *J. Big Data*, vol. 10, no. 1, 2023, doi: 10.1186/s40537-023-00788-3.
- [7] A. M. 'Ainul Yaqin, M. J. Rosyid, V. A. Leksono, and A. D. Wantira, "A Preference-Oriented Multi-Criteria Decision Model for Stunting-Prevention Food Basket Ranking using AHP-TOPSIS," *Jurnal Teknik Industri: Jurnal Keilmuan dan Aplikasi Teknik Industri*, vol. 26, no. 2, pp. 145–156, 2024, doi: 10.9744/jti.26.2.145-156.
- [8] G. Qiao *et al.*, "Food recommendation towards personalized wellbeing," *Trends Food Sci. Technol.*, vol. 156, no. January, p. 104877, 2025, doi: 10.1016/j.tifs.2025.104877.
- [9] Z. Xu, Y. Gu, X. Xu, M. Topaz, Z. Guo, and H. Kang, "Developing a personalized meal recommendation system for Chinese elderly population : a knowledge- driven and community-based approach Table of Contents," *JMIR Publications*, 2023.
- [10] Badan Gizi Nasional, *Petunjuk Teknik Tata Kelola Penyelenggaraan Program Makan Bergizi Gratis Tahun Anggaran 2026*. 2026.
- [11] À. Gaona, A. Guisasola, and J. A. Baeza, "An integrated TOPSIS framework with Full-Range Weight Sensitivity Analysis for robust decision analysis," *Decision Analytics Journal*, vol. 17, no. July, p. 100642, 2025, doi: 10.1016/j.dajour.2025.100642.
- [12] Z. Bánhidi and I. Dobos, "Sensitivity of TOPSIS ranks to data normalization and objective weights on the example of digital development," *Cent. Eur. J. Oper. Res.*, vol. 32, no. 1, pp. 29–44, 2024, doi: 10.1007/s10100-023-00876-y.
- [13] C. Troussas, A. Krouska, P. Mylonas, and C. Sgouropoulou, "Personalized Instructional Strategy Adaptation Using TOPSIS: A Multi-Criteria Decision-Making Approach for Adaptive Learning Systems," *Information (Switzerland)*, vol. 16, no. 5, 2025, doi: 10.3390/info16050409.
- [14] T. Tjahjanto, A. Arista, and E. Ermatita, "Application of the Waterfall Method in Information System for State-owned inventories Management Development," *Sinkron*, vol. 7, no. 4, pp. 2182–2192, 2022.
- [15] I. As'ad, Y. Mukhlis, and S. Anraeni, "Penerapan Metode Technique For Order Preference By Similarity To Ideal Solution (Topsis) Pada Sistem Pendukung Keputusan Pemilihan Menu Makanan Bagi Balita Yang Mengalami Kekurangan Gizi," *Buletin Sistem Informasi dan Teknologi Islam*, vol. 3, no. 2, pp. 150–156, 2022.
- [16] S. Anisa and N. Ransi, "Implementasi Metode TOPSIS Dalam SPK Pemilihan Menu Makanan Pada Penderita Obesitas," *ANIMATOR*, vol. 1, no. 3, pp. 1–5, 2023.
- [17] H. Syahputra, D. Guswandi, and N. Yolanda, "Pemilihan Makanan Terbaik Bagi Penderita Hipertensi Menggunakan Metode Topsis," *Jurnal Pustaka AI (Pusat Akses Kajian Teknologi Artificial Intelligence)*, vol. 3, no. 1, pp. 8–17, 2023, doi: 10.55382/jurnalpustakaai.v3i1.536.
- [18] S. W. Sihwi, H. Mulyasari, R. Saptono, and B. Wiboworini, "Sistem Rekomendasi Menu Harian Makanan Pendamping Air Susu Ibu (MPASI) Berdasarkan Kebutuhan Kalori Bayi dengan Metode TOPSIS," *Jurnal Ilmu Komputer dan Agri-Informatika*, vol. 3, no. 2, p. 122, 2016, doi: 10.29244/jika.3.2.122-131.

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