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MULTIASPECT SUSTAINABILITY ANALYSIS
(THEORY AND APPLICATION)

IRMAN FIRMANSYAH[1]
[1]Exsimpro Software; E-mail : irmanf@gmail.com

ABSTRACT

Multiaspect Sustainability Analysis can be used in various scientific fields, including social, economic, environmental, development planning, and other multidisciplinary groups and other assessments that are still abstract to be included in multi-aspect sustainability analysis. The principle used is Rapid Appraisal Process/Procedures, where respondents are not the number of samples but are in the form of key stakeholders/key persons who can be discussed with in-depth interviews or through observation and Focus Group Discussions. Several stages in applying Multiaspect Sustainability Analysis are analysis stages, namely the aggregate status value, the aspect status value, the future possibility value (future condition), the status value ordination, the aspect driving factors (leverage factor), uncertainty error, validation with random iteration, and policy priority scenarios. Scenario selection can be done on Multiaspect Sustainability Analysis based on the status values that appear. Apart from the scenario value, the leveraging factor is also the basis for the scenario analysis that is raised. If the researcher wants to do a tiered scenario analysis (moderate scenario, optimistic scenario, and progressive scenario) the researcher can determine it by choosing the number of scenarios and driving factors to be analyzed.

Keywords: Sustainability Analysis, Performance, Indicator, Scenario, Decision Support System

I. INTRODUCTION

In making a strategic policy based on planning and evaluation, it needs an approach to assessing the status of current conditions. This step is carried out to see the level of success of the program that we make. Planning needs to look at the status or value of performance in existing conditions, so that future planning has better results than current conditions. While in use for evaluation, it can be seen by assessing the condition of the status or performance which must be better than the previous condition assessment. Sustainability that is based on tiered planning and evaluation will continue to improve its status, performance, and future performance. Sustainability analysis with Multiaspect Sustainability Analysis (MSA) can be used for this purpose both for planning and evaluation. MSA can be used in various scientific fields, including social, economic, environmental, development planning, and other multidisciplinary groups, and assessments that are still abstract can be all included in multi-aspect sustainability analysis. In this assessment, certain standards can be used or even other standards can be created in each particular case.

Sustainability analysis can provide good, fast, effective, and efficient decisions, with multi-aspect considerations (Multiaspect Sustainability Analysis or MSA) is very easy to do quickly because it uses and applies the principle of RAP (Rapid Appraisal Process/Procedures), where the allocation of financing is certainly more economical if using this RAP method. For example, to get information about the condition of pollution of irrigation or river, it is not necessary to take water samples but it can be asked with the agency that always routinely observes the quality of the water so that the status of the pollution can be quickly known. RAP is a form of qualitative research used by sociologists, anthropologists, and psychologists phenomenologically since 1980. Sampling in the RAP was carried out on a small number of respondents called key informants or key stakeholders. The selection of respondents was carried out purposively according to the problem and research objectives.

RAP is an assessment method that is classified in qualitative research but in its development, it becomes a broad Rapid Appraisal Process and adds quantitative methods in its stages such as rapid surveys. In this research and assessment, we need a method or technique that is fast, and relatively inexpensive but still pays attention to scientific rules to answer the why and how of the existing data. Some of these methods are Rapid Assessment (RA), Rapid Survey (Quick Survey), and Rapid Evaluation Method (REM) which are in principle different but each can complement the other. The Rapid Appraisal Process (RAP) is a quick assessment method to obtain in-depth information about what is behind people's behavior including socio-cultural factors in a relatively short time. Data collection techniques that are generally used in RAP are in-depth interviews conducted on individuals as expert respondents and Focus Group Discussions (FGD) on groups of people or observations. The information obtained from this research is in the form of words whose meaning is interpreted through Content Analysis. RAP is used as a data collection method, some problems may be difficult to explain with quantitative research, so the Rapid Appraisal Process is the method of choice for data collection which is a Complementary Approach to understanding other research methods and not a substitute for these methods. The RAP is implemented to complement and verify both quantitative and qualitative data.

However, in its implementation there are important things from the successful implementation of this RAP, it is an adequate understanding and methods for evaluators. Experience has shown that a successful RAP program requires (i) evaluators with prior training in the field/study concerned, (ii) specific skills and improvisation in RAP techniques, and (iii) spontaneous follow-up support and input when evaluators begin fieldwork.[8] Sustainability is also a way that can be done by rearranging the conditions of life; reviewing the economic sector; or work practices, which use science to develop new technologies (such as green technology, renewable energy, and sustainable development); or designing systems flexibly and reversibly [4] and adapting individual lifestyles by conserving natural resources or existing resources.[1]

II. CONCEPTUAL FRAMEWORK OF MSA

Multi-aspect Sustainability Analysis is used to find the value of sustainability status, performance index, or performance index of activity, place, activity, institution, or company in the context of self-assessment or assessing conditions and descriptions, to know the strategies that must be carried out in the future. This assessment is also called a rapid assessment because it uses an existing database submitted through selected experts or respondents who meet the criteria. Then this assessment can be upgraded at any time if there are new data or conditions without having to re-analyze with the latest formulation or build a new model. The conceptual framework for the MSA approach is shown in Figure 1.

The database used in the multi-aspect sustainability analysis (MSA) is data that comes from desk studies, judgment results from experts who are in charge of or competent in the field of study or research that is being carried out, and can also come from experts in FGDs. From the desk study analysis, the factors and indicators that will be used are scientifically based, in the form of journals, papers, books, research results and other scientific varieties.

Meanwhile, the results of the FGD can be in the form of expert concepts related to the variables to be used. The results of the literature study and expert judgment will produce aspects, factors, and indicators that will be used to assess status or performance. The assessment was carried out by expert respondents, the number of respondents can be adjusted according to the study conducted. The number of respondents does not have to be large, but rather those who know or are competent in the field being studied, because this Multiaspect Sustainability Analysis is based on expertise. These respondents are not the number of samples but are in the form of key stakeholders/key persons who can be discussed with in-depth interviews or through observation and Focus Group Discussions, while the number of expert respondents should be odd to anticipate the selection of mode values. The assessment technique is carried out by selecting indicators according to actual conditions or based on expert judgment. In addition to assessing the existing condition, an assessment of future conditions can also be carried out. Assessment of future conditions will help in describing what scenarios need to be taken for the sustainability of the status of an organization.

The value that has been used will then be taken in mode (the value that often appears), and then processed into several outputs. The output generated in the MSA analysis is the status index and leverage factors, random iteration, and uncertainty error. Furthermore, the leverages are driven to carry out the desired scenario, so that the scenario can be developed into a policy or strategy in building the organization for the future.

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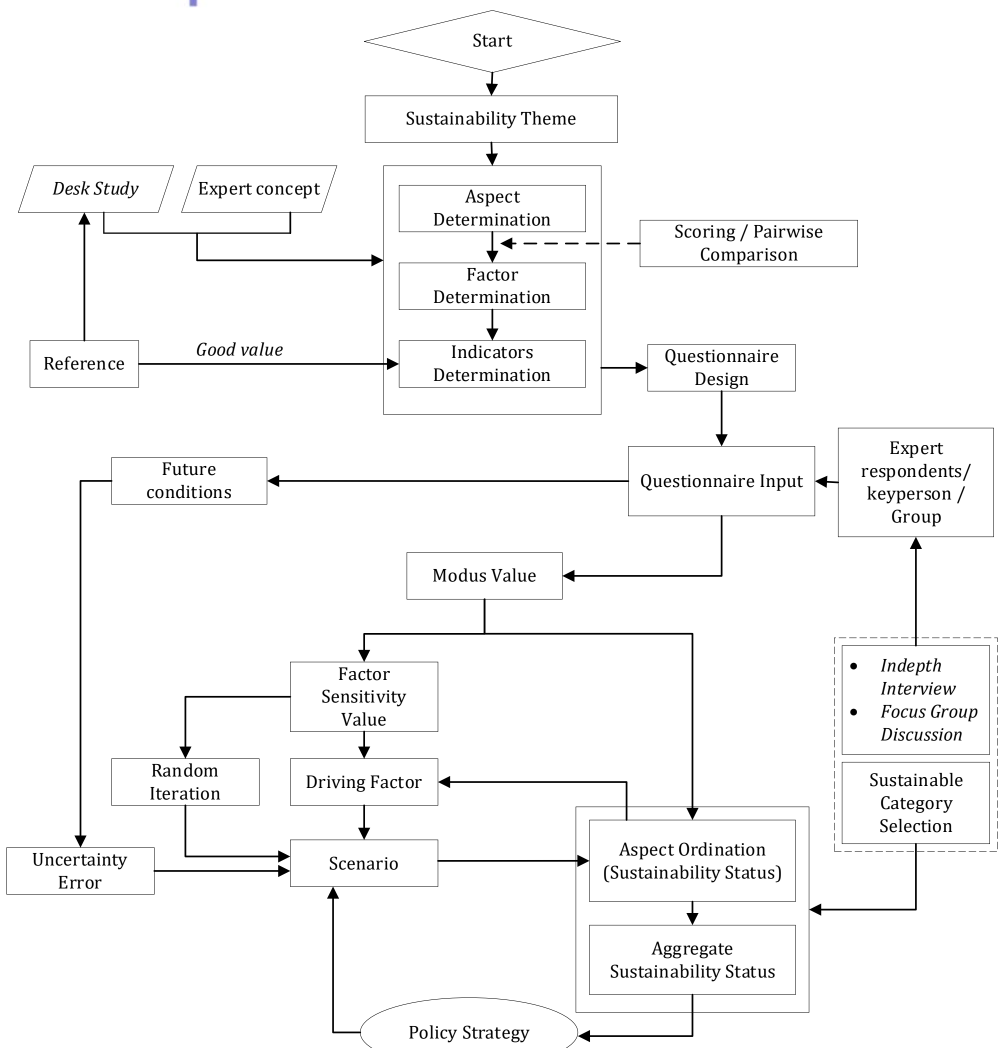

Figure 1. Conceptual framework of the Multiaspect Sustainability Analysis approach

III. SUSTAINABILITY STATUS VALUE AND BASED-ON ASPECTS PERFORMANCE

According to the triangular conceptual framework of sustainable development, development activity is declared sustainable, if the activity is economically, ecologically, and socially sustainable.[6][9] The term 'sustainability' can be defined as a socio-ecological process characterized by the achievement of the same ideals[8]. In more general terms, sustainability is the durability of a system and process. The organizing principle of sustainability is sustainable development, which includes four interconnected domains, namely ecology, economy, politics, and culture[3]. However, in its development, these aspects develop according to the needs of the study, which can be more than 3 aspects of sustainability. Many methods have been developed to assess sustainability.[9] Assessment can be done, for example through life cycle assessment [7] ecological footprint analysis, and land use sustainability.[2]

The value of sustainability and performance is determined from the aggregate calculation of each aspect. This value can be in the form of an aggregate average or an aspect value that has been multiplied by the pairwise comparison. Generally, this value has a range between 0%-100%, whereas on the X-axis getting closer to 100% means that the value has a better status or performance. while a value close to 0% means it has a worse value. On the other hand, there is a value that can be seen whether future conditions increase or decrease. If the value on the Y axis has a value of 50% or above, close to 100%, it means that future conditions tend to increase, while if it has a value below, close to 50% or close to 0%, it means that future conditions tend to decrease. The grouping of status values has several criteria options, ranging from 2 criteria to 5 criteria used. The assessment can be adjusted to the needs of the grouping of criteria and it can also be developed according to the needs of both the score level and the naming of the criteria. The grouping of these criteria in detail is presented in Table 1.

Table 1. Grouping of Criteria in Status Assessment

Status Value Criteria	Status Naming		Status Color (Map)
	Sustainability	**Performance**	
2 Criteria			
0-50	Unsustainable	Bad Performance	Brown
>50-100	Sustainable	Good Performance	Dark green
3 Criteria			
0-33	Unsustainable	Bad Performance	Brown
>33-66	Moderate Sustainable	Moderate Perfotrmance	Light green slightly yellow
>66-100	Sustainable	Good Performance	Dark green
4 Criteria			
0-25	Unsustainable	Bad Performance	Brown
>25-50	Low Sustainable	Low Performance	Orange
>50-75	Sustainable	Moderate Performance	Light green slightly yellow
>75-100	Very Sustainable	Very Good Performance	Dark green
5 Criteria			
0-20	Unsustainable	Bad Performance	Brown
>20-40	Low Sustainable	Low Performance	Orange
>40-60	Moderate Sustainable	Moderate Performance	Yellow
>60-80	Sustainable	Good Performance	Light green slightly yellow
>80-100	Very Sustainable	Very Good Performance	Dark green

The naming of the status can be adjusted according to the criteria of the status, for example ranging from unsustainable to very sustainable, ranging from poor performance to very good performance. Even the adjustment of status naming criteria is by existing standards, both based on regulations, SOPs, and minimum service standards, which of course would be better if based on the existing literature in the assessment. In some other cases, it can be applied to regional sustainability, agriculture, fisheries, forestry, mining, and other sectors including in assessing the performance of an institution or company as well as a school or university.

IV. THE FORMULATION AND APPLICATION OF MSA

In the calculation, the status value for sustainability or performance will appear with several stages of calculation and an assessment of the status value, future condition value, driving factor, uncertainty value, and error validation of the opinion. The formulas used in the calculations are described one by one.

- Aggregate status value

  The aggregate status value is the average of the status values in each aspect. This value can be obtained from the average directly on the status value of each factor. On the other hand, it can also be obtained from the factor status value which has been multiplied by the weighted value or pairwise comparison assessment between factors. The aggregate status value has the following formula:

$$Y = \frac{y_1 + y_2 + y_3 + y_4 + \cdots + y_n}{n} = \frac{\sum y_n}{n}$$

Where :
Y = status value (sustainability/performance)
y = aspect status value
n = number of aspect

The calculation of the status aggregate value can also be obtained from the weighted value of the aspect by using a scoring with the following formula:

$$Y_c = \frac{ay_1 + by_2 + cy_3 + dy_4 + \cdots + my_n}{n} = \frac{\sum my_n}{n}$$

Where :
Y_c = status value (sustainability/performance) with comparison value (weight value)
y = aspect status value
m = weight value on aspect
n = number of aspect

In addition to the scoring value, the choice of weighted values can be used by using pairwise comparisons. The description of the aggregate status values from the simulation results can be seen in Table 2.

Table 2. Aggregate Status Values from Aspect

No.	Aspect	Existing	Scenario 1	Scenario 2
1	Social	63.4	82.66	97.03
2	Economic	32.39	45.34	58.3
3	Environmental	50.11	56.69	64.68
4	Infrastructure & Technology	56.05	65.55	72.68
5	Legal and institutional	76.14	95.29	100
Total Average		55.62	69.11	78.54
Status Sustainability		Moderate Sustainable	Sustainable	Sustainable

- <u>Aspect status value</u>

The status value on the aspect is depicted in the ordinance visualization as a value on the x-axis, which is obtained from the mode value in the indicator assessment divided by the highest indicator value (good) on each factor, which then calculates the average of all these factors. The formula for calculating the status value in these aspects is as follows:

$$y = \frac{y_{f1} + y_{f2} + y_{f3} + y_{f4} + \cdots + y_{fn}}{fn} \; x \; 100\% = \frac{\sum y_{fn}}{fn}$$

$$y_{fn} = \frac{Mo.fn}{Gfn}$$

Where :
y = aspect status value
yf = aspect factor
Mo = modus value on factor
G = the highest score (good) on the factor of the indicator assessment
f = factor value

The G value is taken from the highest value or the best value (good) on the factors of the assessed indicator, while the mode value (Mo) is taken from the value that appears the most based on the expert respondent's input. The results of the comparison values between aspects and scenarios can be seen in Figure 2. This figure shows the scenarios that experienced significant changes from each aspect as well as the aspects that had the least good or unsustainable performance.

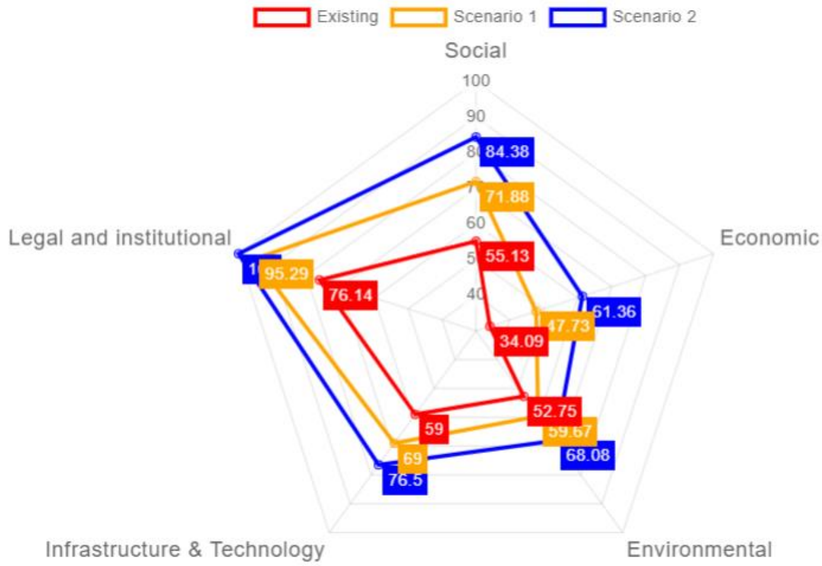

Figure 2. Status values between aspects

The more dominant visualization regarding the achievements of each aspect is shown in the form of a polar diagram, so this can also be applied to the SDGs (Sustainable Development Goals) assessment to make it easier to see the achievements of each aspect as presented in Figure 3.

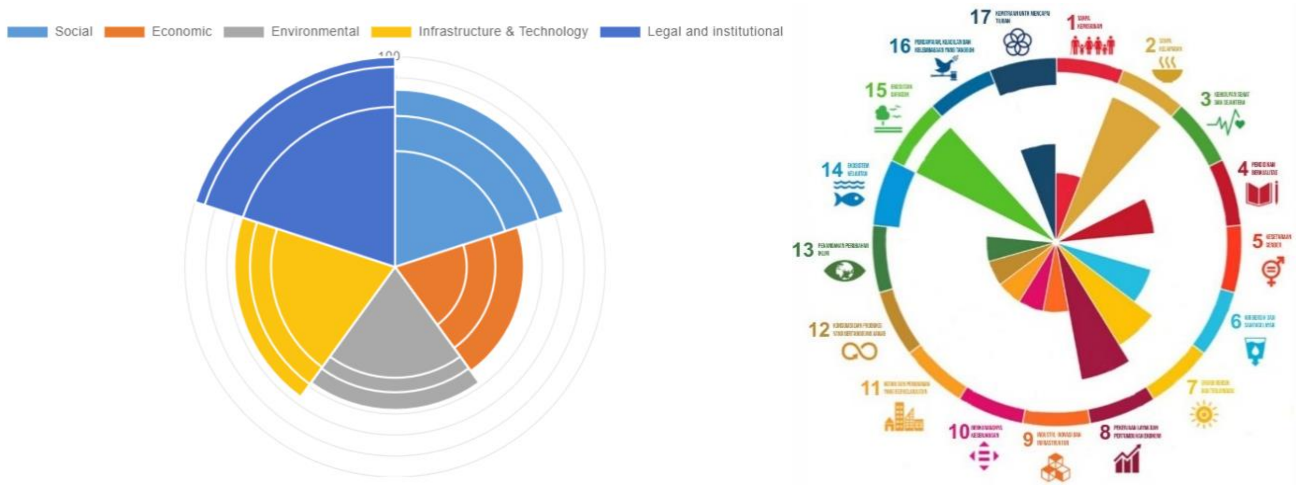

Figure 3. Status value with polar diagram

- <u>Possible Value in the future (future condition)</u>

  This value describes the possibility of the factor in the future, whether in general there will be an increase or decrease. But the number of assessments of the possibility or decrease will cause a higher uncertainty value. From this assessment, to strengthen the results it needs to see the value of uncertainty (uncertainty error) as well. To calculate the value of the future condition that describes the position on the visualization, the ordinance is represented by the y-axis. Where the formula calculates the value of factor conditions in the future as follows:

$$Fc = \frac{MoC_1 + MoC_2 + MoC_3 + MoC_4 + \cdots + MoC_n}{n} \; x \; 25$$

Where :
Mo = modus value
C = future condition value on factor

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The values include 0 (strongly decreasing), 1 (decreasing), 2 (fixed), 3 (increased) and 4 (highly increased). The value of 25 as the standard is multiplied to normalize to a value of 100, because the highest future condition value is 4, so if it is equalized with a value of 100, it needs to be multiplied by 25. The value of future possibilities is limited to the assessment of the factor, if the factor value already has the highest value (good) then the scenario in the future condition cannot be increased, and vice versa if the factor value already has a low value (poor) then the scenario in the future condition cannot be lowered again. The results of status values on aspects and possible future values are seen in the ordinance as presented in Figure 4.

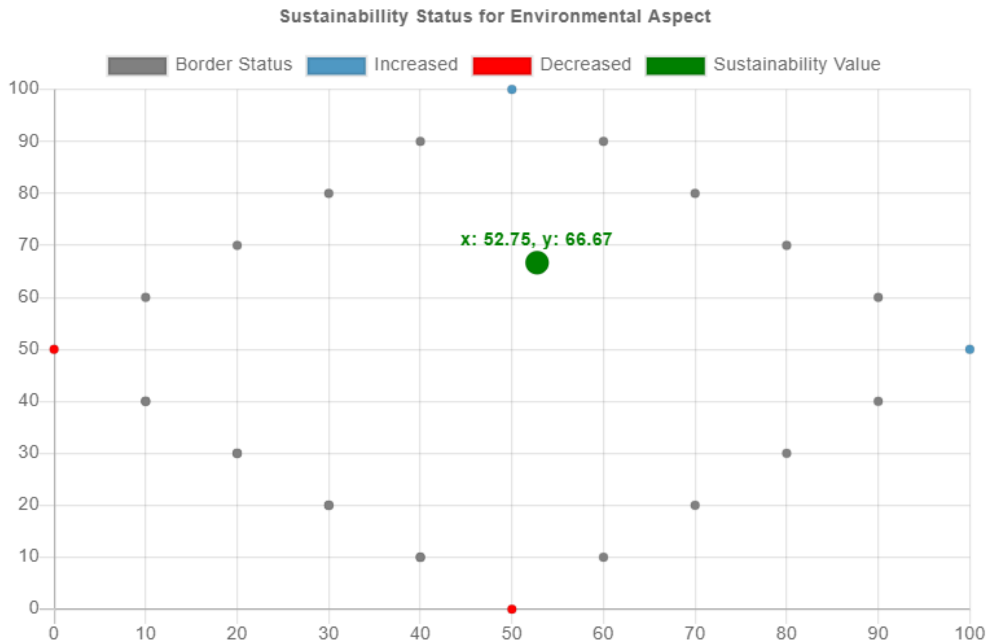

Figure 4. Status value in future aspects and values

Based on the picture of the sustainability status value, it can be seen that the value for environmental aspects is 52.75, which is indicated by the x-axis on the ordinance diagram, this is in the category according to what has been determined. For example, here are made 5 categories so that it is categorized as quite sustainable. On the y-axis with a value of 66,67, it shows that this environmental aspect is likely to increase in performance or status in the future if business conditions are as usual as currently, even without any intervention. For the assessment of future conditions, better describes the changes that may occur in the future, using an assessment of greatly increasing, increasing, constant, decreasing, and greatly decreasing. This assessment is quite easy but the more inclined to large changes such as greatly increasing and greatly decreasing, then this causes greater uncertainty as well. The value of future conditions certainly has uncertainty, the value of this uncertainty should not be more than 10% or should not exceed or be outside the border.

- Status Value Ordination

After obtaining the status value, to strengthen the conditions and the selection of policy scenarios, it needs to see beforehand the mapping of conditions based on the status value in the ordinance that has been generated. There are several conditions based on the ordinance such as good, priority, important, urgent, bad, and unlogic. The distribution or status position based on conditions has an order of importance as presented in Figure 5.

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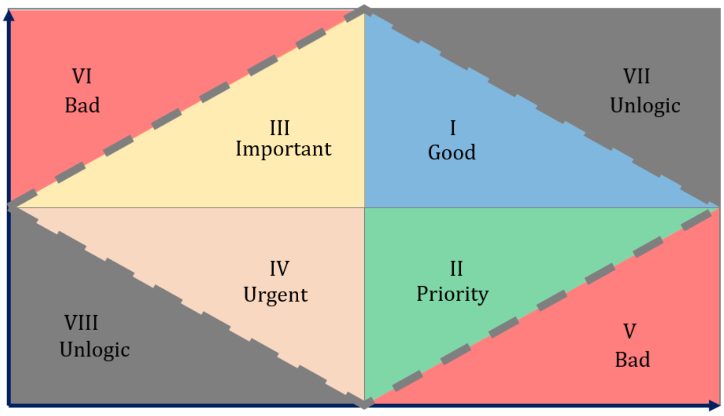

Figure 5. Determination of Conditions Based on Ordination

From the picture of the determination of conditions based on ordination, it can be seen that each condition is assessed as follows:

- Group I with good condition, as a condition that is highly expected because it has a good value with an x-axis value above 50 and there is a possibility of a better increase because it has a y-axis value above 50, so it needs to be maintained.
- Group II with priority condition, is an expected condition because it has a good value with an x-axis value above 50 but there is a possibility that a decrease can occur because it has a y-axis value below 50, so it needs to be supported.
- Group III with an important condition, as a less expected condition because it has a bad value with an x-axis value below 50 but there is a possibility of a better increase because it has a y-axis value above 50, so it needs to be taken first.
- Group IV with Urgent condition, as an unexpected condition, because it has a bad value with an x-axis value below 50 and there is a possibility of a worse decline because it has a y-axis value below 50, so it is very necessary to take a more major policy.

Groups V-VIII include groups that are not suitable because they have a high uncertainty value, so if conditions occur in this group, it needs to be clarified again to expert respondents, especially in future values, or it cannot be used because the bias is quite high. The description of these conditions is as follows:

- Group V with Bad condition, is an inappropriate condition because it has a high uncertainty bias, although it is still possible if there is a condition decrease. This condition has an x-axis value of more than 50 but the value of the y-axis exceeds the specified borderline.
- Group VI with Bad condition, is an inappropriate condition because it has a high uncertainty bias, although it is still possible if there is a decline. This condition has an x-axis value of less than 50 but the y-axis value exceeds the specified borderline. So this group is worse than quadrant V
- Group VII with Unlogic condition, is an impossible and inappropriate condition because it has a high uncertainty bias, even though it has an x-axis value of more than 50 but the y-axis value exceeds the specified borderline. In this condition, it is impossible to occur an increased value that exceeds the specified limit line.
- Group VIII with Unlogic conditions, is an impossible and inappropriate condition because it has a high uncertainty bias, especially having the x-axis value less than 50 and the y-axis value exceeding that specified on the borderline. In this condition, it is impossible to occur a decrease value that exceeds the specified limit line.

Thus, when making a policy sequence, apart from looking at the most sensitive factors, first choose a policy in the order of groups IV, III, II, and I, which means that the bad conditions need to be corrected first. If a condition occurs in quadrants V-VIII, it is necessary to correct the opinion of the expert judgment because the condition is bad or even illogical, this causes high uncertainty in the future.

- The driving factor in aspects (Leverage Factor)

These driving factors describe the factors that have the most influence on changes in status either in their respective aspects or aggregate status. The value of the driving factor is taken from the highest value resulting from the sum of the maximum sensitivity values added to the real sensitivity value. The formula for calculating the driving factor is as follows:

$$L = S_M + S_V$$
$$S_M = \frac{1}{Gfn}$$
$$S_V = (Gfn - Mofn)\ x\ S_M$$

Where :
L = leverage factor value
S_M = sensitivity maximum
S_V = sensitivity value
Mo = modus value on factor
G = the highest score (good) on the factor of the indicator assessment
f = factor value

The driving factor in the aspect is taken from the highest value of all the factors, and it still has the sensitivity value. An overview of the sensitive leverage is presented in Figure 6.

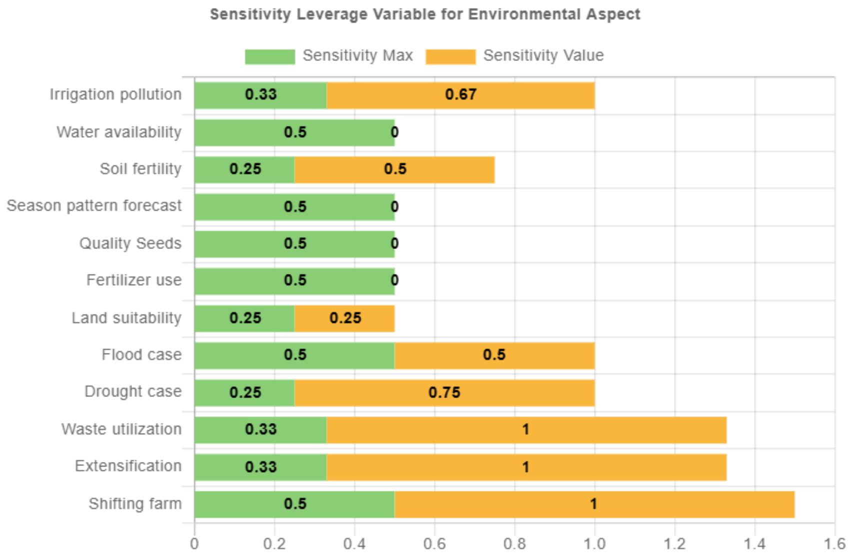

Figure 6. Driving Factors on MSA

The bar chart image of the driving factors shows the selected factor as the driving factor is the one that has the highest sensitivity and it is a combination of the maximum sensitivity value of the factor plus the sensitivity value. In the example shown, the leverage factor chosen is shifting cultivation because it has a value of 1.5 and is the highest. The maximum sensitivity shows where the factor has a maximum sensitivity of 0.5 with the highest value of 1, while the sensitivity value is illustrated in the sensitivity value bar chart, in the example above the highest sensitivity value is 1, where the highest value is also the largest. 1. The meaning of this value is that the sensitivity value is shown by the maximum sensitivity bar chart, while the value filled in (good or poor) is shown in the sensitivity value. If there are two or more bar charts with the highest max sensitivity, but there is no sensitivity value, then it cannot be taken as a driving factor because it is in good condition. In this case, the condition as a driving factor must have a sensitivity value, meaning that it is still in a condition that needs to be improved.

- Uncertainty error

This value is calculated to strengthen the estimated value of future conditions (future conditions). If the value is more than 10% it is possible to have high uncertainty, so the error value of this uncertainty should have a value of 10%. This value is generated when we generate and assess the condition of the factors in the future. The calculation of the future uncertainty error value is as follows:

$$U_Y = \frac{\sum U_{fn}}{n}$$
$$U_y = if\ (ABS(C-2)\ x\ 10\%)$$

Where :
U_Y = *uncertainty error aggregate*
U_f = *uncertainty error factor*
C = condition value that will arise in factors

The condition is expected to decrease in the future if the assessment is below the value of 2 or (if C < 2), and the condition is expected to increase if the assessment is above the value of 2 or (if C > 2) with a maximum value of 4 (highly increasing).

- Validation with Random Iteration

Validation on MSA (Multiaspect Sustainability Analysis) is calculated by looking at the random values that arise from the opinion value or mode value in factor assessment. It is important to do an assessment not only as a simulation value of factor status based on random values but also to see how far the deviations from the mode opinion value are. For example, the assessment of several expert respondents shows the mode value of 2 from the results (2,2,2,2,3,2,2) is certainly more accurate than (2,2,2,2,3,3, 3). It is even more inaccurate if the assessment is further away from the mode value, for example, the mode value of 2 with the highest value (good) is 5, and the mode value is obtained from (2,2,1,5,3,4,0). So that the mode value is not taken for granted because of course the more diverse the error value will be, thus the random value as validation needs to be raised. The more diverse, the wider the error range. The limit for the error value from random is 0.5 in absolute difference from the mode value, while the status limit for the difference is not more than 10%. This value is based on the standard of random status assessment based on the opinion of the expert respondent, because the error value for the respondent is only allowed to be 10% (Estimation Respondent Error).

Random iteration assessment can be repeated based on the existing iterations. The repetition can be several times from iteration 5, iteration 10, and iteration 20 times bring up the random value. The calculation of the error value in the simulation random iteration value is as follows:

$$P = \frac{fr}{\sum In}$$
$$K_n = P_{(n+(n-1))}$$
$$I_r = K_n x\ 100$$
$$A_{rn} = RIn\ (1{,}100)$$
$$SI_f = \sum if\ (A_{rn}; In)$$
$$\overline{SI_f} = \frac{SI_f}{RIn}$$

Where :
P = Probability
I_r = interval random
In = indicator value (start from 0)
fr = indicator value frequency
K = cumulative value
RI = random iteration
SI_f = indicator value simulation
$\overline{SI_f}$ = random simulation average of indicator values on factor

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The random iteration value is taken from the indicator assessment by the respondents (experts). It uses the frequency value of the number of indicator values that often appear by grouping the levels on the indicator values. The total number of frequencies will be equal to the number of respondents, which can then be calculated as the probability value of each of the existing indicators. After getting the probability value, the cumulative value of the probability is calculated so that the total will be 1, the grouping is done based on the level of the cumulative results per indicator. [5]

The number of iterations that you want to simulate by inputting a random value in each iteration will be adjusted according to the grouping of the cumulative level per indicator. The adjustment of the simulation results indicator values will appear based on the grouping of the cumulative level per indicator. Then it will get a simulation value that is close to the mode value by averaging the total simulation value that appears, thus obtaining a comparison value between the random value and the mode value. The calculation of the error value based on the random iteration will show the value of its validation status and the value of Estimation Respondent Error (E_r) by calculating using the following formula:

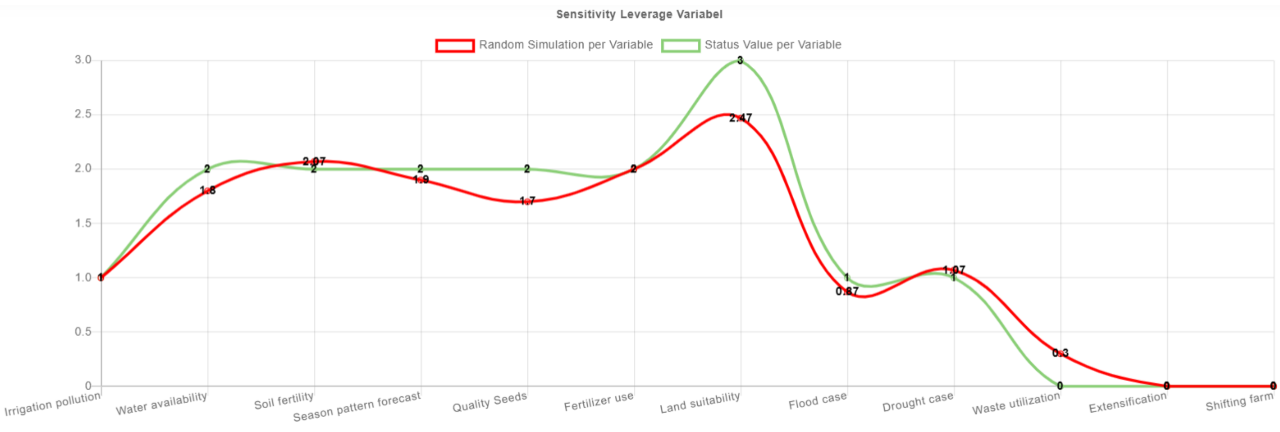
$$V_s = ABS\ (y_{RI} - y)$$

$$E_r = \frac{SI_f}{5}$$

Where :
V_s = Validation Status
y_{RI} = status value based on random iteration
y_n = number of aspect
E_r = Estimation Respondent Error

In the calculation of Estimation Respondent Error (E_r), it is divided by a value of 5. If the limit of the status value of the mode result and the status value based on the allowed random iteration is 0.5, then the limit value is considered as a limit of 10% which means it is equivalent to 0.1.

Random iteration describes the difference in the simulation value of the random value to the mode value on factors. The more diversity, the higher the difference in the mode value. This random iteration value will describe the comparison of each factor and the allowable difference of 0.5 from the existing assessment. The results of the random iteration simulation can be seen in Figure 7.



Status Real	52.75
Random Iteration Status	50
Status Validation	2.75
Estimation Respondent Error	0.55

Figure 7. Random Iteration Simulation Results

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Based on the simulation results, it can be seen that the status value simulation results are based on the random value between the two is calculated as the Validation status value, with a maximum limit of 5. In MSA, the bias value against the opinion of expert respondents is also calculated with the mode value of each factor, where this value describes the limits or ranges allowed for the difference in assessment, which is 0.5 from the opinion on the mode value so that the limit is normalized as the limiting value of 10%.

- Policy Priority Scenarios

Scenario selection can be made from the status value in the scenario results. Besides the scenario value, the leveraging factors also become the basis for the scenario analysis that is raised. If the researcher wants to do a tiered scenario analysis (moderate scenario, optimistic scenario, and progressive scenario) the researcher can determine by choosing the number of scenarios and driving factors to be analyzed.

Policy scenario selected validation is comparing scenarios 1, scenarios 2, and so on. If the scenario title has been adjusted and categorized, for example moderate, optimistic, and progressive, it means it compares the highest and most significant value to the changes. The value of scenario 2 must be twice or higher than scenario 1 and scenario 3 must be 3 times higher than scenario 1 when these scenarios are taken as the priority of choice. Meanwhile, if it is still lowered than the most likely and optimal scenario, then it will be better to take the previous scenario. An example of the calculation results is in Table 3. Calculation of the scenario priority value in the following way:

$$\Delta y_n = y_{sn} - y_0$$
$$\Delta Y = \overline{y_{sn}} - \overline{y_n}$$
$$P_{sn} = \frac{Y_n}{Y_1}$$
$$\frac{Y_n}{Y_1} > n$$

Where :
y = status value
y_s = scenario status value
Δy_n = the difference between the scenario status value and the existing status value
n = number of aspect
ΔY = difference between scenario value and aggregate status value
P_s = scenario priority
Y_n = the difference in the value of scenario n against scenario 1
Y_1 = existing value = 1

Table 3. Policy priority scenarios

Aspect	ΔS1S	ΔS2S	ΔS2S/ΔS1S
Social	19.26	33.63	1.75
Economic	12.95	25.91	2
Environmental	6.58	14.57	2.21
Infrastructure & Technology	9.5	16.63	1.75
Legal and institutional	19.15	23.86	1.25
Average Scenario Priority			**1.79**

- <u>Map Integration</u>

Additional analysis as a spatial-based visualization of results can be applied in MSA, but of course, it must be based on the boundaries of an area which can be a state, province, district or city, even a village, or a boundary that has been determined in advance with spatial-based boundaries. This spatial-based MSA analysis describes the status value in the area or region concerned based on the respondents' judgment, with the distribution of the status values of each aspect on the resulting map. Aggregate values can also be visualized as a combined result of all existing analyses that is a spatially based description of MSA results as shown in Figure 8.

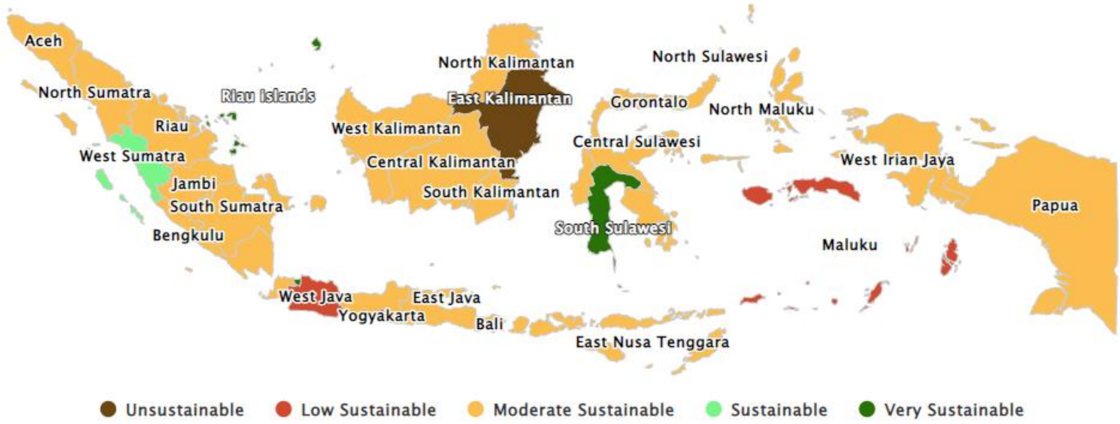

Figure 8. Spatial-based visualization of the sustainability status

Based on Figure 8, it can be seen the status in each region, especially in the province. The map can be viewed based on the color and status values that have been previously determined. The status categories are divided into 5 status categories based on values and colors, including 1) unsustainable status with a value of 0-20 with a brown color; 2) less sustainable status with values >20-40 with red color; 3) moderately sustainable status with values >40-60 with orange color; 4) sustainable status with values >60-80 with bright green color and; 5) very sustainable status with values >80-100 with dark green color. Spatial-based MSA is only limited to administrative areas or polygons from the world to the smallest area.

V. CONCLUSION

MSA can be used to create an overview of scenarios that will be applied because it has the advantage of a planning analysis tool. Especially in the case of planning research, it can elaborate the future condition analysis. The experts can assess conditions that will occur in the future, therefore they do the assessment based on their judgment who have already known very well about the case being studied. It will help the analysis of current conditions and possibilities in the future. MSA has accommodated pairwise comparison. If the aspect conditions have different characteristics, there will be maximum sensitivity value and real sensitivity value. Then the factors that need intervention will appear, and we can see the value of the simulation scenario from the status value development, where there is random iteration, status validation, estimation of error respondent, and uncertainty error to see the level of accuracy of the analysis results.

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