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SUSTAINABLE MANAGEMENT STRATEGY OF CONSTRUCTION MATERIALS MINING IN JENEBERANG RIVER, SOUTH SULAWESI

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ABSTRACT

Mining activities in Jeneberang River carry out to fulfil construction materials demand of Gowa Regency and Makassar City. In the recent years mining activities are under strong pressure to comply with good environmental practice. The issue of sustainable development is becoming increasingly important for the mineral extraction. Analysis of four dimensions (social, economic, environmental, and institutional) indicates that currently, management sustainability of mining categorized as quite sustainable with index value 54.28%. Therefore, objective of this study is to formulate strategy of the sustainable management based on scenarios considering key attributes to increase the index value. The sustainability index and key attributes were conducted by Multidimensional Scaling (MDS) analysis. Meanwhile, to define future states of the scenarios were analysed by prospective analysis. Result of leverage analysis in Multidimensional Scaling indicates that 18 out of 43 attributes are categorized as sensitivity attributes of the sustainability. Based on prospective analysis, the selected scenario for developing the management sustainability is moderate scenario. There are seven key attributes affecting the sustainability. The scenario will take place if the key attributes develop positively in order to increase from 54.28% to 60.48%.

Keywords: mining management, sustainability, multidimensional scaling, prospective analysis.

INTRODUCTION

Construction materials are basic raw materials required for all construction activities. The most common of construction materials are sand, gravel, and crushed stone. The materials produced from natural sources extracted from quarries and gravel pits and used either in their natural state of after crushing, washing, and sizing [1]-[2]. They are used in many different applications such as road-building, rail ballast, mass concrete for foundation or major structures, concrete blocks, steel reinforced beams, flooring and walls, mortar, plaster and filter media for sewage and other water treatment [3].

Jeneberang River is one of the main rivers in South Sulawesi. It is located at Gowa Regency and flows westward across the Province of Sulawesi to Makassar City. On 26 March 2004, gigantic caldera wall collapsed at the east ridge of caldera of Mt. Bawakaraeng. The volume of the collapsed mass was estimated at about 235 million m^3 (originally) and based on more detailed survey the collapse was estimated to be 231 million m^3. Small to middle scale collapse deposits were estimated at 1.6 million m^3 and surface erosion (2004-2009) was estimated at 11.7 million m^3. In 2009, the remains of the collapsed deposit in the caldera were estimated at 82.7 million m^3. Sediment volume flowing into the Jeneberang River was estimated at 162.2 million m^3 [4]. After the collapse of the caldera wall, Jeneberang River was supplied with a large amount of sediment that are mined conveniently and economically to fulfil the needs of Gowa Regency and Makassar City.

The issue of sustainable development is an important issue for the construction industry as the industry uses a lot of un-renewable resources and is the main contributor to the depletion of the resources. Nevertheless, we must have access to a readily available supply of construction materials to maintain our current lifestyle and continuing demand for the material, which must be obtained without causing negative impacts. Even though, mining activities in Jeneberang River become a part of sediment control plan to mitigate the potential debris flow resulted from the Mt. Bawakaraeng collapse [4].

From the previous research we have known that currently sustainability index value is 54.28% which means that the mining management currently is quite sustained [5]. In order to achieve development strategy in maintain the management sustainability; it is need to develop some scenarios based on key attributes. Prospective analysis is a comprehensive and quickly operational framework to design the scenarios. The analysis generates identification key attributes and building scenarios based on states of key attributes in the future.

The result of this research is selected scenario that expected to contribute to local government about the necessity to consider action plans to develop the sustainability of mining management.

The aim of research

The objective of this study is to formulate strategy to increase the index value of management sustainability. The strategy is developed based on scenarios in the future considering key attributes.

LITERATURE REVIEW

Multidimensional scaling

The relative sustainability status is analysed by using multidimensional scaling (MDS) which is an ordination method and analysis is done following the procedure of Rapfish analysis introduced by Kavanagh and Pitcher (2004).

Attribute leveraging analysis shows the effect of removal of one attribute at a time on the ordination of the mining sustainability. Leverage (sensitivity) analysis is roughly the average radius of the leveraging scatter for the status of dimension [6].

Prospective analysis

Prospective analysis is a tool used to generate a new kind of knowledge. The type of knowledge is foreknowledge. Foreknowledge is about how and why the future may take various aspects, and about what these aspects are. Thus, prospective analysis can be used either as an exploratory tool, anticipating changes through scenarios or as a normative tool as an action-oriented approach starting from a selected vision of the future and determining the path to reach it [7].

There are several stages in prospective analysis [7]:

a) Definition of the system's limits

The definition of the issue to which this method intends to provide foreknowledge is used to define the limits of the exercise. The issue can be regarded as a system whose nature can be characterized.

b) Identification of variables

The objective of this stage is to establish a list of variables that have an influence on the constitution, and evolution of the system.

c) Mutual influence analysis

In this stage, all variables are analysed their influence/dependence (I/D) links of each variable on the others, using a consensual valuation approach. Influence assessment consists of a valuation of the direct influence of each variable on the others using a scale from "0 = no influence" to "3 = very strong influence". The value entered in the Influence/Dependence (I/D) matrix.

d) Interpretation of the graphs

The influence graphs display how the variables are scattered in a four-quadrant space delimited by two axes. Each quadrant in the graph corresponds to specific characteristics of the variables. The upper-left quadrant (I) is the area of driving variables where most of the strongest variable are present. The upper-right quadrant (II) corresponds to leverage variables, both influent and dependent. Some of them can be considered also as strong variables. The lower-right quadrant (III) corresponds to the output variables, very dependent and little influent. In the lower-left quadrant (IV) one will find the marginal variables. Little influent and little independent, these variables behave rather independently from the system. Godet (1991) identifies also a grey area, along the axes that separate quadrant IV from the others, where a "bunch" of variables can be found; whose role in the system is not clearly identified (Figure-1).

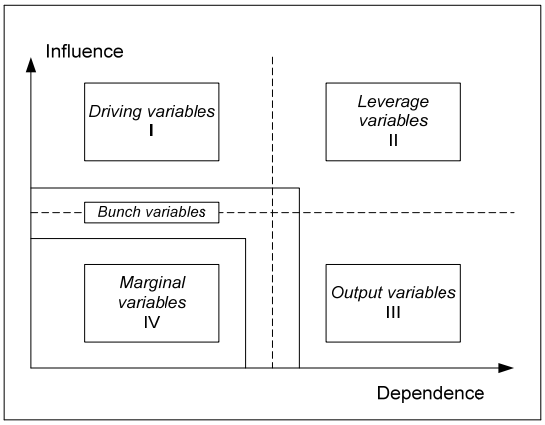

Figure-1. Signification of variables according to their place in the I/D graph (Bourgeois and Jesus, 2004).

e) Building scenarios

A scenario is a combination of variables in different states. Scenarios are then constructed based on a combination of future possible states of the selected variables. The number of scenarios proposed is usually limited to five. The strategic elements identified in the scenario can become indicators for monitoring the evolution and give early indication on its possible evolution. The result is generation of foreknowledge about what it may look like according to how some key variables evolve, so stakeholders could better prepared to face changes.

RESEARCH METHODOLOGY

Data of attributes were collected by using questionnaires. It was conducted a purposive sampling of mining companies, Department of Mines and Energy, Environmental Agency, and Head of Districts and Villages of Gowa Regency.

The sustainability index and key factors were conducted by Multidimensional Scaling (MDS) analysis. Meanwhile, to define future states of the scenarios were analysed by using prospective analysis.

RESULTS AND DISCUSSIONS

The sustainability dimensions consist of economic, social, environmental, and institutional dimensions (43 attributes). There are seven attributes in economic dimension as indicates in Table-1.

Table-1. Attributes of economic dimension.

No.	Attributes
1	Amount of construction materials demand
2	Companies profit
3	Income of employees
4	Economic conditions of inhabitants due to the mining companies
5	Mining sector's contribution to GDP
6	Mining tax revenue
7	Effectiveness of mining tax revenue

Social dimension consist of 15 attributes as shown in Table-2.

Table-2. Attributes of social dimension.

No.	Attributes
1	Community participation in mining management
2	Local employment
3	Age of mine workers
4	Working hours
5	Guidelines of occupational health and safety
6	Availability of safety equipment
7	Frequency of occupational accidents
8	Availability of occupational accidents insurance
9	Availability of health insurance
10	Availability of Corporate Social Responsibility (CSR)
11	Public perception toward mining activities
12	Complaint from inhabitants
13	Frequency of conflict
14	Changes in socio-cultural values
15	Changes in the quality of inhabitants' life

The attributes of environmental dimension are shown in Table-3.

Table-3. Attributes of environmental dimension.

No.	Attributes
1	Distance from settlement to mining sites/processing plants
2	Environmental management and monitoring
3	Impact of mining on water quality of the river
4	Nuisance of noise from trucks and crushers
5	Nuisance of dust from trucks and crushers
6	Impact of trucks on road damage
7	Release of mining waste in the river
8	Impact of mining on civil buildings in the river
9	Impact of mining on riverbanks
10	Mining companies' concern to the environment

Institutional dimension consists of eleven attributes as indicates in Table-4.

Table-4. Attributes of institutional dimension.

No.	Attributes
1	Availability of river mining guidelines
2	Availability of regulations and guidelines of occupational health and safety
3	Compliance of mining companies with regulations
4	Education on mining environmental and regulations
5	Enforcement of monitoring, supervision, and controlling by institutions
6	Availability of labour union
7	Inter-institutional cooperation
8	Transparency in policy
9	Services of mining permit issuance
10	Mining land use zoning
11	Number of illegal mining

Leverage analysis result shows that there are eighteen leverage attributes of the sustainability [5]. The attributes are shown in Table-5.

Table-5. Leverage attributes.

No.	Attributes
1	Guidelines of occupational health and safety
2	Community participation in mining management
3	Changes in the quality of inhabitants' life
4	Availability of safety equipment
5	Changes in socio-cultural values
6	Frequency of conflict
7	Mining sector's contribution to GDP
8	Income of employees
9	Economic conditions of inhabitants due to the mining companies
10	Amount of construction materials demand
11	Impact of mining on water quality of the river
12	Impact of trucks on road damage
13	Nuisance of dust from trucks and crushers
14	Nuisance of noise from trucks and crushers
15	Availability of labour union
16	Availability of river mining guidelines
17	Mining land use zoning
18	Availability of regulations and guidelines of occupational health and safety

Based on prospective analysis (Figure-2), there are 8 out of 18 attributes as key attributes influencing dominantly to the system.

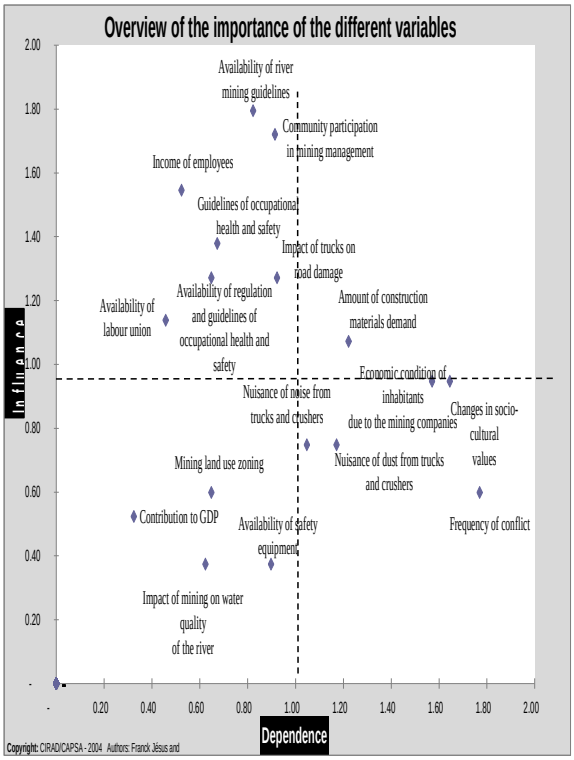

Figure-2. Position of the leverage attributes.

Figure-2 indicates that 7 attributes are located in the area of driving variables (quadrant I) namely: (1) community participation in mining management, (2) guidelines of occupational health and safety, (3) impact of trucks on road damage, (4) availability of river mining guidelines, (5) availability of regulations and guidelines of occupational health and safety, (6) availability of labour union, and (7) income of employees. Only 1 attribute is in quadrant II as leverage variable, namely amount of construction materials demand.

All of the key attributes and their possible changes in the coming future are shown in Table-6.

Table-6. Possible changes of attributes.

Dimension	Attributes	Code	Possible changes		
			A	B	C
			(0)	(1)	(2)
Social dimension	Community participation in mining management	1	Low	Middle	High
	Guidelines of occupational health and safety	2	None	Available, not obeyed	Available, obeyed
Economic dimension	Income of employees	3	Under minimum wage	Same as minimum wage	More than minimum wage
	Amount of construction materials demand	4	Decrease	Constant	Increase
Environmental dimension	Impact of trucks on road damage	5	High	Middle	Low
Institutional dimension	Availability of river mining guidelines	6	None	Available, not socialized	Available, socialized
	Availability of regulations and guidelines of occupational health and safety	7	None	Available, not socialized	Available, socialized
	Availability of labour union	8	None	Available, not active	Available, active

Based on identified of the key attributes and their possible changes, three state scenarios are built namely pessimistic, moderate, and optimistic. Each scenario describes the combination of attributes and states as shown in Table-7.

Table-7. States scenarios.

Baseline		1A-2B-3B-4B-5B-6B-7B-8A
No.	Scenario	Attributes
1	Pessimistic	1A-2B-3A-4A-5A-6B-7B-8B
2	Moderate	1B-2C-3B-4C-5C-6C-7C-8C
3	Optimistic	1C-2C-3C-4C-5C-6C-7C-8C

Selected scenario is moderate scenario which is decide by consider ability and capability of institution to monitor and evaluate regularly mining companies in implementation of laws and regulations. Government should to establish some policies to achieve sustainable management of mining. The development strategies of sustainable management of mining based on moderate scenario are shown in Table-8.

In moderate scenario, 1 attribute namely income of employees is quite difficult to change into higher value of category. Based on previous research by using questionnaires we knew that from total mine workers observed (67 mine workers), about 34 % generate a monthly income between 0.5-0.75 million rupiahs. Following that is 49 % of mine workers who generate a monthly income between 0.751-1.2 million rupiahs and only 17% generate a monthly income more than 1.2 million rupiahs. It has been discovered that the payment of employees is low. A total 83% of the mine workers get payment below the government monthly minimum wage or lower than 1.2 million rupiahs per month [8].

Table-8. Development strategies of sustainable management.

Attributes	Strategies
Community participation in mining management	Entitles the community to give inputs in rulemaking of local regulations
	Forming community organisation to perform the role of control
	Provide access to involve in decision making and policy
Guidelines of occupational health and safety	Implement occupational health and safety training for all employees
	Encourage companies to have ISO of occupational health and safety
Amount of construction materials demand	Law enforcement against illegal mining
	Restrict condition of mining permit issuance
Impact of trucks on road damage	Organized movement of "Say No to Overloading"
	Implementing road user tax as environmental tax
Availability of river mining guidelines	Optimization of institutional performance
Availability of regulations and guidelines of occupational health and safety	Optimization of institutional performance
	Establish occupational health and safety unit in each company
Availability of labour union	Encourage companies to facilitate the workers to form or and join in labor union

Category values in moderate scenario become input parameters in multidimensional scaling analysis. Implementation of the strategy will increase index value of management sustainability from 54.28% to 60.84%. Nevertheless, the strategy still needs more effort from local government and involvement of all stakeholders to develop the management sustainability.

CONCLUSIONS

Based on prospective analysis there are 8 attributes categorized as sensitivity influential to sustainability of mining management. The attributes are: (1) availability of river mining guidelines, (2) availability of regulations and guidelines of occupational health and safety (3) income of employees, (4) community participation in mining management, (5) availability of labour union, (6) impact of trucks on road damage, (7) amount of construction materials demand, and (8) guidelines of occupational health and safety.

The strategy of management will make the sustainability index increase from 54.28% to 60.48%. Nevertheless, the strategy needs to strengthen role of institution to carry out the selected scenario (moderate scenario) by regular monitoring and evaluating the key attributes.

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