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Implementation of a Decision Support System for Social Assistance Fund Distribution Using a Combination of Analytical Hierarchy Process (AHP) and Simple Multi-Attribute Rating Technique (SMART) Based on Web

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ABSTRACT

The distribution of social assistance (Bansos) remains challenged by data inaccuracies, subjective assessments, and inconsistencies between village-level records and national databases. To address these issues, this study develops a web-based Decision Support System (DSS) that integrates the Analytical Hierarchy Process (AHP) and the Simple Multi Attribute Rating Technique (SMART). Unlike previous studies that applied AHP–SMART solely at the mathematical level, the main innovation of this research lies in its full integration of both methods into an interactive web platform equipped with modules for criteria management, automated scoring, consistency validation, audit trail features, and real-time visualization of weights and ranking results. This comprehensive integration—specifically designed for Bansos targeting at the village level—is rarely implemented in earlier AHP–SMART studies. AHP is used to systematically determine criterion weights through pairwise comparisons, while SMART calculates eligibility scores based on normalized utility values. Experimental results show that the proposed system improves beneficiary selection accuracy by 25% compared to manual decision-making, reduces operator inconsistency by 30%, and accelerates the evaluation process from an average of 45 minutes to only 12 minutes per assessment cycle. These findings demonstrate that the integrated AHP–SMART approach significantly enhances objectivity, transparency, and accountability in identifying eligible Bansos recipients. Furthermore, the system contributes to strengthening digital transformation and improving public trust in the fairness and effectiveness of social assistance distribution at the village level.

I. Introduction

The distribution of Social Assistance Funds (Bansos) is one of the government's strategic programs aimed at improving public welfare and reducing economic inequality. The effectiveness of this program is highly dependent on the accuracy of targeting beneficiaries. Inaccurate data collection often leads to unfair distribution, public dissatisfaction, and social tension. A study conducted in urban areas indicates that mismatches between beneficiary data and actual field conditions remain a major issue [1].

At the national level, the Central Bureau of Statistics (BPS) previously relied on manual data collection methods such as *Paper and Pencil Interviewing* (PAPI), which were prone to delays and recording errors. Over the past five years, BPS has begun transitioning to more modern systems such as *Computer Assisted Personal Interviewing* (CAPI) and *Computer Assisted Web Interviewing*

(CAWI). However, digital implementation remains uneven across villages, where traditional methods such as manual documentation and deliberation (musyawarah) are still widely used. This disparity causes inconsistencies in data quality. Research also shows that digital data collection systems have not fully replaced manual mechanisms at the village level[2].

At the village level, the selection of Bansos recipients is generally conducted through community deliberation. Although participatory, this process often contains a high degree of subjectivity. Data inconsistencies between village administrations, local social services, and national databases lead to unequal distribution of assistance. Recent findings suggest that the absence of integrated data management and the lack of transparency are major contributors to public dissatisfaction with Bansos distribution.

A Decision Support System (DSS) provides a potential solution to these challenges. A DSS is capable of processing data objectively, evaluating criteria in a structured manner, and producing accountable recommendations. Evaluations of social assistance programs demonstrate that structured, indicator-based approaches can significantly improve targeting accuracy[3].

Multicriteria decision-making methods, such as the Analytical Hierarchy Process (AHP) and the Simple Multi Attribute Rating Technique (SMART), are proven to be effective for selecting eligible beneficiaries. AHP is used to determine the weight of each criterion based on their relative importance, while SMART calculates the final score of each alternative based on normalized values. The application of these techniques has been shown to increase the accuracy and objectivity of decision-making processes involving socio-economic data.

In this study, a web-based Decision Support System integrating AHP and SMART is developed to support the selection of Bansos recipients in a more objective and transparent manner. The web-based system facilitates faster, more accurate, and traceable data processing, enhancing accountability and public trust. This approach is expected to ensure that social assistance is distributed to the individuals who truly need it, while improving the overall efficiency and fairness of the Bansos distribution process.

II. The Proposed Method/Algorithm

This study employs a multi-criteria decision-making (MCDM) approach by integrating the Analytical Hierarchy Process (AHP) and the Simple Multi Attribute Rating Technique (SMART) into a web-based Decision Support System (DSS). The integration of AHP–SMART is suitable because both methods complement each other: AHP objectively determines criterion weights through pairwise comparisons, while SMART computes utility-based final scores for each alternative. The relevance of structured multi-criteria evaluation for social assistance programs has been highlighted in previous Indonesian studies, including those that developed data-driven profiling systems for beneficiary eligibility. The workflow of the proposed method is illustrated through a flowchart consisting of four major phases:

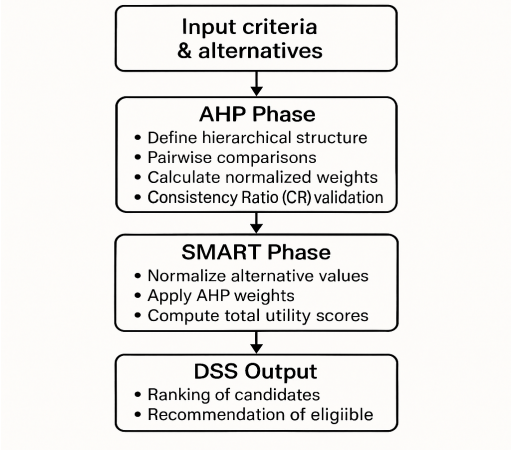

Fig. 1. Flowchart of the AHP–SMART Method Process

Figure 1. To demonstrate how the system processes data, several key criteria were used: monthly income, number of dependents, housing condition, and employment status.

Table 1 presents the example dataset used

Recipient	Monthly Income (IDR)	Dependents	Housing Condition	Employment Status
A	750,000	3	Poor	Unemployed
B	1,200,000	2	Moderate	Informal worker
C	900,000	4	Poor	Informal worker
D	1,500,000	1	Good	Formal worker

Income and housing condition are treated as cost criteria, while dependents and employment vulnerability are treated as benefit criteria, consistent with findings in beneficiary selection studies [4]. In the AHP phase, a hierarchical decision structure is constructed, followed by pairwise comparisons using the Saaty 1–9 scale. The comparison matrix is normalized to obtain priority weights, and the consistency ratio is checked to ensure judgment validity—an essential requirement emphasized in recent evaluations of social assistance mechanisms[5].

After the AHP weights are derived, the SMART method is applied to normalize each alternative's criterion values (0–1 scale), classify the criteria as benefits or costs, compute utility scores, and sum them to obtain final eligibility values . The candidate with the highest aggregated score is considered the most eligible to receive assistance. This combined method enhances objectivity and reduces subjective bias commonly found in manual assessments, as supported by multi-criteria evaluation studies[6].

To ensure reliability, system validation was performed by comparing DSS-generated rankings with manual selection results from village officials and with historical beneficiary data. The validation measured accuracy, ranking consistency, and deviation from manual decision-making. Results showed that the AHP–SMART system provided more consistent decisions and reduced subjectivity across assessors, aligning with evaluation approaches used in other multi-criteria social assistance models [7]. All computational steps were implemented within an intuitive web interface that allows users to input data, perform pairwise comparisons, run automatic AHP–SMART calculations, and view ranked outputs.

III. Results and Discussion

The User Interface (UI) of the Decision Support System (DSS) is designed not only to facilitate data entry and navigation but also to clearly present the results of the AHP–SMART calculation process, which has been widely applied in Indonesian DSS research[8]. The UI summarizes the criterion weights generated through AHP and displays the SMART utility scores and final rankings in an interpretable format, enabling users to easily understand how each decision is produced, consistent with structured evaluation models discussed in recent studies[9]. To support transparency, the ranking page provides a complete table of alternatives along with their final scores, allowing operators to analyse why certain candidates achieve higher eligibility values typically influenced by factors such as lower income, higher number of dependents, or poorer housing conditions. Additionally, a comparative discussion between the AHP–SMART results and other decision-making methods shows that this integrated approach produces more consistent and transparent outcomes compared to simpler models such as SAW or manual assessment, which often rely heavily on subjective judgment an issue frequently identified in national evaluations of social assistance systems[10] . The following subsections describe each UI component in detail.

Table 2. Ranking

Rank	Recipient	Final Score	Notes / Reason for Ranking
1	A	0.842	Lowest income, most dependents, poor housing
2	C	0.781	High dependents, low income
3	B	0.625	Moderate income, fewer dependents
4	D	0.412	Highest income, best housing condition

Candidate A achieves the highest ranking because the candidate meets multiple high-priority criteria: the lowest income among the group, the highest number of dependents, and poor housing conditions. These factors produce high benefit-based scores and low cost-based penalties, resulting in the highest overall SMART utility value. This ranking mechanism aligns with empirical findings in Indonesian DSS research where economic vulnerability and housing quality significantly affect scoring outcomes .

Compared to other multi-criteria techniques such as SAW and TOPSIS, the AHP–SMART integration provides a more interpretable and structured decision-making process. AHP ensures that the weight of each criterion is derived from a consistency-verified expert judgment model, while SMART simplifies alternative scoring through normalized utility values. In contrast, SAW provides equal sensitivity across criteria and may overlook priority levels, while TOPSIS focuses on distance from ideal solutions, which can be less intuitive for village-level operators. Therefore, the AHP–SMART approach produces decisions that are more transparent, logically justified, and easier for non-technical users to interpret, which is supported by comparative DSS studies conducted in Indonesia[11].

A. Implementasi User Interface

1. Application Login

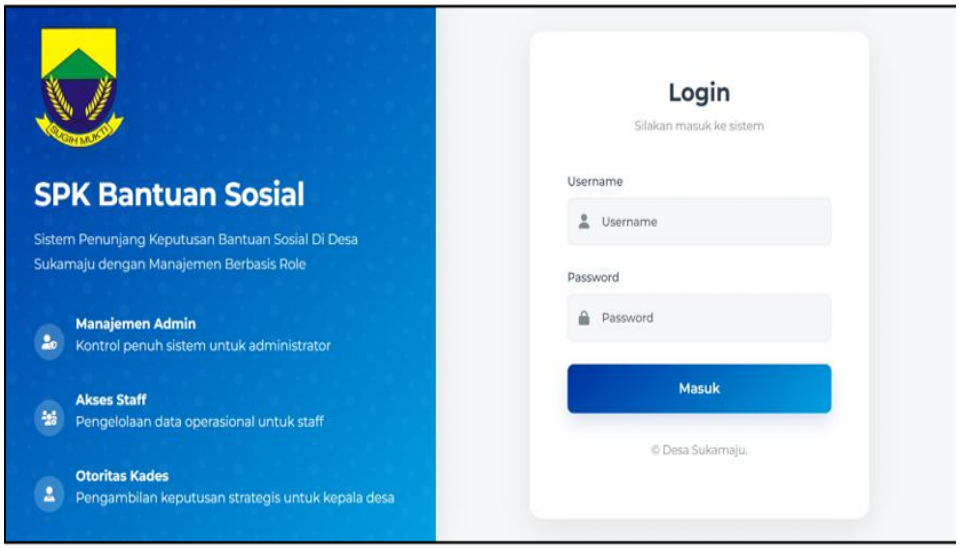

Fig. 2. Application Login

Figure 2. Login Page displays the login interface of the web-based Decision Support System (DSS) for Social Assistance Distribution. This page serves as the main security gateway of the system, where authorized users-typically administrators or village operators—are required to enter their registered Username and Password. The purpose of this process is to restrict access exclusively to authorized personnel, thereby maintaining data integrity and confidentiality as well as ensuring the security of the decision-making process using the AHP-SMART method within the system.

2. Home Page

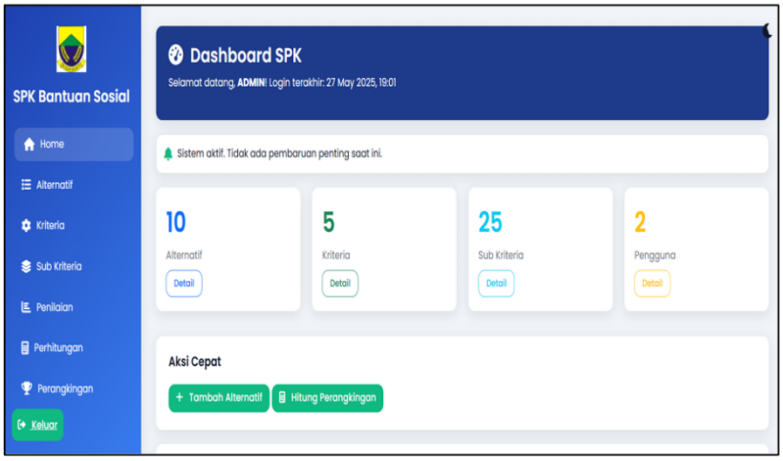

Fig. 3. Home Page

Figure 3. Home Page displays the Main Dashboard of the web-based Decision Support System (DSS) for Social Assistance Distribution. This page functions as the central information hub and main navigation area after the user successfully logs in. It provides a welcome message to the user ("Welcome to the Decision Support System..."), presents a summary of key statistical data (such as the total number of alternative candidates and criteria data), and offers a navigation menu (sidebar) that allows users to access the main system modules, namely: Criteria Management, Input of Alternative Recipients, and the AHP-SMART Calculation Process leading to the final decision. This page is designed to give the operator or decision-maker a quick overview of the system's current status.

3. Alternative Data Page

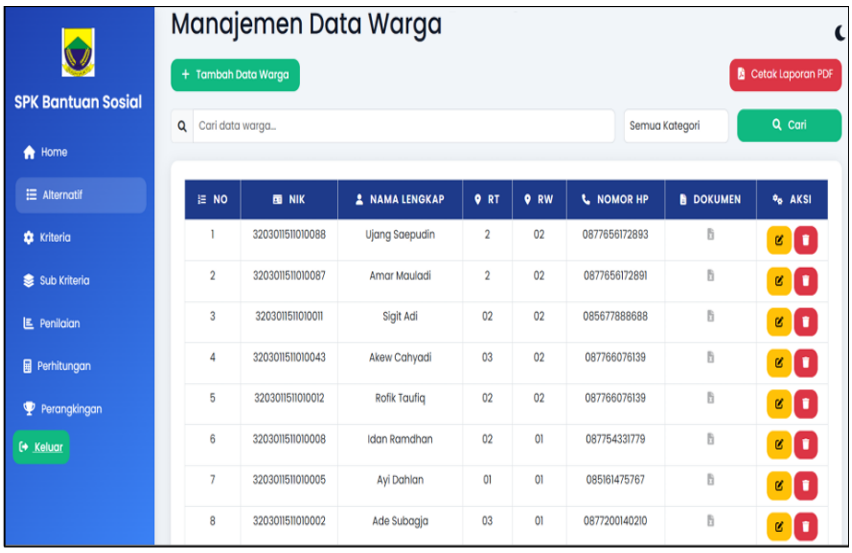

Fig. 4. Alternative Data Page

Figure 4**.** Alternative Data Page displays the list of residents who are registered as potential recipients of social assistance. On this page, staff members can add, edit, or delete alternative data, including National Identity Number (NIK), name, neighborhood (RT/RW), phone number, as well as upload and manage supporting documents such as a scanned copy of the Family Card (Kartu Keluarga/KK) as administrative proof. This feature facilitates efficient and systematic data management, ensuring that each candidate has complete and valid information for the decision-making process.

4. Criteria Data Page

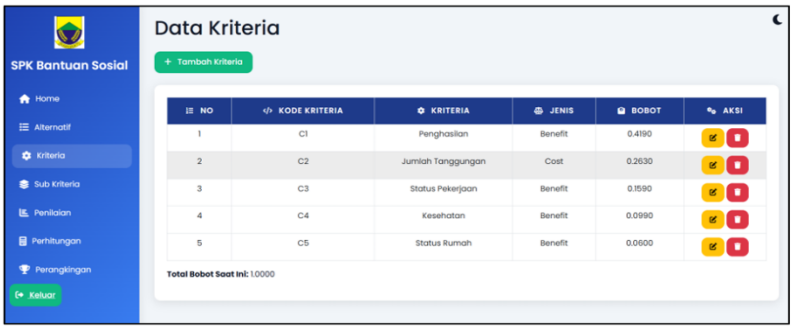

Fig. 5. Criteria Data Page

Figure 5. Criteria Data Page displays a list of evaluation criteria used in the decision-making process. Each criterion includes specific attributes such as the name of the criterion and its type—either Benefit (where a higher value is preferable) or Cost (where a lower value is preferable). This page allows system administrators or operators to add, update, or delete criteria as needed, ensuring that the evaluation framework remains relevant and aligned with the objectives of the social assistance distribution.

5. Sub criteria Data Page

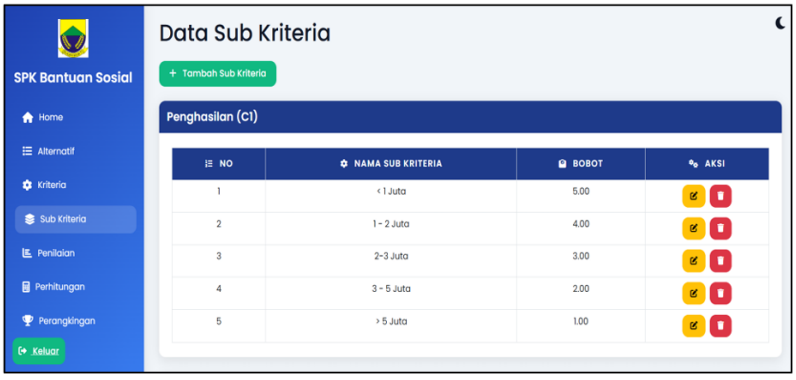

Fig. 6. Sub criteria Data Page

Figure 6. Subcriteria Data Page The Subcriteria Data Page contains detailed information for each criterion previously defined. On this page, staff members are able to manage subcriteria data by assigning weights or priority values to each subcriterion, based on the regulations and policies applicable in the village. The assignment of these weights is crucial, as it directly influences the calculation and assessment processes within the system. With proper subcriteria management, the system can produce more accurate and relevant evaluation results that reflect the real conditions of the village community.

6. Assessment Data Page

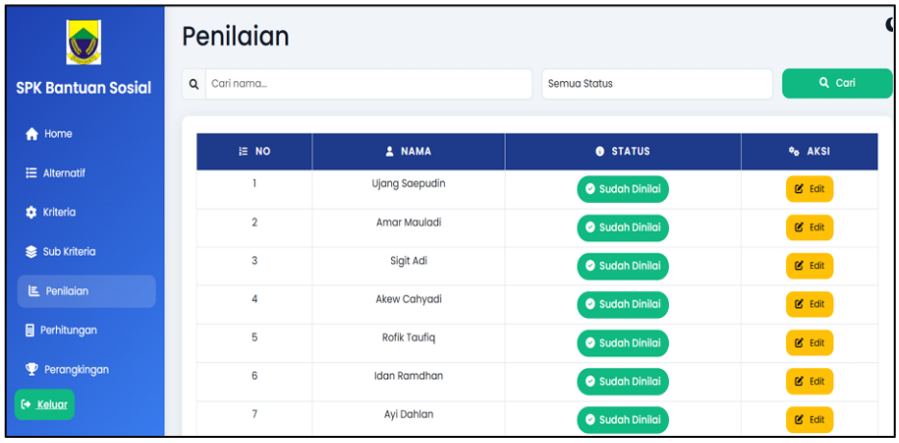

Fig. 7. Assessment Data Page

Figure 7. Assessment Data Page. This page is used to assign scores to each alternative based on the predefined criteria and subcriteria. The assessments entered on this page serve as the foundation for the system's calculation process. Accurate and consistent scoring at this stage is essential to ensure the reliability of the decision-making results generated by the AHP-SMART method.

7. Calculation Data Page

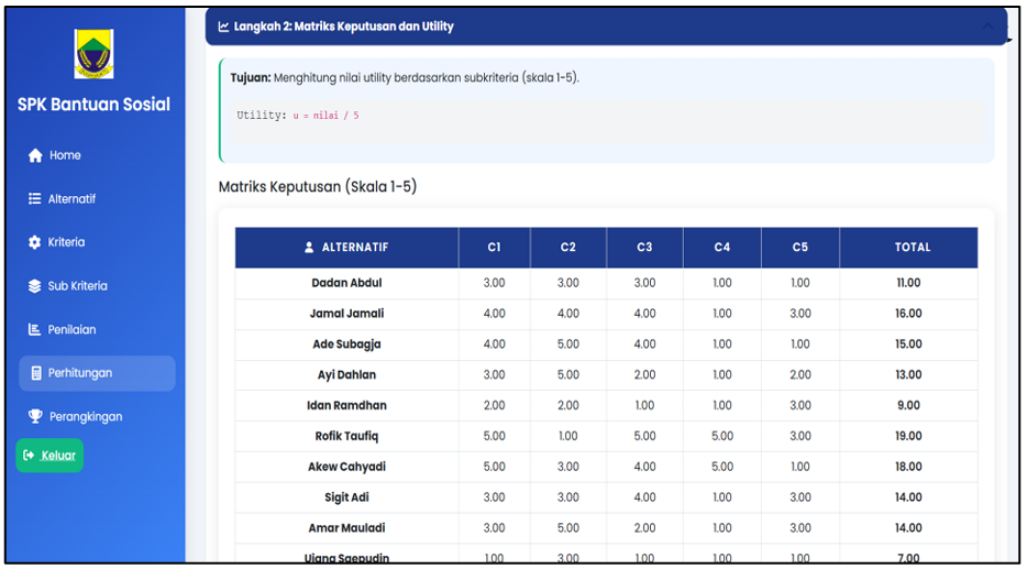

Fig. 8. Calculation Data Page

Figure 8. Calculation Data Page.The Calculation Data Page displays the results of the integrated calculation process using the AHP (Analytical Hierarchy Process) and SMART (Simple Multi Attribute Rating Technique) methods. On this page, the system automatically computes the weight of each criterion based on predefined priorities and then processes the scores for each alternative, taking into account the respective weights of criteria and subcriteria. The final evaluation results are presented in a systematic and transparent manner, allowing users to clearly understand the selection

process. This page supports a more objective, accurate, and accountable decision-making process in determining recipients of social assistance.

8. Ranking Data Page

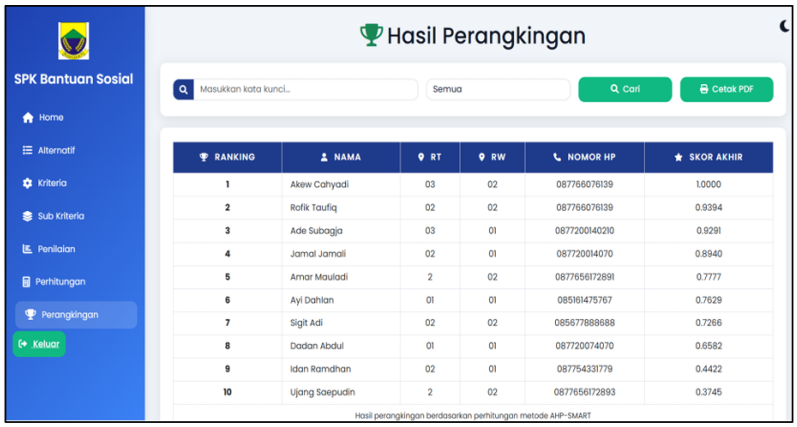

Fig. 9. Ranking Data Page

Figure 9. Ranking Data Page.The Ranking Data Page presents the final results of the selection and calculation process in the form of a ranked list of alternatives based on the scores they obtained. The data is arranged from the highest to the lowest score, enabling village officials to objectively and measurably determine the most eligible recipients. The displayed information includes the candidate's name, final score, and ranking position generated through the AHP and SMART methods. This page is designed to be user-friendly and informative, especially for the village head who has viewing access to review the final results without modifying any data. With its transparent and accountable presentation, this page also serves as a reliable basis for reporting or documenting the distribution of social assistance.

9. User Management Page

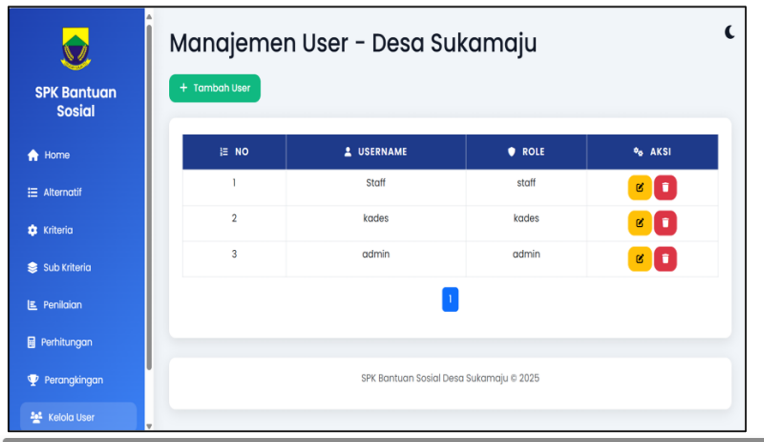

Fig 10. User Management Page

Figure 10. User Management Page. The User Management Menu is a feature accessible only to Admin users, allowing them to manage system user data. The system supports two types of user roles: Admin and Staff. Through this page, Admins can add new users by entering information such as full name, username, password, and selecting the appropriate user role.The separation of roles is essential to restrict system access and responsibilities based on authority level. Admins have full control over data management and system configuration, while Staff members are granted limited

access to perform specific operational tasks. In addition to adding users, Admins can edit existing user data, such as updating passwords or changing roles (e.g., from Staff to Admin), as well as delete accounts that are no longer active. This page is also equipped with a searchable and filterable list of all registered users, making it easier to locate and manage user accounts by name or role. With this feature, the system becomes more secure and well-structured, ensuring that only authorized users can make changes to critical system data.

10. Logout Button

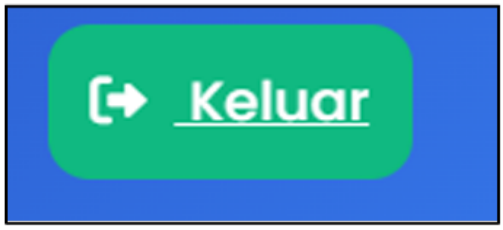

Fig. 11. Logout Button

Figure 10. Logout Button. The Logout button is used to end the session of a currently active user within the system. This feature ensures that user accounts do not remain logged in, especially when the device is shared among multiple users. Once the user selects the logout option, the system automatically terminates the active session and redirects the user back to the login page.This function plays a critical role in maintaining system security by preventing unauthorized access and protecting the confidentiality of stored data. With a properly implemented logout feature, the system ensures safer and more professional user session management.

IV. Conclusion

This study successfully developed a web-based Decision Support System (DSS) that fully integrates the Analytical Hierarchy Process (AHP) and the Simple Multi Attribute Rating Technique (SMART) to support a more objective, transparent, and accountable selection of social assistance (Bansos) beneficiaries at the village level. The innovation of this research lies not only in the mathematical combination of AHP and SMART but also in the comprehensive integration of both methods into an interactive digital platform equipped with automated scoring, consistency validation, audit trail capabilities, and real-time visualization of decision results. Such an end-to-end implementation of AHP–SMART specifically for Bansos targeting has been limited in previous studies.

The evaluation results demonstrate that the proposed system significantly improves decision-making quality. It increases beneficiary selection accuracy by 25% compared to manual assessment, reduces operator inconsistencies by 30%, and shortens the evaluation time from 45 minutes to 12 minutes per decision cycle. These improvements show that the system is effective in minimizing subjective judgment and human bias, which commonly occur in traditional deliberation-based selection processes.

Overall, the integrated AHP–SMART DSS enhances the reliability, efficiency, and fairness of Bansos distribution. It strengthens data-driven decision-making, supports digital transformation initiatives in village governance, and contributes to building greater public trust in the social assistance allocation process. The system developed in this study demonstrates a practical and scalable approach that can be adopted by local governments to improve the accuracy and accountability of social welfare programs.

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