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Identification of Key Variables in the Utilization of Medicinal Ethnobotanical in KPHP Limau Unit VII Hulu Sarolangun

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Abstract: The ethnobotanical utilization of medicinal plants is an integral part of the local wisdom of the Penguluh Tribe community in KPHP Limau Unit VII Hulu Sarolangun, Jambi. However, the lack of systematic documentation of key variables hampers efforts to preserve and develop this practice. This study aims to identify key variables that play a role in the sustainability of medicinal ethnobotany utilization. The methods used include primary data collection through in-depth interviews with stakeholders, literature reviews, and analysis of relationships between variables using the MICMAC (Matrix of Cross-Impact Multiplication Applied to Classification) approach. The results of the study show that of the 15 variables analyzed, seven main variables, such as regulation, types of medicinal plants, cultivation techniques, sources of knowledge, social roles, conservation efforts, and integration of local and formal learning, have a significant influence on the medicinal ethnobotany utilization system. The regulatory variable is identified as the key factor with the highest impact. The discussion highlights the importance of managing driver and linkage variables to ensure system sustainability. In conclusion, strengthening regulations, conservation of natural resources, and integrating local knowledge with scientific approaches are needed to strengthen medicinal ethnobotany and sustain local communities' welfare.

Keywords: Conservation; Ethnobotany; Medicinal Plants; MICMAC.

Introduction

Using medicinal plants, ethnobotany is an integral part of the local wisdom of communities in various regions, including in the Limau KPHP Unit VII Hulu Sarolangun area, Jambi. The Penguluh tribe inhabits this area and has rich traditional knowledge regarding using medicinal plants to treat various diseases naturally. This knowledge is passed down from generation to generation. It is the primary source in maintaining the health of local communities, especially in areas where access to modern health services is still limited [1]. Ethnobotanical studies reveal the types of medicinal plants used and key variables such as processing methods, utilization methods, and socio-cultural factors that influence the sustainability of these practices.

Identifying key variables in medicinal ethnobotany is crucial to preserving traditional knowledge while increasing the effectiveness and sustainability of using biological natural resources in production forest areas such as KPHP Limau Unit VII. This research can contribute to developing biodiversity conservation and empowering local communities through a science and culture-based approach. Previous research by [2] confirmed that the Penguluh tribe still actively uses medicinal plants as part of their traditional medicine system in the area, with various types of plants utilized and their utilization techniques. This shows the urgency of an in-depth study regarding what variables play a role in the utilization process to formulate further preservation and development strategies.

In addition to cultural and social aspects, the use of medicinal ethnobotany also has significant economic potential for local communities in KPHP Limau Unit VII Hulu Sarolangun. With the increasing interest in natural medicine and herbal products in the national and international markets, sustainable management of medicinal plant resources can be an alternative source of income while encouraging environmental conservation [3]. However, the main challenge faced is the lack of systematic documentation of key variables that influence the successful use of medicinal plants, such as traditional knowledge, access to natural resources, and policy support from the local government.

Previous studies have shown that the utilization of medicinal plants by indigenous communities not only plays a role in maintaining public health but is also crucial for preserving local knowledge and biodiversity conservation. [4] emphasized the importance of socio-demographic factors in sustaining ethnobotanical knowledge among indigenous groups. [5] further highlighted the global significance of locally grounded ethnobiology, especially in responding to ecological changes. Additionally, [6] demonstrated that the cultivation techniques of medicinal plants could enhance ecological function and ensure resource sustainability. [7] stressed that regulatory frameworks strengthen community access rights and participation in the conservation of medicinal plant resources. [8] also found that community-based conservation practices are key to the successful preservation of ethnobotanical resources. Therefore, integrating local practices with scientific approaches is

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essential to ensure the sustainable utilization of medicinal ethnobotany.

This study aims to identify key variables in using medicinal ethnobotany in the Limau KPHP Unit VII Hulu Sarolangun area, Jambi, as a basis for developing conservation and community empowerment strategies. This approach is essential so that traditional practices are preserved and can be developed scientifically to provide optimal benefits for community welfare while maintaining the sustainability of production forest biodiversity.

Research Methods

Data Collection

This research was conducted at KPHP Limau Unit VII Hulu Sarolangun, Jambi, using secondary data in 2019 and was added to and managed in 2024. The primary and secondary data types are primary data, which provides specific information from the field, while secondary data provides additional context and support. Combining the two allows a holistic understanding of key factors in using medicinal ethnobotany. Primary data describes actual conditions, while secondary data provides historical and theoretical information. Combining the two allows this researcher to obtain a comprehensive picture of design conservation and community empowerment to utilize medicinal ethnobotany. The following explains the key factors to be analyzed, presented in Table 1.

Table 1. Data on key factors or variables studied in this study

Key Variables	Information
Types of Medicinal Plants	Plant species are used as medicine by local people.
Parts of the Plant that are Used	Parts of the plant used (leaves, roots, bark, flowers, fruit).
Processing Method	Methods of processing plants into medicine (boiling, pounding, roasting, etc.).
How to use	How to use traditional medicine (drink, paste, rub, bathe).
Types of Diseases Treated	Types of diseases or health complaints that are treated using these plants.
Source of Knowledge	The origins of ethnobotanical knowledge (hereditary, shamans, and local literacy).
Frequency of Use	How often are these plants used in everyday practice?
Availability of Plants in Nature	The abundance or scarcity of medicinal plants in the forest/around the village.
Medicinal Plant Cultivation Techniques	Efforts to domesticate or plant medicinal plants in home gardens or village forests.
Economic Value of Medicinal Plants	The potential selling value of medicinal plants in local markets or as commodities.
Social Role in Drug Use	The role of community leaders, healers, or shamans in managing the use of medicinal plants.
Public Perception of Effectiveness	Public belief in the efficacy of medicinal plants compared to modern medicine.
Threats to Plant Availability	Factors that threaten the sustainability of medicinal plants include deforestation and overharvesting.
Medicinal Plant Conservation Efforts	Conservation actions carried out by the community or KPHP towards essential species.
Integration of Local and Formal Knowledge	Efforts to combine local knowledge with scientific/modern approaches (e.g., through training and research).

Interview

Data sources obtained through in-depth interviews are important in analyzing key variables or factors that play a role in the utilization of medicinal ethnobotany. Deep interviews allow researchers to gain in-depth insights and specific information from experts, practitioners, or relevant stakeholders. By exploring their views and experiences, deep interviews allow for collecting rich and detailed data on key variables that are significant in using medicinal plants based on ethnobotany. Through deep interviews, researchers can access in-depth information, enrich perspectives, and identify diverse perceptions, which are very useful in analyzing key variables to support the management and development of the utilization of medicinal ethnobotany.

Data Analysis

A study of factors that influence the utilization of medicinal ethnobotany and identification of key factors that influence the success of the utilization of medicinal ethnobotany is carried out using the MICMAC approach data analysis method used by [9]. MICMAC is part of a series of strategic forecasting developed by Godet 1994 and Godet et al. 1999 in [10]. The interaction of important factor variables is important in determining a policy's sustainability level [10], in this case, looking at the utilization of medicinal ethnobotany. The MICMAC method is based on a structural study that can identify important factors in a complex system [11]. In addition, the MICMAC method can also help in understanding the relationship between factors and the hierarchy of these factors based on input from related actors (stakeholders) [9]. There are four main stages in examining important factors using the MICMAC method [9], [10], [11].

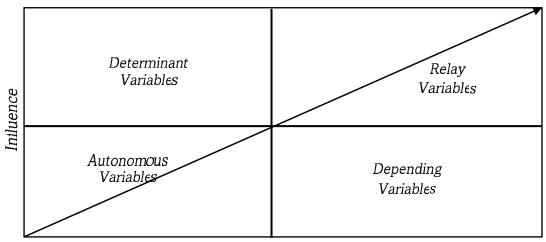

Figure 1. Map of the influence and dependency quadrants of variables.

Results and Discussion

The discussion results showed that 15 variables were considered to influence the management of sustainable deer breeding. These key variables were grouped into four clusters of factors that shape the development of deer breeding, as shown in Figure 1. These variables were then arranged in MICMAC software in the Matrix of Direct Influence (MDI) to determine the intensity of the influence of each variable. MDI is a fundamental matrix for compiling an indirect influence matrix (MII) that shows the intensity of the indirect influence of variables, and a potential direct influence matrix (MPDI) that projects the intensity of the influence of variables if the system changes in the future. The results of this study were primarily determined by the informants' accuracy in identifying variables suspected of influencing the use of medicinal ethnobotany in KPHP Limau Unit VII Hulu Sarolangun, Jambi.

The Deep interview process was conducted with various stakeholders in KPHP Limau Unit VII Hulu Sarolangun. Before the deep interview process was conducted, a literature review related to sustainable deer breeding was carried out, and factors were obtained that indicated the utilization of medicinal ethnobotany. The factors obtained from the literature review process were then presented to stakeholders in the deep interview process to obtain additional input on other factors that had not been found in the literature review process. The results of the study of important factors in the utilization of medicinal ethnobotany are presented in Figure 3. Important factors related to the utilization of medicinal ethnobotany were mapped based on the level of influence and its influence (dependency). Based on the mapping of these factors, they were then grouped based on the level of influence and dependency into four groups of factors, namely 1) Influence variables in quadrant I describe variables that are very influential with little dependency, so they are very crucial variables in the system and act as key variables; 2) variables in quadrant II are relay variables, which are variables that are very influential but also very dependent, so they are often seen as variables that reflect instability in a system; 3) quadrant III contains dependent variables which are outcome variables because they are characterized by high dependency. These variables are also quite sensitive to changes in influence and relay variables, and 4) quadrant IV describes excluded variables or autonomous variables because of their small influence and dependency. These variables are excluded because they will not stop a system from working or utilizing the system itself. The direct influence matrix of these variables can be seen in Figure 2. These variables are then entered into the MICMAC Analysis group.

	1: Types of Medicinal Plants	2: Parts of Plant Used	3: Processing Method	4: Method of Use	5: Type of Disease Treated	6: Source of Knowledge	7: Frequency of Use	8: Availability of Plants in Nature	9: Cultivation Techniques of Medicinal Plants:	10: Economic Value of Medicinal Plants	11: Social Role in Drug Use	12: Community Perception of Effectiveness	13: Threats to Plant Availability	14: Medicinal Plant Conservation Efforts	15: Integration of Local and Formal Knowledge
1 : Types of Medicinal Plants	0	3	3	2	3	2	2	2	2	3	2	3	3	3	3
2 : Parts of Plant Used	2	0	2	3	3	2	2	3	0	2	2	3	3	1	2
3 : Processing Method	1	2	0	3	3	1	1	3	2	1	1	2	1	1	1
4 : Method of Use	1	3	3	0	3	2	2	3	3	1	2	3	2	1	1
5 : Type of Disease Treated	2	3	2	2	0	1	1	3	1	3	1	3	1	1	1
6 : Source of Knowledge	2	3	3	3	2	0	3	3	3	3	2	3	2	3	3
7 : Frequency of Use	1	2	2	2	2	2	0	2	2	3	2	2	3	2	3
8 : Availability of Plants in Nature	3	3	3	3	3	2	3	0	2	3	3	3	2	3	3
9 : Cultivation Techniques of Medicinal Plants:	2	0	3	3	3	1	1	3	0	3	2	3	3	3	3
10 : Economic Value of Medicinal Plants	2	2	2	2	3	2	1	2	2	0	2	3	2	2	2
11 : Social Role in Drug Use	2	3	3	3	3	3	1	3	3	3	0	3	2	3	2
12 : Community Perception of Effectiveness	1	3	3	3	3	2	1	2	2	2	1	0	2	2	2
13 : Threats to Plant Availability	2	3	3	3	3	2	2	3	2	3	3	3	0	3	3
14 : Medicinal Plant Conservation Efforts	2	3	3	3	3	3	2	3	2	3	3	3	2	0	2
15 : Integration of Local and Formal Knowledge	2	3	3	3	3	2	2	3	2	3	3	3	2	3	0

Figure 2. Direct Influence Matrix (MDI)

The MICMAC evaluation of 15 input variables shows that seven main variables significantly impact the utilization of medicinal ethnobotany both directly and indirectly. Of the 15 variables, seven were identified as the most important key factors in supporting the sustainability of the utilization of traditional medicinal plants. In this context, the regulation variable received the highest ranking as the most vital key variable and significantly influenced the sustainability of the utilization of medicinal ethnobotany.

This finding aligns with previous studies that emphasize the importance of regulation in the conservation and sustainable use of medicinal plants. For example, a study by [12] in Ethiopia showed that regulatory policies play a central role in regulating access and protection of ethnobotanical resources, thereby ensuring the sustainability of ecosystems and traditional practices. [13], in a study in Assosa District, also stated that regulation strengthens the social and economic aspects of the community by strengthening access rights and community participation.

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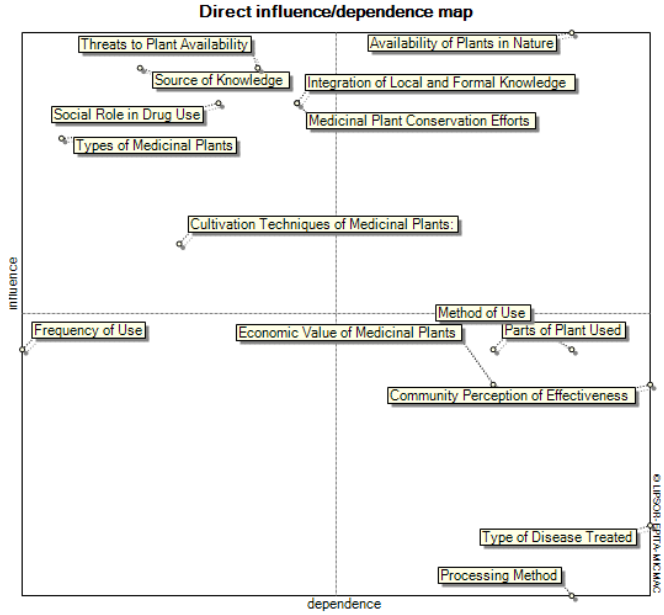

Figure 3. Mapping of important factors related to the use of medicinal ethnobotany based on the level of influence and dependency of direct influence.

The first group is driver variables with a high influence but low dependency on the system. Variables such as Types of Medicinal Plants, Knowledge Sources, Cultivation Techniques, Social Roles, Threats to Availability, Conservation Efforts, and Integration of Local and Formal Knowledge fall into this category. This suggests that changes in these variables can drive significant changes in the overall system of medicinal ethnobotany utilization. Therefore, Driver variables should be a top priority in developing sustainable medicinal ethnobotany management strategies to maximize their positive impacts. Threats to the availability of medicinal plants have also been identified as a critical factor in a study by [14], who highlighted the need for active conservation efforts to maintain the sustainability of these resources.

The second group is Linkage, a variable with a high influence and dependence on the system. In this context, the Availability of Plants in Nature is the primary linkage variable. This variable is very interactive and sensitive to changes in other variables while also significantly impacting the entire system of medicinal ethnobotany utilization. The critical linkage characteristics indicate that if this variable is not managed correctly, it can cause instability and vulnerability of the system as a whole. Therefore, the management of the sustainability of the availability of medicinal plants must be carried out carefully and involve various related parties, including local communities, governments, and conservation institutions.

The third group is Dependent, a variable with a low influence but high dependence on other variables in the system. Variables such as Plant Parts Utilized, Processing Method, Use Method, Type of Disease Treated, Economic Value, and Community Perception of Effectiveness are included in this category. These variables do not directly drive significant changes in the system but are highly dependent on the dynamics of the Driver and Linkage variables. In other words, an increase or decrease in the Dependent variable is more a consequence of changes that occur in the primary variable. Previous research supports the importance of understanding this dependency relationship. A research study by [15] highlighted that the method of processing and using medicinal plants is highly influenced by the availability of resources and local knowledge as the main driving factors. In addition, research by [16] showed that community perceptions of the effectiveness of medicinal plants are closely correlated with the type of plant and cultivation techniques used.

Figure 4, the Direct Influence Graph from the MICMAC analysis, shows a strong relationship between key variables in using medicinal ethnobotany in KPHP Limau Unit VII Hulu Sarolangun. Variables such as Types of Medicinal Plants, Parts of Plants Utilized, and Types of Diseases Treated dominate other variables, indicating their position as the main drivers in the system. Most of the relationships between variables are very strong (marked with the number 3 and a thick red line), reflecting the high complexity level in utilizing traditional medicinal plants in the KPHP Limau Unit VII Hulu Sarolangun area. Recent research supports these findings by emphasizing the importance of these variables as significant factors in the ethnobotany system. For example, a study by [17] revealed that the types of medicinal plants and plant parts directly affect the effectiveness of traditional medicine and the sustainability of local practices. In addition, research by [18] highlighted that the type of disease treated is a critical factor in determining the pattern of medicinal plant use and the adaptation of local knowledge to community health needs.

Variables such as the availability of plants in nature and threats to availability act as linkage variables because they significantly influence and are influenced by other variables. On the other hand, variables such as Frequency of Use are classified as autonomous variables because their

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Linkage is relatively low. This pattern shows that to maintain the sustainability of medicinal ethnobotany, the main attention needs to be focused on the management of plant species, conservation of natural resources, and preservation of local knowledge.

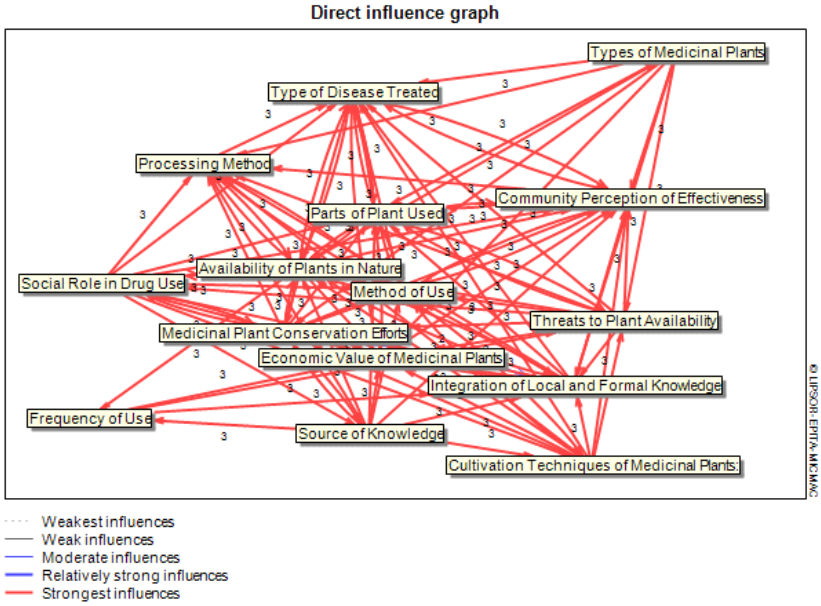

Figure 4. Direct interaction between factors in the use of medicinal ethnobotany

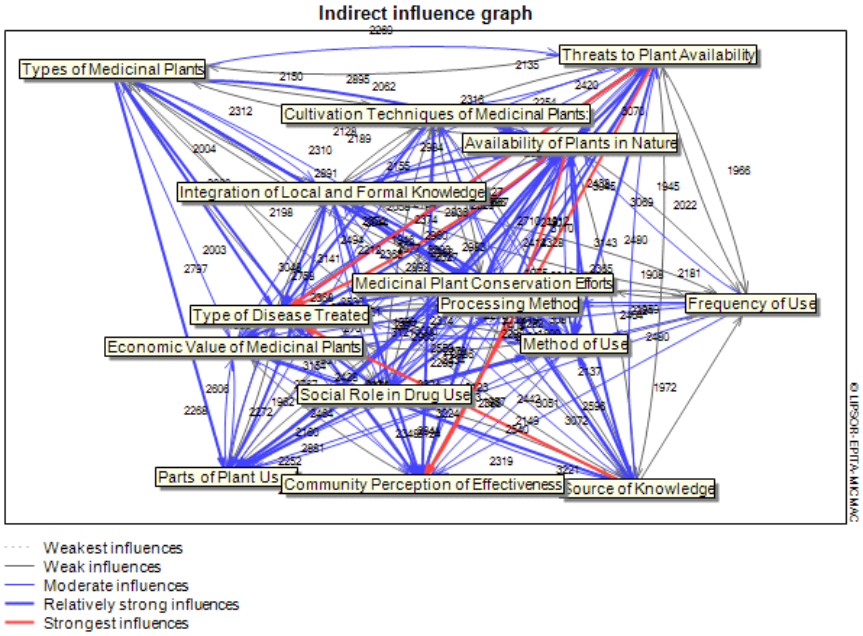

Figure 5. Indirect interactions between factors in the use of medicinal ethnobotany

Figure 5, the Indirect Influence Graph, shows the indirect relationship between key variables in using medicinal ethnobotany in KPHP Limau Unit VII Hulu Sarolangun. Compared to the direct influence graph, we can see a much more complex and dense relationship pattern, with many blue and red lines indicating moderate to powerful influences. Variables such as Types of Medicinal Plants, Cultivation Techniques, and Integration of Local and Formal Knowledge have a significant indirect impact on the sustainability of medicinal plant utilization. However, these relationships are not always explicitly apparent in daily interactions. In addition, the variables Availability of Plants in Nature and Threats to Availability still play a central role, given their strong relationship with other variables through indirect pathways. Variables such as the Economic Value of Medicinal Plants and Conservation Efforts also gain strength in this graph, indicating that the success of conservation strategies does not only depend on direct factors but also a wider network of influences. Understanding these indirect influences is important for designing more systematic and long-term impactful interventions.

Recent research supports the importance of these variables in medicinal ethnobotany systems. Sintayehu [19] asserted that integrating local knowledge with formal science strengthens traditional practices while enhancing community adaptation to socio-ecological changes. A study by [17] revealed that medicinal plant cultivation techniques

indirectly affect resource availability by increasing productivity while mitigating environmental threats.

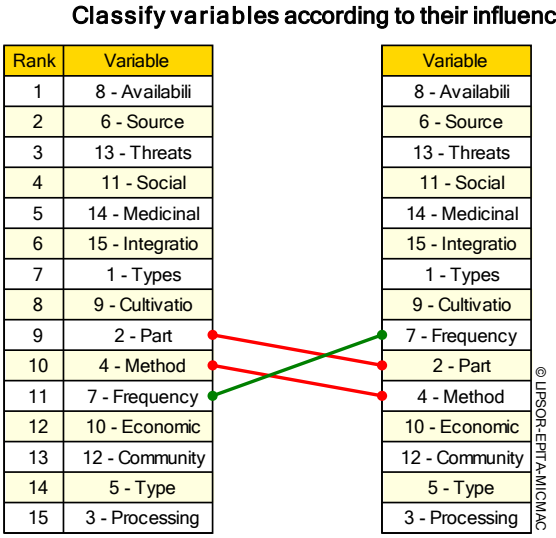

Figure 6. Order of Factors Based on Direct and Indirect Influence

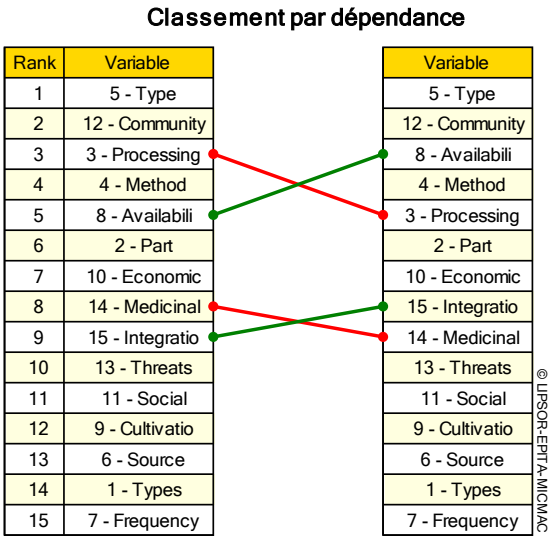

Figure 7 Order of Factors Based on Direct and Indirect Dependence

Figure 6 compares the ranking of variables based on their level of influence and dependence. Most variables, such as Source of Knowledge, Social Role, Integration of Local and Formal Knowledge, and Cultivation Techniques, maintain consistent positions, reflecting the stability and importance of these variables in the medicinal ethnobotany utilization system. This is in line with the findings of [20], who emphasized that integrating local knowledge with formal science is a key factor in maintaining the sustainability of traditional practices while bridging modern scientific approaches. In addition, a study by [17] confirmed that medicinal plant cultivation techniques play an important role in increasing productivity and conserving natural resources in local communities. The social role of the community is also a vital element, as described by [18], who showed how social structures influence the distribution of knowledge and practices of effective medicinal plant use. Thus, the stability of the positions of these key variables emphasizes the need for continued focus on these aspects to support a holistic medicinal ethnobotany utilization system.

Figure 7 compares the ranking of variables based on indirect influence in the medicinal plant use system. Most variables, such as Community Perception, Threats to Plant Availability, Cultivation Techniques, and Plant Types, show consistent positions, indicating the stability of their roles in the variable relationship network. However, there are differences in position between the variables Method of Use and Part of the Plant Utilized and between Medicinal Value and Knowledge Integration, as indicated by the red and green cross lines. This change indicates that, in indirect influence, local and formal knowledge integration becomes more significant than the medicinal value itself, reinforcing the importance of a knowledge-based approach in managing medicinal plant resources. Research by [21] revealed that threats to plant availability, such as habitat degradation and overexploitation, significantly impact the sustainability of ethnobotanical resources. Cultivation techniques have also been identified as an important factor that can increase productivity while reducing pressure on wild populations of medicinal plants [17]. The type of plant used determines the pattern of utilization and effectiveness of traditional medicine, as explained by [18] in their study of medicinal plant diversity in local communities.

Conclusion

This study successfully identified seven main variables that have a significant influence, both directly and indirectly, on the sustainability of medicinal ethnobotany utilization in KPHP Limau Unit VII Hulu Sarolangun, Jambi. Regulatory variables emerged as the most vital key factors, followed by variables such as types of medicinal plants, cultivation techniques, sources of knowledge, social roles, conservation efforts, and integration of local and formal knowledge. Mapping using MICMAC analysis showed that driver variables have a significant role in encouraging system stability. In contrast, linkage variables, such as the availability of plants in nature, are critical and vulnerable to change. In addition, dependent and autonomous variables enrich the understanding of the system even though their contribution to change is lower. These results emphasize the importance of regulatory management, resource conservation, social involvement, and integration of traditional knowledge with a scientific approach as strategies to strengthen the practice of sustainable medicinal ethnobotany utilization.

Author's Contribution

Rizky Febriana Br Lubis: contributed to conceptualization, data analysis, and manuscript drafting. Alfi Laila Zuhriansah: was responsible for literature review, data collection, and formatting. Risnayanti R. Juramang: participated in field validation, stakeholder interviews, and results interpretation. Ikraeni Safitri: contributed to visualizations and editing. Sutan Sahala Muda Marpaung: provided supervision, methodology, MICMAC data processing, data analysis critical revision, and final approval of the manuscript. All authors have read and agreed to the published version of the manuscript.

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References

[1] S. S. M. Marpaung, Y. I. Rahmila, D. H. Has, T. Setiawan, and S. P. A. Nugroho, "Ethnographic and plant utilization: A case study of the Penguluh Tribe, Jambi Province, Indonesia," *IOP Conf. Ser.: Earth Environ. Sci.*, vol. 1359, no. 1, p. 012104, 2024. doi: 10.1088/1755-1315/1359/1/012104

[2] D. H. Has, E. A. M. Zuhud, and A. Hikmat, "Etnobotani obat pada masyarakat suku Penguluh di kphp limau unit vii hulu Sarolangun, Jambi," *Media Konservasi*, vol. 25, no. 1, pp. 73–80, 2020. doi: 10.29244/medkon.25.1.73-80

[3] R. F. B. Lubis, S. S. M. Marpaung, M. F. Srena, Y. S. Kusuma, J. S. Batubara, and U. Siadari, "Ecology of *Scaphium macropodum* in the Sarolangun Jambi Production Forest Area," *J. Biol. Tropis*, vol. 24, no. 4, pp. 726–743, 2024. doi: 10.29303/jbt.v24i4.7774

[4] S. Tamene, M. Negash, F. B. Makonda, and L. Chiwona-Karltun, "Influence of socio-demographic factors on medicinal plant knowledge among three selected ethnic groups in south-central Ethiopia," *J. Ethnobiol. Ethnomed.*, vol. 20, no. 1, p. 29, 2024. doi: 10.1186/s13002-024-00672-1

[5] N. J. Turner, A. Cuerrier, and L. Joseph, "Well grounded: Indigenous Peoples' knowledge, ethnobiology and sustainability," *People Nat.*, vol. 4, no. 3, pp. 627–651, 2022. doi: 10.1002/pan3.10321

[6] M. Dalir, S. Choobchian, and E. Abbasi, "Identifying the relative importance of cultivating medicinal plants in improving rural livelihoods," *Environ. Dev.*, p. 101159, 2025. doi: 10.1016/j.envdev.2025.101159

[7] A. Zehra, M. Meena, D. M. Jadhav, P. Swapnil, and Harish, "Regulatory mechanisms for the conservation of endangered plant species, *Chlorophytum tuberosum*-potential medicinal plant species," *Sustainability*, vol. 15, no. 8, p. 6406, 2023. doi: 10.3390/su15086406

[8] M. T. A. Diantaris, "Conservation Strategies for Endangered Ethnobotanical Species in Tropical Regions," *Int. J. Adv. Ethnobot. Res. Appl.*, vol. 1, no. 1, 2024.

[9] N. Ariyani and A. Fauzi, "Analysis of strategic variables for ecotourism development; an application of Micmac," *South Asian J. Soc. Stud. Econ.*, vol. 3, no. 3, pp. 1–12, 2019. doi: 10.9734/sajsse/2019/v3i330107

[10] A. Fauzi, *Teknik analisis keberlanjutan*. Jakarta: Gramedia Pustaka Utama, 2019.

[11] R. Teimouri and H. Hodjati, "Structural analysis of affecting factors for future development of green spaces in Tabriz City," *Asian Soc. Sci.*, vol. 13, no. 3, p. 185, 2017. doi: 10.5539/ass.v13n3p185

[12] N. Gonfa, D. Tulu, K. Hundera, and D. Raga, "Ethnobotanical study of medicinal plants, its utilization, and conservation by indigenous people of Gera district, Ethiopia," *Cogent Food Agric.*, vol. 6, no. 1, p. 1852716, 2020. doi: 10.1080/23311932.2020.1852716

[13] Z. K. Tessema, Y. Zelalem, and A. Moges, "An Ethnobotanical study of medicinal plants used by the local people of Assosa District, Benishangul Gumuz Regional State, Ethiopia," *Ethnobot. Res. Appl.*, vol. 29, pp. 1–29, 2024. doi: 10.32859/era.29.66.1-29

[14] L. Pari and M. A. Satheesh, "Antidiabetic activity of *Boerhaavia diffusa* L.: effect on hepatic key enzymes in experimental diabetes," *J. Ethnopharmacol.*, vol. 91, no. 1, pp. 109–113, 2004. doi: 10.1016/j.jep.2003.12.013

[15] M. Tabuchi, T. Yamaguchi, S. Iizuka, S. Imamura, Y. Ikarashi, and Y. Kase, "Ameliorative effects of yokukansan, a traditional Japanese medicine, on learning and non-cognitive disturbances in the Tg2576 mouse model of Alzheimer's disease," *J. Ethnopharmacol.*, vol. 122, no. 1, pp. 157–162, 2009. doi: 10.1016/j.jep.2008.12.010

[16] M. G. Ortega, *et al*., "*Huperzia saururus*, activity on synaptic transmission in the hippocampus," *J. Ethnopharmacol.*, vol. 104, no. 3, pp. 374–378, 2006. doi: 10.1016/j.jep.2005.11.002

[17] Y. Jiang and L. Fan, "The effect of *Poria cocos* ethanol extract on the intestinal barrier function and intestinal microbiota in mice with breast cancer," *J. Ethnopharmacol.*, vol. 266, p. 113456, 2021. doi: 10.1016/j.jep.2020.113456

[18] G. Yu, *et al*., "Brucine alleviates neuropathic pain in mice via reducing the current of the sodium channel," *J. Ethnopharmacol.*, vol. 233, pp. 56–63, 2019. doi: 10.1016/j.jep.2018.12.045

[19] S. Tamene, M. Negash, F. B. Makonda, and L. Chiwona-Karltun, "Influence of socio-demographic factors on medicinal plant knowledge among three selected ethnic groups in south-central Ethiopia," *J. Ethnobiol. Ethnomed.*, vol. 20, no. 1, p. 29, 2024. doi: 10.1186/s13002-024-00672-1

[20] Á. Fernández-Llamazares, *et al*., "The global relevance of locally grounded ethnobiology," *J. Ethnobiol. Ethnomed.*, vol. 20, no. 1, p. 53, 2024. doi: 10.1186/s13002-024-00693-w

[21] S. Eaton, C. Ellis, D. Genney, R. Thompson, R. Yahr, and D. T. Haydon, "Adding small species to the big picture: Species distribution modelling in an age of landscape scale conservation," *Biol. Conserv.*, vol. 217, pp. 251–258, 2018. doi: 10.1016/j.biocon.2017.11.012