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Conference Paper

Determination of Policy Development Priorities in Integrated Waste Management Site at Bantargebang Bekasi

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Abstract.
The garbage problem from DKI Jakarta in the integrated waste management (IWM) site at Bantargebang Bekasi is still interesting for study. The existing studies generally relate to water, soil, air pollution, social conflict, institutional, and area expansion. This study focuses on determining priority strategies for policy development at the IWM Site. The analytical hierarchy process (AHP), analysis method was used to measure priority options regarding integrated Jakarta waste management policies at the IWM site. They collected data by interviewing experts, primary data sources, and other information from various related agencies. The existing condition performance graphs and dynamic sensitivity results show that alternative strategies for improving human resources are a priority for policy development at the IWM Site. The next priority in a row is facilities and infrastructure development, waste utilization management regulations, and increased stakeholder cooperation and coordination. The conclusion is that the policy to raise human resources is most relevant to the current needs of the implementing management unit of the IWM site. It is recommended that further studies related to risks and disasters from the existence of technology-based waste processing have the potential to cause new problems from environmental and social aspects.

Keywords: AHP, alternative priority, human resources, integrated waste management

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1. Introduction

One form of service for a city is to provide facilities for processing waste generated by city residents. The existence of this service is part of the responsibility of the city to create a clean, excellent and healthy city environment while maintaining public health. Generally, a big city like Jakarta, with a dense population, will undoubtedly face waste problems that require having waste management facilities and managing professionally.

Waste management in urban areas is generally used in conventional and informal systems [1, 2]. Traditional systems include collection, transportation, waste disposal, treatment, and recycling activities. The government usually manages these systems. Another system is an informal system in which there is the participation or involvement of scavengers such as collecting waste for sales such as plastic, paper, bottles, and iron. Studies on urban waste management using conventional and non-conventional systems have been carried out by researchers such as [3] and [4].

Entering the 2000s, the residents of Jakarta already have integrated waste management (IWM) site covering an area of 110.3 ha in Bantargebang Bekasi as an asset owned by the provincial government of DKI Jakarta. However, during its implementation, cooperation between the DKI Jakarta Provincial Government and the Bekasi City Government is still being carried out. Based on data from the Jakarta Environment Agency, the daily volume of waste from Jakarta to the IWM shows an increasing trend every year. For example, in 2014 (5665tons), 2015 (6,419tons), 2016 (6,562tons), 2017 (6,875tons), 2018 (7,453tons), 2019 (7,702tons), and 2020 (7,424tons). tons). Most types of waste from Jakarta consist of food waste as much as 53%, plastic waste 9%, paper waste 7%, residue 8%, polyethylene terephthalate (PET) 6%, and grass and wood 6% [5].

To overcome the waste problem in Bantargebang, waste management law 18 of 2008 is considered very strategic. However, along the journey of waste management at IWM, it turns out that the waste management problem is still not optimal, and efforts to reduce waste have not been fully effective so far. The existing problems in the IWM Site are the shrinking of the remaining capacity of 10 million tons until 2022, and the open dumping height has exceeded 35 meters. Another problem is social conflicts that arise due to negative externalities from air pollution and competition from groups of users of waste that have economic value, both groups of users from inside and outside the IWM area.

The settlement of solid waste in the IWM site must be considered a multidimensional performance aspect. Several aspects of reliable waste management performance that can be measured include: (a) Institutional aspects highlighting institutional performance as supporting the smooth implementation of waste management [6, 7], (b) Aspects Technical analysis is used to measure the efficiency of technical implementations such as sweeping of scattered garbage, mounding, bagging or receptacle, removal of waste, transportation of piles of garbage, and disposal of garbage in the final place [3], (c) The financial aspect is associated with the performance of limited funds available for operational financing of waste management from collection to transportation [7], and (d) The social aspect is assessed based on the contribution of the participation of the community, scavengers and the private sector to the successful implementation of management waste management [8].

Integrated waste management must focus on creating good quality waste management that is environmentally friendly and economically valued. Integrated waste management pays attention to the problem of waste generation from Jakarta so that it can be reduced. The government of DKI Jakarta has responded to the environmental and social issues mentioned above by bringing up the idea of IWM management which has economic value and added value. IWM, in addition to serving the conventional needs of the community. Also, waste's benefits or added value must be able to take into account. One of the IWM activities running in the management area is utilizing organic waste in planting media that involves labor. Organic waste processing does not touch community involvement and has not been coordinated institutionally, including the role of market institutions in it. Waste management with community participation will be responded well if the market system has been prepared and is sustainable. The certainty of sales guarantees for recycled products and planting media such as compost to increase people's income is a determinant of community participation [9-11].

Still related to the response to the IWM idea above, the IWM site implementing unit took an innovative waste management approach. The management concept is to reduce waste accumulation in the landfill area and reuse it with a waste mining system or landfill mining. Waste management is considered more environmentally friendly and integrated to suppress negative perceptions of environmental and social problems for some communities and stakeholders. The policy of dredging waste at the IWM site economically has the potential to be used as an alternative fuel, namely a new energy source through waste power plants (PLTSa) [12-14].

The construction of the IWM site in Bantargebang Bekasi can be developed measurably when decision-makers can determine the priority of the alternative strategies. The hierarchical analysis process or AHP (analytical hierarchy process) is a decision-making support system. The AHP approach is often used to solve complex problems with multiple factors where the problem is broken down into a hierarchy so that it becomes more simple, structured, and systematic. The AHP is used to select the most dominant and best alternative with several criteria through organizing information and judgment [15, 16].

The waste management policy at the IWM site involving the community is undoubtedly strategic. Based on the description of the research problem, the research aims to determine the priority strategy for waste management policies at the IWM site. This study is considered essential and strategic if it is associated with one of the main orientations of the DKI Jakarta government, namely, the development of the IWM strategy through the application of environmentally friendly technology and a more coordinated approach.

2. Method

2.1. Study design

The study design of this study is AHP (analytical hierarchy process) analysis method was used to measurable priority options regarding integrated Jakarta waste management policies at the IWM site. Research was conducted in April – July 2021. The research location is around the IWM site in Bantargebang District, Bekasi City.

2.2. Sample

Sample of this study is integrated waste management system dan policy.

2.3. Instrument

Instrument of this research is a questionnaire design according to the AHP standard [17].

2.4. Data collection procedure

Data was collected from expert interviews through the snowball method using a questionnaire. Several previous studies have applied questionnaire design with AHP standards to determine alternative priorities for waste management [8, 18, 19]. The second step in using the AHP method is to elicit the experts' judgments and represent them in a comparison matrix for the elements concerning the selected criteria and a comparison matrix to compare the requirements. The expert respondents' assessments were then combined to obtain a decision-making model.

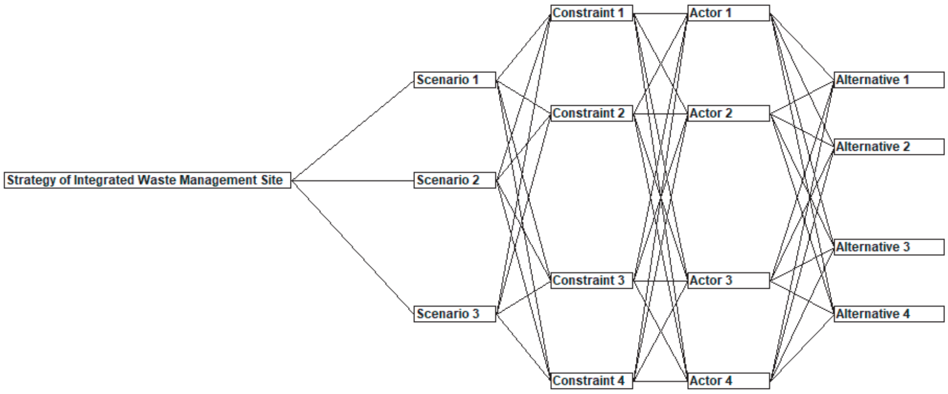

Figure 1: AHP Hierarchy: Priority Strategy Integrated Waste Management Site.

2.5. Data analysis

The research analysis technique used a hierarchical analysis process approach (AHP) with the help of Expert-Choice software. The AHP method uses the following procedures: a) the preparation of a five-level hierarchical structure, namely Level 1, The goal to be achieved. Level 2 Scenario options: development of IWM management, expansion of IWM Site, and strengthening of regulations. Level 3 Constraints of the existing situation: Conflict of interest in the IWM Site, implementation of rules enforcement, limited funding, adequacy of government human resources. Level 4 Stakeholder actors: Government, Private, NGO, Community. Level 5 Alternative priority strategies for IWM management: Enhanced collaboration and coordination of stakeholders, Human Resources Development, Development of Infrastructure, and Regulations for managing waste utilization. The AHP hierarchical structure diagram of the priority strategy for the IWM site policy is presented in Figure 1.

The performance sensitivity graph is an expert's choice based on the data submitted by the respondents. The chart is to calculate the priority of the elements as a priority forecasting and modifier of the simulated strategy alternatives. Expert choice provides a helpful feature where the process at this stage applies a comparison matrix towards prioritizing among the options given. The performance sensitivity graph is displayed in a different color. On the x-axis, three criteria are seen in this case scenario 1,2,3 used in the model, and on the y-axis, on the right side, one can see the overall score of all software products (alternatives). The sum of these overall scores equals 1 or 100%, according to the AHP methodology. The performance sensitivity graph is an expert's choice based on the data submitted by the respondents. The chart calculates the priority of elements for priority forecasting and changes to the simulated strategy alternatives.

Expert selection provides a helpful feature where the process at this stage applies a comparison matrix toward prioritizing among the options given. The performance sensitivity graph is displayed in a different color. On the x-axis, three criteria are seen in this case scenario 1,2,3 used in the model, and on the y-axis, on the right side, one can see the overall score of all software products (alternatives). This total score equals 1 or 100%, according to the AHP methodology.

3. Result

The hierarchical analysis process (AHP) analysis obtained the form of performance sensitivity graph conditions as shown in Figure 2 and dynamic sensitivity graphs as shown in Figure 3. Where both graphs are known, there are three scenarios for IWM site, namely Scenario-1 Development of IWM site, Scenario-2 Expansion of the IWM Site, and Scenario-3 Strengthening of regulations, overall choosing alternative strategy 2, namely increasing human resources (HR) as a priority for policy programs to support the IWM site in Bantargebang Bekasi.

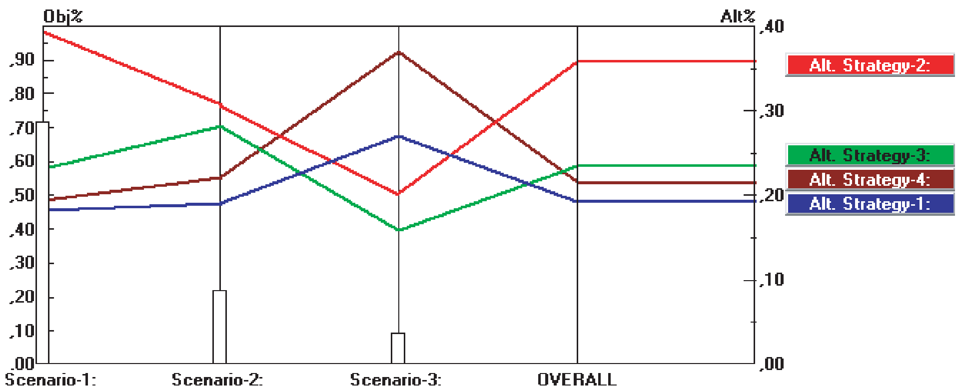

Figure 2: Performance Sensitivity Graph.

The most crucial is to increase human resources, especially in the internal IWM site. The number of operational employees at the IWM site is still tiny. IWM site, on average, accommodates around 7,500 tons of waste a day, so 500-700 people are needed to process waste. The amount of energy is for the operation of heavy equipment, which amounts to dozens of units, technicians, workers assigned to the plastic waste recycling section, compost or planting media workers, operators in the power plant engine section, and so on. The number of human resources does not include office staff, field supervisors, equipment guards, and heavy equipment technicians. It was coupled with the human resources in the power plant unit, as many as 59 people, in the

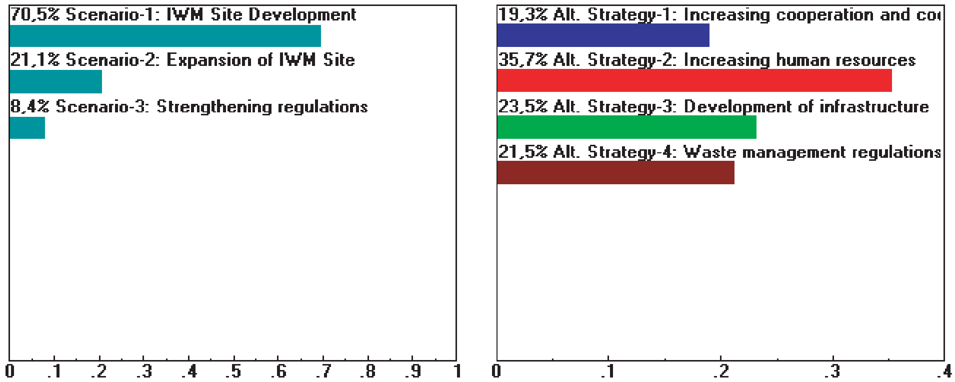

Figure 3: Dynamic Sensitivity Graph.

compost and plastic waste recycling. The strong dependence of waste management on the availability of sufficient human resources is also found in the research of [2], [5], [6], [7], and [18].

Although the policy program Alternative Strategy-4: Waste utilization governance regulations is the best concerning "Scenario-2", Alternative Strategy-2: Human resource improvement ranks as the top policy program, as it has the highest score concerning all other criteria (except "Scenario-3 Assessment", where the alternative program strategies 1 and 4 are superior). Alternative Strategy-4: Waste utilization management regulations were also observed to show superiority concerning the criteria of "Scenario-1 Development of IWM site" and Alternative Strategy-3: Development of infrastructure. Thus, these two policy programs are suitable for competing policies in the IWM site where scenario-1,2, namely the Development of the IWM site and expansion, is very important to survive the existence of the IWM site in Bantargebang Bekasi. Strategies that require smooth operation and technical support can adopt alternative infrastructure development strategies. Compared to Alternative Strategy-2: Improvement of human resources, policy programs Alternative Strategy-3: Development of infrastructure is lower concerning all criteria so that policymakers may choose Alternative Strategy-2: Improved human resources over Alternative Strategy-3: Development of infrastructure. However, the policy program Alternative Strategy-3: Development of infrastructure can be a good alternative by expanding the IWM Site to areas that are already operating. Alternative Strategy-1: Increased cooperation and coordination of stakeholders, which is the lowest policy alternative. Implementing Alternative Strategy-1 in the long term is more effective in implementing Scenario-3: Strengthening regulations. This program choice is suitable for developing IWM management areas through a policy involving wider community and stakeholder interactions and supported by strengthening existing laws.

In the existing condition, it is known that the performance sensitivity graph, as shown in Figure 2, shows the alternative priorities of HR improvement strategies. In the next term, the IWM site development program successively alternative strategies 3, 4, and 1, namely the development of facilities and infrastructure and waste management regulations at the end of the development program to increase cooperation and coordination of stakeholders. Suppose it is linked to the performance sensitivity graph in Figure 3. In that case, the selection of HR improvement strategies as an alternative priority due to the decision to allocate resources for scenario-1 development of the IWM site is 70.5% of the total resource allocation of 100%. On the other hand, the allocation for scenario 2 is the expansion of the IMW site by 21.1% and scenario 3, namely the strengthening of regulations by 8.4%. The large proportion of resource allocation for scenario-1 development of the IWM site has implications for adjusting the increase in human resources (HR) and increasing human resources by recruiting selected employees according to the needs of leadership, coaching, and career development [18]. In the existing condition, developing the IWM site needs support by increasing human resources. The main focus of improving its human resources is on the managerial and operational aspects. It is because the allocation of resources is intended for scenario-1, namely the development of IWM management, meaning that the presence of competent operators and regulators who have a strong commitment will determine the success of the selected scenario [5, 20].

4. Discussion

The IWM site implementation unit manages repairs and improvements to facilities and infrastructure for the smooth operation of operational activities on the IWM Site. This shows that there has been progress in implementing the IWM site's revitalization. The arrangement starts with repairing the weighbridge I and weighbridge II, the construction of a new three-story office for the administration section equipped with administrative support equipment for employees, operational vehicle washing facilities, workshops or heavy equipment workshops, and so on. The readiness and adequacy of the provision of facilities and infrastructure in the waste management area determine the success of the revitalization program [1, 6, 20].

Through governance regulations, waste utilization programs have reduced the volume of waste transported to the IWM site. The DKI Jakarta Provincial Government has reduced waste generation by providing 3R IWM site facilities distributed at the sub-district level. In addition, there are 3⌧5 units of energy waste processing facilities, which are predicted to have a waste reduction capacity of around 18 million m^3. The strategy for developing a waste processing area at the IWM site needs to respond to the acceleration of providing facilities for processing waste to energy, namely electricity based on environmentally friendly technology, as mandated in Presidential Decree No. 35 of 2018. According to Sukwika and Noviana [20], there are strategic values in the development of PLTSa, such as acceleration and a significant reduction in the volume of reduced waste that is environmentally friendly. Several other studies also found the value of investment efficiency and economic benefits from constructing PLTSa [12-14, 21]. Based on DKI Jakarta Governor Regulation No. 50 of 2016 through the Provincial Government supports the reduction of waste in cities, the evidence is in the construction and operation of intermediate processing facilities (ITF). Until 2020, DKI Jakarta has four ITF units. Technology-based processing equipment can reduce waste by 2 thousand tons per day. The provision of this ITF tool indicates the city's prerequisites for achieving an innovative environment and smart living.

The use of ITF waste processing technology can have a positive impact on reducing the duration of transportation and the volume of shipments. Besides producing electrical energy to support processing operations, the ITF also has other useful functions for Jakarta residents [2, 20]. Through increased cooperation and coordination of stakeholders, the implementation of ITF in densely populated settlements prevents the emergence of social conflicts due to waste. Several other studies have stated that ITF can avoid social conflicts due to waste [22, 23]. The presence of new technology is not necessarily a perfect solution. Inaccuracy in designing the ITF system could potentially lead to further problems when the ITF operates, such as investment support and operational financing; air pollution control, B3 waste treatment and fly ash and bottom ash (FABA); and the emergence of health problems in the surrounding community. Therefore, collective support during the ITF design stage is very much needed, especially when determining the development location to obtain sustainable benefits from environmental, social, and economic aspects [20, 24].

Simulations on the hierarchical analysis process (AHP) can be performed to obtain an overview of the trade-off changes in resource allocation. Suppose the choice that

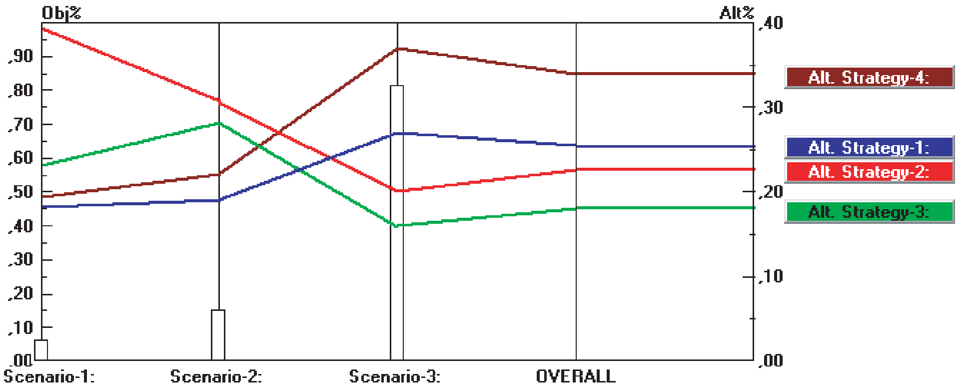

Figure 4: Performance sensitivity graph: Strategy-4 simulation as a priority.

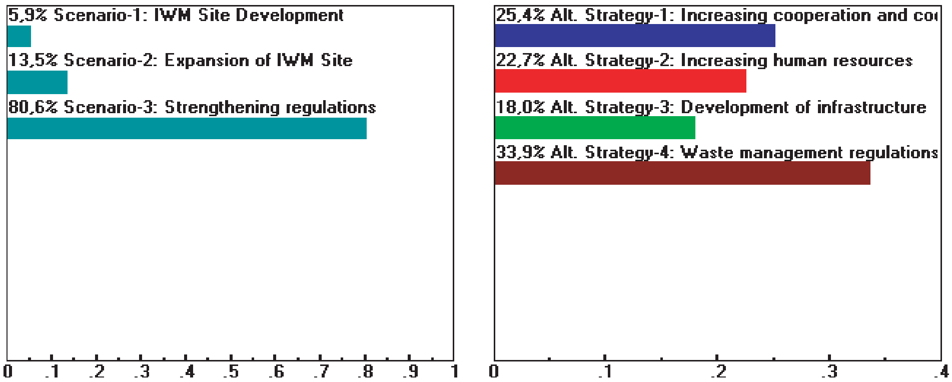

Figure 5: Dynamic sensitivity graph: Strategy-4 simulation as a priority.

becomes the priority is strategy 4 Regulations for managing waste utilization to support the direction of the IWM site. In that case, the scenario that needs to be done is to interpolate the performance sensitivity graph.

Based on Figure 3 presented above, the bars on the x-axis indicate the relative importance given to each of the seven criteria by the decision-maker (whose values are shown on the left-hand side of the y-axis). Alternative Strategy-1 decision-makers can interactively change the length of the bar and observe how the rankings and priorities of strategic alternatives change. As the size of a bar increases, the weight of the corresponding criterion also increases. For example, when the bar height according to the measure "Scenario-3": Strengthening of regulation" (second bar from left) is increased sufficiently, Alternative Strategy-4 becomes the best policy strategy, as shown in Figure 4. The reason is that the weight of the criterion "Scenario-3", where Alternative Strategy-4 dominates, is rising in the chart. The performance sensitivity chart changes as the "Scenario-3" bar is interactively lifted, elevating Strategy-4 Alternative to the highest position.

In Figure 4, it can be seen that the condition of the performance sensitivity graph changes after the simulation is conducted. For example, policy makers want an alternative strategy for the development of the IWM site , namely Strategy-4 as the chosen priority. In that case, the simulation that must be carried out is to reduce Scenario-1 from 70.5% (the initial proportion position in Figure 2) to 5.9%. Likewise, Scenario-2 from the part of 21.1% was lowered to 13.5%. Furthermore, in Scenario-3, the proportion of resource allocation is increased by ten times from 8.4% to 80.6% of the total resource allocation of 100%. In Figure 5, after the performance sensitivity graph simulation is performed, a dynamic shift phenomenon occurs. In the picture, it can be seen that there is a change in alternative priorities from Strategy-2 to increase human resources to strategy-4 for waste management regulations. This shift results from allocating 80.6% of resources for strengthening laws. On the other hand, as a trade-off, the allocation of resources in Scenario-1 and Scenario-2, namely the development of IWM management and expansion of the IWM Site, needs to reduce the allocation proportionally.

Based on the simulation results, it is known that strategy-4 for waste management regulations will be a priority in the future. So that prevention of waste problems can be done by improving regulations on the management of waste utilization. Especially with regard to Law Number 18 of 2008 and Regional Regulation of DKI Jakarta Number 3 of 2013 [2, 20, 25]. Policies issued to improve cooperation and coordination of stakeholders and the informal sector that have contributed to waste management with 3R. Namely, reduce, reuse, and recycle [11, 26, 27].

Finally, the strategy for developing infrastructure and strengthening collaboration and coordination of stakeholders can be implemented in an integrated manner. For example, the construction of facilities and infrastructure for ITF incinerators in dense settlements can prevent social conflicts due to waste [22-24]. However, it is still necessary to conduct a risk and disaster assessment of the existence of the ITF which has the potential to cause new problems from environmental and social aspects.

5. Conclusion

The conclusion of the research is that it has succeeded in determining the priority strategy for waste management policies at the IWM site, namely increasing reliable human resources. The second priority strategy is the development of facilities and infrastructure. The next priority strategy is strengthening waste management regulations and establishing collaboration and coordination across stakeholders. While the simulation results show a change in priority which is waste management regulations become a priority in the future.

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Conflict of Interest

We declare that we have no competing interest as the author.

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