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Sustainability Institutional Model of Regional Solid Waste Disposal Site in Bantargebang, Bekasi

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Abstract

In the year of 2008, Act of The Republic of Indonesia Number 18 Year 2008 Regarding Waste Management has been issued. Some of the objective of this act are: 1) in Mei 7th, 2013 all disposal sites in Indonesia must implement sanitary landfill and 2) a partnership can be formed between two or more local governments to manage their Municipal Solid Waste (MSW) together with investor or local community in a Regional Solid Wate Disposal Site (RSWDS). Somehow these goals are difficult to achieve because of limited government's budget and complexities in selecting which local governments should join the partnership and type the of institution to develop to carry all the complex agreements in that partnership. Using Analytic Network Process (ANP) with BCOR (Benefits, Cost, Opportunities, Risks) filter as the tool to analyze technical and economic feasibility of four alternatives institutions (Regional Working Unit, Regional Solid Waste Management Bureau, Joint Secretariat, Regional Public Service Agency) proposed in this research, concludes that Regional Solid Waste Management Board (RSWMB) is the best institution chosen to control and manage Bantargebang disposal site as a Regional Disposal Site. Using Interpretative Structural Modelling (ISM) to analyze the structure of the five element of the institution of regional disposal site i.e: 1) influenced organizations or groups, 2) involved organizations or groups, 3) the main obstacles, 4) possible or desired changes, and 5) model purpose, this paper offers what elements or factor should has the highest priority in managing a sustainable Regional Solid Waste Disposal Site at Bantargebang, Bekasi.

Keywords: ANP, Interrregional Partnership, ISM, Regional Solid Waste Disposal Site (RSWDS), Regional Solid Waste Management Board

1. Introduction

The development of a city or a region means the city needs to plan and manage its settlements, including all the facilities and the utilities in the area. Public infrastructures and facilities is government responsiblity to provide because of its relation to the quality life of inhabitant. This responsiblities include providing and managing them (Sadyahutomo, 2009). Municaipal solid waste (MSW) is one problem that contiue to challenge local government. The task related to MSW is an integrated one, that begins at the source until to the last processing facilities or a disposal site.

A disposal site is a facility provided and prepared by governments so all the people not just an individu or some fraction of a region can get the benefits of the facility. Many regions in many countries fail to provide or maintain this facilility because of the multi problems arise from many aspects of its existence, not only environment, technology and financial, but also political and social aspects.

In Indonesia, this disposal facility is local government responsibility to develop with supports from several government agencies. The needs of this disposal sites is increased with the growing of population and social economy activities as Kholil (2005) states that population growth is one of leverage factors in municipal solid waste management.

Urbanization, social gap, economic growth, social-culture aspect, problems due to policy of government and institution, and international concern has made solid waste management in developing countries more complex (Marshall et al., 2013). In 2008 Indonesia has issued a specific law about solid waste management that is Act Numer 18. This law requires:

1. In Mei 7th, 2013 all disposal sites in Indonesia must implement sanitary landfill.

2. Local governments can join with other local governments to manage their solid waste together with investor or a private organization or local community.

Number 1 is hard to achieve and up to this day many disposal site in Indonesia still implement open dumping or controlled landfill. Several reason behind this tardiness are: (1) local government sets limited budget on solid waste treatment and management; (2) high operational cost; (3) limited suitable area for disposal site; (4) high cost to construct and develop a sanitary landfill site and its infrastructures.

That is why this law has second requirement. To solve the problems above, this law suggests that local government create a partnership with other local governments, private sectors or local community since solid waste affairs is an environmental matters and do not recognize municipal bounderies. Lately municipal bounderies is a constraint in MSW management, but now with this 2008 Act, one can work together with another organization from outside its region to manage their MSW in one disposal site called Regional Solid Waste Disposal Site (RSWDS). With this arrangement every city/regency not need to have a final disposal site/final processing facility within its borders as shown on Figure 1.

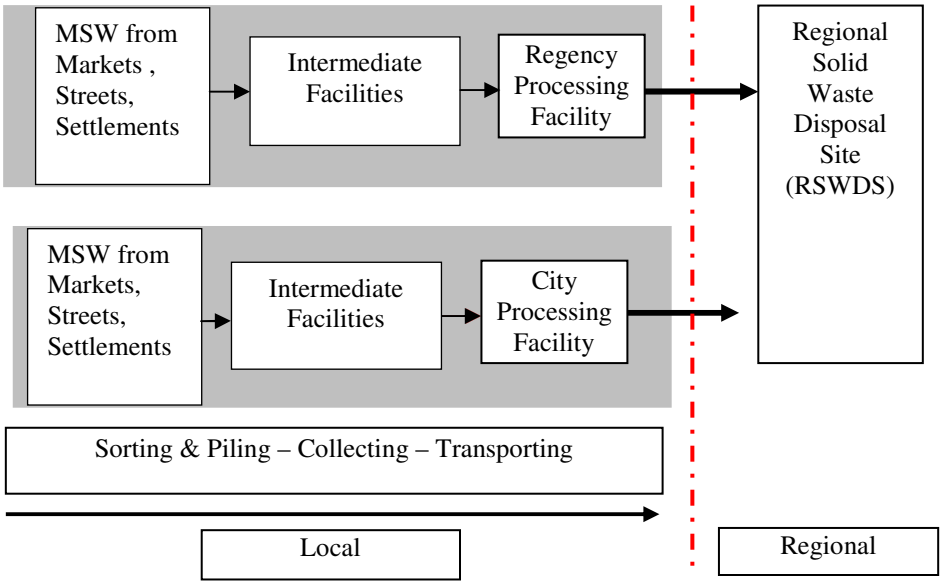

Figure 1. Regional solid waste disposal site process flow

But so far the partnership that is there outside has not worked well, the main reasons are: (1) difficulties to build an agreement between local governments in a partnership; (2) Conflict of interests and different orientation on MSW handling; (3) Difficulties in finding suitable location for disposal site and on how much tipping fee is charged on all the parties in partnership, what are the percentages. (4) Difficulties in formulating or build the new institution borned from the agreement which will operate the new Regional Solid Waste Disposal Site (RSWDS).

Institutional model for regional disposal site is urgently needed in Indonesia's solid waste management. With this new model, it is expected that management of municipal solid waste will be improved sitematically. All the problems that all local governments are struggling with, make the needs for a new model for regional disposal site institution become extremely urgent. This new model is expected to be a reference or guidance for local governments in handling their solid waste.

This regional disposal site concept goes hand in hand with the concept of interregional partnership. With the implementation of Act Number 2 Year 1999, which renewed with Act Number 23 Year 2014 Regarding Local Government, bring broader changes in Indonesia. Before the implementation of this act, centralized government system, in which every decision regarding provincial matters was decided by central government, often made cities/regency lose their initiative to build their territory, besides they only had limited budget.

If a model for agreement and MSW management is built it is a certainty that local governments find their task easier in bringing into reality a RSWDS which will be run effectively and efficiently on institutional level and operational level.

2. Analytic Network Process (ANP)

In this paper a comprehensive decision making model, ANP, is used to take strategic view into account. Analytic Network Process (ANP) is one of the multiple attribute decision making methods presented by Saaty to solve those kind of decision making problems in which interrelations and correlations between decision making levels (purpose, decision making criteria, sub criteria and alternatives) are considered (Saaty. 2001). Any decision has several favorable and unfavorable concerns to consider. The favorable sure concerns are called benefits while the unfavorable ones are called costs. The uncertain concerns of a decision are positive opprotunities that the decision might create and the negative risks that it can entail (Saaty. 2006)

In the prioritization step the decision model is constructed for one strategic goal by five strategic criteria (economy, institutional & regulation, social, technology, and environtment) and 12 decision criteria. It will be useful to determine priorities by ANP. The Analytic Network Process (ANP) provides a general framework to deal with decisions without making assumptions about the independence of higher-level elements from lower level elements and about the independence of the elements within a level as in a hierarchy (Saaty. 2004). The modified ANP structure in this paper is the BOCR model which can improve the solving process.

The aim of this article is to show how to select the best institution for the establishment of Regional Solid Waste Processing in Indonesia, using Bantargebang Integrated Solid Waste Processing Facility, as the case study. The decision is examined in a framework of benefits, opportunities, costs, and risks (the BOCR). This model is a hierarchal structure that focuses on benefits, opportunities, cost and risks merits in each decision problem.

3. Interpretive structural modeling (ISM)

Interpretive structural modeling (ISM) is a well-established methodology for identifying relationships among specific items, which define a problem or an issue (Rajesh. 2013) or an interactive learning process. In this technique, a set of different directly and indirectly related elements are structured into a comprehensive systematic model (Sage. 1997). ISM starts with an identification of variables, which are relevant to the problem or issue, and then extends with a group problemsolving technique. Then a contextually relevant subordinate relation is chosen. Having decided on the element set and the contextual relation, a structural self-interaction matrix (SSIM) is developed based on pairwise comparison of variables. In the next step, the SSIM is converted into a reachability matrix (RM) and its transitivity is checked. Once transitivity embedding is complete, a matrix model is obtained. Then, the partitioning of the elements and an extraction of the structural model called ISM is derived. Interpretive Structural Modeling is a computer-aided method for developing graphical representations of system composition and structure.

Based on their drive power and dependence power, the factors, have been classified into four categories i.e. autonomous factors, linkage factors, dependent and independent factors (Eriyatno, 2003).

Sector 1: Weak driver-weak dependent variabels (Autonomous factors): These factors have weak drive power and weak dependence power. They are relatively disconnected from the system, with which they have few links, which may be very strong.

Sector 2: Weak driver-strongly dependent variabels (Dependent factors): These factors have weak drive power but strong dependence power.

Sector 3: Strong driver-strongly dependent variabels (Linkage factors): These factors have strong drive power as wellas strong dependence power. These factors are unstable in the fact that any action on these factors will have an effect on others and also a feedback effect on themselves.

Sector 4: Strong driver-weak dependent variabels (Independent factors): These factors have strong drive power but weak dependence power. A factor with a very strong drive power, called the ‘key factor’ falls into the category of independent or linkage factors.

This step is to analyze by using this ISM methode, which resulted in driver power-dependence matrix to obtain model of institutional regional municipal solid waste with factors that need most attention or priority and their relation with the other factors in managing a regional municipal disposal site sustainably.

4. Bantargebang Disposal Site

Bantargebang Integrated Solid Waste Processing Facility is located in Indonesia, West Java Province, at Bantargebang district of Bekasi City. The borders for this city are Bekasi Regency at the north and east, Bogor Regency and Depok City at the south, at the west is DKI Jakarta. This facility covered 120.8 ha area and so become the largest landfill site in the country. This site do not belongs to West Java Province, but DKI Jakarta Province, and only receive and manage MSW from five cities of DKI Jakarta: Central Jakarta, West Jakarta, East

Jakarta, North Jakarta, and South Jakarta. Since its operation in 1989 this site has modernized its processing method, from open dumping to sanitary landfill integrated with composting, plasting recycling, and waste to energy. This site has been developed and operated by private company PT. Godang Tua Jaya joint operation with PT. Navigat Organic Energy Indonesia, since 2008.

By 2008 there are almost 10 milion m3 solid waste piled in this area. And with its increasing volume every year as shown on Table 1 and limited budget as described previously, this facility, which belong to Indonesia's capital, has shown all kinds of challenges other regencies and cities has to face to provide sanitation service to their population.

Table 1. Total MSW delivered to Bantargebang and tipping fee

Year	TPD	Tipping Fee/Ton
2008	4,500	US$ 7.259
2009	4,998	
2010	5,065	US$ 7.840
2011	5,173	
2012	5,264	US$ 8.467
2013	5,651	
2014	5,664	US$ 9.145
2015	6,170	

A situational descriptive analysis is applied to determine whether Bantargebang disposal site is ready to become a regional facility on operational level. With total area 120,8 ha and daily input of 6,169 ton of MSW in 2015, this facility is not still allowed to receive additional input of MSW from other cities/regencies. In 2014 with population almost 2.5 milion, Bekasi City produced 1,500 tpd MSW and only 500 ton of it went to Sumur Batu Disposal Site. In 2013 Bekasi Regency produced 6,750 m3 daily but only 18% of it or around 275 tpd went to Burangkeng Disposal Site. In 2015 there was 450 tpd of MSW transported to Galuga Disposal Site from Bogor Regency. Asumming that only 50% of MSW from Bogor Regency goes to Bantargebang Disposal Site, the total MSW delivered to Bantargebang from the four region would be 7,169 tpd.

This amount is acceptable if intensification and extensification programs are adopted by Bantargebang disposal site. Intensification program includes reduction program such as composting, recycling, and waste to energy technologies. Extensification program includes area expansion. Based on field research, there is almost 30 ha area next to the existing area potential for expansion. This land belongs to the private company, incumbent operator of Bantargebang disposal site.

With the combination of extensificaton and intensification programs, Bantargebang disposal site is plausible to be a regional facility for the four city and regency.

5. Other Sites Near Bantargebang

There are severals disposal sites in neighboring area that belongs to regencies and cities in West Java Province (see Fig. 2) as shown on Table 2.

All the four sites are operated by local government using open dumping or controlled landfill at best. Primarily these local govements face two problems in managing their MSW: limited allocated landfill area and limited budget. With this condition, environtment in that area are exposed to pollution and when the sites can no longer receive MSW or reach their capacity, the local governments has to find another place which is almost impossible.

These are the case also in most cities and regencies all over the country. And to solve the problem, Indonesia Act Number 18 Year 2008 suggest these cities to joint into a partnership to manage their solid waste together in one location called Regional Solid Waste Disposal Site. So far there are several forms of existing institutions in Indonesia that run this regional site. In Yogyakarta, three local governments formed Joint Secretariat (JS), in West Java their local governments formed Regional Solid Waste Management Board (RSWMB), others formed Regional Public Service Agency (RPSA) and there is also Regional Working Unit (RWU) in another area. The first two are new agencies created based on local governments regulations, the latter created based on central government regulations. Which one of these four can bring most advantage to the local governments, local community, and investors will be decided by using ANP BCOR which analyze data drawn from questionnaires

involving 11 experts in MSW.

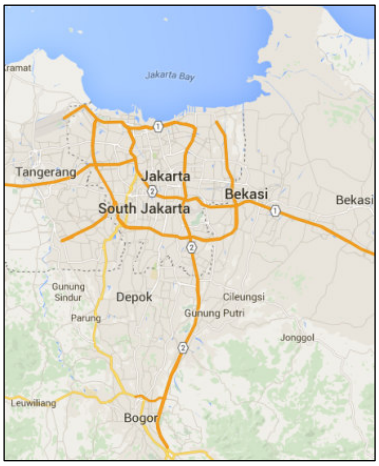

Figure 2. Map of Jakarta Province, and West Java Province (Bekasi, Bogor, Depok)

Table 2. List of other facilities near Bantargebang

No	Landfill Site	Operated By – Location	Total Area	TPD
1	Cipayung	Depok City Government-West Java Province	11.6 ha	450
2	Sumur Batu	Bekasi City Government-West Java Province	14.2 ha	500
3	Burangkeng	Bekasi Regency Government-West Java Province	11.0 ha	500
4	Galuga	Bogor City and Bogor Regency Government-West Java Province	31.8 ha	1500

6. Types of Instititution

6.1. Regional Working Unit (RWU)

Regional Work Unit is a Indonesia's goverment office working for a governor in a province or a mayor in a city/regency. City/rengency secretariat, expert staff, Regional House of Representatives Secretariat, goverment agencies are all a Regional Working Unit. They have direct responsiblity to the head of the region.

6.2. Regional Solid Waste Management Board (RSWMB)

This institution was first introduced by government of West Java Province, and now it is managing six regional sites in the province. Each regional site serve more than two cities/regencies, even one of them serves six cities/regencies. This institution works under Settlement and Residential Agency of West Java Province. As shown in Figure 3, in West Java there are four Regional Solid Waste Disposal Site, all of them exist in one umberella, that is this board.

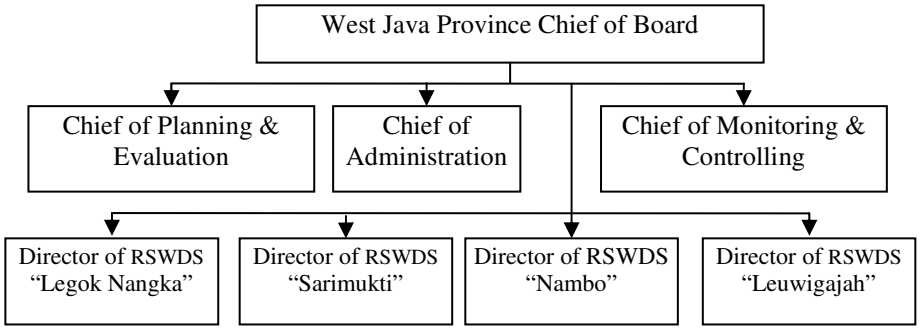

Figure 3. Organizational sructure of regional solid waste management board

An investor/private company who runs a Regional Solid Waste Disposal Site would gain benefits from this arrangement or system since it needs not get in touch with every local governments of cities or regencies whose solid waste come to its door. The investor only have one institution to go to coordinate their operation, that is this board.

Fund for developing a regional sites will be supported by three sources: cities/regencies fund, province fund, and state fund. With this scheme, investors would be stimulated to put their investment in developing more regional sitesin in others provinces.

6.3. Joint Secretariat (JS)

Joint Secretariat was established in Yogyakarta Province among Yogyakata City, Sleman Regency, and Bantul Regency. This institution runs a regional disposal sites named Kartamantul at Bantul Regency. Basically this institution is a team which its staffs comes from all the local governments. This institution tries to aim equal, fair, participative, transparent, and democratic partnership among them. The mission of this institution are: to negotiate to get fair deal or output; to mediate to get solution; to coordinate management efforts and its implementation; to facilitate decision making process; to build strong network; to initiate improvement; and to formulate a proposal of new policy.

The organizational structure of this institution consists of incumbent agencies executives as the board and directors of the institution. They appoint a manager and staffs to run the Joint Secretariat office.

6.4. Regional Public Service Agency (RPSA)

Regional Public Service Agency is a division in Regional Work Unit formed to sell people services or goods. This institution is not profit oriented, its task is to increase efficiency in budgeting and to improve quality and quantity of public service. Not like other government institutions or agencies, Regional Public Service Agency has special right: flexiblity to manage its fund; to do sound businesses to promote public prosperity.

7. ANP and ISM Results

7. 1. Determining The Most Advantageous Institution to Run Regional Solid Waste Disposal Site

To find a model of sustainable Regional Solid Waste Disposal Site Institution that would be implemented at Bantargebang is an important task. This model is expected to be a institutional model that considers economy factors, institutional and regulation, social, technology and environtment factors and even become a solution for every local government in the country that wants to enter into a partnership to manage solid waste at downstream or disposal site.

A set of questionnaire then derived from the ANP framework (Figure 4) that has been developed in a focus group discussion. There are four steps taken in this stage to synthesize the output: 1) building ANP framework; 2) confirmation of the ANP framework in a FGD; 3) formulating the pairwised comparisons questionnaire whom respondents are 11 experts on MSW; 4) testing the consistency and synthetize the output.

On the ANP framework four institutions will be analyzed: formation of RWU institution, formation of Regional Solid Waste Management Board (RSWMB) institution, formation of Join Secretariat, and formation of Regional Public Service Agency (RPSA). These four institutions will be analyzed using ANP to determine the best model.

Using Super Decision software, data from respondents will result supermatriks which provide prioritized list of the most important clusters from related factors of institutional model. So according to the respondents opinion as shown in the Table 3 and Figure 5**,** Regional Solid Waste Management Bureau (RSWMB) is the first priority (0.482), followed by RPSA at 0.236, and the last priority are RWU and JS. The over all outcome for the four altertanives is shown on the Table 4 after considering BOCR elements. Based on BOCR result of each alternatives element of the four institutions, overall outcome are drawn, and the conclusion is Regional Solid Waste Management Board is the best alternative.

The effort to develop Bantargebang disposal site as a regional disposal site should be done stage by stage and in a well planned and integrated way because this effort involves several local governments, central governments, and investor or incumbent operator. Institutional model in form of Regional Solid Waste Management Board should be planned with the help of Ministry of state for Public Works, State Ministry for Development Planning/National Development Planning Agency, Ministry of Home Affairs, and Ministry of Environment.

The regional disposal site should receive only sorted MSW since at the moment all the MSW transported to Bantargebang disposal has not been sorted yet. And this would be met if the socialization at upper stream or the source of MSW on sorting has succeed.

In order to reach sinergy in budgeting for solid waste, a National Solid Waste Managing Board is urgently needed to prevent ovelapping budget over environment and solid waste at every level of government agencies. This board should be able to control all regulation implementation, management, and technology, and budget regarding solid waste matters. This board should be able to integrate solid waste handling methods at source till they reach a disposal site, and implement them nationally. This board should carry its mission in a sustainable manner and considers not only economic aspect, but also social and ecology aspects.

This national board should be able to manage the Regional Solid Waste Management Boards that would be exist in all the province across the country. Every province should develope several regional solid waste disposal sites according to theirs needs and their capability with the help of this national board. Through this scenario, regional solid waste disposal site will rise rapidly and meet the needs of all local governments regarding municipal solid waste handling especially at the end of the process or downstream. Regional Solid Waste Management Boards will coordinate all the efforts to attract private companies in every province to invest their sources on MSW handling. And their path would be easier since basically they only have to come one office, Regional Solid Waste Management Board, to coordinate their investments, be it about economic aspects, regulations aspect, social or technology.

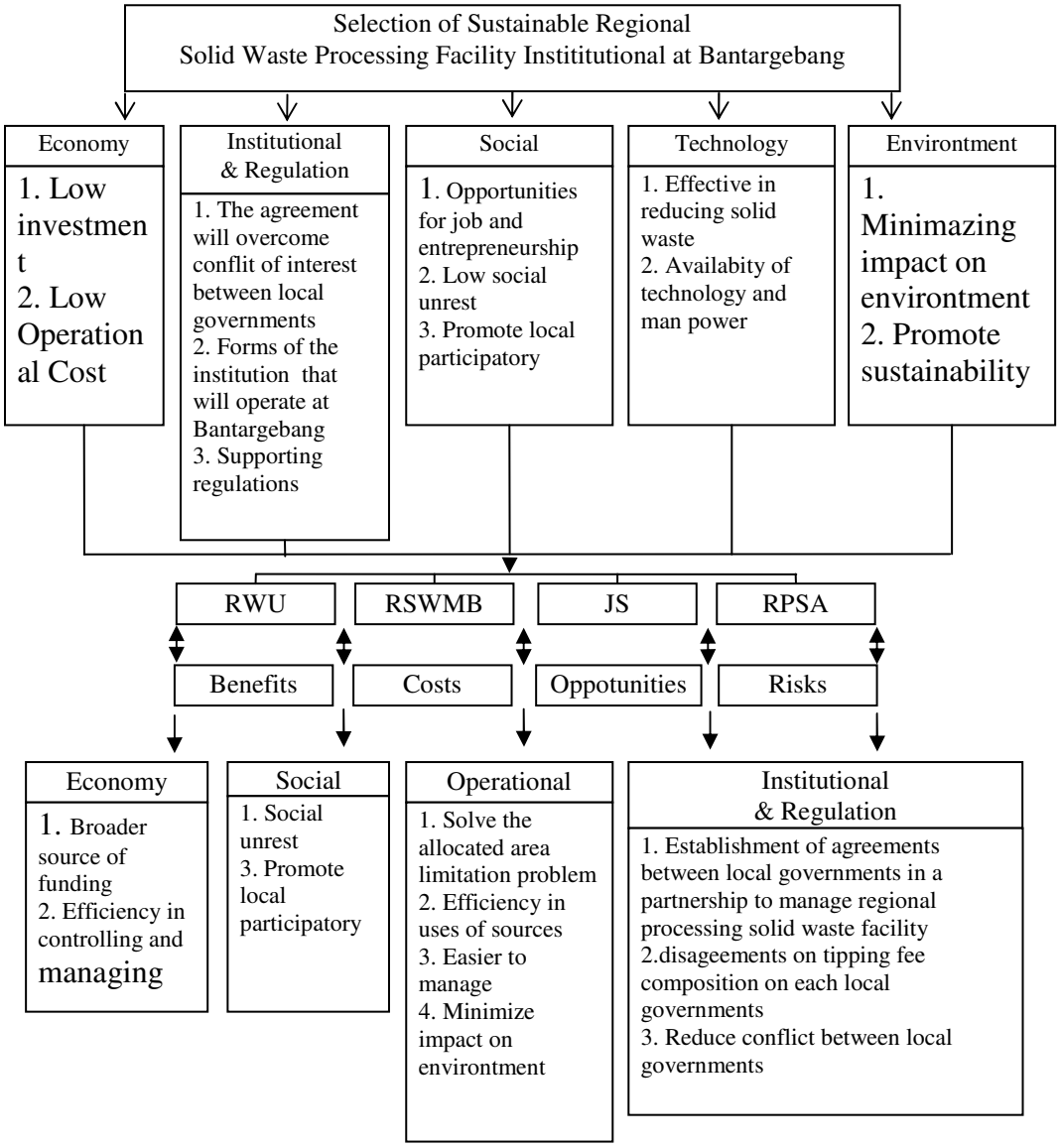

Figure 4. The institutional selection decision frame work

Table 3. Alternatives pair-comparison matrix under BCOR merits

No	Name	Normal	Limiting	Ranking
1	RWU	0.156	0.019	3
2	RSWMB	0.482	0.059	1
3	JS	0.126	0.016	4
4	RPSA	0.236	0.029	2
1	Benefits	0.460	0.210	1
2	Costs	0.266	0.121	2
3	Opportunties	0.123	0.056	4
4	Risks	0.151	0.069	3

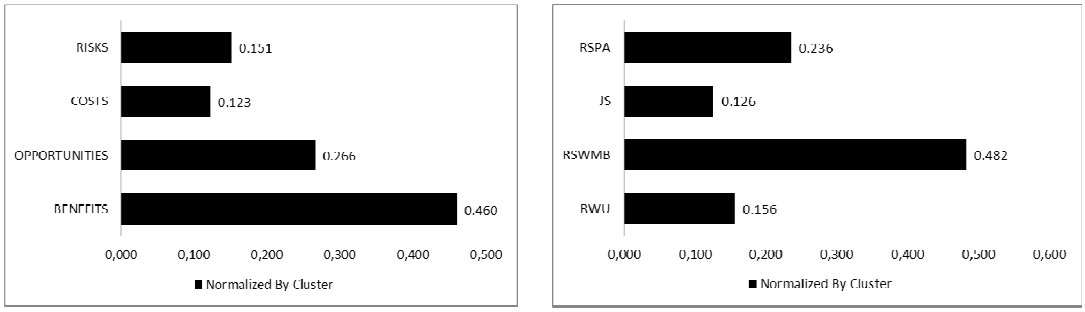

Figure 5. BCOR and alternatives pair-comparison grapichs

Table 4. Relative Weight of Alternatives Under BOCR Merits

No	Strategy Alternatives	BOCR Value				Outcome			
		Benefit	Opportunities	Costs	Risks	Standard	Optimistic	Realistic2	Pessimistic
		0.460	0.266	0.123	0.151	B/C	BO/CR	bB+oO-cC-rR	B/(CxR)
1	RWU	0.153	0.135	0.132	0.237	1.159	0.660	0.054	4.891
2	RSWMB	0.527	0.550	0.360	0.356	1.464	2.262	0.291	4.112
3	JS	0.087	0.083	0.317	0.278	0.274	0.082	-0.019	0.987
4	RPSA	0.235	0.232	0.192	0.130	1.224	2.184	0.127	9.415

7.2. Determining The Priorities of The Elements Of The Institutional Model

Institutional model for regional disposal site is built based on the asumptions of experts with the highest priority is set as requirement to be considered in building the model. The structure of the elements of the institution of regional disposal site are analyzed with ISM (*Interpretative Structural Modelling*). There are five main elements, drawn from experts focus group discussion, which should be considered in decision making i.e: 1) influenced organizations or groups, 2) involved organizations or groups, 3) the main obstacles, 4) possible or desired changes, and 5) model purpose. The results of ISM are driver-power matrix for the five elements:

7.2.1. Influenced organizations or groups

Based on ISM analysis, the investor (2) and the managing instution (5) are the primary organizations that have power to influence the other organizations. Society (4) is also has significant influence as shown Figure 6 and 7.

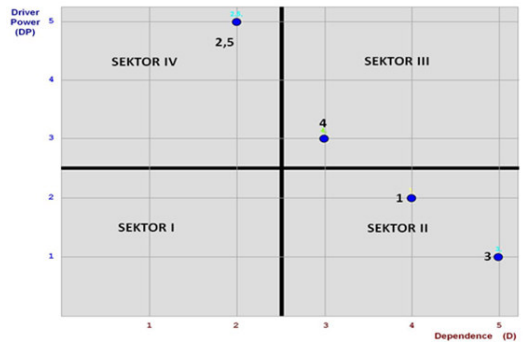

Figure 6. Driver-power dependence matrix of the elements of impacted organizations or groups

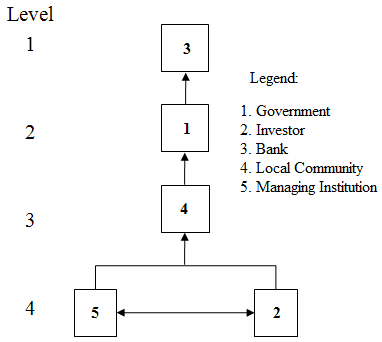

Figure 7. Hierarchical structure of the elements of impacted organizations or groups

7.2.2. Involved Organizations Or Groups

Figure 8 and 9 means that central (1) and local government (2) are the main involved organizations, while local community (5) do not have direct involvement in the operational or institutional level of regional disposal site.

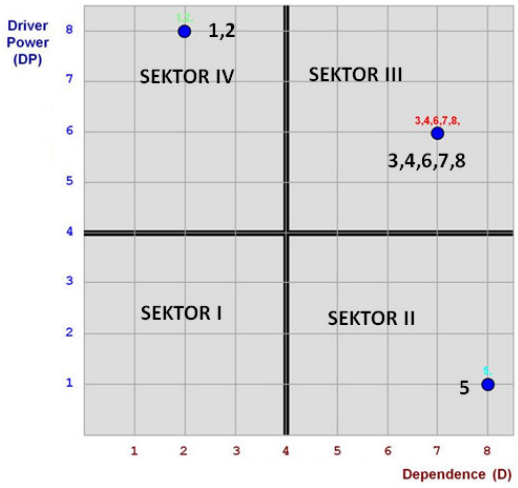

Figure 8. Driver-power dependence matrix of the elements of involved organizations or groups

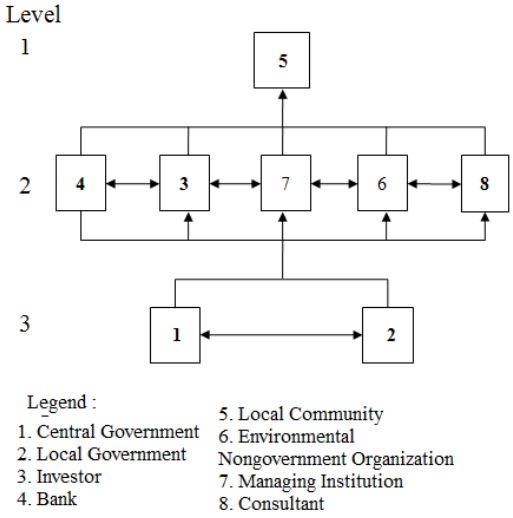

Figure 9. Hierarchical structure of the elements of involved organizations or groups

7.2.3. The Main Obstacles

Figure 10 and 11 show that the scarcity of regulation on regional disposal site (5) and interregional agreement among local governments is hard to achieve (1) are the main obstacles in regional disposal site establisment.

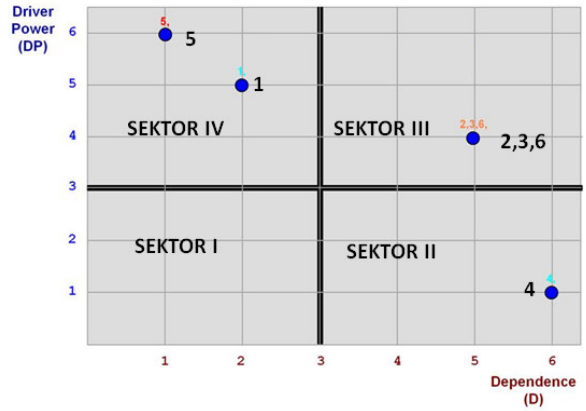

Figure 10. Driver-power dependence matrix of the elements of the main obstacles

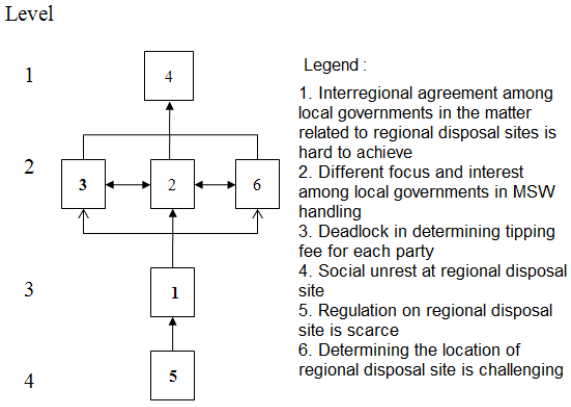

Figure 11. Hierarchical structure of the elements of of the main obstacles

7.2.4. Possible Or Desired Changes

Figure 12 and 13 show that the establishment of regulation regarding regional disposal site is the desired changes in this model of regional dosposal site institution.

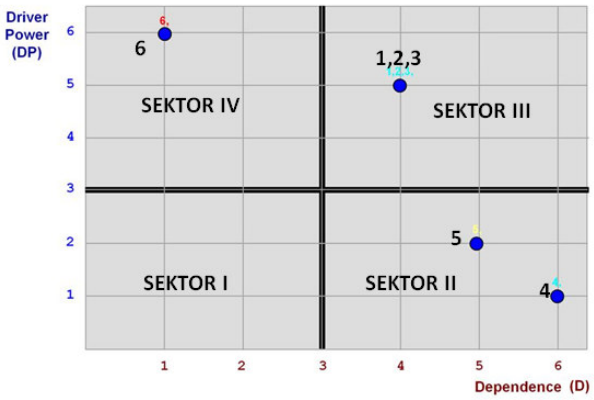

Figure 12. Driver-power dependence matrix of the elements of possible or desired changes

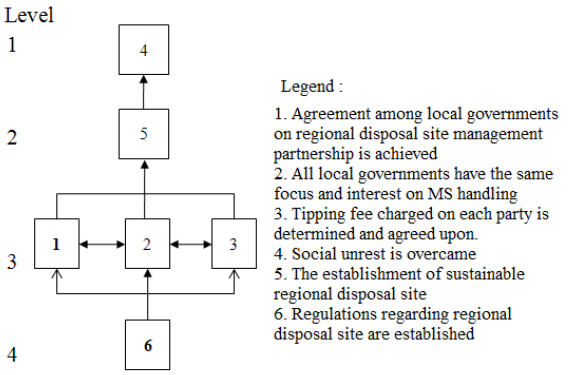

Figure 13. Hierarchical structure of the elements of possible or desired changes

7.2.5. Model Purpose

Figure 14 and 15 mean that the establishment of system of sustainable regional disposal site management (4) is the main purpose of the regional disposal site institution. In fact, declining of social unrest is dependent on the other sub elements.

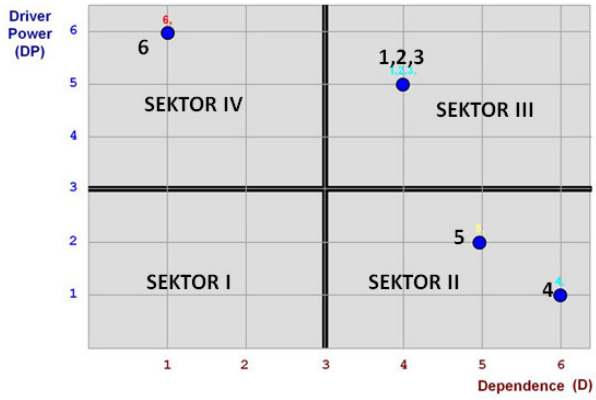

Figure 14. Driver-power dependence matrix of the elements of model purpose

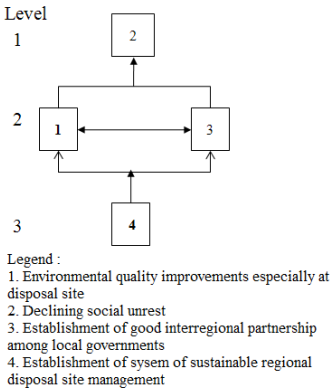

Figure 15. Hierarchical structure of the elements of model purpose

8. Conclusion

1. With the combination of extensificaton and intensification programs, Bantargebang disposal site is plausible to be a regional facility for the four city and regency (Bekasi City, Bekasi Regency, Bogor Regecy)
2. According to ANP the Regional Solid Waste Management Board (RSWMB) is the most advantageous institution to run an regional solid waste disposal site in Indonesia
3. The result of ISM shows that RSWMB is the best model for developing the regional muncipal disposal site with BPSR itself as the main key sub element; as the biggest drive power with the lowest dependency to the other sub elements. Based on the analysis, the strategies that should be adopted in managing regional solid waste disposal site are: 1) establishment of the purpose of the sustainably regional solid waste disposal site management with its orientation lies on the improvement of environment quality, minimizing social unrest, and good partnership among local governments 2) the management of regional solid waste disposal site should involve central and local government, investor, banking, local communtiy, nongovernment organization (NGO), and consultant, and 3) creating a sustainable regional solid waste disposal site needs regulations which support the its establishment on central level and regional level as well so that all the main obstacles could be addresed.

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