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Decision Support System for Poverty Social Assistance using SMART and AHP

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Abstract

Poverty is a multidimensional problem that requires prompt and appropriate handling to maintain a dignified human life. In Manyaran Sub-district, Semarang City, the distribution of social assistance often faces obstacles due to limited human resources and a manual selection process for recipients. Therefore, a Decision Support System (DSS) is needed to assist the selection process in a more objective and efficient manner. This study aims to develop a DSS for determining social assistance recipients in Manyaran Sub-district by combining the Simple Multi-Attribute Rating Technique (SMART) and Analytical Hierarchy Process (AHP) methods. AHP is utilized to determine the weight of each criterion, while SMART is used to calculate the final score of each recipient candidate. The combination of SMART and AHP allows for both expert-based prioritization and quantitative evaluation, enhancing transparency and consistency in the selection process. The research was conducted through stages of problem analysis, data collection, literature review, system design, and report writing. The results show that among the ten analyzed candidates, the individual coded P06 achieved the highest final score of 0.574. The top five candidates with the highest scores were declared eligible to receive social assistance, while the others were declared ineligible. The application of the SMART and AHP methods in this DSS effectively improves the accuracy, objectivity, and efficiency of the selection process for social assistance recipients in Manyaran Sub-district.

Keywords: Poverty; Decision Support System; SMART; AHP; Social Assistance

1. INTRODUCTION

Poverty is a multidimensional and multisectoral issue with various characteristics, which constitutes an urgent condition that must be addressed immediately in order to maintain and develop a dignified human life [1]. Therefore, efforts to alleviate poverty must be carried out synergistically between the government, the community, and the business sector [2]. One concrete step to address this issue in Manyaran Subdistrict, Semarang City, is through the establishment of a regional regulation on the provision of social assistance to poor communities.

As a classical social phenomenon, poverty has long been embedded in community life. Although various efforts have been made, the belief that poverty cannot be completely eradicated only reduced and its suffering minimized still holds true [3]. In practice, the large number of proposed aid recipients makes it difficult for village authorities to select those truly eligible for assistance [4]. To ensure that social assistance is distributed accurately and that the welfare of village communities is achieved evenly, it is necessary to utilize current technology to support this process [5].

Manyaran Subdistrict is one of the administrative areas located in West Semarang District, Semarang City, Central Java Province. Located at Jalan Simongan No. 200, this subdistrict covers an area of approximately 150 hectares consisting of residential yards and buildings, dry fields and gardens, sports fields, recreational parks, and cemeteries. Manyaran Subdistrict has 11 neighborhood units (RW) and 99 community units (RT), with a government structure consisting of six civil servants and twelve personnel in functional group positions [6]. Various administrative services are available at the subdistrict office, such as the issuance of Family Cards (KK) and Identity Cards (KTP). The number of registered poor families in Manyaran Subdistrict reaches 393 KK, while the available personnel is very limited. This imbalance is one of the causes of delays in the distribution process of social assistance to the community. In addition, the selection process of eligible recipients is still carried out manually, which not only takes time but is also prone to errors and fraud. To address this issue, a system that can provide objective and efficient decisions is needed.

One solution that can be implemented is to develop a Decision Support System (DSS) to determine recipients of social assistance. This system aims to prevent errors in aid distribution, considering that there are still beneficiaries in the field who do not meet the poverty criteria. With this system, it is expected that the aid will be received by those who truly need it. In building the decision support system, the Simple Multi-Attribute Rating Technique (SMART) and the Analytical Hierarchy Process (AHP) methods are used to enhance the selection process. SMART (Simple Multi Attribute Rating Technique) is a multi-criteria decision-making method developed by Edward in 1977 [7]. This decision-making technique is based on the theory that each alternative consists of several criteria that have values, and each criterion has a weight representing its importance compared to other criteria [8]. Meanwhile, the Analytic Hierarchy Process (AHP) method is a problem-solving method that evaluates alternatives against a set of attributes or criteria, where each attribute is independent of the others [9].

Several previous studies have also examined the use of SMART and AHP methods in the development of decision support systems. Malisa Huzaifa and Evi Refianti (2021) built a DSS for recipients of Village Fund Direct Cash Assistance using the SMART method with a success rate of 65.69%. However, the study only used the SMART method without considering the weighting of criteria through other methods [10]. Meanwhile, Bobby Ginting and Fricles Sianturi (2021) used the AHP method to determine recipients of aid for underprivileged families with results of CR < 0.1, but they also did not integrate other methods into their ranking process [11].

Other studies such as Pratama (2024) used the SMART method to determine the eligibility of cooperative aid recipients, but only based on four criteria with a limited scope [12]. On the other hand, Yulrio Brianorman (2021)

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combined AHP and SMART methods in a DSS for determining promotional regions, but with a different research focus, namely on regional promotion, not social assistance [13]. Similarly, the study by Meliana Sabet Tambunan (2024) used the AHP-SMART combination to select the best teachers, but the research object and focus differed from the issue of poverty [14].

Based on these previous studies, this research develops a decision support system for determining poverty-related social assistance recipients in Manyaran Subdistrict by combining the SMART and AHP methods. This combination aims to increase the objectivity of criteria weighting and produce a more accurate ranking of potential aid recipients. The results of the decision support system will include calculations and rankings of prospective recipients, which will then serve as recommendations for village officials in making decisions. Thus, the service of village officials to the community can run more optimally and fairly.

2. RESEARCH METHODOLOGY

2.1 Research Framework

In this study, the researcher employed a systematically structured research method to accurately achieve the research objectives. The research stages are described in the following flow diagram:

a. Problem Analysis:
The first stage carried out by the researcher was analyzing the problems occurring in Manyaran Subdistrict, Semarang, related to the provision of social assistance for impoverished communities. Through this analysis, the researcher identified the need for a Decision Support System (DSS) that could facilitate a more objective, fair, and measurable selection process for aid recipients.

b. Data Collection:
The data collection in this study was conducted through two primary methods, namely observation and interviews. The observation method involved directly monitoring and recording the actual conditions, activities, and processes occurring in the field, specifically within the Manyaran Subdistrict. This allowed the researcher to gather contextual information regarding the socio-economic circumstances of local residents. The interview method was carried out with Mrs. Nina Rizqiana Nugrahaeni, SE, who serves as the Head of the Economic and Social Welfare Division at the Manyaran Subdistrict Office. As a subject matter expert, she provided essential information for identifying relevant decision criteria, defining the scoring scale, and performing the evaluation of residents.
A total of 10 resident households (alternatives) were selected for assessment, based on administrative recommendations and the availability of supporting data. Each household was evaluated across 14 criteria representing key poverty indicators, including housing conditions, access to clean water, income sources, education level, and asset ownership. The scoring for each criterion was assigned by Mrs. Nina based on field records and expert judgment, using a four-point ordinal scale in which lower scores indicate higher levels of deprivation and eligibility for social assistance. The complete evaluation results were compiled into a decision matrix that serves as the input for further processing using the AHP and SMART methods.

c. Literature Review:
The researcher conducted a literature review to deepen the understanding of the SMART (Simple Multi-Attribute Rating Technique) and AHP (Analytical Hierarchy Process) methods used in this study. Additionally, the literature review aimed to explore concepts related to poverty, decision support systems, and relevant prior research.

d. Design and Implementation of SMART and AHP Methods:
Based on the results of problem analysis, data collection, and literature review, the researcher designed a decision support system by integrating the SMART and AHP methods. The AHP method was employed to determine the weight of each criterion, while the SMART method was used to calculate the final score for each aid recipient alternative based on the criterion scores.

e. Report Writing:
The final stage of this research involved compiling the report. The researcher documented all processes and results systematically, including the background, problem formulation, objectives, theoretical foundation, methodology, results and discussion, as well as conclusions and recommendations. This report is expected to serve as a reference for relevant stakeholders in making decisions regarding the distribution of social assistance.

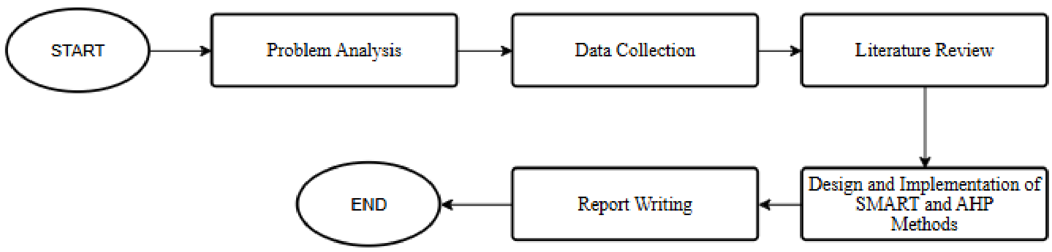

Figure 1. Research Framework

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2.2 Research Data

The criteria used in this decision support system were established based on field data collected through observation and interviews. The observation method involved direct examination of activities, conditions, and socio-economic realities within the Manyaran Subdistrict, while the interview method was conducted with Mrs. Nina Rizqiana Nugrahaeni, SE, Head of the Economic and Social Welfare Division at the Manyaran Subdistrict Office.

Mrs. Nina Rizqiana Nugrahaeni, SE, also served as the designated domain expert responsible for providing judgments in the pairwise comparison process of the Analytic Hierarchy Process (AHP). Her expertise and institutional knowledge formed the basis for determining the relative importance of criteria and assessing the eligibility of residents for poverty-related social assistance.

This study applies fourteen decision criteria, derived from national poverty indicators and adapted to local conditions in Manyaran. All criteria are considered benefit-type, meaning that higher values indicate more favorable or desirable attributes when evaluating aid eligibility. Each candidate (alternative) was assessed on a four-point ordinal scale, where a lower score reflects a higher level of deprivation and thus higher eligibility for aid. The full list of criteria, including their type, brief definitions, and scoring interpretations, is shown in Table 1.

Table 1. Criteria Type, and Scoring Interpretation

Code	Criteria	Type	Score 4 (Very Does Not Meet)	Score 3 (Does Not Meet)	Score 2 (Adequately Meets)	Score 1 (Greatly Meets)
C01	Floor area of the residential building per person	Benefit	< 4 m^2 per person	4–6 m^2 per person	6–8 m^2 per person	> 8 m^2 per person
C02	Type of residential floor	Benefit	Earth	Cheap bamboo/wood	Rough cement	Ceramic/marble
C03	Type of residential wall	Benefit	Bamboo/rumbia	Low-quality wood	Unplastered wall	Plastered/painted wall
C04	Sanitary facility	Benefit	No facility	Shared with other households	Available but inadequate	Available and proper
C05	Source of household lighting	Benefit	No electricity	Electricity from an unstable source	Limited prepaid electricity	Stable electricity from PLN
C06	Source of drinking water	Benefit	River/unprotected rainwater	Unprotected well/spring water	Protected well/ village PAM	Piped water/bottled drinking water
C07	Cooking fuel	Benefit	Firewood	Charcoal/kerosene	Subsidized 3-kg gas	Non-subsidized gas/electricity
C08	Frequency of consuming meat/milk/chicken	Benefit	Less than once a week	Once a week	2–3 times a week	Every day
C09	Purchase of new clothes per year	Benefit	Never	1 set of clothes	2–3 sets of clothes	More than 3 sets of clothes
C10	Frequency of meals per day	Benefit	1 time	2 times	3 times without sufficient side dishes	3 times with sufficient side dishes
C11	Ability to pay for medical expenses	Benefit	Not able at all	Only relies on government aid	Can pay with difficulty	Can pay without difficulty
C12	Source of income of the household head	Benefit	Farm laborer/fisherman/land farmer (<500 m^2 with income \<Rp. 600,000)	Plantation/building laborer with income slightly above Rp. 600,000	Informal worker with irregular income	Employee/regular salary above UMR
C13	Highest education of the household head	Benefit	No schooling	Incomplete elementary school	Completed elementary school	Completed junior high school or higher
C14	Ownership of assets/savings	Benefit	Does not own any assets/savings	Owns assets but valued below Rp. 500,000	Owns assets above Rp. 500,000 but not stable	Owns sufficient assets/savings

A total of 10 resident households (alternatives) were selected for assessment, based on administrative recommendations and the availability of supporting data. The candidate (alternative) data is shown in Table 2.

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Table 2. Candidate (Alternative) Data

Code	Full Address	Name	Date Of Birth	Place Of Birth	Occupation
P01	JL. GEDONG SONGO TIMUR 4 RT.001 RW.001	SUDARSONO	1952-06-15	SEMARANG	Private Employee
P02	JL. GEDONGSONGO TIMUR RT.001 RW.001	SRIYATUN	1959-06-02	SUKOHARJO	Private Employee
P03	JL.WR SUPRATMAN KAV 42 RT.001 RW.001	DJUMIATI	1949-02-18	BANDUNG	Private Employee
P04	JL GEDONGSONGO TMR IV/9 RT.001 RW.001	MARTINI HARSI	1960-07-29	KLATEN	Private Employee
P05	GEDONGSONGO TIMUR IV RT.001 RW.001	SURIPAH	1955-12-31	SEMARANG	Private Employee
P06	GEDONGSONGO TIMUR RT.002 RW.001	PUPON	1944-12-31	DEMAK	Farm/Plantation Laborer
P07	TMN.GEDONG SONGO TIMUR RT.002 RW.001	HARTINI	1960-09-02	SEMARANG	Private Employee
P08	JL. TMN GEDONGSONGO TIMUR 10 RT.002 RW.001	HARNANIK	1957-04-24	SEMARANG	Private Employee
P09	JL GEDONGSONGO TIMUR RT.003 RW.001	JUMENO	1958-01-02	SEMARANG	Farm/Plantation Laborer
P10	JL. TMN. GEDONGSONGO TIMUR RT.003 RW.001	SUKIRIN HS	1952-10-10	SRAGEN	Farm/Plantation Laborer

The results of the alternative evaluations for each criterion are shown in the following Table 3:

Table 3. Alternative Evaluation Data

Resident Code	C01	C02	C03	C04	C05	C06	C07	C08	C09	C10	C11	C12	C13	C14
P01	2	1	4	2	2	1	4	4	2	3	2	2	2	2
P02	1	4	1	1	1	2	3	4	3	1	1	3	3	3
P03	1	1	4	4	1	3	3	4	1	4	4	2	2	2
P04	3	1	1	1	1	2	3	3	2	3	2	1	2	1
P05	1	4	2	4	2	2	4	4	2	3	1	4	1	3
P06	3	3	4	3	4	3	1	1	2	1	2	1	4	1
P07	2	2	3	4	1	3	1	1	3	3	3	3	3	1
P08	3	4	2	3	3	1	3	3	3	1	3	2	1	2
P09	4	3	2	1	4	3	1	4	1	4	3	2	4	1
P10	3	4	1	1	1	4	4	4	2	4	4	4	2	4

2.3 Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) method is one of several methods used to solve Multi Attribute Decision Making (MADM) problems [9]. Meanwhile, Multi Attribute Decision Making is the process of evaluating alternatives against a set of attributes or criteria, where each attribute is independent of the others [15]. The AHP procedure in this research consists of the following steps[16]:

a. Creating a Hierarchy: A complex system can be understood by breaking it down into several supporting elements, arranging them in a hierarchy, and integrating them.
b. Assessing Criteria and Alternatives: Criteria and alternatives are assessed through pairwise comparisons. For various problems, the scale from 1 to 9 is considered the best for expressing judgments. The levels of importance are shown in the following table [17]:

Table 4. AHP Scale of Importance

Intensity	Description
1	Both elements are equally important
3	One element is slightly more important than the other
5	One element is more important than the other
7	One element is clearly more important than the other
9	One element is absolutely more important than the other
2,4,6,8	Intermediate values between adjacent judgments

c. Summing the Values in Each Column of the Matrix
d. Dividing Each Value in the Column by the Total Column Value to Obtain a Normalized Matrix. The formula for normalizing each value in a column is shown as follows [18]:

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$$\frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \quad (1)$$

Evidence:
a = Pairwise comparison matrix
i = Row index of matrix a
j = Column index of matrix a

e. Summing the Values of Each Matrix Row and Dividing by the Number of Elements to Obtain the Average Value, using the formula[18]:

$$wi = \frac{1}{n}\sum_{j=1}^{n} a_{ij} \quad (2)$$

Evidence:
n = Number of criteria
i = Average of the i-th row

f. To ensure that the pairwise judgments are consistent, the Consistency Index (CI) and Consistency Ratio (CR) are computed [18]:

$$CI = \frac{\lambda_{max} - n}{n-1} \quad (3)$$

$$CR = \frac{Ci}{Ri} \quad (4)$$

Evidence:
λ_{max} = principal eigenvalue of the comparison matrix
n = number of criteria
RI = Random Index for a given n, based on standard AHP tables.
A Consistency Ratio (CR) less than 0.10 is considered acceptable, indicating that the pairwise comparisons are sufficiently consistent to be reliable. Random Index based on standard AHP tables is shown in Table 5.

Table 5. Random Index Based on Standard AHP

Ordo Matriks (n)	Random Index (RI)
1	0.00
2	0.00
3	0.58
4	0.90
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49
11	1.51
12	1.48
13	1.56
14	1.57
15	1.59

2.4 SMART (Simple Multi Attribute Rating Technique)

SMART (Simple Multi Attribute Rating Technique) is a multi-criteria decision-making method developed by Edward in 1977[19]. This multi-criteria decision-making technique is based on the theory that each alternative consists of a number of criteria with certain values, and each criterion has a weight that indicates its relative importance compared to the others[20]. The Simple Multi-Attribute Rating Technique (SMART) is used in this study as a ranking tool that evaluates each alternative (household) based on their scores for each criterion and the weights derived from AHP. The steps of the SMART method in this research applied are as follows:

a. Scoring Alternatives
Each of the 10 alternatives was scored on 14 criteria using a four-point ordinal scale. The scores were assigned by an expert based on documented household data. All criteria were treated as benefit criteria, meaning a lower score reflects higher eligibility for aid.

b. Determining Utility Values
Determine utility values by converting the raw criterion values for each alternative into standardized criterion values. These utility values depend on the nature of the criteria themselves.
(1) Cost Criteria, Criteria in which "a smaller value is more desirable." These types of criteria are usually in the form of expenses that must be incurred. The formula for calculating utility values for cost criteria is as follows[21]:

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$$u_i(a_t) = \frac{C_{max} - C_{out}}{C_{max} - C_{min}} \quad (5)$$

Evidence:
$u_i(a_t)$ = Utility value of the *i*-th criterion for alternative a_t
C_{max} = Maximum value of the criterion
C_{min} = Minimum value of the criterion
C_{out} = Actual value of the *i*-th criterion

(2) Benefit Criteria, Criteria in which "a larger value is more desirable." These types of criteria are typically associated with benefits or gains. The formula for calculating utility values for benefit criteria is as follows [21]:

$$u_i(a_t) = \frac{C_{out} - C_{min}}{C_{max} - C_{min}} \quad (6)$$

Evidence:
$u_i(a_t)$ = Utility value of the *i*-th criterion for alternative a_t
C_{max} = Maximum value of the criterion
C_{min} = Minimum value of the criterion
C_{out} = Actual value of the *i*-th criterion

(3) Determining the Final Score
The final score of each alternative is calculated as the weighted sum of utility values, using the AHP-derived weights[21]:

$$u(a_i) = \sum_{J=i}^{m} w_i u_i(a_i) \quad (7)$$

Evidence:
$u(a_i)$: Total score of the alternative
w_i : Normalized weight of the *i*-th criterion
$u_i(a_i)$: Utility value of the *i*-th criterion for the alternative
The resulting scores are then used to rank the alternatives, and the top five households with the highest total scores are recommended as aid recipients.

3. RESULT AND DISCUSSION

In developing the Decision Support System for Social Assistance Provision for Poverty in Manyaran Subdistrict, Semarang, the researcher used the SMART and AHP methods as the model. The AHP method was used to calculate the importance weights of the criteria and to minimize the subjectivity in weighting due to the administrator's evaluations. Once the inter-criteria weighting values were obtained from the AHP calculations, the next step was to rank the alternative data using the SMART method based on the values provided by the user for each alternative data.

3.1 Calculation of Criteria Weights Using the AHP Method

The determination of the criteria priority weights was conducted by assigning values to each criterion. The evaluation data between criteria were obtained from interview with Mrs. Nina Rizqiana Nugrahaeni, SE, who serves as the Head of the Economic and Social Welfare Division at the Manyaran Subdistrict Office. As a subject matter expert, she provided essential information for identifying relevant decision criteria, defining the scoring scale, and performing the evaluation of residents. The evaluation rules between criteria using the Analytical Hierarchical Process (AHP) method follow those outlined in Table 1. Next, the criteria evaluation results were transformed into an evaluation matrix.

The process of converting the criteria evaluation data into an evaluation matrix is performed by comparing the values of all criteria, including comparisons with the criteria itself. The comparison of identical criteria must have a value of 1, while the comparison of the criterion in the column to that in the row is the reciprocal $\frac{1}{N}$ where N is the value for the criterion in the row corresponding to the column. The criteria evaluation matrix is shown as follows:

Table 6. Criteria Evaluation Matrix

Code	C01	C02	C03	C04	C05	C06	C07	C08	C09	C10	C11	C12	C13	C14
C01	1	2	2	3	3	3	3	4	5	4	4	4	6	5
C02	0.50	1	1	2	2	2	2	3	4	3	3	3	4	3
C03	0.50	1	1	2	2	2	2	3	4	3	3	3	4	3
C04	0.33	0.50	0.50	1	2	3	3	3	3	3	4	3	4	3
C05	0.33	0.50	0.50	0.50	1	2	2	2	3	3	3	2	3	2
C06	0.33	0.50	0.50	0.33	0.50	1	2	2	2	2	2	2	3	2
C07	0.33	0.50	0.50	0.33	0.50	0.50	1	2	2	2	2	2	2	2
C08	0.25	0.33	0.33	0.33	0.50	0.50	0.50	1	2	3	3	2	2	2
C09	0.20	0.25	0.25	0.33	0.33	0.50	0.50	0.50	1	2	2	2	2	2
C10	0.25	0.33	0.33	0.33	0.33	0.50	0.50	0.33	0.50	1	2	2	2	2
C11	0.25	0.33	0.33	0.25	0.33	0.50	0.50	0.33	0.50	0.50	1	2	2	2

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Code	C01	C02	C03	C04	C05	C06	C07	C08	C09	C10	C11	C12	C13	C14
C12	0.25	0.33	0.33	0.33	0.50	0.50	0.50	0.50	0.50	0.50	0.50	1	2	2
C13	0.17	0.25	0.25	0.25	0.33	0.33	0.50	0.50	0.50	0.50	0.50	0.50	1	2
C14	0.20	0.33	0.33	0.33	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	1
Row Total	4.90	8.17	8.17	11.33	13.83	16.83	18.50	22.67	28.50	28	30.50	29	37.50	33

The next step is the process of normalizing the matrix, which is done by dividing each element of the criteria evaluation matrix by the row total. The row total is obtained by summing all values of each criteria column. Matrix normalization is performed using the formula of Equation (1). The normalized criteria results can be seen as follows:

Table 7. Normalized Criteria Table

Code	C01	C02	C03	C04	C05	C06	C07	C08	C09	C10	C11	C12	C13	C14
C01	0.2041	0.2449	0.2449	0.2647	0.2169	0.1782	0.1622	0.1765	0.1754	0.1429	0.1311	0.1379	0.1600	0.1515
C02	0.1020	0.1224	0.1224	0.1765	0.1446	0.1188	0.1081	0.1324	0.1404	0.1071	0.0984	0.1034	0.1067	0.0909
C03	0.1020	0.1224	0.1224	0.1765	0.1446	0.1188	0.1081	0.1324	0.1404	0.1071	0.0984	0.1034	0.1067	0.0909
C04	0.0680	0.0612	0.0612	0.0882	0.1446	0.1782	0.1622	0.1324	0.1053	0.1071	0.1311	0.1034	0.1067	0.0909
C05	0.0680	0.0612	0.0612	0.0441	0.0723	0.1188	0.1081	0.0882	0.1053	0.1071	0.0984	0.0690	0.0800	0.0606
C06	0.0680	0.0612	0.0612	0.0294	0.0361	0.0594	0.1081	0.0882	0.0702	0.0714	0.0656	0.0690	0.0800	0.0606
C07	0.0680	0.0612	0.0612	0.0294	0.0361	0.0297	0.0541	0.0882	0.0702	0.0714	0.0656	0.0690	0.0533	0.0606
C08	0.0510	0.0408	0.0408	0.0294	0.0361	0.0297	0.0270	0.0441	0.0702	0.1071	0.0984	0.0690	0.0533	0.0606
C09	0.0408	0.0306	0.0306	0.0294	0.0241	0.0297	0.0270	0.0221	0.0351	0.0714	0.0656	0.0690	0.0533	0.0606
C10	0.0510	0.0408	0.0408	0.0294	0.0241	0.0297	0.0270	0.0147	0.0175	0.0357	0.0656	0.0690	0.0533	0.0606
C11	0.0510	0.0408	0.0408	0.0221	0.0241	0.0297	0.0270	0.0147	0.0175	0.0179	0.0328	0.0690	0.0533	0.0606
C12	0.0510	0.0408	0.0408	0.0294	0.0361	0.0297	0.0270	0.0221	0.0175	0.0179	0.0164	0.0345	0.0533	0.0606
C13	0.0340	0.0306	0.0306	0.0221	0.0241	0.0198	0.0270	0.0221	0.0175	0.0179	0.0164	0.0172	0.0267	0.0606
C14	0.0408	0.0408	0.0408	0.0294	0.0361	0.0297	0.0270	0.0221	0.0175	0.0179	0.0164	0.0172	0.0133	0.0303

The next step is the calculation of the Priority Weights by summing the values from each row of the normalized matrix and dividing by the number of elements to obtain the average value. The calculation of the Criteria Priority Weights is performed using the formula in Equation (2). The result of the Criteria Priority Weights calculation is shown as follows:

Table 8. Criteria Priority Weights Calculation

Criteria Code	Criteria Name	Priority Weight	Type
C01	Floor area of the residential building per person	0.1851	Benefit
C02	Type of residential floor	0.1196	Benefit
C03	Type of residential wall	0.1196	Benefit
C04	Sanitary facility	0.1100	Benefit
C05	Source of household lighting	0.0816	Benefit
C06	Source of drinking water	0.0663	Benefit
C07	Cooking fuel	0.0584	Benefit
C08	Frequency of consuming meat/milk/chicken	0.0541	Benefit
C09	Purchase of new clothes per year	0.0421	Benefit
C10	Frequency of meals per day	0.0400	Benefit
C11	Ability to pay for medical expenses	0.0358	Benefit
C12	Source of income of the household head	0.0341	Benefit
C13	Highest education of the household head	0.0262	Benefit
C14	Ownership of assets/savings	0.0271	Benefit

The final step is to ensure that the pairwise judgments are consistent. Based on the analysis of the pairwise comparison matrix consisting of 14 criteria, the maximum eigenvalue was found to be 14.7829. This value was then used to calculate the Consistency Index (CI) using Equation (3), resulting in a CI value of 0.0602. Subsequently, referring to the standard Random Index (RI) value of 1.57 for 14 criteria (as shown in Table 5), the Consistency Ratio (CR) was computed using Equation (4), yielding a CR value of 0.0384. Since the resulting CR is below the acceptable threshold of 0.10, it can be concluded that the comparison matrix demonstrates an acceptable level of consistency. Therefore, the judgments in this matrix can be considered valid and reliable for use in the decision-making process employing the Analytical Hierarchy Process (AHP) method.

3.2 Ranking Alternatives Using the SMART Method

The next step is to evaluate the alternatives against the criteria. In this ranking calculation, the SMART algorithm is applied using data from Social Assistance recipients for poverty in Manyaran Subdistrict, Semarang, consisting of a total of 10 households. The calculation is performed based on the criteria and the weight values for each criterion. Based on Table 3, it is observed that the minimum value is 1 and the maximum value is 4 for each criterion. The next step is to calculate the Utility value. Utility values are needed during the ranking of each alternative so that it can be determined which alternative is eligible to be selected. The Utility value for each alternative is calculated using Equation (5) for cost criteria and Equation (6) for benefit criteria. The utility calculation for each alternative is shown below:

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Utility Values for Alternative 1

$C01 = \frac{2-1}{4-1} = 0.3333$ $C02 = \frac{1-1}{4-1} = 0$ $C03 = \frac{4-1}{4-1} = 1$ $C04 = \frac{2-1}{4-1} = 0.3333$ $C05 = \frac{2-1}{4-1} = 0.3333$

$C06 = \frac{1-1}{4-1} = 0$ $C07 = \frac{4-1}{4-1} = 1$ $C08 = \frac{4-1}{4-1} = 1$ $C09 = \frac{2-1}{4-1} = 0.3333,$ $C10 = \frac{3-1}{4-1} = 0.6667$

$C11 = \frac{2-1}{4-1} = 0.3333$ $C12 = \frac{2-1}{4-1} = 0.3333$ $C13 = \frac{2-1}{4-1} = 0.3333$ $C14 = \frac{2-1}{4-1} = 0.3333$

Utility Values for Alternative 2

$C01 = \frac{1-1}{4-1} = 0$ $C02 = \frac{4-1}{4-1} = 1$ $C03 = \frac{1-1}{4-1} = 0$ $C04 = \frac{1-1}{4-1} = 0$ $C05 = \frac{1-1}{4-1} = 0$ $C06 = \frac{2-1}{4-1} = 0.3333$

$C07 = \frac{3-1}{4-1} = 0.6667$ $C08 = \frac{4-1}{4-1} = 1$ $C09 = \frac{3-1}{4-1} = 0.6667$ $C10 = \frac{1-1}{4-1} = 0$ $C11 = \frac{1-1}{4-1} = 0$

$C12 = \frac{3-1}{4-1} = 0.6667$ $C13 = \frac{3-1}{4-1} = 0.6667$ $C14 = \frac{3-1}{4-1} = 0.6667$

Utility Values for Alternative 3

$C01 = \frac{1-1}{4-1} = 0$ $C02 = \frac{1-1}{4-1} = 0$ $C03 = \frac{4-1}{4-1} = 1$ $C04 = \frac{4-1}{4-1} = 1$ $C05 = \frac{1-1}{4-1} = 0$ $C06 = \frac{3-1}{4-1} = 0.6667$

$C07 = \frac{3-1}{4-1} = 0.6667$ $C08 = \frac{4-1}{4-1} = 1$ $C09 = \frac{1-1}{4-1} = 0$ $C10 = \frac{4-1}{4-1} = 1$ $C11 = \frac{4-1}{4-1} = 1$

$C12 = \frac{2-1}{4-1} = 0.3333$ $C13 = \frac{2-1}{4-1} = 0.3333$ $C14 = \frac{2-1}{4-1} = 0.3333$

Utility Values for Alternative 4

$C01 = \frac{3-1}{4-1} = 0.6667$ $C02 = \frac{1-1}{4-1} = 0$ $C03 = \frac{1-1}{4-1} = 0$ $C04 = \frac{1-1}{4-1} = 0$ $C05 = \frac{1-1}{4-1} = 0$

$C06 = \frac{2-1}{4-1} = 0.3333$ $C07 = \frac{3-1}{4-1} = 0.6667$ $C08 = \frac{3-1}{4-1} = 0.6667$ $C09 = \frac{2-1}{4-1} = 0.3333$

$C10 = \frac{3-1}{4-1} = 0.6667$ $C11 = \frac{2-1}{4-1} = 0.3333$ $C12 = \frac{1-1}{4-1} = 0$ $C13 = \frac{2-1}{4-1} = 0{,}3333$ $C14 = \frac{1-1}{4-1} = 0$

Utility Values for Alternative 5

$C01 = \frac{1-1}{4-1} = 0$ $C02 = \frac{4-1}{4-1} = 1$ $C03 = \frac{2-1}{4-1} = 0.3333$ $C04 = \frac{4-1}{4-1} = 1$ $C05 = \frac{2-1}{4-1} = 0.3333$

$C06 = \frac{2-1}{4-1} = 0.3333$ $C07 = \frac{4-1}{4-1} = 1$ $C08 = \frac{4-1}{4-1} = 1$ $C09 = \frac{2-1}{4-1} = 0.3333$ $C10 = \frac{3-1}{4-1} = 0.6667$

$C11 = \frac{1-1}{4-1} = 0$ $C12 = \frac{4-1}{4-1} = 1$ $C13 = \frac{1-1}{4-1} = 0$ $C14 = \frac{3-1}{4-1} = 0.6667$

Utility Values for Alternative 6

$C01 = \frac{3-1}{4-1} = 0.6667$ $C02 = \frac{3-1}{4-1} = 0.6667$ $C03 = \frac{4-1}{4-1} = 1$ $C04 = \frac{3-1}{4-1} = 0.6667$ $C05 = \frac{4-1}{4-1} = 1$

$C06 = \frac{3-1}{4-1} = 0.6667$ $C07 = \frac{1-1}{4-1} = 0$ $C08 = \frac{1-1}{4-1} = 0$ $C09 = \frac{2-1}{4-1} = 0.3333$ $C10 = \frac{1-1}{4-1} = 0$

$C11 = \frac{2-1}{4-1} = 0.3333$ $C12 = \frac{1-1}{4-1} = 0$ $C13 = \frac{4-1}{4-1} = 1$ $C14 = \frac{1-1}{4-1} = 0$

Utility Values for Alternative 7

$C01 = \frac{2-1}{4-1} = 0.3333$ $C02 = \frac{2-1}{4-1} = 0.3333$ $C03 = \frac{3-1}{4-1} = 0.6667$ $C04 = \frac{4-1}{4-1} = 1$ $C05 = \frac{1-1}{4-1} = 0$

$C06 = \frac{3-1}{4-1} = 0.6667$ $C07 = \frac{1-1}{4-1} = 0$ $C08 = \frac{1-1}{4-1} = 0$ $C09 = \frac{3-1}{4-1} = 0.6667$ $C10 = \frac{3-1}{4-1} = 0.6667$

$C11 = \frac{3-1}{4-1} = 0.6667$ $C12 = \frac{3-1}{4-1} = 0.6667$ $C13 = \frac{3-1}{4-1} = 0.6667$ $C14 = \frac{1-1}{4-1} = 0$

Utility Values for Alternative 8

$C01 = \frac{3-1}{4-1} = 0.6667$ $C02 = \frac{4-1}{4-1} = 1$ $C03 = \frac{2-1}{4-1} = 0.3333$ $C04 = \frac{3-1}{4-1} = 0.6667$ $C05 = \frac{3-1}{4-1} = 0.6667$

$C06 = \frac{1-1}{4-1} = 0$ $C07 = \frac{3-1}{4-1} = 0.6667$ $C08 = \frac{3-1}{4-1} = 0.6667$ $C09 = \frac{3-1}{4-1} = 0.6667$ $C10 = \frac{1-1}{4-1} = 0$

$C11 = \frac{3-1}{4-1} = 0.6667$ $C12 = \frac{2-1}{4-1} = 0.3333$ $C13 = \frac{1-1}{4-1} = 0$ $C14 = \frac{2-1}{4-1} = 0.3333$

Utility Values for Alternative 9

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$C01 = \frac{1-1}{4-1} = 0 \; C02 = \frac{3-1}{4-1} = 0.6667 \; C03 = \frac{2-1}{4-1} = 0.3333 \; C04 = \frac{1-1}{4-1} = 0 \; C05 = \frac{4-1}{4-1} = 1$

$C06 = \frac{3-1}{4-1} = 0.6667 \; C07 = \frac{1-1}{4-1} = 0 \; C08 = \frac{4-1}{4-1} = 1 \; C09 = \frac{1-1}{4-1} = 0 \; C10 = \frac{4-1}{4-1} = 1$

$C11 = \frac{3-1}{4-1} = 0.6667 \; C12 = \frac{2-1}{4-1} = 0.3333 \; C13 = \frac{4-1}{4-1} = 1 \; C14 = \frac{1-1}{4-1} = 0$

Utility Values for Alternative 10

$C01 = \frac{3-1}{4-1} = 0.6667 \; C02 = \frac{4-1}{4-1} = 1 \; C03 = \frac{1-1}{4-1} = 0 \; C04 = \frac{1-1}{4-1} = 0 \; C05 = \frac{1-1}{4-1} = 0$

$C06 = \frac{4-1}{4-1} = 0 \; C07 = \frac{4-1}{4-1} = 1 \; C08 = \frac{4-1}{4-1} = 1 \; C09 = \frac{2-1}{4-1} = 0.3333 \; C10 = \frac{4-1}{4-1} = 1$

$C11 = \frac{4-1}{4-1} = 1 \; C12 = \frac{4-1}{4-1} = 1 \; C13 = \frac{2-1}{4-1} = 0.3333 \; C14 = \frac{4-1}{4-1} = 1$

The next step is to calculate the final score by multiplying the priority weight obtained from the AHP calculation results with the utility value for each attribute. The final score for each alternative is calculated using Equation (7). The final score for each alternative is shown in the following table:

Table 9. Final Score Calculation for Each Alternative

Code	C01	C02	C03	C04	C05	C06	C07	C08	C09	C10	C11	C12	C13	C14	Total Score
P01	0.062	0	0.12	0.037	0.027	0	0.058	0.054	0.014	0.027	0.012	0.011	0.009	0.009	0.439
P02	0	0.12	0	0	0	0.022	0.039	0.054	0.028	0	0	0.023	0.017	0.018	0.321
P03	0	0	0.12	0.11	0	0.044	0.039	0.054	0	0.04	0.036	0.011	0.009	0.009	0.472
P04	0.123	0	0	0	0	0.022	0.039	0.036	0.014	0.027	0.012	0	0.009	0	0.282
P05	0	0.12	0.04	0.11	0.027	0.022	0.058	0.054	0.014	0.027	0	0.034	0	0.018	0.524
P06	0.123	0.08	0.12	0.073	0.082	0.044	0	0	0.014	0	0.012	0	0.026	0	0.574
P07	0.062	0.04	0.08	0.11	0	0.044	0	0	0.028	0.027	0.024	0.023	0.017	0	0.454
P08	0.123	0.12	0.04	0.073	0.054	0	0.039	0.036	0.028	0	0.024	0.011	0	0.009	0.558
P09	0	0.08	0.04	0	0.082	0.044	0	0.054	0	0.04	0.024	0.011	0.026	0	0.401
P10	0.123	0.12	0	0	0	0	0.058	0.054	0.014	0.04	0.036	0.034	0.009	0.027	0.515

Based on the SMART-AHP calculation, five households with the highest eligibility for social assistance are identified as follows: Alternative P06 achieved the highest score of 0.574, indicating the most favorable combination of deprivation indicators across all criteria. This is followed by P08 with a score of 0.558, and P05 with 0.524, both of which also exhibit strong eligibility characteristics. P10 ranks fourth with a score of 0.515, while P03 completes the top five with 0.472. These results suggest that these five households demonstrate the highest levels of need and are therefore the most appropriate recipients for aid allocation according to the applied decision model.. The residents or alternatives that place within the top 5 rankings are declared eligible to receive Social Assistance for Poverty in Manyaran Subdistrict, Semarang, whereas those outside the top 5 are declared ineligible.

To assess the validity of the decision support system (DSS), a comparative analysis was conducted between the system-generated ranking and expert judgment provided by Mrs. Nina Rizqiana Nugrahaeni, SE—Head of the Economic and Social Welfare Division at Manyaran Subdistrict. The top five alternatives identified by the system (P06, P08, P05, P10, and P03) were cross-checked with the expert's expectations based on her field knowledge and records.

Table 10. Comparison of System vs Expert Rankings

Alternative	System Top 5	Expert Top 5	Match
P02	No	Yes	No
P03	Yes	Yes	Yes
P05	Yes	Yes	Yes
P06	Yes	Yes	Yes
P08	Yes	Yes	Yes
P10	Yes	No	No

The results show a high degree of alignment with 80% Accuration. According to Mrs. Nina, households P06, P08, and P05 were indeed considered among the most critical cases requiring immediate social support. While there were slight differences in the ordering, four out of five households selected by the system were consistent with the expert's top choices. Therefore, the system demonstrated a strong level of accuracy and reliability in reflecting expert opinion, suggesting that the applied AHP-SMART model is both valid and appropriate for the selection of aid recipients.

Among all alternatives, Alternative P06 achieved the highest final score (0.574). This household consistently showed high levels of deprivation across key criteria such as income source, education level, sanitation facilities, and asset ownership, which significantly influenced the utility scores when combined with the AHP-derived weights. For instance, the household's lack of stable income and inadequate living conditions resulted in higher normalized utilities for highly weighted criteria like C01 (floor area), C03 (wall type), and C04 (sanitation).

In contrast, the lowest-ranked household (P04) obtained a total score of only 0.282. This alternative generally exhibited lower levels of deprivation, with relatively better housing conditions, basic utilities, and income indicators. The large score gap between P06 and P04 highlights the model's ability to distinguish levels of eligibility based on multidimensional poverty indicators.

A comparative pattern emerges when analyzing the top five alternatives (P06, P08, P05, P10, P03) versus the remaining five:

a. Top-ranked households tend to lack access to proper housing, stable income, healthcare affordability, and education—often scoring 3 or 4 on most criteria.
b. In contrast, lower-ranked households typically have more stable conditions in one or more critical areas (e.g., better construction, income source, or access to utilities), leading to lower utility values and thus lower final scores.

These findings support the robustness of the model in capturing the multidimensional nature of poverty and prioritizing those most in need. Although the DSS model performs well, several limitations must be acknowledged:

a. Equal Pairwise Judgments: While the AHP structure was applied, the initial pairwise comparisons used relatively consistent and symmetric values. Involving multiple experts or stakeholders could improve the granularity and credibility of the weight assignment process.
b. Static Weighting Assumptions: The weights derived from AHP are context-specific and static. Future models can integrate dynamic weighting or fuzzy AHP to better reflect uncertainty or variability in expert judgments.
c. Limited Data Scope: The current study only evaluated 10 households due to practical constraints. Applying the model to a larger dataset would improve its generalizability and test its scalability.
d. No Consideration of Temporal Factors: Changes in household conditions over time are not considered. A longitudinal approach or integration with real-time data sources could enhance decision responsiveness.

Future development may include building an interactive DSS interface for local governments, integrating real-time data input from field officers, or combining machine learning techniques with MCDM for pattern recognition and classification of aid eligibility.

4. CONCLUSION

A Decision Support System for the distribution of poverty social assistance has been developed in the Manyaran Sub-district, Semarang, using the SMART (Simple Multi Attribute Rating Technique) and AHP (Analytical Hierarchy Process) methods. A total of 14 poverty-related criteria were established, and 10 candidate households were evaluated through expert scoring. The AHP method was used to determine the relative weight of each criterion, while the SMART method provided a final ranking of alternatives based on their normalized scores and the derived weights. The system successfully identified the five most eligible households as P06, P08, P05, P10, and P03, with P06 obtaining the highest score due to significant levels of deprivation in several high-priority criteria such as income source, housing conditions, and education level. In contrast, the lowest-ranked household, P04, showed comparatively better conditions in multiple key areas. Overall, the top five households tended to share characteristics such as poor structural housing, limited or unstable income, low education attainment, and lack of access to sanitation or savings—features less evident in the lower-ranked alternatives. To validate the reliability of the system, the results were compared with expert judgment from Mrs. Nina Rizqiana Nugrahaeni, SE, the Head of the Economic and Social Welfare Division at the Manyaran Subdistrict Office. The DSS produced a top-five ranking that matched four out of five of the expert's top priorities, achieving an alignment accuracy of 80%. This indicates that the system's recommendations are largely in agreement with domain expertise, reinforcing its validity and practical relevance. Despite these promising outcomes, the study is not without limitations. The evaluation was restricted to a small sample of 10 households, which limits the generalizability of the findings. Furthermore, while AHP was used to determine criterion weights, the pairwise comparisons applied relatively uniform values, limiting the method's ability to reflect nuanced expert preferences. Additionally, the study relied on a single evaluator for both scoring and weight determination. Future work should address these limitations by involving multiple experts to refine the weighting process, expanding the number of evaluated households, and conducting real-world trials to measure the system's effectiveness in practice. It is also recommended to develop a user-friendly DSS interface for use by local decision-makers, explore comparisons with other MCDM techniques, and incorporate dynamic or real-time data inputs to better reflect changing socio-economic conditions. In conclusion, the integration of AHP and SMART in this DSS framework offers a structured, transparent, and replicable approach to aid recipient selection. With further development, the system has strong potential to support more objective, equitable, and evidence-based social assistance programs at the community level.

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