Intelligent Decision Support Systems of Medicinal Forest Plants for Skin Disease

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***Abstract*— The richness of Borneo's biodiversity with the potential for indigenous tribal knowledge, one of which is through the use of various types of medicinal plants used in traditional local ethnic medicine, especially those around forest areas. This study aims to develop Borneo's medicinal forest plants decision-making system for skin diseases based on the International Classification of Diseases (ICD-10 version 2016). The determination of medicinal plants for the treatment of skin diseases is based on criteria types of plant species, how to process, how to use, and plant parts used. This research resulted in a decision support system intelligence software product for determining of 94 dataset medicinal forest plants for skin diseases using the AHP method for weight determination (priority), and WASPAS for preference. The implementation of the AHP-WASPAS method in case studies of medicinal forest plants decision shows that the user's subjectivity in weighting and decision-making criteria affects the recommended preference values. Furthermore, the multi-criteria analysis method approach to decision making in applied case studies is less objective because the knowledge base of alternatives and criteria is complex.**

Keywords*— *forest, medicinal-plants, skin-disease, AHP-WASPAS, Borneo

I. INTRODUCTION

The utilization of various forest plant types for the treatment of disease is one of the local cultural heritages that are preserved by the indigenous tribe of Borneo[1]. Treatment of minor and severe diseases uses ingredients derived from certain types of plants found around gardens and in forests. Currently, the use of medicinal plants or jamu is an alternative for people to maintain health and treat disease, this is because the use of medicinal plants or herbs is not only affordable but also does not cause side effects when using modern medicinal plants derived from chemicals.

Most of the medicinal plants are used by indigenous people in rural areas, especially in areas where public health facilities are not yet reached. For their daily needs, they often take plants as medicinal raw materials directly from natural forests. However, in the last few decades, there has been forest destruction and/or deforestation of forests in Borneo, which has changed the function of forests into activities and human interests[2]. Without realizing it, deforestation or forest destruction have impacts such as climate change (increasing global warming). Another impact is that flooding occurs because the barrier's forest for preventing flooding has been deforested. Frequent floods that afflict areas throughout villages and cities in Borneo cause skin diseases.

Skin diseases (skin disorders) are caused by fungi, germs, parasites, viruses, or infections[3] that affect anyone of all ages[4], [5]. Skin diseases can attack all or certain parts of the body and can worsen the patient's health condition if not treated seriously. Skin disorders often occur due to factors such as climate, environment, place of residence, unhealthy living habits, allergies[6] and others.

The potential for medicinal plants in the Borneo forest area is very diverse[7], both those that have been exploited by the people around the area and those that have not been utilized. Various studies have been conducted to explain that the Borneo forest area has the potential for various medicinal plants. The currently recorded potential has not shown the potential of Borneo medicinal plants as a whole, but it can describe the potential of medicinal plants in certain forest areas only[7]. The potential for medicinal plants is scattered in various forest areas including conservation areas such as research forest areas, national parks, protected forests and other forest areas. Types of medicinal plants that have been identified and documented through various studies [7], [8], one of which is the types of forest plants for the treatment of skin diseases.

The study purposes to develop a decision support system for determining Medicinal Forest Plants for skin diseases based on the International Statistical Classification of Diseases[9] (ICD-10 version 2016). The main source of data collection on medicinal plants is obtained from the Research and Development Center for Natural Resources Technology, East Borneo. Indonesia. Determining the weighting importance of medicinal plants using the Analytical Hierarchy Process (AHP) and the Weighted-aggregated Sum Product-assessment (WASPAS) for preference decision recommendations.

Research contribution is intended as an added value to science in the pharmaceutical sector, particularly in the use of medicinal forest plants for the treatment of skin diseases based on information technology and decision support systems. Provide recommendations for the selection of drugs for the right skin diseases related to the processing method, method of use, and parts of medicinal plants used for treatment, making it easier for the community to avoid misconceptions properties of the forest medicinal plants.

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II. MATERIALS

A. Skin Disease

Skin disease in this study is defined as a skin disorder caused by fungi, germs, parasites, viruses or infections that can affect anyone of all ages[4]. Skin diseases can attack all or part of a certain body and can worsen the patient's health condition if not treated seriously. Disorders of the skin often occur due to factors such as climate, environment[10], habitation, lifestyle, allergies and others[11].

Skin disease is increasingly developing, this is evidenced by Indonesia's health profile in 2015 which shows that skin and subcutaneous tissue disease ranks third of the 10 most common diseases of outpatients at hospitals in Indonesia based on the number of visits, namely 192,414 visits, new case visits 122,076 visits while the old case was 70,338 visits[12].

The classification code for skin diseases according to ICD-10 version:2019[13], WHO (World Health Organization) are shown in "Table 1".

TABLE I. ICD-10 VERSION:2019 [13]

Num	Block	Description	Block	Description
1	L00-L08	The skin infection and subcutaneous-tissue	L01	Impetigo
			L02	Cutaneous Abscess
			L03	Cellulitis
			L08.0	Pyoderma
2	L10-L14	Bullous disorder	L10	Pemphigus
3	L20-L30	Dermatitis and eczema	L20	Atopic dermatitis
			L21	Seborrheic
			L23.9	Allergic Contact
4	L40-45	Papulosquamous	L40	Psoriasis
5	L50-54	Urticaria and erythema	L50	Urticaria
6	L60-L75	Skin appendages disorders	L60	Nail disorders
			L60.0	Ingrown nails
			L70	Acne
			L72.0	Epidermal Cyst
			L74.3	Miliaria
7	L89	Other skin disorders and subcutaneous tissue	L89	Decubitus ulcer
			L91.0	Keloid Scars
8	B35-B49	Mycoses	B35	Dermatophytosis
			B35.0	Beard ringworm
			B35.3	Tinea Pedis
			B35.4	Tinea Corporis
			B36.0	Pityriasis Versicolor

B. Medicinal Forest Plants

Medicinal plants in Kalimantan forests are not only woody plants but also non-timber plants with various habitus, namely trees, shrubs, herbs, lianas and ferns. Medicinal plants in forest areas in Kalimantan have the most tree and shrub habitus. The recorded of potential medicinal plant in some forest areas in Kalimantan[1] according to Noorhidayah et al., are shown in "Table II".

TABLE II. THE POTENTIAL MEDICINAL PLANTS IN SOME FOREST AREAS IN KALIMANTAN[1]

Forest area	Potency of medicinal plant		
	Family	*Genus*	*Species*
Betung Kerihun National Park, West Kalimantan	27	36	41
Hampangen Education Forest Central Kalimantan	25	35	38
Malinau Forest Research area, East Kalimantan	61	111	132
Sangkima Nature Tourism Area, Kutai National Park	27	28	30
Kutai National Park, East Kalimantan			49
Samarinda Botanical Garden	19	22	24
Apo Kayan Plateau	77	165	200
Barongtongkok area, distric of west Kutai, east Kalimantan	-	-	301

The types of medicinal plants that have been identified and documented through various studies are the types traditionally used by local communities [7]. Some studies have even examined the ethnobotany of certain tribes in Kalimantan, including the use of medicinal plants for treatment [7]. There is a tendency that the types of medicinal plants found in forest areas in Kalimantan are the types used by the tribes who inhabit the area [7].

C. Decision Support System Analysis

The knowledge-based system management model of medicinal forest plants is packaged in the framework of a decision support system that can recommend several alternative decisions to become the preference for forest plant species desired by the user, based on several criteria such as how to process, how to use, the part of the plant, and plant types. The analytical method the decision making of the forest medicinal plants for skin disease are:

1) Analytic Hierarchy Process (AHP), is method from Thomas L. Saaty (in the 1970s) and supports decision-makers to find the best alternative from the many elements of choice[14]. AHP method used to important weighting criteria. The AHP initial stage in determining element priority, comparing elements in pairs to represent the relative importance of one element to another[15] through a pairwise comparison matrix.

2) Weighted Aggregated Sum Product Assessment (WASPAS), is a combination of weighted sum model and weighted product model [16], [17]. The WASPAS method is expected to provide better results in helping to determine the decision support system of forest plants with medicinal properties for skin diseases.

III. METHODOLOGY

A. Data Collection Methods

Several data collection methods were applied, among others, through literature studies of various data sources for forest medicinal plants, the theory of decision support methods and other sources. The main source of data on medicinal plants is obtained from the results of research publications and books related to forest medicinal plants. In addition, the method of interviewing expert sources from several natural resource conservation organizations, national parks, botanical gardens, in East Kalimantan Province.

B. Decision Making: Elements and Variables

Forest medicinal plants are an alternative treatment for skin diseases analyzed based on 4 criteria, ie forest plant species, how to process, how to use and parts of forest plants. The criteria are shown in "Table III".

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TABLE III. THE ELEMENTS AND CRITERION

Code	Criterion	Elements	Type
C1	Plants Types	Tree, Shrubs, Liana, Bush, Herbs	Benefit or Cost
C2	How to Process	Pounded, Boiled, Direct, Shredded Burned	Benefit or Cost
C3	How to use	Eaten, Stuck, Drunk, Smeared, Bathe	Benefit or Cost
C4	Parts of the plants	Leaf, Root, Fruit, Rhizome, Stem, Sap, Flower, Branches, Seed	Benefit or Cost

C. *Decision Analysis Methods: AHP-WASPAS*

The design of the decision-making process for determining medicinal forest plants for the treatment of skin diseases combines the AHP-WASPAS method. AHP is used to determine element weights (criteria) while WASPAS is used to determine preference values. An overview of the flowchart decision-making process for determining medicinal forest plants for the treatment of skin diseases is shown in "Fig. 1"

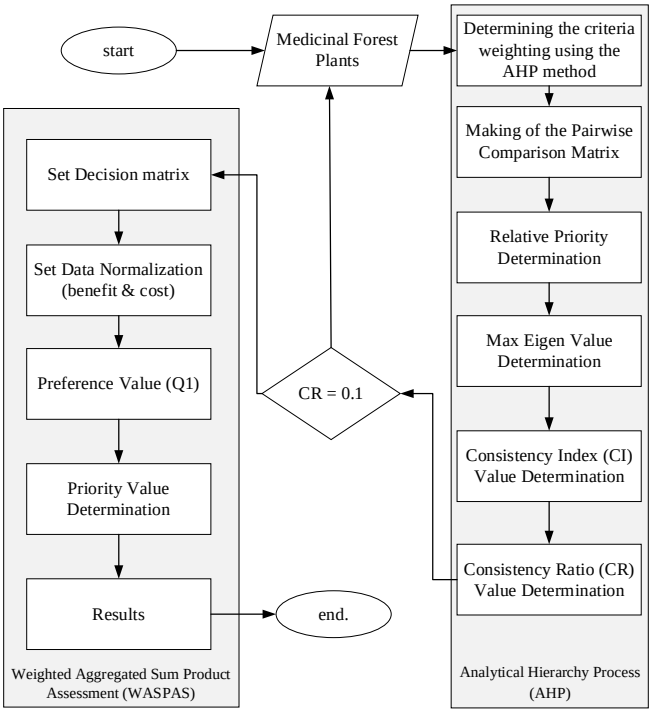

Fig. 1. Flowchart of the AHP-WASPAS method decision-making process

1) *Elements Priority and Pairwise Comparisons Matrix*

The elements priority stage is making pairwise comparisons that is comparing elements in pairs according to the available criteria[18]. Pairwise comparison matrix is filled using numbers to represent the relative importance of an element with other elements[18]. Using Saaty, and Vargas[14] the equation use "(1)".

$$A = [r_{im}] = \begin{bmatrix} 1 & r_{12} & \cdots & r_{1n} \\ 1/r_{12} & 1 & \cdots & r_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ 1/r_{1n} & 1/r_{2n} & \cdots & 1 \end{bmatrix} \quad (1)$$

Where, i, m = 1, 2 ....,, n = index criteria

The Saaty's scale[19] of importance intensity on the pairwise comparison matrix is presented in "Table IV".

TABLE IV. SAATY'S SCALE OF RELATIVE IMPORTANCE [19]

Scale	Numerical rating
Extremely preferred	9
Very strong to extremely	8
Very strongly preferred	7
Strongly to very strongly	6
Strongly preferred	5
Moderately to strongly	4
Moderately preferred	3
Equally to moderately	2
Equally preferred	1

Determining Relative Priority, calculate its value in equation use "(2").

$$Priority - i = \frac{\sum_i^n c_i}{n} \quad (2)$$

Where, i is the relative priority, Ci is the sum of values for the column, and n is the criterion number.

Determine the Max Eigenvalue using the equation use "(3)".

$$\lambda \max = \sum_1^n (Priority - i * sum\ of\ C_i \quad (3)$$

The determination of the consistency index (CI) value uses the equation use "(4)".

$$CI = \frac{\lambda\ max - n}{n-1} \quad (4)$$

The Consistency Ratio using the equation use "(5)"

$$CR = \frac{CI}{RI} \quad (5)$$

Where, CR is Consistency Ratio determined based on the comparison matrix in the Consistency Random Index List.

The preference value calculation of each alternative forest medicinal plants based on the selection of skin diseases using the WASPAS method refers to Zavadskas, E. K. et al. [20] the equation use "(6)".

$$Qi = 0.5 \sum_j^n = 1\ x_{ij} w_j + 0.5 \prod_j^n = 1(x_{ij}) w_j \quad (6)$$

The value of λ is the equivalent value, where the value of λ ranges from 0 to 1 according to the conditions obtained by the value of λ = 0.5.

D. *Maintaining the Integrity of the Specifications*

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IV. Results and Discussion

The decision support system that was built was designed to assist the decision-making process in determining recommendations for medicinal plants for skin diseases using the AHP-WASPAS method based on the Website.

The DSS system has two types of users, namely admin and user, admin has full access (database and system management). Meanwhile, the role of a user who will use the medicinal forest plant system for skin diseases. Users display the results of recommendations and information on forest medicinal plants.

A. Results:Collection Data

The main source of data on medicinal plants is obtained from the results of research publications and books related to medicinal forest plants. In addition, the method of interviewing expert sources from several natural resource conservation organizations, national parks, botanical gardens, in East Kalimantan Province.

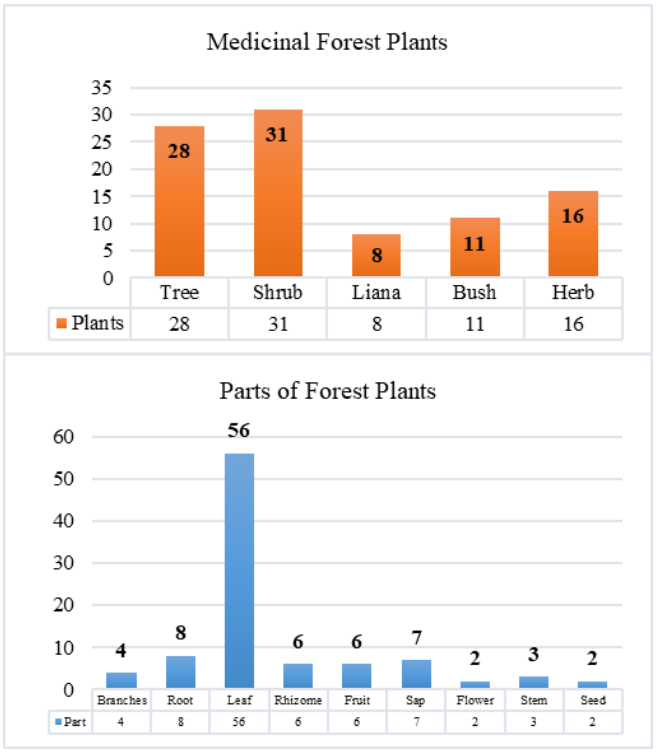

Fig. 2. Data Collection for the knowledge base on skin disease treatment

Collecting data results “Fig. 2” for the knowledge base on skin disease treatment obtained 94 medicinal forest plants consisting of 28 tree species, Herb of 16 species, Liana of 8 species of, shrubs of 31 species, and Bush of 11 species. Data for Medicinal Forest Plants in for Medicine has been collected for the 4 types branches, 8 types roots, 56 leaves, 6 rhizomes, 6 fruits, 7 saps, 2 flower and 3 stems. Furthermore, a screenshot of the User interface on the decision support system is shown in "Fig 3".

Fig. 3. DSS GUI of the Medicinal forest plants for skin diseases

"Fig. 3" shows the medicinal forest plant data recorded in the database system. The attribute of medicinal forest plant data contains information on the Latin and local name of the plant, taxonomy (family), how to process is, how to use, the plant parts used are efficacious for the treatment of skin diseases, and others.

B. Results: DSS Medicinal Forest Plant for Skin Disease

The implementation of the decision analysis method in the intelligent system for determining medicinal plants for skin diseases is designed in a graphical user interface (GUI) in the disease selection process shown in “Fig. 4.

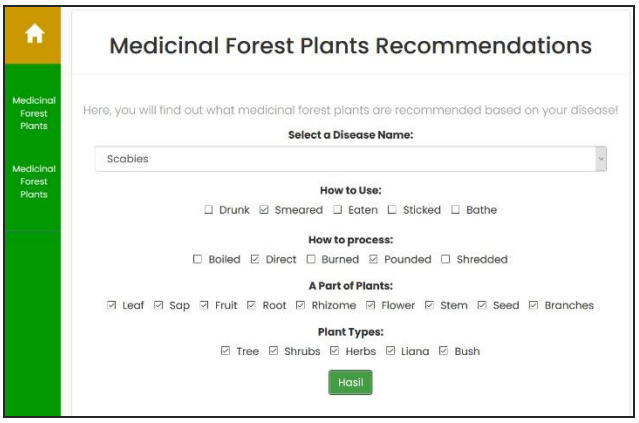

Fig. 4. GUI DSS of medicinal forest plant for skin disease

Interface system in "Fig. 4" shows the menu options for the type of disease user selected, there are 4 lists ie. How to use (drunk, eaten, smeared, stuck and bathed), how to process (direct, burned, pounded, boiled, shredded), and a list of plant parts used to treatment (roots, stems, branches, leaf, sap, rhizome, fruits, flowers and seeds). Besides that, you

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will also list the types of plants such as trees, shrubs, lianas, bushs and herbs. An example is the use of the DSS system to determine Forest plants in the treatment of "scabies" if the user selects a checklist as shown in "Fig. 4".

In "Fig 4" if the user selects scabies, the system provides a checklist of options for each criterion, for example, the user chooses how to use medicinal plants "smeared", chooses the checklist "direct, and pounded" how to process, and selects all parts and types of plants that treat the Scabies disease. Thus, the DSS system analyzes using the AHP-WASPAS method and recommends Medicinal Forest Plants that can treat Scabies disease according to the criteria selected by the user.

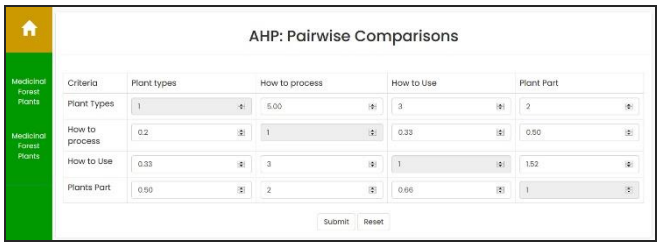

Fig. 5. Pairwise comparison in determining element priority

The level of pairwise comparison weight recommendation from experts from the Center for Research and Development of Conservation Technology for Natural Resources of East Kalimantan Province which determines the level of importance of criterion (C) to other criteria in shown in “Fig. 5”. In case the user selects "Scabies", then the system processes forest plants that can treat. In the DSS system, there are 7 knowledge bases of 94 forest plants for the treatment of scabies are shown in "Table V".

TABLE V. MEDICINAL FOREST PLANTS FOR SCABIES DISEASE

Plant Local Name	Latin Name	Plant types	Part of plants	How to process
Tea tree oil	*Camellia sinensis*	Tree	Sap	Direct
Aloe vera	*Aloe Vera*	Herbs	Sap	Direct
Pigeon pea	*Cajanus Cajan L. Millsp.*	Tree	Leaf	Pounded
Bay-leaf	*Syzygium Polyanthum*	Tree	Leaf	Pounded
Mudar plant	*Calotropis Gigantea (L.) D*	Tree	Leaf	Pounded
Neem, Nimtree	*Azadirachta indica A. Juss*	Tree	Leaf	Pounded
Turmeric	*Curcuma domestica Val.*	Shrubs	Rhizome	Pounded

In "Table V" obtains there are 7 medicinal forest plants for the treatment of scabies, 5 types of trees, 1 type of shrub, and 1 herb. The plant parts used are 2 Sap, 4 Leaves, and 1 Rhizome. As for the processing, all the plants are Pounded. Each criterion and forest plant element is weighted as the best alternative recommendation from the DSS system.

The next stage is determining the relative priority value for each criterion based on "Fig. 5" use "(2)" so that the value is shown in "Table VI". Determination of the Max Eigenvalues of the pairwise comparison matrix in "Fig. 6" use "(3)". The calculation results obtained the value of $\lambda\_max = 4.088726$. Whereas for the calculation of the consistency ratio use "(4)", for the random index value in "Fig. 6" the CR value is obtained = 0.03286.

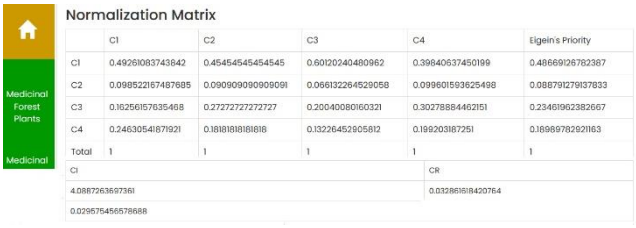

Fig. 6. The Max Eigenvalues of the normalization matrix

Hierarchy consistency check for CR value <0.1 (0.03286 <0.1) so that this calculation is stated to be consistent, then the relative priority value for each criterion can be used as the weight of the criteria.

The WASPAS method to determine the priority of alternative medicinal forest plants for skin diseases, the determination of the weight based on the ratio value of the alternatives number, the results of weighting determining are shown in the "Table VI".

TABLE VI. WEIGHT DECISION MATRIX FOR SCABIES

Plant Local Name	Plant types	Part of plants	How to process	How to use
Tea tree oil	0.71428	0.285714	0.285714	1
Aloe vera	0.14285	0.285714	0.285714	1
Pigeon pea	0.71428	0.571428	0.714285	1
Bay-leaf	0.71428	0.571428	0.714285	1
Mudar plant	0.71428	0.571428	0.714285	1
Neem, Nimtree	0.71428	0.571428	0.714285	1
Turmeric	0.14285	0.142857	0.714285	1

The weighting in the "Table VII" is used to convert the data set into an alternative decision matrix table in determining alternative priorities.

TABLE VII. WEIGHTS: PLANT TYPE, PART USED, HOW TO USE, AND HOW TO PROCESS

Sub-Criterion	Forest Plants	Freq.	Weights	Eigein's Priority
Plant Types	Tree	5	0.714286	0.1898
	Shrub	1	0.142857	
Plant Part	Herb	1	0.142857	0.0887
	Leaf	4	0.571429	
	Rhizome	1	0.142857	
	Sap	2	0.285714	
How to process	Direct	2	0.285714	0.2346
	Pounded	5	0.714286	
How to Use	Smeared	7	1	0.4867

The calculation results of the weight value of each criterion are presented in "Table VII". User priority selection based on criteria and Eigen Priority in "Table VI" and refers to the weight of each criterion.

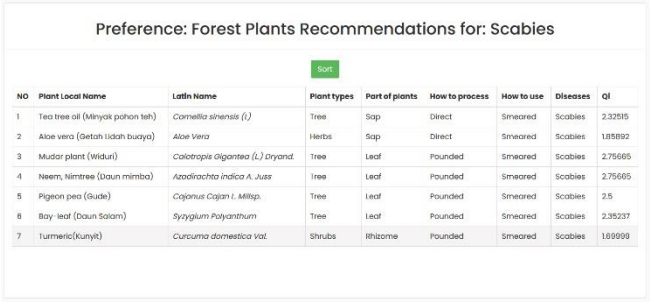

Fig. 7. Calculation Result of Preference Value (Qi)

Determination of the preference value (Qi) of each alternative of scabies use “(6)”, the results of the calculation of the value of Qi are presented in the "Fig. 7", shows the recommended forest plant alternatives for the treatment of scabies. There are 7 plant recommendations based on the WASPAS analysis. The ranking process obtained the best alternative value as shown in the "Table VIII".

TABLE VIII. THE BEST ALTERNATIVE OF FOREST PLANTS FOR SCABIES DISEASE RECOMMENDATIONS

Alt	Plants Name	Preference Qi	→	Alt	Qi	Ranking
A1	Tea tree oil	2.3251535	Sorting	A4	2.75665	1
A2	Aloe vera	1.8589183		A5	2.71225	2
A3	Pigeon pea	2.5		A6	2.59494	3
A4	Bay-leaf	2.7566543		A3	2.50	4
A5	Mudar plant	2.7122587		A1	2.32515	5
A6	Neem, Nimtree	2.5949489		A2	1.85891	6
A7	Turmeric	1.6999916		A7	1.69999	7

C. Discussion

Intelligent decision support systems built on a web basis are expected to make it easier for users to determine medicinal forest plants from Borneo that are used to treat skin diseases. The data source comes from research results of Samboja Center for Natural Resources Conservation, East Kalimantan Province. The combination of AHP-WASPAS analysis method was applied for analyzing 94 datasets of medicinal forest plants as an alternative for skin disease decisions.

This research resulted in a decision support system intelligence software product for determining medicinal forest plants for skin diseases using the AHP method for weight determination (priority), and WASPAS for preference. The implementation of the AHP-WASPAS method in case studies of medicinal forest plants decision shows that the user's subjectivity in weighting and decision-making criteria affects the recommended preference values. The multi-criteria analysis method approach in the case study of medicinal forest plant data exploration for decision making in the analysis is less objective and requires a knowledge-based analysis method where alternatives and criteria are complex.

Future research is applied to the expert system analysis method approach which is expected to optimize the inference engine for more objective results.

ACKNOWLEDGMENT

Thank you to the Natural Resources Conservation Center, Samboja, East Kalimantan. Thanks to the Mulawarman University for supporting and providing assistance, both financial and administrative for research.

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