

WASTE BANK POLICY AS SOCIAL ENGINEERING BASED ON THE GREEN ECONOMY CONCEPT IN THE MALANG CITY, INDONESIA

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Abstract

On average, each person in Indonesia generates 0.45 kg of waste a day. The country is home to 231.8 million people, so the average daily waste generated is approximately 104.31 million kg. Malang, one of the biggest cities in East Java Province, generated 1,790.5 m³ of waste in 2001. Bank Sampah Malang (BSM), a waste bank program, has been established as a social engineering project to socialize and educate waste management in the community. The Malang Waste Bank (BSM) management policy was made as social engineering, providing socialization and education to the community to manage waste. This study aims to analyze the BSM policy by using the Analytic Hierarchy Process (AHP). Information from informants about policy evaluation shows that AHP consists of criteria, sub-criteria, and policy determination based on a green economy concept. The green economy includes economic, social, and environmental/ecological aspects. To sum up, BSM policy as the priority of social engineering requires institutional and environmental support as well as information availability.

Keywords:

AHP;
Green economy;
Social engineering;
Malang waste bank;
Waste management.

1 Introduction

Human activities generate waste. The amount of waste generated is proportional to the consumption levels of daily goods, and the materials people use daily determine the types of waste generated. In addition, given that waste volume is positively correlated with population growth, the increase in population and varied lifestyles in these modern days have profoundly affected the amount of waste generated. Since waste is closely related to people's lifestyles, waste management cannot be separated from our everyday lives.

Data from the Indonesian Waste Statistics in 2008 shows that each person in Indonesia generates an average of 0.45 kg of waste daily. The country is home to 231.8 million people, so the average daily waste generated is approximately 104.31 million kg [1]. This massive amount of waste certainly needs a vast landfill for dumping; however, as landfill capacity is limited, it can only accommodate about 30% of all waste generated [2]. A similar situation also happens in Malang, a city in East Java Province. Data from the Sanitation Department of Malang City in 2021 shows that the city generated 1,790.5 m³ of waste.

The Sanitation and Landscaping Department of Malang City mentions that waste always increases, but the landfill capacity is limited. Approximately 69% of landfill waste is generated from domestic and 31% from non-domestic waste [3]. Thus, a sound understanding and practice of waste management are needed. The government of Malang City has initiated the implementation of the 3R (Reduce, Reuse, and Recycle) concept in waste management, following the zero waste initiative of the green economy [4]. The green economy starts with a recommendation for efficient use of resources to minimize waste. This is applied to industrial or product activities aimed at achieving zero emissions [5]; science-based creativity is needed to implement the principles of the green economy [6].

Bank Sampah Malang (BSM), or Malang Waste Bank, is established to reduce waste generation toward a zero-waste objective. This initiative surely needs community assistance or participation, and efforts have been made to attract public attention. Regional Regulation of Malang City Number 10 of 2010 concerning Waste Management puts BSM under operation since 2011. BSM attracts public attention through several unique offers. People can exchange a certain amount of domestic inorganic trash with groceries (such as rice, sugar, and oil), borrow money from BSM and pay the debt with inorganic trash deposited to BSM, and deposit inorganic trash to be exchanged with money saved in their accounts managed by BSM. Thus, in addition to helping people manage their waste, BSM also aims to improve public welfare.

Regulation by the Government of the Republic of Indonesia Number 81 of 2012 concerning the Management of Household Waste and Waste Similar to Household Waste regulate waste reduction, including limiting waste generation, recycling of waste, and reusing materials; BSM's operation is based on the Regulation and is made a social engineering effort since it provides the public with socialization and education on waste management. BSM has shown a positive impact in terms of waste reduction and economic improvement for the local community of Malang City. Wulandari et al. [7] mention that the waste bank management model helps create a cleaner environment and increase the income of households around the waste bank.

Managing household waste these days has been challenging because it consists of too many plastic items that can harm the environment [8, 9]. Nandi et al. [10] urge proper waste management and innovative ideas for new sustainable technologies. Research on tackling noise pollution with risk management methods mentions using systematic steps to identify existing and potential negative phenomena, including revealing the possibility of phenomena occurring, assessing and measuring the negative consequences of such phenomena, and proposing a model to solve environmental problems [11]. The green economy concept has been challenged with environmental problems. The concept is the foundation for BSM as a social engineering effort to raise the community's awareness and understanding of waste management. This study involved five (5) informants, including two representatives of BSM customers, one of the government office responsible for environmental management, and two of the general public. This research was conducted at the beginning of 2022 amid the Covid-19 pandemic.

2 Materials and methods

2.1 Research design and respondents

The research design is a policy analysis related to the management of the Malang Waste Bank as social engineering. The objects studied are policymakers related to the Malang Waste Bank in Malang City. A tool for determining policies using The Analytic Hierarchy Process (AHP). This method was developed by Thomas L. Saaty [15], which describes various hierarchically complex factors. The main tool of The Analytic Hierarchy Process (AHP) is a functional hierarchy with the main input being human perception. A hierarchy allows complex or unstructured problems to be broken down into sub-problems, then arranged into a hierarchical form [16]. The description starts by identifying the problem and then is structured as a model. This tool can be used to analyze policies [17]. In this study, five (5) informants, namely: two representatives of Malang Waste Bank customers, one representative of the Government for the Environment, and two representatives of the general public. This research was conducted at the beginning of 2022 and is still in the Covid-19 pandemic by implementing health protocols.

2.2 Data collection

Data collection based on the application of AHP is shown in Fig. 1 as follows.

Assessment of the BSM policy as a social engineering effort was done based on the data collected using questionnaires distributed to various relevant parties playing a role in the policy. AHP calculates the weighting of criteria, sub-criteria, and policy determinations, described as follows:

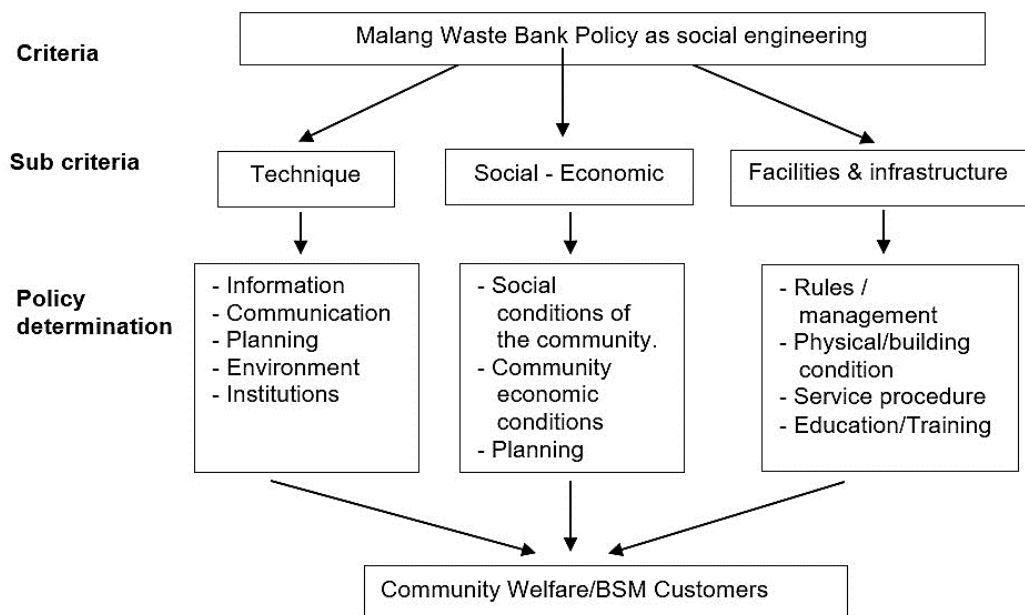


Fig. 1: AHP structure, BSM policy.

We obtained three (3) criteria: technical, socio-economic, and infrastructure and facilities. Each criterion has more detailed sub-criteria. The technical sub-criteria are information, communication, planning, environment, and institutions. Socio-economic sub-criteria consist of the community's social and economic conditions and planning. The sub-criteria for infrastructure and facilities are rules or management, physical or building conditions, service procedures, and education and training.

2.2.1 AHP method in calculation of criteria weight

Weight calculation of the criteria was carried out with the Microsoft Excel program, and each respondent was tested for data consistency. The results of the relative weights of the combined criteria by five respondents are presented in Table 1.

Table 1: Calculation of criteria weight.

Criteria	Technical	Socio-economic	Infrastructure	Number of rows	Normalized eigen vector	%	Priority
Technical	0.53	0.89	0.60	2.03	0.676	68 %	I
Socio-economic	0.14	0.03	0.02	0.20	0.066	7 %	III
Infrastructure	0.33	0.07	0.37	0.78	0.258	26 %	II

Table 1 shows that the technical criteria have the highest priority vector, with an interest percentage of 68%. Infrastructure and facility have the second highest priority vector, with an interest percentage of 26%. Socioeconomic criteria have the lowest priority, with an interest percentage of only 7%. After calculating the weights of the five respondents' combined criteria, the following process is calculating the weight of the five respondents' combined sub-criteria. The calculation of weights of the technical sub-criteria using a pairwise comparison is presented in Table 2, the socio-economic sub-criteria in Table 3, and the infrastructure and facility sub-criteria in Table 4.

Table 2: Calculation of the weight of the technical sub-criteria.

Criteria	Sub-criteria	Information	Communication	Planning	Environment	Institutions	Total	Eigen vector normalisasi	%	Priority
Technical	Information	0.15	0.15	0.34	0.180299	0.101029	0.92	0.184968	18 %	III
	Communication	0.10	0.10	0.18	0.19285	0.054201	0.62	0.12499	12 %	IV
	Planning	0.03	0.03	0.06	0.174825	0.054201	0.34	0.068281	7 %	V
	Environment	0.23	0.13	0.09	0.266081	0.465361	1.18	0.23576	24 %	II
	Institutions	0.49	0.59	0.34	0.185944	0.325207	1.93	0.386002	39 %	I

Table 2 shows that the technical sub-criterion with the highest priority vector is institutions, with an interest percentage of 39%. The sub-criterion of environment comes second, with an interest percentage of 24%. The third highest priority vector is information, with an interest percentage of 18%.

Table 3: Calculation of the weights of the socio-economic sub-criteria.

Criteria	Sub-criteria	Community social conditions	Community economic conditions	Planning	Total	Eigen vector normalisasi	%	Priority
Social-economic	Community social conditions	0.56	0.61	0.82	2.69	0.672678	67 %	I
	Community economic conditions	0.19	0.14	0.06	0.55	0.177375	18 %	II
	Planning	0.20	0.21	0.09	0.58	0.145477	15 %	III

Table 3 shows that the sub-criterion of socio-economic with the highest priority vector is the community's social conditions, with an interest percentage of 39%. The sub-criterion of the community's economic conditions follows, with an interest percentage of 18%. The third highest priority vector is planning, with an interest percentage of 15%.

Table 4: Calculation of sub-criteria for infrastructure facilities.

Criteria	Sub-criteria	Rules/ Management	Physical/Building condition	Service procedure	Education/ Training	Total	Eigen vector normalisasi	%	Priority
Facilities-Infrastructure	Rules/Management	0.1518	0.20	0.10	0.06	1.17	0.19	19 %	II
	Physical/Building condition	0.1046	0.14	0.09	0.19	0.77	0.13	13 %	IV
	Service procedure	0.3398	0.20	0.55	0.11	1.59	0.51	51 %	I
	Education/Training	0.0301	0.20	0.10	0.36	1.00	0.17	17 %	III

Table 4 shows that the infrastructure and facility sub-criterion with the highest priority vector is service procedure, with an interest percentage of 51%. The sub-criterion of rules or management comes second, with an interest percentage of 19%. The third highest priority vector is education or training, with an interest percentage of 17%.

2.2.2 Calculation of the relative weight of each sub-criteria

After calculating the weights of combined criteria and sub-criteria, the next step was determining the weight of each criterion. To determine the relative weight of each criterion, the first step was to calculate the relative percentage according to the percentage importance of each criterion. The formula used to calculate the relative percentage is as follows:

Relative Proportion Formula

$$\text{Relative \% of Sub - Criteria} = \frac{\text{Criteria \%}}{100} \times \% \text{ Eigenvector normalized subcriteria} . \quad (1)$$

After obtaining the relative percentage of sub-criteria, then the percentage is distributed according to the weight grouping as follows:

Table 5: Weight grouping presentation.

Relative percentage	Relative weight
0 – 8,83 %	1
8,84 – 17,67 %	2
17,68 – 26,52 %	3

The calculation results of the relative weight of each criterion are presented in Table 6.

Table 6: Calculation of the relative weight of each criterion.

Priority	Criteria	Criteria percentage	Sub-criteria	Normalized eigen vector percentage	Relative percentage	Relative weight
Priority I	Technical	68 %	Institutions	39 %	26,52 %	3
			Environment	24 %	16,32 %	2
			Availability of information	18 %	13,26 %	2
			Communication	12 %	12,24 %	2
			Planning	7 %	8,16 %	1
Priority II	Facilities-Infrastructure	26 %	Service Procedure	51 %	4,94 %	1
			Rules/Management	19 %	4,76 %	1
			Education/Training	17 %	4,69 %	1
			Physical/Building Condition	13 %	4,42 %	1
Priority III	Socio-economic	7%	Community Social Conditions	67 %	3,38 %	1
			Community Economic Condition	18 %	1,26 %	1
			Planning	15 %	1,05 %	1

2.2.3 Scoring method in determining BSM policy as social engineering

Weighting is a decision-making technique that simultaneously involves various factors by giving weight to each. It can be done objectively with statistical calculations or subjectively by assigning it based on specific considerations. Subjective weight determination must be based on an understanding of the process. This score is assessed based on the ranking of sub-criteria. The following is the value of the sub-criteria for determining BSM policy as a social engineering effort.

Table 7: Value of sub-criteria in determining bsm policy as social engineering.

Criteria	Sub criteria	Weight
Technical	Information	2
	Communication	2
	Planning	1
	Environment	2
	Institutions	3
Socio-economic	Community social conditions	1
	Community economic conditions	1
	Planning	1
Facilities-infrastructure	Rules/Management	1
	Physical/Building condition	1
	Service procedure	1
	Education/Training	1

2.3 Data analysis

Data analysis was done based on scoring results. A score assesses each sub-criterion from the highest to the lowest. The higher the score, the higher the priority level of the policy. The following are weighting results from scoring informants' answers to questionnaire items.

2.3.1 Informant 1

The following is the recapitulation and calculation results obtained from scoring the answers of Informant 1. The determination of BSM policy as social engineering is described in Table 8.

Table 8: Informant 1 scoring in determining Malang waste bank policy as social engineering.

Criteria	Sub criteria	Weight	Value	Score (Weight x Value)
Technical	Information	2	5	10
	Communication	2	4	8
	Planning	1	4	4
	Environment	2	5	10
	Institutions	3	4	12
Socio-economic	Community social conditions	1	4	4
	Community economic conditions	1	5	5
	Planning	1	4	4
Facilities-Infrastructure	Rules/Management	1	4	4
	Physical/Building condition	1	4	4
	Service procedure	1	4	4
	Education/Training	1	4	4

2.3.2 Informant 2

The following is the recapitulation and calculation results obtained from scoring the answers of Informant 2. The determination of BSM policy as social engineering is described in Table 9.

Table 9: Scoring of informants 2 in determining Malang waste bank policy as social engineering.

Criteria	Sub Criteria	Weight	Value	Score (Weight x Value)
Technical	Information	2	5	10
	Communication	2	4	8
	Planning	1	3	3
	Environment	2	5	10
	Institutions	3	5	15
Socio-economic	Community social conditions	1	3	3
	Community economic conditions	1	3	3
	Planning	1	3	3
Facilities-Infrastructure	Rules/Management	1	5	5
	Physical/Building condition	1	5	5
	Service procedure	1	5	5
	Education/Training	1	4	4

2.3.3 Informant 3

The following is the recapitulation and calculation results obtained from scoring the answers of Informant 3. The determination of BSM policy as social engineering is described in Table 10.

Table 10: Scoring of informants 3 in determining Malang waste bank policy as social engineering.

Criteria	Sub criteria	Weight	Value	Score (Weight x Value)
Technical	Information	2	4	8
	Communication	2	5	10
	Planning	1	4	4
	Environment	2	4	8
	Institutions	3	5	15
Socio-economic	Community social conditions	1	4	4
	Community economic conditions	1	4	4
	Planning	1	4	4

Criteria	Sub criteria	Weight	Value	Score (Weight x Value)
Facilities-Infrastructure	Rules/Management	1	5	5
	Physical/Building condition	1	5	5
	Service procedure	1	5	5
	Education/Training	1	4	4

2.3.4 Informant 4

The following is the recapitulation and calculation results obtained from scoring the answers of Informant 4. The determination of BSM policy as social engineering is described in Table 11.

Table 11: Respondent's score 4 in determining Malang waste bank policy as social engineering.

Criteria	Sub criteria	Weight	Value	Score (Weight x Value)
Technical	Information	2	5	10
	Communication	2	4	8
	Planning	1	4	4
	Environment	2	5	10
	Institutions	3	4	12
Socio-economic	Community social conditions	1	3	3
	Community economic conditions	1	4	4
	Planning	1	3	3
Facilities-Infrastructure	Rules/Management	1	4	4
	Physical/Building condition	1	3	3
	Service procedure	1	4	4
	Education/Training	1	3	3

2.3.5 Informant 5

The following is the recapitulation and calculation results obtained from scoring the answers of Informant 5. The determination of BSM policy as social engineering is described in Table 12.

Table 12: Scoring of informants 5 on the determination of Malang waste bank policy as social engineering.

Criteria	Sub criteria	Weight	Value	Score (Weight x Value)
Technical	Information	2	4	8
	Communication	2	4	8
	Planning	1	4	4
	Environment	2	5	10
	Institutions	3	4	12
Socio-economic	Community social conditions	1	3	3
	Community economic conditions	1	3	3
	Planning	1	3	3
Facilities-Infrastructure	Rules/Management	1	4	4
	Physical/Building condition	1	3	3
	Service procedure	1	4	4
	Education/Training	1	3	3

From the tables above, the following conclusions are drawn.

Table 13: Final result of scoring in determining Malang waste bank policy as social engineering.

Criteria	Sub criteria	Value x Weight					Total
		Informan 1	Informan 2	Informan 3	Informan 4	Informan 5	
Technical	Information	10	10	8	10	8	46
	Communication	8	8	10	8	8	42
	Planning	4	3	4	4	4	19
	Environment	10	10	8	10	10	48
	Institutions	12	15	15	12	12	66
Socio-economic	Community's social conditions	4	3	4	3	3	17
	Community's economic conditions	5	3	4	3	3	19
	Planning	4	3	4	3	3	17
Facilities-Infrastructure	Rules/Management	4	5	5	4	4	22
	Physical/Building condition	4	5	5	3	3	20
	Service procedure	4	5	5	4	4	22
	Education/Training	4	4	4	3	3	18

4 Conclusion

This study aims to analyze BSM policy in Malang City using the Analytic Hierarchy Process (AHP) method. Information from the research informants related to policy evaluation confirms the following findings. First, AHP consists of criteria, sub-criteria, and policy determination based on the green economy concept. Second, using the AHP method, we achieved the objectives of strategic ranking: rating 1 – innovation, rating 2 – a supportive surrounding environment, and rating 3 – availability of complete information. This research supports BSM policy as social engineering. Our findings imply that innovation in waste management is needed to encourage people to manage their domestic waste better by collecting waste at BSM to exchange it for money or groceries; thus, waste can be managed well, reduced, reused, and recycled, and the people's income can increase.

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