Index and management sustainability condition of *Kenegerian Rumbio* customary forest, Riau Province - Indonesia

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Abstract: - Forest utilization aims to obtain the benefits in terms of forest products and services in an optimal, fair, and sustainable manner for the welfare of people, especially those living around the forest as well as to foster public awareness to maintain and enhance the function of conserved forests to realize the preservation of natural resources and the environment for both present generation and future generation. The objective of this research is to confirm sustainability and the driving variables regarding the management of the customary forest of Rumbio, Kampar Regency, Riau Province. Developing a model for managing sustainable forest on customary land is carried out with interviews with experts in the field of forestry, adat stakeholders, spatial planning and the environment. there are 7 experts including government, academics, practitioners, community leaders, customary stakeholders, and non-governmental organizations. The overall Rapfor analysis show that the value of sustainability condition is 57.31% which is categorized as quite sustainable (in which the ecological dimension is 57.00%, the economic dimension is 48.55%, the social cultural dimension is 60.41%, and legal / institutional dimension is 61.13%). These conditions reveal that the Rumbio customary forest management is fairly good. The driving variables of the sustainability of the forest management include; institutional capacity, government budget, community agency involvement, tourism potential, and local wisdom practice factors.

Key-Words: -Driving variables, sustainability condition, Kenergerian Rumbio customary forest

1 Introduction

The sustainable development paradigm has become the basis of the concept of development in almost all countries in the world. In line with the paradigm, some experts expressed their point of view on the concept of sustainable developments. The term sustainability is defined as the development of multidimensional agreements to achieve a better quality of life for everyone [1]. Another definition of the concept of sustainability was proposed by [2]. He said that sustainability requires management of sustainable economies scale to support ecological systems, the distribution of resource and opportunities between present and future generations in a balanced and fair manner and efficiency in allocating resources. On the other occasion, sustainable development in general can be grouped into four dimensions, namely ecology, social economy, social politics, and law and institutions [3]. The principle of sustainable development has a general impact on the overall context of decision making by integrating the concepts of justice, environment and economy, specifically, the impact on the economic dimension, management of environmental resources and socio-cultural development [4].

Meanwhile, forests are natural resources that are very potential. They also play a strategic role in development. Due to the strategic role, the concept of forest management in Indonesia is dynamic, in accordance with the interests and needs to be achieved. The function of forests in environmental services is provided by the presence of forests as carbon filter, germplasm protection, biodiversity, and potential aesthetic values that can provide economic value if they can be well managed. Thus, forests deal with not only the timber business but also various diverse economic, social and cultural systems, which are potential to develop various fields of science and technology.

Forest conservation is a must to guarantee the sustainability of the forest. Comprehensive management regarding forest conservation sometimes cannot be implemented in accordance with expectations. There are some problem regarding the forest conservation policies implemented by the government, environmental organizations and communities. The problems can be identified from the increasing rates of deforestation (altering the functions of forest areas to non-forested areas) and forest degradation (degradation of forest quality). Supriadi [5] was

predicted that 70-80% of forest destruction in Indonesia is caused by human actions.

Pursuant to Law Number 41 of 1999 concerning forestry and the Constitutional Court Decree Number 35 of 2012, customary conservation forests are defined as forests that are within the territories of indigenous and ethnic group of peoples. The forests are stipulated by the government as long as the customary community still exists and its existence is recognized, and if and when the customary community no longer exists, the customary forest management rights are returned to the Government.

A customary community is a group of people who are bound by their customary legal provisions as a common citizen of a legal alliance because of the similarity of their domicile or descent.

The customary land tenure rights are known as *Hak Ulayat* (indigenous land). Pursuant to the Regulation of the Minister of State Land/ Head of the National Land Agency number 5 of 1999 regarding the guidelines for resolving the customary community's rights issue, it is stated that customary rights are the authority according to customary provisions implemented by certain customary communities over certain areas which are the environment of their citizens to take advantage from natural resources, including land in the area, for their life, arising from outward and inward relationships from one generation to next generation continuously between the customary community and the area concerned.

One of the indigenous land of *Kenegerian Rumbio* community that has been recognized by the Kampar Local Government is *ghimbo laghangan* (literally means prohibited forest' or protected forest). The forest is a legacy from generation to generation and has existed for a long time. The forest is called *Pusako Tinggi* (high legacy) of indigenous Rumbio community, which contains various natural resources, flora and fauna. In addition, the forest is process asset for the Rumbio indigenous people. The forest plays hydrological and environmental functions, namely as a source of fresh water that can be consumed without cooking it first.

In order to preserve the customary forest, *ninik mamak* (customary community leaders) play very important roles. Policies issued by ten *ninik mamak* under the leader *Datuok Ulak Simano* from *Pitopang* ethnic. The programs implemented by *ninik mamak* include: 1) discussing the plan to conserve the forest, including sanctions imposed on those who carry out logging, forest encroachment and hunting; 2) holding a meeting or deliberation to support programs or activities from the government such as forest plant enrichment programs; 3) holding a meeting or deliberation if *ninik mamak* or community make proposals related to the forest.

Forest utilization aims to obtain the benefits of forest products and services in an optimal, fair, and sustainable manner for the welfare of the community, especially the people around the forest as well as to foster public awareness to maintain and improve the function of protected forests to realize the preservation of natural resources and the environment for both the present generation and future generations. The objective of this research is to confirm sustainability and the determinant factors regarding the management of the customary forest of Rumbio, Kampar Regency, Riau Province.

2 Research Methods
2.1 Types and Sources of Research Data

The type of data used in this study includes primary data secondary data. Primary data were data obtained in the field from the informants, in form of interviews and the present condition of customary forest management in the area researched. Primary data were collected through surveys, interviews with experts and people of the community. Interviews were conducted in a semi-structured manner with a number of key informants and other relevant parties. Secondary data were collected regarding statistical data such as: population, environmental, economic and socio-cultural data; research findings or annual reports, documents on planning, regulations, maps and other processed data and related agencies. The types, sources of research data in details can be seen in Table 1.

Table 1. Types and source of the research data

Aspects	Variable	Description	Types of Data	Source of Data
level/status of sustainability of customary forest management	Sustainability Dimensions and Attributes	Dimensions and attributes used as a sustainability assessment	Primary and Secondary Data	Analysis findings and Secondary data
Leverage attributes/variables of management	Leverage attribute of each dimension	Determinants or attributes of sustainability	Primary Data	Questionnaire (stakeholders)

Source: Research Design of 2019

2.2 Data Collection Methods

In order to collect the data, the researcher carried out a survey and literature study method. The survey method was carried out for primary data collection by conducting interviews and observations (visual observations) of the present of management of the forest. Meanwhile, the literature study method was carried out to collect the secondary data collection in the form of documents related to the level of Rumbio customary forest management. Data collection methods in details are presented in Table 2.

Table 2. Data collection methods

Objectives	Variables	Types of Data	Data Collection
Study on the level / condition of sustainability of Rumbio customary forest management	Sustainability dimensions and attributes Primary data and secondary data	Primary and Secondary Data	- Survey (assessment and observation) - Literature Study
Study of key variables / attributes in the management of the customary forest	Leveraging attributes of each dimension	Secondary Data	Survey (interviews)

Source: Research Design of 2019

2.3 Research Data Analysis Methods

Data analysis methods are adapted to the research objectives, including; MDS analysis by using Rapfor software (Rapfish modification), and prospective analysis. Data analysis methods in details are presented in Table 3.

Table 3. Research data analysis methods

Objectives	Variable	Description	Analysis Methods	Analysis Findings
Study on the level / status of sustainability of Rumbio customary forest management	Dimensions and attributes of sustainability	Dimensions and attributes used as a sustainability assessment	Analysis MDS (Rapfor)	- Sustainability condition - Sensitive attributes
Study of key variables / attributes in customary forest management	Leverage attribute of each dimension	Determinants or attributes of sustainability	Prospective analysis	- Driving variable - Leverage variable - Dependent variable - Independent variable

Source: Research Design of 2019

2.4 Multi-Dimensional Scaling (MDS) Analysis

The sustainability analysis is aimed to obtain a description of the sustainability condition of the Rumbio customary forest management. The analysis was carried out with a multi-dimensional scaling approach (MDS) with Rapfor (Rapfish modification) software. Rapfor stands for Rapid Appraisal for Forest. This approach is based more on the principle of Multi Criteria Analysis (MCA) by relying on an algorithm called the MDS algorithm [6].

Scoring system for each dimension are expressed on a scale of bad 0% to good 100%. The dimensions were categorized into four:
• 0% - 25% (bad or not sustainable),
• 25.01% - 50% (less sustainable)
• 50.0% - 75% (fairly sustainable) and
• 75.01% - 100% (good or very sustainable),
If the score of sustainability value is larger than or equal to 50 (> 50%), the system is classified sustainable. On the other hand, it is classified unsustainable if the index value is less than 50 (<50%). The value of the sustainability index of each dimension can be seen in the form of a kite diagram. The diagram is symmetrically set by the index of each dimension (ecological, economic, socio-cultural, and institutional provisions).

2.5 Prospective Analysis

Prospective analysis is a method used to analyze problems through expert systems that can combine decision makers in order to rearrange several plans with different approaches [7]. Prospective analysis aims to determine the position of the attributes of the lever to obtain key attributes or the driving variables. Prospective output analysis results in 4 (four) quadrants which are the positions of the lever attributes, as shown in Fig. 1.
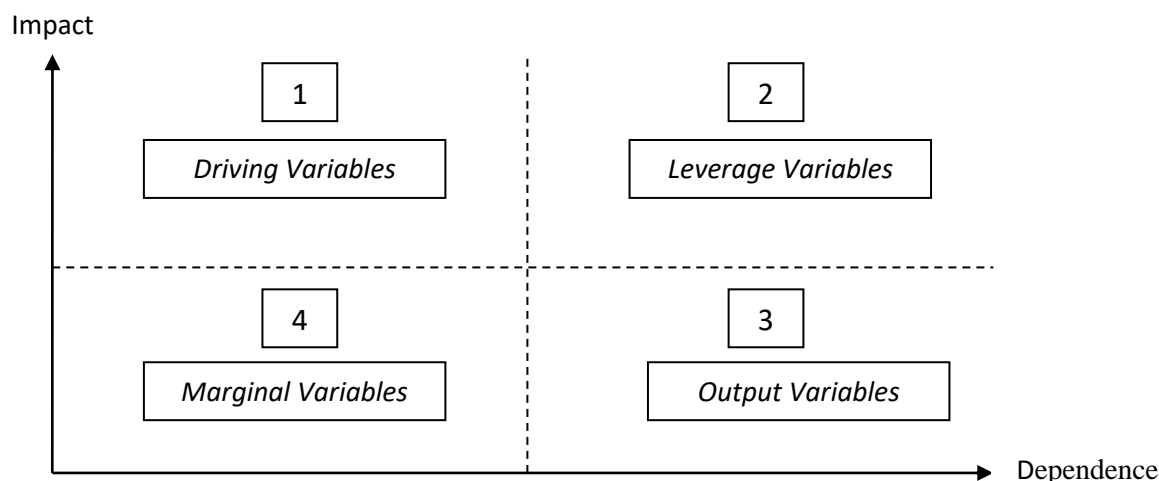
Fig. 1 Diagram of impact and dependence of variables in the system

3 Research Findings and Discussions

3.1 Sustainability Condition

The study on the level of sustainability of Rumbio customary forest management is carried out by evaluating the sustainability of 4 (four) management dimensions namely; ecological, economic, socio-cultural, legal / institutional dimensions. Each dimension is assessed based on the attributes of sustainability indicators. The findings of the Rapfor analysis for all management dimension reveal that the ordination value is 57.31%. The value assures that the sustainability condition of Rumbio customary forest is fairly sustainable. The findings can be seen in Fig. 2.
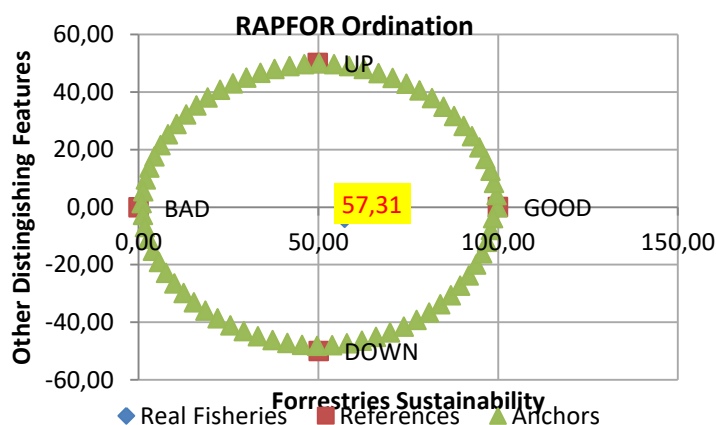

Fig. 2 Sustainability condition of Rumbio customary forest management

The Rapfor analysis findings reveal that the value of sustainability condition is 57.31%. Such percentages is categorized fairly sustainable. The conditions show that the Rumbio customary forest management is fairly good. These findings are validated with a Monte Carlo value of about 56.66% which shows a very small difference of 0.65% or less than 1%. This value shows that the impact of the error, or the impact of a relatively small scoring error. Kavanagh and Pitcher [8] assured that the Monte Carlo analysis can be used as a validation value of the impact of random errors. In addition, Fauzi and Anna [6] reassured that Monte Carlo analysis can be used as an indicator of errors caused by giving scores to each attribute, variations in scoring that are multidimensional due to different opinions, the process of data analysis that is carried out repeatedly, and error when inputting data or data missing.

The validity of the Rapfor findings can also be seen from the findings of the test of goodness of fit on the Squared Correlation (R^2) value of about 0.9574 or close to 1. R-square value got closer to 1 meaning that the existing data were more perfectly mapped. This value showed that more than 95% of the model can be well explained, and the rest <5% is explained by other factors / attributes. Kavanagh [9] assured that a Squared Correlation (R^2) value of

more than 80% indicates that a good and adequate sustainability index estimation model is used. On the other hand, the finding of a lack of fit measure or stress value was 0.1284 or close to 0 (zero). Stress value was close to zero, the output produced was more similar to the actual situation. In other words, the lower the stress value is, the better the model is. On the other hand, the higher the stress value, the more incompatible the model. Kavanagh [9] also states that the value of stress that can be tolerated is less than 20%.

This condition can also be seen from the partial analysis for each dimension of the four dimensions. There are three dimensions which have a sustainability value above 50% or are categorized as fairly sustainable. More detail descriptions are explained as follows.

3.2 Ecological Dimension

The findings of the analysis using MDS RAPFOR on 8 attributes that affect the ecological dimension of Rumbio customary forest management show that the value of the sustainability index of the ecological dimension of the forest management was 57.00. The value is between 50.01-75.00. So, the sustainability condition is fairly sustainable (see Fig. 3).
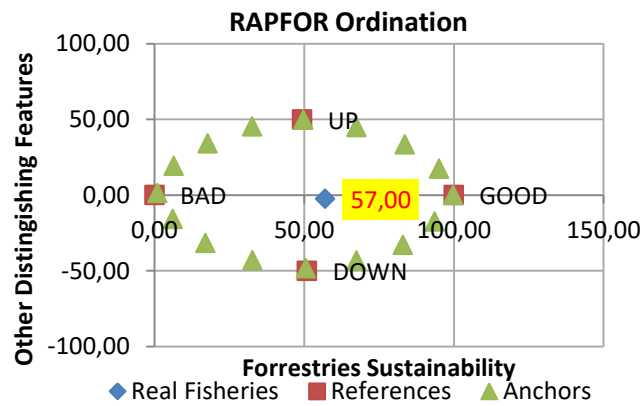

Fig. 3. Ecological dimension sustainability condition

Based on the leverage analysis of Fig. 4, of 8 analyzed attributes, it can be seen that there are two main attributes that have a high leverage on the sustainability of the Rumbio customary forest. They are the diversity of flora and fauna species in which the sustainability value was 5.83, and the availability of seedlings to support planting in the forest in which the value was 5.72. Considering the two main leverage attributes that make sustainability in the ecological dimension, both of these attributes play important roles in determining the sustainability condition of Rumbio customary forest management.
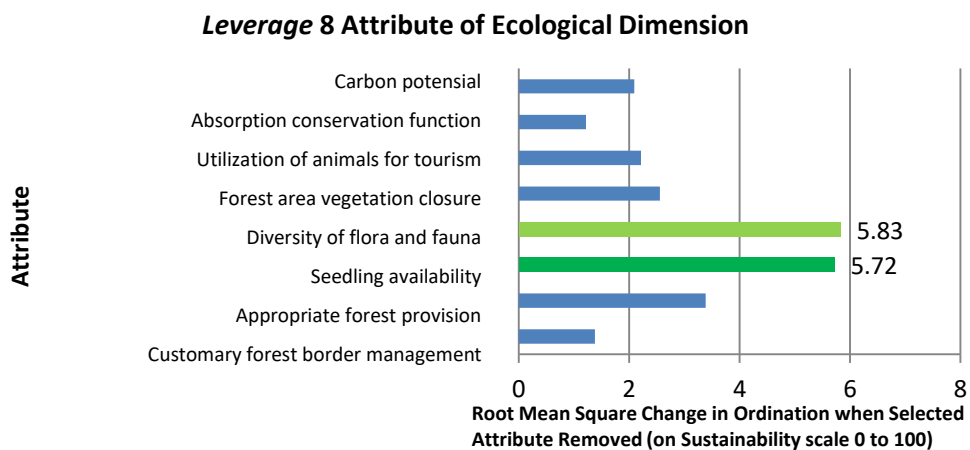

Fig. 4 Leverage Attribute Analysis Findings of Ecological Dimension

The diversity of flora and fauna in the forest area is the main indicator that influences the current sustainability condition. This indicator needs to be considered because the existence of flora and fauna is an important part of the balance of the ecosystem in the forest area. A community that is physically and biologically disturbed will bring an impact on the diversity of species or individuals, which gives a tendency for high species diversity [10].

Dealing with customary forest rehabilitation, people of a community, in some cases, often use seeds that are available in nature. This seed availability indicator contributes a fairly high value to the sustainability condition of the customary forest management plan in the ecological criteria that

reaches > 50%. The category is fairly sustainable. The procurement of seeds guarantee is a major support in the preservation of the customary forest areas.

3.3 Economic Dimension

Based on the analysis using MDS RAPFOR on 9 attributes that affect the economic dimensions of *Kenegerian Rumbio* customary forest management, it can be seen that the index value of economic dimension sustainability is 48.55. The value is in the range of 25.01 - 50.00. It means that it is less sustainable (see Fig. 5).
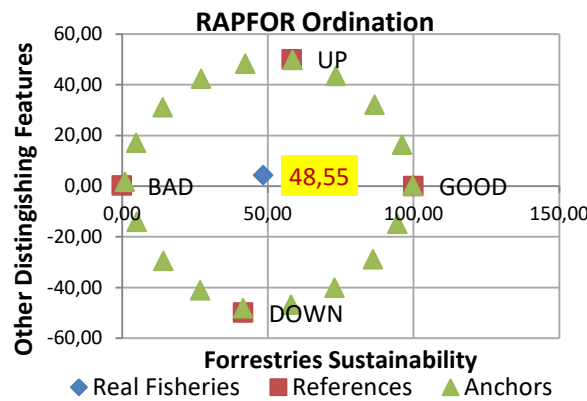

Fig. 5 Sustainability condition of economic dimension

Based on the analysis of leverage Fig. 6, of the 9 attributes analyzed, there are three main attributes that have a high leverage on the sustainability. They are the attribute of the number of poor people in which the sustainability value was 8.30, government budget attributes for customary forests in which the sustainability value was 8.18 and attribute tourism

potential in which the sustainability value was 6.78. Considering the three main lever attributes above that make sustainability in the economic dimension, the three attributes need to be considered in determining the sustainability condition of *Kenegerian Rumbio* customary forest management.
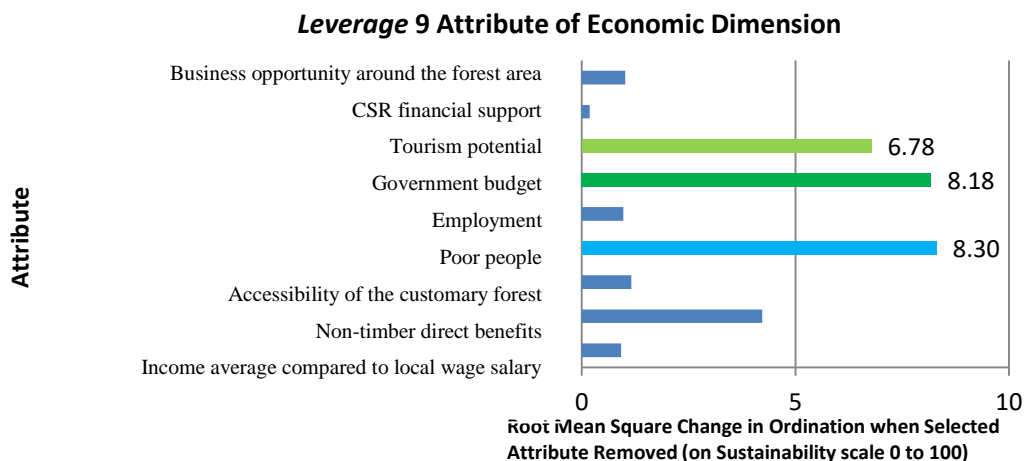

Fig. 6 Leverage analysis findings for each attribute in the economic dimension

Some findings revealed the poor condition of the community by the forest. Such condition still take place. It can be seen from number of critical land around the forest that are not cultivated yet. In addition, the amount of incentives provided by the government for communities by the forest is not sufficient. The program that can be offered is to give a role to the community to cultivate critical lands by the forest. It can be implemented by empowering community based forest management (CBMF). Incentives can be provided by giving technical assistance and opening markets for non-timber forest products.

The potential regarding a place of interest and number of tourist visiting the forest also determine the sustainability of *Kenegerian Rumbio* customary forest management. Some spots in the forest are very suitable to be used as a tourist object. Historical tourism is also potential there. In addition, fruits are available almost throughout the year. So, places of interest can attract people to visit the customary forest.

Regarding financial aid, Kampar local government set a budget for the forest conservation. One of the biggest private company in Riau PT RAPP took a part to provide financial aid for the forest. The local government together with IPB (Bandung Institute of Technology) in 2015 carried out a study and designed a *Kenegerian Rumbio* customary forest zoning master plan. In order to realize the idea, a lot of financial aid is required to provide a variety of supporting facilities from the tourism office. The customary forest should also be promoted both in domestic and international level. Other parties should take a part in the promotion since people of *Rumbio* community cannot handle the promotion.

3.4 Sociocultural Dimension

The findings of the analysis by using MDS Rapfor on 9 attributes that affect the social dimension of *Kenegerian Rumbio* customary forest management revealed that the index value of the social dimension of *Kenegerian Rumbio* customary forest management is 60.41. The value is between 50.01–75. In other words, the sustainability condition is fairly sustainable (see Fig. 7).

The leverage analysis of Fig. 8, on 9 attributes analyzed revealed that there are two main attributes that have a high leverage on the sustainability of *Kenegerian Rumbio* customary forest management. They are the conflict management attribute in which the sustainability value was 4.41 and the local cultural practice attribute in which the sustainability value was of 3.96. Considering the two main leverage attributes that make sustainability in the socio-cultural dimension, both attributes need to be considered in determining the sustainability condition of *Kenegerian Rumbio* customary forest management.
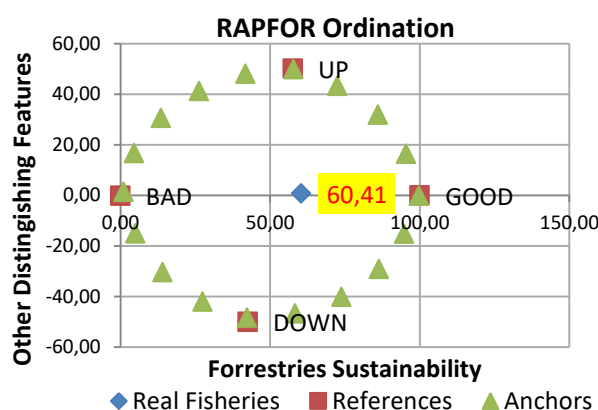

Fig. 7 Sociocultural dimension sustainability condition

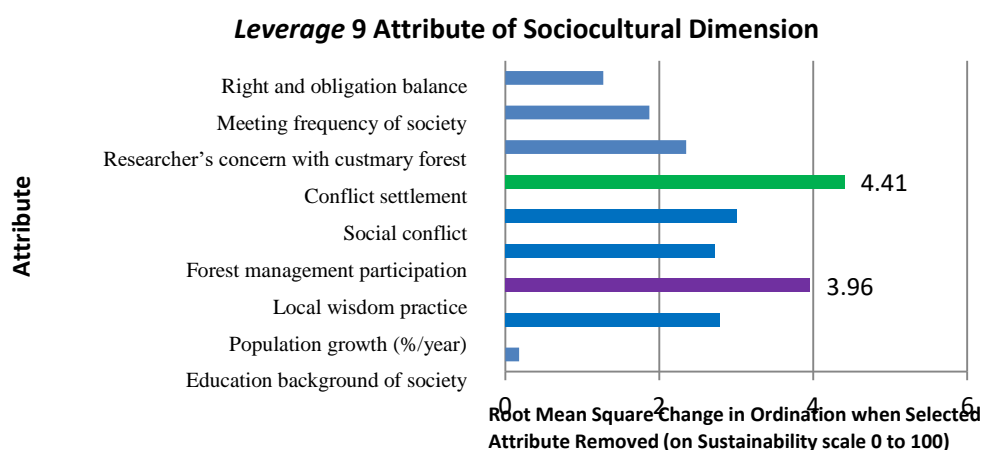**Leverage 9 Attribute of Sociocultural Dimension**

Fig. 8 Findings of the leverage analysis of each attribute on the sociocultural dimension

Problem solving in *Kenegerian Rumbio* traditional institutions was carried out in a discussion between *ninik mamak* and his apparatus. Even a very big problem must be resolved through a process of consultation with *ninik mamak* first. He has a great responsibility towards people in his community. He is like *kayu besar di tengah padang* (a big tree in the middle of the field. As a wise person in the community said that *ninik mamak* is *"Urat tempat duduk, batang tempat bersandar, dahan tempat bergantung, daunnya rimbun tempat berteduh ketika kepanasan, tempat berlindung ketika kehujanan oleh anak kemenakan"* (*ninik mamak* is simply a problem solver that all people in his community rely on him regarding solving problem).

The local cultural wisdom is also practiced in *Kenegerian Rumbio* customary forest. People must not an activity that might damage the function of the forest as a water source or can make environmental sustainability broken [11]. The local wisdom is implemented by people around *Kenegerian Rumbio* customary forest in protecting the customary forest. The local wisdom is a kind of prohibitions that are obliged by people around the forest. Based on the local wisdom, people must not cut down trees, must not take the benefits of forest products without the agreement of *nink mamak*, must not use forest products excessively, must not sell forest products from the customary forest, must not enter the forest without agreement of *ninik mamak*, must not behave arrogantly when being in the forest, must not hunt

fauna, must not harm anything, must not pronounce bad words in the forest.

People around the customary forest also implement a proverb *tangan mencencang, bahu memikul* applies tight hands. It means that any person must be responsible for what he or she does. Regarding the local wisdom, more appropriately referred to the traditions that exist in the community in which any action or activity action is adjusted to the rules that exist in the community itself [12].

Several cases of community forest management, local wisdoms bring positive impacts on forest sustainability because people in the community depend on the forest [13]. Therefore, the utilization of the forest leads to the sustainability of the forest. Local people have a great motivation and obtain the most valuable incentives to protect the forest compared to other parties because they rely on the forest for their live. People around Rumbio customary forest also have a great motivation to protect the forest [14].

3.5 Legal/ Institutional Dimension

Findings of analysis by using MDS Rapfor on 10 attributes that affect the legal / institutional dimension of Rumbio customary forest management revealed that the sustainability index value of the legal / institutional dimension of Rumbio customary forest management is 61.13. The value is the interval of 50.01 - 75.00. Therefore, the sustainability condition is fairly sustainable (see Fig. 9).
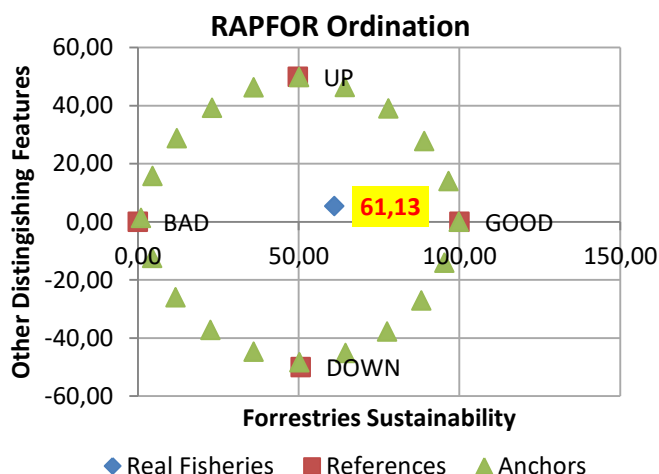
Fig. 9 Legal/ institutional dimension sustainability

Based on the analysis of leverage Fig. 10, from 10 attributes analyzed, there are two main attributes that have a high leverage on the sustainability of *Rumbio* customary forest management. They are the institutional capacity attribute and individual members in which the sustainability value is 3.96, and then the institutional involvement community attribute in which the value is 3.61. Considering the two main lever attributes that make sustainability in the legal / institutional dimension, both of these attributes play an important role in determining the sustainability condition of *Rumbio* customary forest management.
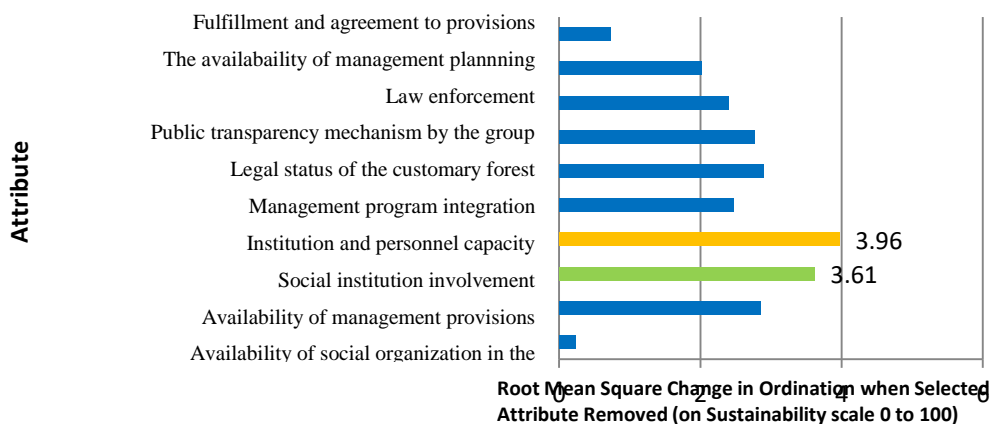

Fig. 10 Leverage analysis findings of each attribute of legal/ institutional dimension

In order to manage the customary forest, customary provisions are stipulated and promulgated in customary deliberations. In the customary institutional structure in Kenegerian Rumbio, there are 10 tribal leaders. They are representatives of four tribes (Domo, Putopang, Piliang, Chaniago and Kampai). In the customary structure, *ninik mamak* in Kampar regency from the lowest to the highest level have certain authority and responsibility to solve internal problems. If and when the problem cannot be resolved, *ninik mamak* deriving from a lower level may ask for consideration from the *ninik mamak* of a higher level. However, *ninik mamak* from a higher level must not interfere *ninik mamak* affairs of the lower level unless requested.

In line with the principles of *tali bapilin tigo, tigo tungku sajoghangan*, *Kenegerian Rumbio* customary institution needs to equip itself to be a reliable informal institution. The institution shall establish cooperative relations with the government. A local non-governmental organization called Yayasan Pelopor Sehati consisting of Rumbio local people was appointed by the *ninik mamak* to be the Secretariat of *Kenegerian Rumbio* customary institution.

3.6 Stress Values and Determination Coefficients

The ability of each attribute to explain and contribute to the sustainability of the system in this study can be

seen from the value of the coefficient of determination (R^2) of each analyzed dimension. The stress value and the coefficient of determination of each dimension are presented in Table 4.

Table 4. Stress value and determination coefficient on MDS rapfor findings analysis

Dimension	Index MDS	Stress	R^2 (%)	Iteration
Ecological	57.00	0.14	0.9466	2
Economic	48.55	0.14	0.9418	2
Sociocultural	60.41	0.14	0.9490	2
Legal/ Institutional	61.13	0.14	0.9485	2
Average	56.77	0.14	0.9465	2

Source: Primary data of 2019

Table 4 shows that the average stress value of the dimension is 0.14 and the average R2 value is 94.65%. In Rapfish, stress value is classified well if the value is below 0.25. It means the value of goodness of fit in MDS which states that the configuration of attributes can reflect the original data. R2 value of 0.9465 revealed that the attributes or factors assessed in each dimension are able to explain and contribute 94.65% to the sustainability of the system. Kavanagh (2001) stated that R2 value is categorized well if the value is more than 80% or close to 100%.

3.7 Impact of Error
Evaluation of the influence of random errors by using Monte Carlo analysis aims to find out: (a) the impact of making errors in attribute scores, (b) the impact of variations in scoring, (c) the stability of the repetitive MDS analysis process, (d) errors in inputting data or missing data, and (e) the value of stress is accepted if the value is <20%. The findings of the Monte Carlo analysis of all dimensions are presented in Table 5.

Table 5. Monte carlo findings analysis for each rapfor dimension of confidence interval of 95%

Dimension	MDS Rapfor	Monte Carlo (MC)*	Error (MDS – MC)
Ecological	57.00	56.23	0.77
Economic	48.55	48.03	0.52
Sociocultural	60.41	59.52	0.89
Legal/ Institutional	61.13	60.21	0.92

confidence interval error of 95%

The Monte Carlo analysis shows that the value of the sustainability index for customary forest management at a 95% confidence interval shows that the Rapfor analysis between MDS and Monte Carlo analysis did not experience a significant difference.

3.8 Kite Diagram
A kite diagram below shows the index position and multidimensional sustainability condition of Rumbio customary forest management. The diagram shows that there are two dimensions of customary forest management which have almost the same influence on customary forest management. They are the institutional legal dimension and the sociocultural dimension. In addition, there is one dimension that is less influential on the sustainability of customary forest management. Kite diagram can be seen in Fig. 11.
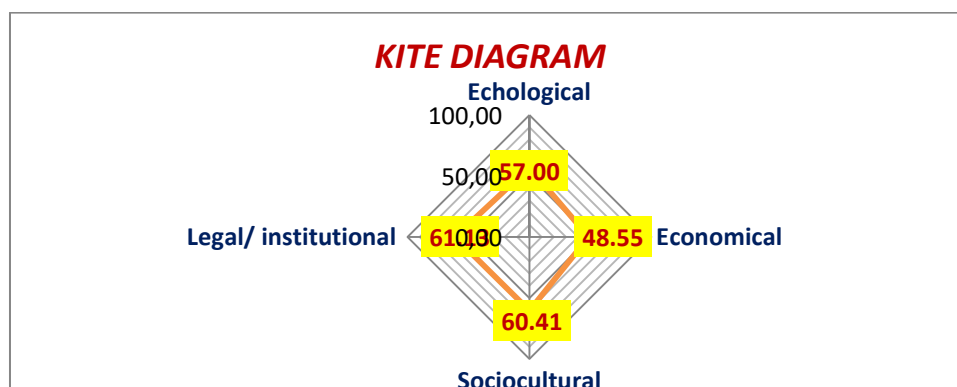

Fig. 11 Index analysis and sustainability condition in kite diagram

3.9 Prospective Analysis

The findings of the Raporest analysis revealed that there are 9 key attributes which are sensitive and they have the highest influence/role on the sustainability of Rumbio customary forest management. The nine attributes include; ecological dimension (2 attributes), economic dimension (3 attributes), sociocultural dimension (2 attributes), and institutional legal dimension (2 attributes).

The nine leverage attributes are then assessed to find out the level of influence among them, both directly and indirectly. The assessment is carried out because there is a relationship between each attribute in the management of the customary forest. The relationship between these attributes can be in the form of influence or dependency between attributes. Prospective analysis findings are presented in Fig. 12.

Based on the findings analysis, it can be seen that there are five factors which have a very high influence on the sustainability of Rumbio customary forest management. The five factors consist of one main determinant of success (input factors) and four factors connecting/supporting the success (stakes factors). One key factor determining the success of Rumbio customary forest management is the institutional capacity.

The determining factors (input factors) in quadrant I are the institutional capacity factors. These factors have a great influence in determining the success of Rumbio customary forest management. In addition, these factors are not influenced by other factors in the system. From these findings, it can be seen that the success of Rumbio customary forest management is determined by the support of institutional capacity as an input factor, while the government budget, institutional involvement, tourism potential, local wisdoms are the connecting factors.
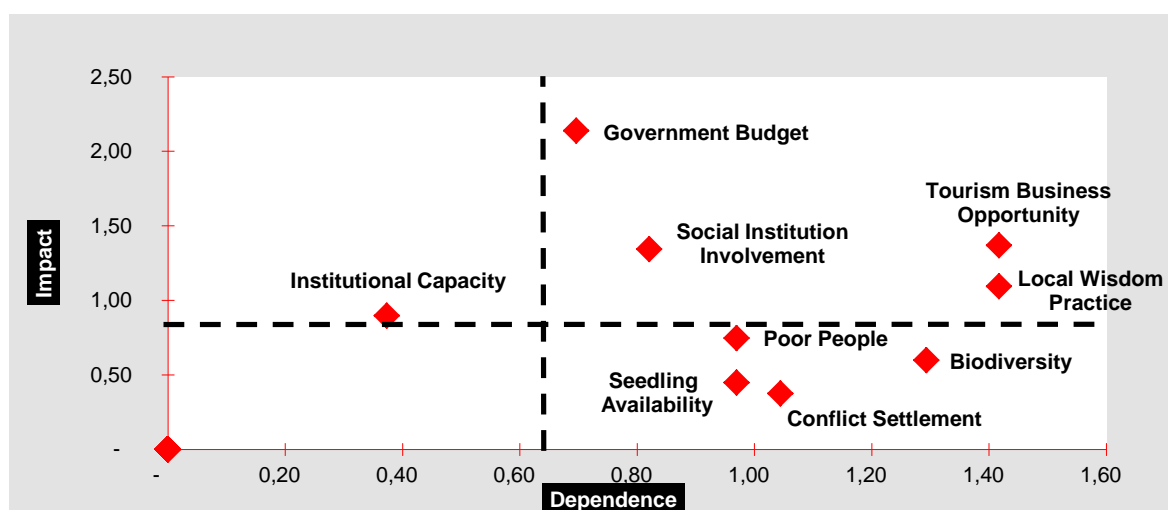

Fig. 12 Overview of significance level of factors influencing the assessed system

4 Conclusions

The findings of overall Rapfor analysis revealed that the value of sustainability condition is 57.31% which is categorized as fairly sustainable in which ecological dimension value is 57.00%, the economic dimension value is 48.55%, the social cultural dimension value is 60.41%, and legal/institutional dimension value is 61.13%). These conditions show that the Rumbio customary forest management is fairly good. The driving variables of the sustainability of Rumbio customary forest management include; the institutional capacity factors, government budget factors, community involvement factors, tourism potential factors, and local wisdom factors.

5 Suggestions

It is important to assure the sustainability condition of the Rumbio customary forest management in which the value of sustainability is in fair sustainable category. In order that these four dimensions become sustainable, it is necessary to improve the 5 driving variables of the sustainability of Rumbio customary forest management.

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