Journal of Economics and Sustainable Development
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.6, No.4, 2015

Sustainability Analysis of Sei Mangkei Palm Oil Based Industrial Cluster

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Abstract
Sei Mangkei Industrial Park have been designed by Government of Indonesia as industrial cluster for palm oil derivative product industries. In many cases, selected areas for industrial cluster developed into an industrial aglomeration than industrial clustering. To ensure industrial cluster accomplishment, sustainability analysis should be done. The aim of paper was to conduct sustainability analysis of Sei Mangkei industrial cluster development. Multidimensional scaling (MDS) was used to determine the value of sustainability index. There were 23 attributes considered for measuring the index categorized in 5 dimensions : economic, social, enviromental, infrastructure and technology, and institutional. The index score range used was 0-100. Results showed that the average of sustainability index of Sei Mangkei Palm Oil Based Industrial Cluster Development was 52.84 showing that the industrial cluster development categorized as sufficient category. The lowest index was found for institutional dimension (36.21) and the highest was environment dimension (64.79). From the leverage analysis, some critical attributes in each dimensions were found and need improvement to increase the sustainability. Institutional strengthening and accelerated development of infrastructure are the crucial factor should be prioritized for the development of palm oil based industrial cluster at Sei Mangkei. This could be a significant reference for the decision makers, in this case is Government and in cooperation with private sectors, to develop Sei Mangkei Industrial Park. Too, readers would find out and learn in developing an industrial park needs sustainability study for comprehensive development.
Keywords: industrial cluster, sustainability analysis**,** mutlidimensional scaling

1. Introduction

The government mission to achieve Acceleration and Expansion of Indonesian Economic Development 2011-2025 (MP3EI) were taken by developing centers of economic growth in producing superior products, and some operational steps were performed by developing innovative industrial cluster and Special Economic Zones (SEZ) (Presidential Regulation of Republic Indonesia No.32/2011). Eight major programs and twenty-two economic activities turned to be the focus of its strategy and development policy. One of the economic activities is the development of a major economic product of palm. The main economic activity takes place in two economic corridors, i.e. Sumatra (Sei Mangkei and Dumai) and Borneo (Maloy). The strategic goal is to enhance Sei Mangkei Industrial Park as an innovative industrial clusters to drive surrounding area development. The concept of clusters have been formulated as a strategy in the development of the national economy and carried out in Indonesia since the 2000s. But, the results are still not encouraging. It is often formed as an economy agglomeration, and is not a form of an industrial cluster yet. Therefore, it is important to figure out the needs for make it sustained.

Sei Mangkei Industrial Park located in the District Bosar Maligas, Simalungun, North Sumatra. Since 2010, this area has been constructed toward a cluster of palm oil downstream industry. Since three years ago, a series of development projects have been carried out. The construction stage was divided into three phases and expected will be completed in 2025. In ensuring sustainability of the industrial cluster, an analysis of sustainability level should be accomplished.

The objective of this research was determining sustainability of Sei Mangkei Palm Oil Based Industrial Cluster Development and formulating some recommendations in ensuring the sustainability of the industrial cluster.

2. Literature Review

2.1 Industrial Cluster

Porter (1990) defines "Clusters are geographic Concentrations of firms, suppliers, related industries, and specialized institutions that occure in a particular field in a nation, state, or city. Porter (2000) adds that "Clusters are geographic Concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions (eg, universities, standards agencies, trade associations) in a particular field but also cooperate that Compete" . Another definition of the industry cluster is the "geographical concentration of industries that gain performance advantages through co-location" (Doeringer and Terkla 1995).

While Rosenfeld (1995) adds the definition Clusters with "the relationship between a company that also provides a range of complementary services, including consultancy services, education and training providers, financial institutions, professional associations and government agencies. The concept of clusters have been formulated as a strategy in the development of the national economy and carried out in Indonesia since the 2000s. But, the results are still not encouraging and still need development in apply this concept.

2.2 Sustainability Analysis

Sustainability Analysis is the identification and analysis of degree of presence or absence of the factors that are likely to impact, either positively or negatively on the prospects of sustained delivery of project benefits. The metrics used for the measurement of sustainability (involving the sustainability of environmental, social and economic domains, both individually and in various combinations) are still evolving: they include indicators, benchmarks, audits, and accounting, as well as assessment, appraisal and other survey and reporting systems. Project sustainability is a major challenge in many developing countries. Large number of projects implemented at huge costs often tend to experience difficulties with sustainability. According to several recently conducted studies, the trend with post implementation sustainability is rather disappointing, and less projects are being sustained. Several factors are responsible for poor sustainability. Several factors are still in control of the project management, while others come from the outside and can be a threat. Several factors can and should be handled properly at the design phase, whereas, others can be identified and corrected during the implementation, through monitoring and evaluation. It is, therefore important that the factors that affect sustainability are articulated well and incorporated, as far as possible at the design stage. Later, the same factors can be followed up through monitoring (Khan 2000).

2.2 Multidimensional Scaling

Multidimensional scaling (MDS) is a technique for analysis of similarity or dissimilarity data on a set of objects. MDS seeks to modeling or mapping the data into geometric space. The main reason for doing this are that one wants a graphical display of the structure of the data that is much easier to understand than an array of number, display the essential information in the data and smoothing the out layer. One of the application of MDS is to use some of its mathematics as models for similarity (dissimilarity) judgment as the result of a mental arithmetic. according to this model, the mind generates an impression of similarity (dissimilarity) by adding up the perceived similarity or differences of the two object over their properties. There are numerous varieties of MDS. Some facets for distinguishing among them are the particular type of geometry into which one wants to map the data, the mapping function, the algorithms used to find an optimal data representation, the treatment of statistical error in the models, or the possibility to represent one or several similarity matrices. Other facet relates to the different purpose for which MDS has been used. Four purpose of MDS : (1) MDS as an method to represent data in order to make these data accessible to visual inspection and exploration; (2) MDS as a technique that allows to test if and how certain criteria can be distinguished among different object of interest; (3) MDS as a method for exploring psychological structure; and (4) MDS as a model of similarity judgment (Borg and Groenen 2005).

3. Research Methodology

3.1 *Logical Framework*

Motivation of this study is developing an industrial cluster determined by various aspects / dimensions. The significant dimensions affect to sustainability of the industrial clusters development are economic, social, environmental, technological & infrastucture and institutional. Each dimension was measured by some attributes which are detailed in appendix 1. Experts judgment was employed to assess the condition of each indicator. These judgment were aggregated and then analyzed by using Multidimensional Scaling (MDS). MDS outputs were inter-related and analyzed to formulate the recommendations. To determine the most influential aspect to increase sustainability index, we used the leverage analysis of each dimension and to test the validity of the model, we compare the results of MDS analysis with the results of Monte Carlo analysis. The illustration of the research framework was shown as figure 1 .

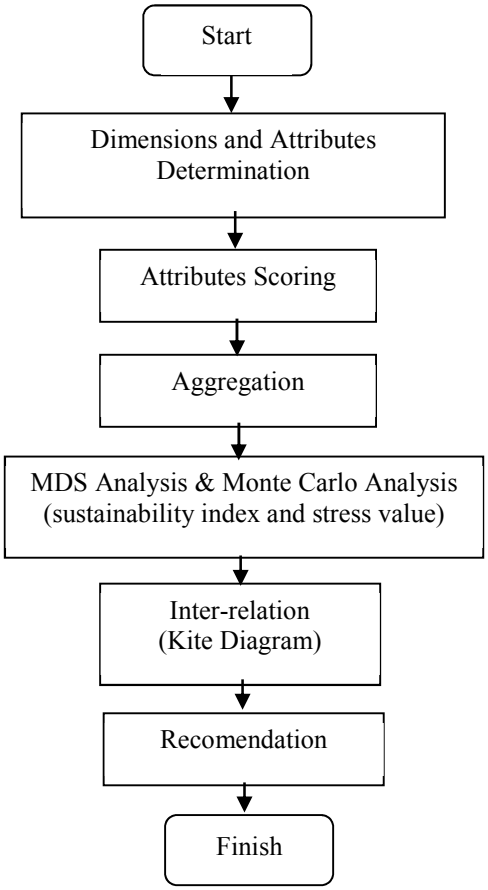

Figure 1. Logical Framework

3.2 *Data Collecting*

The collected data consisted of both primary and secondary data. Primary data were obtained directly from the results of extracting information from experts either by interview or by questionnaire. Experts panels were selected from elements of stakeholder such as researchers, government officials, and agro-industry practitioners. Secondary data were collected from research and government publications. Secondary data consisted of the number and condition of the facilities in Sei Mangkei, the progress of the construction area, Simalungun District in Figures, and North Sumatera Province in Figures.

3.3 *Data Proccesing*

Analysis of sustainability refering to expert judgment, aggregation the judgment and processing were done by using the Multi Dimensional Scaling (RAPFISH technique). Based on the expert judgment, we determined five dimensions of sustainable development of palm oil industrial cluster i.e. : economic, social, environmental, infrastructure & technology, and institutional. We have also identified attributes of each dimension, and the total are 23 attributes for all dimension. Linguistic scales used to assess level of each attribute are : Very Low (1), Low (2), Medium (3), High (4) and Very High (5). The dimensions and attributes in sustainability analysis was show in table 1 and the categorization of sustainability index were shown in appendix 2.

4. Result and Discussion

The result of MDS analysis shows the sustainability index value of each dimension, stress values, R square and the number of iterations. The following is a description of the MDS analysis results for each dimension. And the distribution data of the RAFISH analysis results can be seen in appendix 3:

Table 1. The result of MDS Analysis

Dimension	Sustain. Index (SI)	Stress Value	R^2	Iteration
Economic	57.90	0.164	0.94	2
Social	53.65	0.174	0.93	2
Environment	64.79	0.190	0.92	3
Infrastructure& Technology	52.65	0.160	0.94	2
Institutional	36.21	0.178	0.92	3

1. Economic Dimension
   The economic dimension is the most important aspect in determining the sustainability (weight 0.33). Results of MDS analysis shows that the economic dimension of sustainability index is 57.90, with a stress index 0.164 and R2 = 0.94. It is considered that economically, palm oil industrial cluster in Sei Mangkei is sufficient sustainable.
2. Social Dimension
   The social dimension sustainability index of MDS results is 53.65. As well as the economic dimension, seen from the social aspect, the development of palm oil industrial cluster in Sei Mangkei is also categorized into sufficient sustainable, with the stress index is 0.174 and R2 = 0.93.
3. Environmental Dimension
   In the environmental dimension, the sustainability index value is 64.79, the stress index of 0.19 and R2 = 0.92. This shows that in the environmental aspects, the development of industrial clusters in Sei Mangkei is quite sustainable.
4. Infrastructure and Technology Dimensions
   The infrastructure and technology are the second important aspects in determining the level of sustainability of palm oil industrial cluster development in Sei Mangkei, an expert giving weight to this aspect is 0.28. sustainability index from MDS analysis obtained is 52.65, stress index is 0.16 and R^2 was 0.94. The result shows that the development of industrial clusters in Sei Mangkei is sufficient sustainable in infrastructure and technological aspects.
5. Institutional Dimensions
   From MDS analysis, the sustainability index of institutional dimensions is 36.21, with the stress index is 0.178 and R2 = 0.92. Because of the index is in the range 25 to 50, so the cluster development is considered less sustainable in institutional dimensions.

Based on the results of the MDS analysis, the average of sustainability index is 52.84. This index generally indicates that palm oil industrial cluster in Sei Mangkei Industrial Park is sustainable sufficiently. The lowest index is found for institutional dimension (36.21) and the highest is environment dimension (64.79). The stress value calculated are not more than 20%, and the coefficient of determination (R^2) are more than 92%, its value described that all attributes could represent the real system and the model is fitted statistically.

The next step is validation of the index value using Monte Carlo analysis. Monte Carlo analysis is used to test whether the results obtained from the MDS calculation is valid. Table 2 shows the different index value calculated between MDS analysis and Monte Carlo analysis. The result shows that the difference between index values varies from 0.25 to 1.34 (< 5%). This shows that the calculation is valid.

Table 2. Comparison the sustainability index calculated by MDS and Monte Carlo Analysis

Dimension	MDS	Monte Carlo	Different	Different (%)
Economic	56.90	56.38	0.52	0.91
Social	53.65	53.40	0.25	0.47
Environment	64.79	63.65	1.14	1.76
Infrastructure	52.65	51.88	0.77	1.46
Institutional	36.21	34.87	1.34	3.70

Inter-related analysis by using Kite diagram is presented at figure 2.

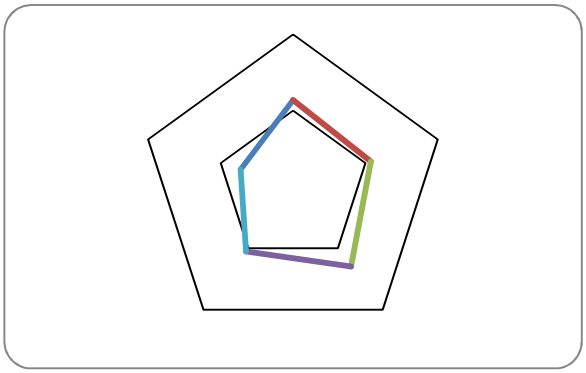

Figure 2. Representation of Sustainability Index of Palm Oil Based Industrial Cluster Development at Sei Mangkei

The result shows that economic, social, environment, infrastructure and technology dimensions value are above 50. The four dimensions are categorized as Sufficient sustainable condition and one dimension (institutional), which gain the lowest index (36.21), is categorized as less sustainable condition.

Leverage analysis is employed to identify the attributes that need attention and improvement in each dimensions to increase sustainability level. Here are the results of the leverage analysis for each dimension and the graphs of the results calculations can be found in the appendix:

1. Economic Dimension
   From the analysis, it appears that the level of sustainability of the cluster development will be enhanced by further developing economic infrastructure that exists within the cluster,for example by encouraging financial institutions to get in to the industrial park.This will encourage economic activities in the larger areas.
2. Social Dimension
   Appendix 3 shows that in order to increase the level of sustainability of the palm oil industrial cluster development in Sei Mangkei, the role of community involvement is crucial, by providing an opportunity for the public to be able to work in these industries. Due to the lack of employment opportunities for the local community, it can lead to social unrest and inequality in society, and this hinders the development of industrial clusters in the region.
3. Environmental Dimension
   On environmental aspects, waste treatment facilities have prepared well, and in the Environmental Impact Assessment document has also been described throughout the estimated impact and treatment plan. To increase the level of sustainability, it is necessary to pay attention to the monitoring of potential impacts that have been identified.
4. Technology and Infrastructure Dimensions
   In terms of technology and infrastructure, there are three critical aspects that need attention to maintain and increase the level of sustainability in this dimension, namely that the industrial park is required to maintain the supply of energy (electricity and gas) continuously, and to improve the infrastructure such as roads, railway and port.
5. Institutions Dimension
   The existence of institutions which regulates the clusters is required by both in the formal structure, as well as the rules and authority therein, in addition to the mechanisms in the institutional relationship also needs to be set, and the government's attention should be focused on this dimension because it has the lowest sustainability index.

5. Conclusion and Recommendations

This research concluded that in general, Sei Mangkei palm oil based industrial cluster is in sufficient sustainable condition. Sustainability index is 52.84 illustrating the condition. However, from the fifth dimension, there is one dimension that is considered less sustainable. This is an institutional dimension whose sustainability index is 36.21. This aspect is the most priority to be improved. Besides the institutional aspects, other aspects are also still need to be improved to increase the level of sustainability. Leverage analysis is used to see which attributes are to be improved, and it is necessary to formulate recommendations.

Based on the result of leverage analysis of the dimensions, we could see the critical aspects. Here are some recommendations to increase sustainability in Sei Mangkei industrial cluster as follows :

1. institutional strengthening. The existence of institutions is needed, in terms of regulating the formal structure, the rules, authority, and the mechanisms of the relationship among all stakeholders.
2. government encouragement to develop physical infrastructure (road, port, electricity and gas) and economic

infrastructure (financial institutions);
3. increase of community involvement and local employment,
4. supervision of the environmental impacts management.

It needs further studies on other aspects of Sei Mangkei Industrial Park development especially in institutional strengthening and how the impact on regional economic development.

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Appendix

Appendix 1. Dimensions and Attributes in Sustainability Analysis of Palm Oil Based Industrial Cluster Development in Sei Mangkei

No	Dimension	Attribute
1	Economy	1. Market demand 2. Economic infrastructure 3. Local economic activity 4. Investment 5. The growth of industry
2	Social	1. Support and stakeholders motivation 2. Cultural and social community 3. Involvement of local communities 4. Employment 5. Equitable income distribution
3	Environmental	1. Environmental management document 2. Waste handling facility 3. The potential environment impact
4	Technology & Infrastructure	1. Port infrastructure 2. Road infrastructure 3. Availability of water 4. The availability of energy (electricity and gas) 5. The availability of telecommunication facilities 6. Technological capability
5	Institutional	1. Completeness of the institutional structure (structure and rules) 2. The mechanism of institutional relations 3. The mechanism of dialogue and problem solving 4. Monitoring and evaluation mechanism

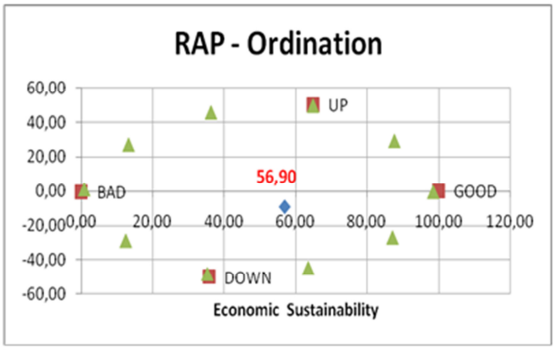
Source : research data treatment

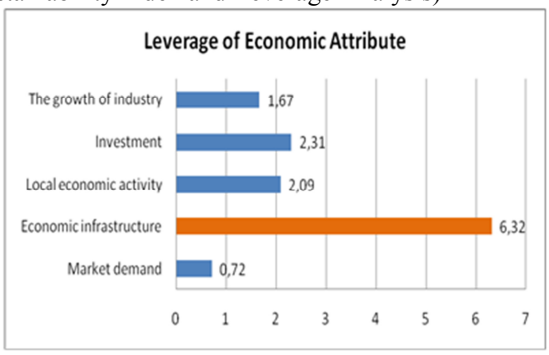
Appendix 2. Range of Sustainability Index (SI)

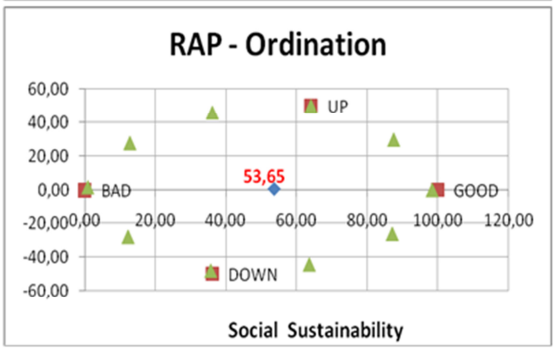
Range of Sustainability Index (SI)	Categorization
$0 < SI < 25$	Not sustainable
$25 < SI < 50$	Less sustainable
$50 < SI < 75$	Sufficient sustainable
$75 < SI < 100$	Sustainable

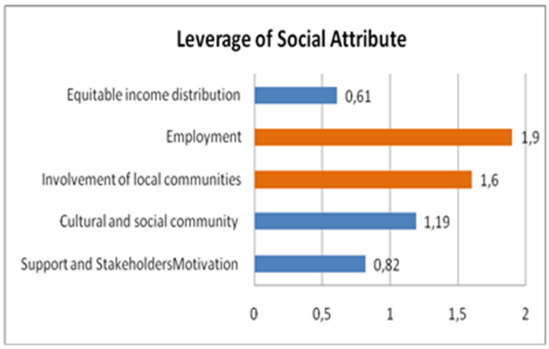
Adapted from : Purnomo (2012)

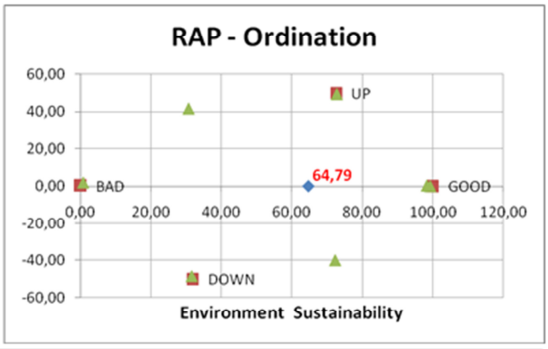
Appendix 3. The result of MDS Analysis (Sustainability Index and Leverage Analysis)

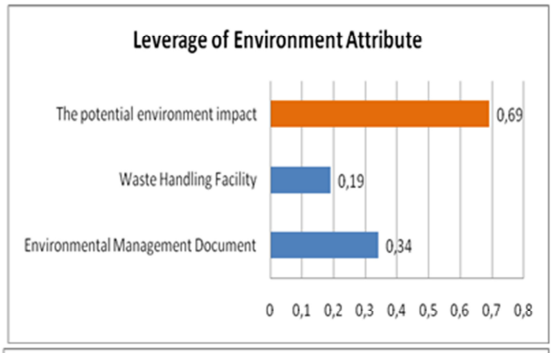


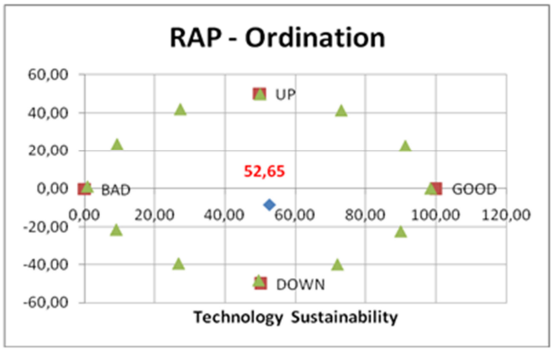


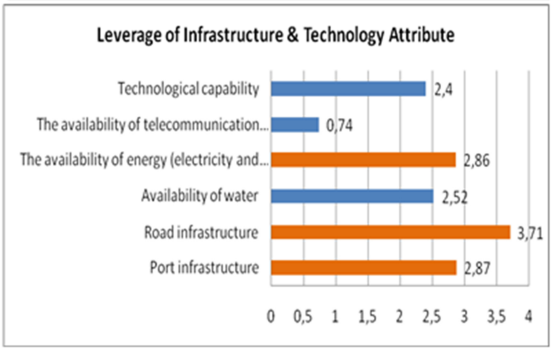


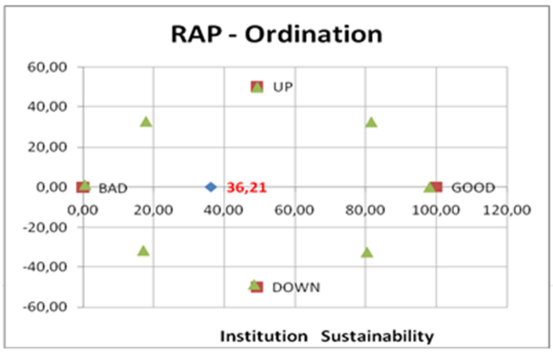


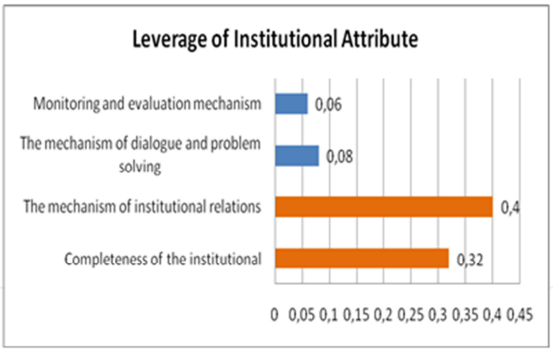












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