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Cost Benefit Analysis for Feasibility of Waste Management Scenario (Case Study of Ganet Landfill, Tanjungpinang City)

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Abstract: The increase in the number and activities of the population will be in line with the increase in waste generation, resulting in an increase in the burden on the Ganet landfill. The current controlled landfill method can no longer manage the increasing waste load. A more efficient waste management design system is needed to minimize and prevent potential environmental damage. Waste management scenarios are designed based on the potential for waste processing at the Ganet landfill. In selecting waste management scenarios, an economic analysis is required, which is key in designing an effective waste management system. Cost Benefit Analysis (CBA) is used as an economic assessment of the 4 scenarios designed, namely scenario 0 (controlled landfill), scenario 1 (utilization by scavengers, composting and controlled landfill), scenario 2 (utilization by scavengers, composting, pyrolysis and controlled landfill) and scenario 3 (utilization by scavengers, composting, pyrolysis, paving block making and controlled landfill). The cost and benefit components were identified for each waste treatment process. The waste processing that costs the most is controlled landfill in scenario 0 amounting to IDR 8,326,123,157.87, while the waste processing process that produces the greatest benefit value is the manufacture of paving blocks amounting to IDR 158,392,662.33. The results of the Cost Benefit Analysis calculation show a Benefit Cost Rasio (BCR) value of 1.91, Net Present Value (NPV) of 8,448,737,857.40 and the fastest Payback Period (PP) of 5 months is scenario 3. This shows that the scenario is economically feasible to do. The results of this study are expected to be a consideration in the policy formulation related to waste management at the Ganet landfill.

Keyword: CBA, economy, landfill, management, waste

INTRODUCTION

Landfill is a location where waste is processed and returned to the environment in a manner that is safe for humans and the environment (Kementerian Pekerjaan Umum dan

Perumahan Rakyat, 2023). Landfill acts as the last stage in waste management, in accordance with the definition regulated in Law No. 18/2008 2008 about Waste Management. According to the law, landfill serves as a place for processing and returning waste to the environment, and is not a place for final disposal. Instead, the landfill is designed as a facility to process waste in a safe and environmentally friendly method.

Along with the increasing population growth, the amount of waste generated will also be affected (Suryono et al., 2021). TPA Ganet is the final waste processing site in Tanjungpinang City, facing challenges due to the increasing population. Data from the Tanjungpinang City Statistics Agency in 2020 recorded an increase in population of 4.30% from 2018 to 2020. This increase is in line with the increase in waste generation entering the Ganet landfill by 4.38% (UPTD TPA Ganet, 2020). This situation shows that the Ganet landfill load continues to increase, resulting in the need for more effective solutions in waste management.

The existing controlled landfill method can no longer manage the increasing waste load. The results of Chemical Oxygen Demand (COD) measurements at the Ganet landfill leachate treatment outlet in December 2021 reached a value of 983 mg/l, exceeding the established quality standards (Minister of Environment and Forestry of the Republic of Indonesia 2016; UPTD TPA Ganet 2021). Therefore, a more efficient waste management system is needed to minimize waste entering landfills and prevent potential environmental damage.

Based on the pre-survey conducted, currently Ganet Landfill has been equipped with several waste management infrastructure facilities such as composting, pyrolysis, and paving block making, but a more integrated and efficient waste management system design is needed. Existing potential, such as pyrolysis technology to convert waste into energy, and composting to produce organic fertilizer, must be maximized in designing the new system. Several types of waste, such as plastic, are also considered to have good economic value (Khodijah & Habibah, 2021).

Economic analysis is key in designing an effective waste management system. Using Cost Benefit Analysis (CBA), an economic evaluation can provide a comprehensive picture of the financial viability of a waste management project (Djajadiningrat et al., 2011; Kurnia, 2017). In this case, the Benefit-Cost Ratio (BCR), Net Present Value (NPV), and Payback Period (PP) indices are used as the main indicators to compare the benefits with the costs incurred (Keat & Young, 2009).

The basis for assessing whether an activity or policy is feasible requires a comparison that produces value. Generating value is crucial in the context of the impact of an activity or policy on the environment. Therefore, economic valuation is needed, which aims to show how valuation techniques can provide an estimate of the value of the entire ecosystem. This economic valuation has the main objective of providing a foundation of information that can be used in formulating policies related to ecosystems, by utilizing economic value as a guide. In this way, the resulting policies can be more informed and balanced in considering economic aspects in relation to environmental sustainability (Wawo et al., 2008).

The design of the waste management system was carried out by proposing four different scenarios. The scenarios consist of scenario 0 (controlled landfill), scenario 1 (utilization by scavengers, composting and (controlled landfill), scenario 2 (utilization by scavengers, composting, pyrolysis and controlled landfill) and scenario 3 (utilization by scavengers, composting, pyrolysis, paving block making and controlled landfill).

The result of the study is the best scenario of Ganet landfill waste management that is best seen from an economic perspective. This research is expected to be a solution to improve the efficiency and sustainability of waste management in Ganet landfill. By implementing the designed system, it is expected to reduce the burden on the landfill, prevent environmental damage, and create long-term economic benefits. This research can also be a guide for the government and related parties in making decisions related to waste management in Tanjungpinang City.

METHOD

Time and Location

This research used a qualitative approach (Ridha et al., 2022) conducted in November 2023 at the Ganet Landfill in Tanjungpinang City, Pinang Kencana Village, East Tanjungpinang District, Tanjungpinang City, Riau Islands. The research was conducted by assessing the economic aspects of the design of waste management at Ganet Landfill. The design is carried out through 4 types of waste management scenarios.

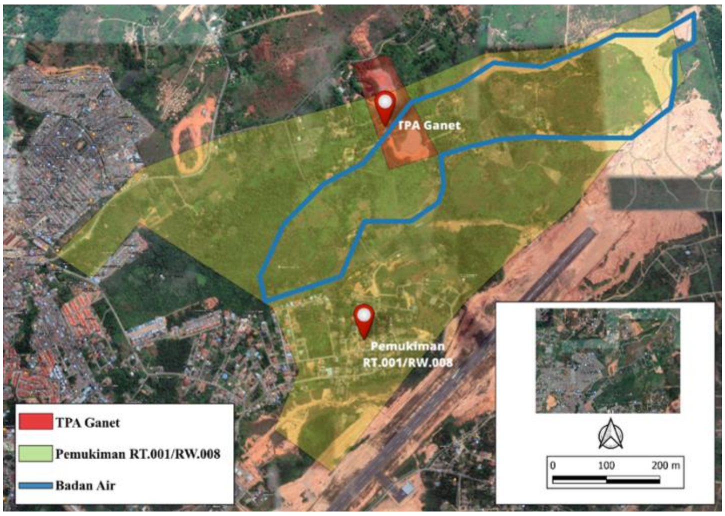

Figure 1. Research Map

Waste Management Scenario Design

Waste management scenarios are designed according to technical and environmental aspects that are in accordance with the potential of the Ganet landfill, which was identified during the pre-survey stage. These scenarios are Scenario 0 (controlled landfill), Scenario 1 (utilization by scavengers, composting and controlled landfill), Scenario 2 (utilization by scavengers, composting, pyrolysis and controlled landfill) and Scenario 3 (utilization by scavengers, composting, pyrolysis, paving block making and controlled landfill).

Population Projection

Planning is conducted by projecting the scenario to the year 2024. In this case, population and waste generation projections for 2024 are needed. The projected population in 2024 can be calculated using the geometric method.

$$P_t = P_0(1+r)^t$$

Description:

P_t = Total population in t year
P_0 = Base year population
r = Population growth rate
t = Time difference between base year and year t

The population growth rate can use the formula:

$$r = \left(\frac{Pt}{P0}\right)^{\frac{1}{t}} - 1$$

Description:
r = Population growth rate
P_t = Total population in year t
P_0 = Population of the base year
t = Time difference between base year and t year

Waste Generation Projection

The calculation of the projected waste generation in 2024 is done by multiplying the projected population in 2024 and the waste generation per person per year entering the Ganet landfill.

$$\text{2023 generation (kg/person/year)} = \frac{\left(\frac{\text{Total waste generation from January to October 2023 (kg)}}{\text{number of days from January to October 2023 (days)}}\right)}{\text{total population 2023 (person)}} \text{x365(days)}$$

2024 generation (kg/year) = 2023 waste generation (kg/org/year) x projected 2024 population (person)

Waste Composition Projection

The calculation of waste composition is based on primary data of segregated waste of Ganet landfill in 2023, so that the projection of waste composition in 2024 can be calculated by the formula:

$$\text{Weight of waste per type 2024 (kg)} = \frac{\text{\% of waste type x Total waste weight 2024}}{100}$$

The CBA Calculation

Each scenario will be analyzed for its economic value with CBA. The CBA assessment will identify the cost and benefit components in the waste management process. This method was chosen because benefit-cost analysis is a major type of environmental policy, comparing the benefits and costs of proposed actions, emphasizing the need to consider the financial consequences and benefits of environmental policies (Field, 2013).

This study considers two cost components, namely direct costs and indirect costs, which are shown in Table 1 below.

Table 1. Cost and Benefit Component

Cost/Benefit		Type Cost/Benefit	Code
Cost	Direct	**Investment Costs:**	
		Procurement cost of goods/equipment	C1
		Operating costs:	
		Wages of workers	C2
		Electricity/fuel costs	C3
		Maintenance costs:	
		Machine maintenance costs (KIR) and taxes	C4
		Building maintenance costs	C5
	Indirect	Emissions from landfilling operations	C6
		Emissions from processing activities	C7
		Health impact costs	C8
Benefit	Direct	Income from product sales	B1
		Reduction in landfill land requirement	B3
	Indirect	Reduction in CO_2 emissions from landfilling operations	B4
		Reduced emissions at landfill	B5
		Reduction in health impacts	B6

The assumptions used in the identification of benefit costs are as follows:
1. Production costs are adjusted to the procurement of goods, electricity/fuel, machine maintenance, taxes, and building maintenance.
2. Workers' wages are adjusted to the Tanjungpinang City UMR.
3. Product benefits are adjusted to market prices.

4. The calculation of the reduction in landfill land requirements is adjusted to the price of land in the Ganet neighborhood, taking into account the volume, area, and height of waste piles. The maximum height in one terrace is 3 m.
5. Calculation of costs and benefits from emissions can use the formula:
   a. CO2 emissions from heavy equipment landfilling operations can use the formula (Peraturan Menteri Lingkungan Hidup dan Kehutanan Republik Indonesia Tahun 2010):

   $$E = EF \times TD \times AV$$

   Description:
   E= Mass of CO2 (tons/year)
   EF= CO2 emission factor (g/kg) : 2,8 g/km = 0,0028 g/kg
   TD= Fuel consumption (liters)
   AV= Number of vehicles (units)

   b. CO2 emissions from composting can use the formula:

   $$\text{Emisi } CO_2 \text{ (kg)} = M \times FC \times EF$$

   Description:
   M= Amount of organic matter processed (kg)
   FC= Carbon conversion factor (0.5 kg carbon per kg organic matter)
   EF= CO2 emission factor (3.67 kg CO2 per kg carbon)

   c. CO2 emissions from landfills can use the formula:

   $$CO_2 \text{ (kg)} = M \times FC \times EF$$

   Description:
   M = Amount of waste landfilled (kg)
   FC = Carbon conversion factor (0,2)
   EF = CO2 emission factor (0.6 kg CO2 per kg or unit kg of waste)

   d. CH4 emissions from composting can use the formula (IPCC, 2006):

   $$CH_4 = \Sigma((Mi \times EFi) x 10^{-3}$$

   Description:
   Mi = Mass of composted waste (Gg)
   FC = Composting emission factor (4 g/kg)
6. Emission values were calculated and converted into CO2 equivalents using the emission price approach from USEPA (2017), where the price of 1 ton of CO2 is USD 11,6 (IDR 180.833,56).
7. CH4 emission values were converted using the LPG gas price approach. This conversion is intended that CH4 can be an energy substitute for LPG.
8. Health costs are related to waste that has the potential to cause health impacts (untreated waste). The benefits of reducing health impacts are focused on waste that has been processed (does not have potential health impacts).

   $$\text{Cos (IDR/ton)} = \left(\frac{\text{amount of untreated or treated waste (tons)}}{\text{number of patients (person)}}\right) x \text{ IDR7.000}$$

   The price of Rp. 7,000 refers to the hospital tariff in the Regulation of the Minister of Health of the Republic of Indonesia Number 69 of 2013 for general diseases.

The cost component analysis involves summing up the cost values of a scenario to calculate the total cost (net cost) of each planned scenario. In contrast, the benefit component analysis involves summing up the benefit values of each scenario to obtain the total benefit (net benefit). With reference to Table 1, the net cost and net benefit equations can be interpreted as follows:

$$\text{Net cost} = C1+C2+C3+C4+C5+C6+C7+C8$$
$$\text{Net benefit} = B1+B2+B3+B4+B5+B6$$

Then, the cost and benefit components were calculated to obtain the Benefit-Cost Ratio (BCR), Net Present Value (NPV), and Payback Period (PP) indices using the following formulas:

1. BCR

BCR= Net benefit / Net cost

BCR is used to assess the feasibility of the business being conducted. BCR assessment is carried out in a way:
BCR>1, the business is feasible
BCR<1, business is not feasible
BCR=1, getting benefits that are comparable to costs but not at a loss.

2. NPV

$$NPV= \left\{ \frac{P}{(1-I)^t} \right\} -C$$

Description:
P = Cash inflow
i = Discount rate
t = Investment period
C= Initial investment
NPV is used to assess the feasibility of a project or investment from a financial perspective. NPV assessment is done in a way:
NPV>0, the business can be run or continued
NPV<0. Business is rejected or should not be continued
NPV=0, the business is implemented or not implemented, will not have an impact

3. PP

PP= Investment / Net cash per year

PP is used to assess the payback period used to assess how quickly the initial investment of a project or investment can be returned through the cash flow generated. The way of decision making is if the payback period is shorter than the expected period, then the project or investment is considered profitable

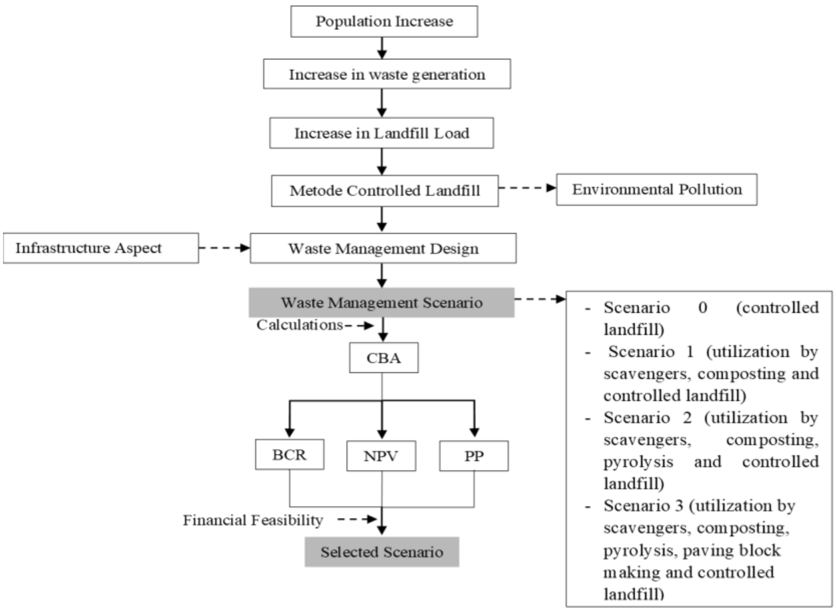

Figure 2. Research Framework

RESULT AND DISCUSSION

Population Projection

The projected population of Tanjungpinang City in 2024 is calculated by referring to the population data of Tanjungpinang City for the last 5 years (2018-2022). The data in Figure 2 shows the total population for 2018-2022, and the calculated population projection for 2023-2024.

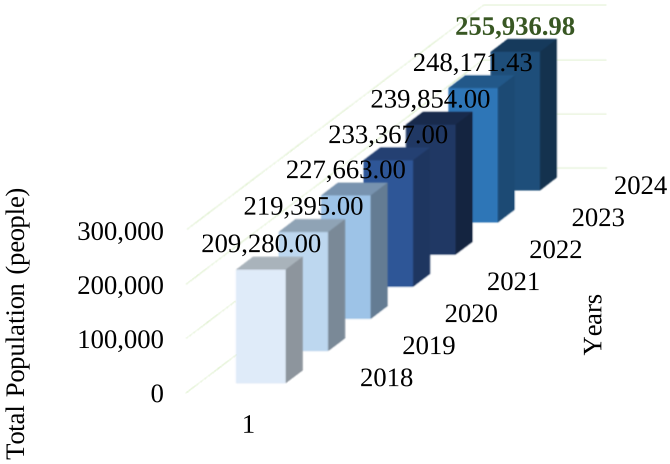

Figure 3. Population for the Last 5 Years (2018-2022) and Population Projection Results for 2023-2024
Source: BPS Kota Tanjungpinang, 2022 and calculation results, 2023

It is known that there is an increase in population in 2023-2024 by 3.3%, this can also be one of the factors causing an increase in the amount of Tanjungpinang City waste that goes to the Ganet Landfill. Along with the increasing population growth, the amount of waste generated will also be affected (Suryono et al., 2021). Perubahan populasi dapat mempengaruhi karakteristik sosial, ekonomi, dan demografi suatu wilayah (Ismail, 2022).

Waste Generation Projection

Calculating the projected waste generation in 2024 requires data on the waste generation that entered the Ganet landfill in 2023.

Table 2. Waste generation in January-October Year 2023

Month	Waste Generation (Kg)
January	2.504.910,00
February	2.241.500,00
March	2.734.870,00
April	2.743.510,00
May	2.662.550,00
June	2.625.240,00
July	2.462.330,00
August	2.727.280,00
September	2.317.350,00
October	2.904.130,00
Total	25.923.670,00
Average per month	2.592.367,00
Total Generation 2023	31.125.459,05
Average per person per year	125,42

Source: Primary Data of Ganet Landfill and Calculation, 2023

So that the projected waste generation in 2024 can be known by:
2024 waste generation (kg/year) = 2023 waste generation (kg/org/year) x projected 2024 population (org)
= 125,42 x 255.937
= 32.099.408,35 kg/year
= 32.099,41 tons/year

Based on this, it is known that there is an increase in waste generation entering the Ganet landfill by 2.81%.

Waste Composition Projection

Waste composition is the percentage of types of waste generated according to waste grouping (Damanhuri, 2010). Waste composition is needed as a reference to determine the appropriate processing according to the type of waste.

Waste composition is calculated based on the amount of segregated waste in Ganet Landfill in each group. Secondary data on the composition of segregated waste in 2022 can be seen in Figure 3.

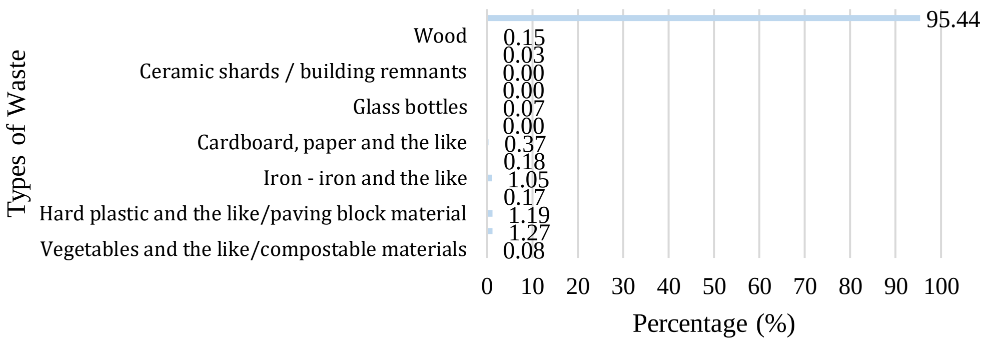

Figure 4. Waste Composition in 2022

The weakness of using the secondary data above is the large amount of unsorted waste in one year, so that the composition dominates at 95.44%. This percentage will be the data used to project the waste composition in 2024, as shown in Table 3.

Table 3. Projected Waste Composition in 2024

	Waste Type	Waste Generation (kg)
Organic Waste	Vegetables and the like/compostable materials	25.793,12
	Food scraps	408.457,81
Non-Organic Waste	Hard plastic and the like/paving block material	381.921,95
	Soft, smooth plastic and the like / pyrolysis material	55.401,50
	Iron - iron and the like	336.384,56
	Aluminum, copper and others	57.271,73
	Cardboard, paper and the like	117.931,24
	Rubber, used tires and the like	1.111,45
	Glass bottles	22.025,94
	Glass - glass	0,00
	Ceramic shards / building remnants	0,00
	Burlap / sack	9.233,58
	Wood	49.748,07
	Total disaggregated	1.465.280,95
	Total generation/year	32.099.408,35

Waste Type	Waste Generation (kg)
Residue	30.634.127,40

Source: Secondary Data, 2022 and Calculation, 2023

It is known that the composition of segregated waste is dominated by food scraps as much as 408,457.81 kg. In the designed waste management scenario, this type of waste can be included in the processing or utilization by scavengers. In addition, utilization by scavengers also involves types of canned and plastic waste. Composting processing involves vegetable waste or the like. Pyrolysis processing involves soft, fine and similar types of plastic waste. Processing waste into paving blocks involves hard plastic waste and the like that cannot be processed by the pyrolysis process. The rest of the waste or residue will be dumped in landfills. The more types and generation of waste that are processed, the less waste that goes to landfills, thereby reducing the risk of pollution and overcoming the problem of limited land because the waste that is deposited in landfills is only the residue of the processing process (Defitri, 2022). But keep in mind that the waste generation to be processed must also be in accordance with the capacity of existing facilities and infrastructure.

Cost and Benefit Components

The cost and benefit components were identified for each scenario as listed in Table 1. The results of the calculation of the cost and benefit components in each scenario are shown in Table 4.

Table 4. Cost and Benefit Components

Waste Management Scenario	Type of Processing	Cost Value (IDR)	Benefit Value (IDR)
Scenario 0	Controlled Landfill	8.326.123.157,87	0,00
	Total	8.326.123.157,87	0,00
Scenario 1	Scavenger Utilization	62.000.000,00	3.365.289.004,84
	Composting	161.225.712,00	182.353.049,51
	Controlled Landfill	8.289.696.071,91	
	Total	8.512.921.783,91	3.547.642.054,35
Scenario 2	Scavenger Utilization	62.000.000,00	3.365.289.004,84
	Composting	161.225.712,00	182.353.049,51
	Pyrolysis	87.318.304,00	2.567.145.866,19
	Controlled Landfill	8.287.459.353,09	
	Total	8.598.003.369,09	6.114.787.920,55
Scenario 3	Scavenger Utilization	62.000.000,00	3.365.289.004,84
	Composting	161.225.712,00	182.353.049,51
	Pyrolysis	87.318.304,00	2.567.145.866,19
	Paving Block Making	158.392.662,33	13.881.812.824,19
	Controlled Landfill	8.155.547.131,55	
	Total	8.624.483.809,88	19.996.600.744,74

In scenario 0, there is no benefit value, because the processing carried out is only in the form of landfilling with controlled landfill, so it only generates costs of IDR 8,326,123,157.87. In scenario 1, utilization by scavengers and composting has been carried out, resulting in an increase in costs by 2,24 % from scenario 0 with a total cost of IDR. 8.512.921.783,91. However, from this process comes a benefit value of IDR 3,547,642,054.3. The rest of the processing will go to landfill.

In scenario 2, utilization by scavengers and composting are carried out, then pyrolysis is carried out which produces products in the form of fuel. From this process there is an increase in costs by 0,999 % from scenario 1 with a total cost of IDR 8,598,003,369.09. However, the process caused an increase in the value of benefits by 72,36 % from scenario 1 with a total benefit of IDR 6,114,787,920.55. The rest of the processing will go to landfill.

In scenario 3, utilization by scavengers and composting, pyrolysis and making paving blocks from melted plastic. From this process there is an increase in costs by 0,307 % from scenario 2 with a total cost of IDR 8,624,483,809.88. Likewise, the value of benefits has increased by 227,02 % from scenario 2 with a total benefit of IDR 19,996,600,744.74 The percentage increase in useful value can be said to be very high, so the process of making paving blocks contributes a large beneficial value. The rest of the processing process will go to landfill.

From Table 4 it is known that the waste processing process that costs the most is controlled landfill in scenario 0 amounting to IDR 8,326,123,157.87. This is because all waste is only landfilled in landfills and no waste processing is carried out. The value of benefits can arise from the waste processing process that produces products that have economic value. While the waste processing process that produces the greatest value of benefits is the manufacture of paving blocks. An amount of IDR 158,392,662.33. This can also be one of the factors that cause waste management in scenario 3 to have the greatest value of benefits.

CBA Calculation

After identifying the benefit-cost component, the next thing that needs to be done is to compare the benefits and costs of the proposed action to emphasize the need to consider the financial consequences and benefits of environmental policies (Field, 2013), which in this case is a waste management scenario.

Each scenario raises the value of costs and benefits, to compare scenarios that have the feasibility of both the process and the investment to be made for the results to be implemented or continued. This value can be found through the calculation of CBA and NPV. To find out the scenario with the fastest return period on the initial investment of a project, we can use PP.

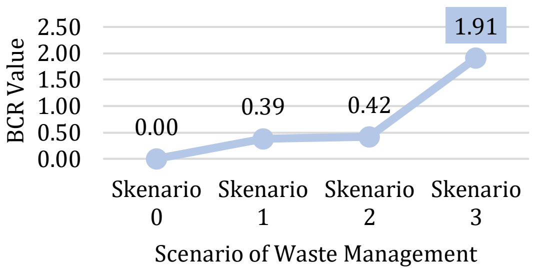

Figure 5. BCR Value

Based on Figure 4 it is known that there is an increase in the BCR value from scenario 0 to 3. A business can be said to be feasible when it has a BCR value> 1. The scenario that has a BCR>1 value is only in scenario 3 with a BCR value of 1.91.

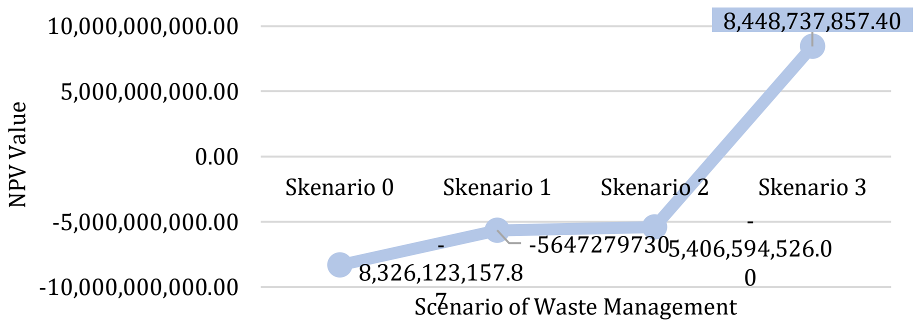

Figure 6. NPV Value

Based on Figure 5 it is known that there is also an increase in the NPV value from scenario 0 to 3. The feasibility of a project or investment from a financial point of view can be said to be feasible and can be continued when it has an NPV>0 value. The scenario that has an NPV>0 value is only in scenario 3, which is 8,448,737,857.40.

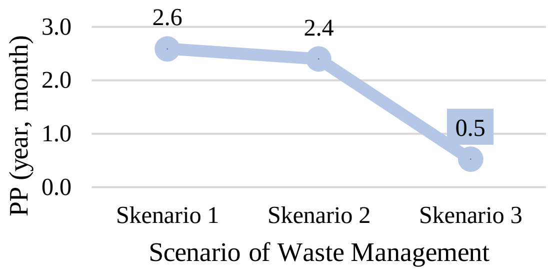

Figure 7. PP Value

Based on Figure 6 it is known that the payback period of PP decreases from scenario 0 to 3. The best business decision is to choose the fastest payback time. The scenario that has the fastest retrieval time is scenario 3, which is for 5 months.

Based on the BCR, NPV and PP values, the best waste management scenario to do is scenario 3 (utilization by scavengers, composting, pyrolysis, making paving blocks and controlled landfill). This is because scenario 3 has proven to be financially feasible.

CONCLUSION

The most costly waste processing is controlled landfill in scenario 0 and the waste processing process that produces the greatest value of benefits is paving block making. The scenario that has financial feasibility and is feasible to do or continue is scenario 3, namely (utilization by scavengers, composting, pyrolysis, making paving blocks and controlled landfill). This can be because scenario 3 has a waste processing process that is converted into paving blocks, where this process produces the greatest value of benefits.

REFERENCES

Badan Pusat Statistik Kota Tanjungpinang. (2020). Jumlah Penduduk (Jiwa), 2018-2020. Tanjungpinangkota.Bps.Go.Id.

Damanhuri, E. (2010). Diktat Pengelolaan Sampah. Bandung: Teknik Lingkungan Institut Teknologi Bandung (ITB).

Defitri, M. (2022). Sanitary Landfill : Pengertian, Metode, Keuntungan dan Kerugiannya. Waste4change.Com.

Djajadiningrat, S. T., Hendriani, Y., & Famiola, M. (2011). Ekonomi Hijau. Bandung: Rekayasa Sains.

Field, A. (2013). Discovering Statistics Using SPSS (4th ed.). Thousand Oaks, CA: Sage.

IPCC. (2006). IPCC Guidelines for National Greenhouse Gas Inventories (Simon Eggelston, Leandro Buendia, Kyoko Miwa, Todd Ngara, & Kiyoto Tanabe (eds.)). Institute for Global.

Ismail, K. (2022). Demografi (T. Media (ed.); 1st ed.). CV Tahta Media Group.

Keat, P. G., & Young, P. K. Y. (2009). Managerial economics: Economic tools for today's decision makers ([sixth edi). New Jersey: Pearson Education (Prentice Hall).

Kementerian Pekerjaan Umum dan Perumahan Rakyat. (2023). Tempat Pemrosesan Akhir (TPA). Open Data PUPR.

Khodijah, & Habibah, S. N. (2021). Development of Microplastic Research in ASEAN. E3S Web of Conferences, 324, 03002. https://doi.org/10.1051/e3sconf/202132403002

Kurnia, F. (2017). Valuasi Ekonomi Sumber Daya Alam dan Lingkungan. Jurnal Islamic

Economic Development 2.
Menteri Kesehatan Republik Indonesia. (2013). Peraturan Menteri Kesehatan No. 69 Tahun 2013 tentang Standar Tarif Pelayanan Kesehatan dalam Penyelenggaraan Program Jaminan Kesehatan.
Menteri Lingkungan Hidup dan Kehutanan Republik Indonesia. (2010). Peraturan Menteri Lingkungan Hidup No. 12 Tahun 2010 tentang Pelaksanaan Pengendalian Pencemaran Udara di Daerah.
Menteri Lingkungan Hidup dan Kehutanan Republik Indonesia. (2016). Peraturan Menteri Lingkungan Hidup dan Kehutanan Republik Indonesia Nomor: P.8/MENLHK/SETJEN/KUM.1/10/2016 tentang Perhutanan Sosial. Kementertian Lingkungan Hidup Dan Kehutanan, 53(9), 1–45.
Republik Indonesia. (2008). Undang-Undang Republik Indonesia Nomor 18 Tahun 2008 tentang Pengelolaan Sampah.
Ridha, Z., Harista, E., Syahfitri, D., Ramayani, N., & Khasanah, B. A. (2022). Penulisan Karya Ilmiah (S. N. I. Trisnawati (ed.)). Tahta Media Group.
Suryono, D. D., Ati, R. N. A., Setiawan, A., Syakti, A. D., Rustam, A., Salim, H. L., Sudirman, N., Daulat, A., Prasetiawan, N. R., Pranowo, W. S., & Jayawiguna, M. H. (2021). Distribution of macro plastic debris in Muaragembong coastal bay during the east moonson and the east to west monsoon transition in 2020. E3S Web of Conferences, 02002.
UPTD TPA Ganet. (2020). Data Sampah Terangkut ke UPTD TPA Ganet Kota Tanjungpinang (2018-2020).
UPTD TPA Ganet. (2021). Laporan Pemantauan Instalasi Pengolahan Lindi (IPL) Zona 4 Unit Pelaksana Teknis Dinas (UPTD) TPA Ganet Desember 2021.
USEPA. (2017). The Social Cost of Carbon: Estimating the Benefits of Reducing Greenhouse Gas Emissions.
Wawo, M., Abrahamsz, J., & Siahaya, J. H. (2008). Valuasi Ekonomi Wisata Pantai Hunimua, Desa Liang, Kecamatan Salahutu– Maluku Tengah.