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Externality Value of Waste Power Plant (PLTSa) in TPA Terjun Medan Marelan Using Benefit Transfer Method

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ABSTRACT

In Indonesia, waste has become a national issue due to the old view that waste management is only collected, transferred, and disposed of in landfills. Several big cities in Indonesia also face the same problem. The open dumping of waste at the landfill in TPA Terjun Medan Marelan has resulted in negative environmental externalities that continue to get worse for the people living in the vicinity. The external costs of TPA Terjun Medan Marelan will be studied in this study. Residents living around the TPA are the research subjects. In this study, replacement costs and the cost of illness will be determined as a logical tool for calculating the total cost of externalities. Externality costs at the TPA Terjun Medan Marelan are calculated using benefit transfers. Given the difficulties and high costs associated with valuing actual costs, the benefit transfer method was developed as an alternative method for assessing externalities using scores from studies of similar circumstances or characteristics conducted elsewhere. This study focuses on estimating the costs of externalities related to the feasibility of a waste power plant (PLTSa) project using the benefit transfer method from the PLTSa project at TPA Benowo Surabaya, which is then applied to the PLTSa project plan at TPA Terjun Medan Marelan. The study found that the existence of the TPA Benowo Surabaya has a negative impact not only on the environment of the residents but also on its social and economic aspects. Then the researchers also found that there was also a negative impact from PLTSa in TPA Terjun Medan Marelan.

KEYWORDS

environmental quality; benefit transfe; waste power plant (PLTSa)

INTRODUCTION

The city of Surabaya, which is located in the province of East Java and is also the largest city in the province with a large population, is a factor in many of the residents' economic activities. This has led to a consistent increase in the amount of waste generated from the daily mobility of the residents of the Final Processing Site (TPA) Benowo, located in Sumberrejo sub-district, Pakal sub-district, Surabaya city. TPA Benowo Surabaya accommodates all the waste generated by residents every day. TPA Benowo Surabaya has been actively operating since around 2001 until now. Derived from information (SIPSN, 2020), which shows waste production reaching 500 to 1,500 tons per day or 182,500 to 547,500 tons per year that goes to TPA Benowo Surabaya and for the composition of waste can be seen in the image below:

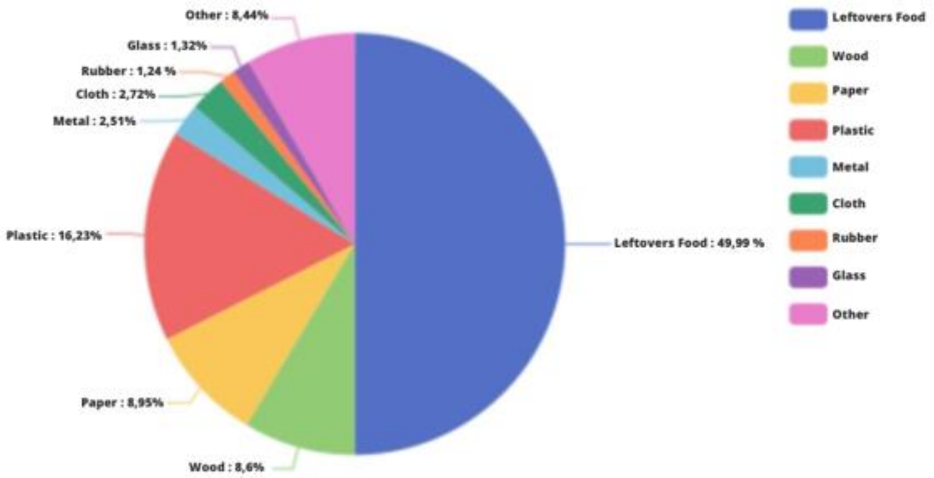

Figure 1. Composition of Waste at TPA Benowo Surabaya Based on Type of Waste
(Source: SIPSN, 2020)

The waste problem in Indonesia, especially in big cities, is generally the same, which then does not find the right solution to solve the waste problem. The city of Medan is no exception, which can produce an average of 850 to 1,500 tons of waste per day or 310,250 to 547,500 tons per year (*SIPSN, 2022*). This is because TPA Terjun Medan Marelan District, Medan City, only applies an open dumping system. All of the waste productivity generated is centralized at the TPA Terjun Medan Marelan, with an average waste that can be managed of only 18,250 tons per year out of a total waste production of 310,250 tons per year. Departing from this problem is one of the big reasons why there should be a PLTSa project because waste management will have an impact on various aspects of life, such as economic, social, environmental, and health. So many countries are trying to improve their waste management systems in order to improve the quality of life of the surrounding population.

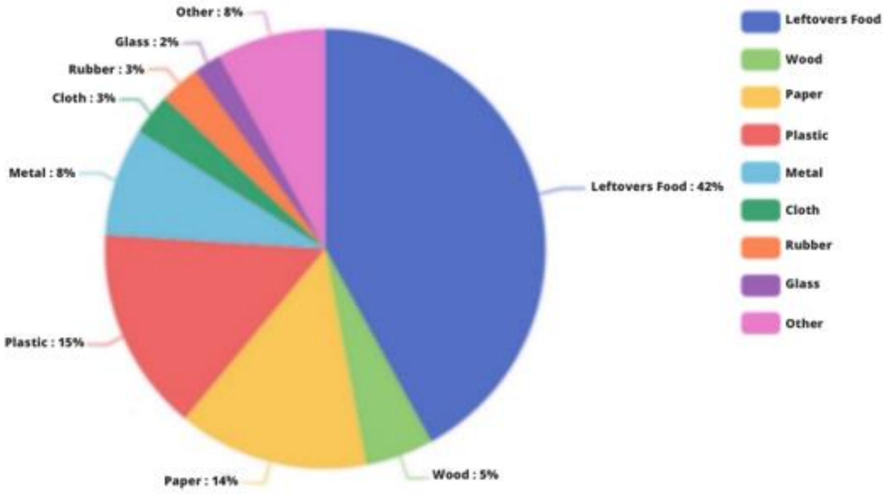

Figure 2. Composition of Waste at TPA Terjun Medan Marelan Based on Type of Waste
(Source: SIPSN, 2020)

TPA Benowo Surabaya and TPA Terjun Medan Marelan have many characteristics in common, so the benefit transfer method was chosen. According to Krupnick's research (1993), the benefit transfer method can be used if the natural resources have the same ecosystem in terms of market and location characteristics. Then proceed with this investigation to determine the externality value of the Garbage Power Plant (PLTSa) project at the Falls Landfill in Medan using two approaches: replacement costs and the cost of illness. One of the fundamental factors used to determine whether or not the PLTSa project is feasible or not is this approach.

RESEARCH METHODS

Benefit transfer techniques include value estimator models, fixed value transfers, and expert opinions. This is comparable to early research that yielded benefit estimates. Benefit transfer techniques are extensively used by government agencies as part of the economic assessment of public policies and projects, despite their conceptual and practical limitations (Bergstrom, J. C. & De Civita, P. 1999).

The benefit transfer in a study conducted to determine the value of ecosystem services. Estimated economic value is used to transfer benefits from one location to another that has the same characteristics. This is what the authors do because research that uses primary data requires a lot of money. A land area or location type that is not significantly different becomes the focus of the benefit transfer used. And also has a level of accuracy that is not much different. The benefit transfer method can make it easier to gain more in-depth knowledge (Palmer, 2009).

The benefit transfer method was also used in research on mangrove forests in the ALKI II area. The quality of the resource map of the mangrove forest is then benefit transferred to the socio-economic characteristics of the local population to calculate the economic valuation in this study using the benefit transfer method. After that, the estimated economic value of the main location (the reference location) is recalculated and transferred to another location. The results showed that the economic valuation of the area studied ranged from US$9,278.14 to US$20,500.99, or 67% to 150% of the total value of the main location (Nahib, 2011).

RESULTS AND DISCUSSION

In the research conducted using descriptive statistical analysis to analyze replacement costs and cost of illness, The impact of TPA Benowo Surabaya was analyzed using descriptive statistical analysis, which was then used for benefit transfers to TPA Terjun Medan Marelan by describing the data collected according to the facts at the location that was the object of research. The amount of money needed to get clean water from residents' wells due to water pollution is used to calculate the replacement cost method used in this study. The Cost of illness is a method for treating diseases caused by pollution in the PLTSa Terjun Medan Marelan.

Replacement Cost

Replacement Cost is used to calculate the negative impact of water pollution on residents' wells. Therefore, residents must use other sources of clean water to meet their needs. Residents use the replacement cost to buy tank facilities, gallons of tap water, or even water from other sources. This replacement fee is also used to pay for electricity bills and the use of cooler pads, fans, air conditioners, and air fresheners, all of which are needed by residents due to the impact of the existence of PLTSa. The cost of clean water and electricity is determined by multiplying the monthly consumption of each respondent by the number of residents in the sub-district closest to the PLTSa location. According to Bujagunasti (2009), the following formula can be used to determine how much it will cost to replace residents' access to clean water:

$$TP_{Water} = \sum BA \qquad (1)$$

Information:

TP_{Water} = (IDR) The total cost of purchasing clean water per year
BA = (IDR) Cost of clean water per household per year

$TP_{air} = \sum BA$ ……………………………………………………………..……..…… (2)

Information:
TP_{air} = (IDR) The total cost of electricity per year
BA = (IDR) Cost of electricity tariff per household per year

Cost of Illness (COI)

The Cost of Illness (COI) method is also used to calculate the impact caused by the PLTSa. The impact of the disease due to contamination of air, soil, and water is a medical expense that must be borne by the population. Resident medical expenses, which include hospital treatment, recovery treatment, and medical expenses, are included in the calculation of the total cost. The formula used in evaluating this method is in the following format (Pahlefi, 2014):

$BP = BPRT \times TBP\ intensity = \sum BP$ ……………………………….…………………..(3)

Information:
BP = (IDR) Cost of Medicine per household per year
BPRT = (IDR) Cost of Medicine per household per year
TBP = (IDR) Total medical expenses per year
Intensity = disease intensity due to the impact of PLTSa per year

The Total Value of the PLTSa Terjun Medan Marelan Impact is a Obtained by Adding up the Total Cost of Illness Plus the Total Costs for Water and Clean Air

$\sum EN = TRC_{Water}+_{air} + TBP$ ……………………………………………………..…..(4)

Information:
$\sum EN$ = Total costs of negative externalities
$TRC_{Water+air}$ = Total Replacement Cost for Water and Air
TBP = Medical Cost (Cost of Illness)

RESULT AND DISCUSSIONS

Replacement Cost

Replacement Cost is a method used to estimate the impact of the PLTSa Terjun Medan Marelan procurement. Furthermore, a benefit transfer will be carried out to calculate the cost of externalities from the procurement of PLTSa Terjun Medan Marelan, which can pollute residents' wells and the air around settlements. This method can also be used to calculate the reduced availability of clean water as a result of PLTSa. So residents have to use other water sources to meet their needs. In selecting the TPA location, it must be in accordance with SNI No. 03-3241-1997, which discusses how to choose a TPA location by meeting the requirements for a final waste disposal site, such as:

i. Have a minimum distance of 500 meters between the TPA and housing
ii. Has a distance from the body of water as far as 100 meters
iii. Has a distance from the airport of at least 1.5 km (for propeller-type aircraft) and 3 km (for jet-type aircraft)
iv. Has a surface to ground water ratio > 3 meters

v. Has soil with a clay soil structure that has a hydrolic conductivity level of < 10-6 cm
vi. PLTSa is built on unproductive land areas
vii. The PLTSa area must have been free from floods for at least the last 25 years

Then, regarding the cost of tank water, gallons of water, PAM water, or other water sources, calculations are made based on estimates and field observations, calculating the average cost incurred by residents in the PLTSa Benowo Surabaya design area, which is calculated on an average every month. Then the results of the calculation of the replacement cost for the purposes of the author's clean water consumption are shown in Table 1.1 below:

Table 1. Total Replacement Cost of Clean Water Consumption Around PLTSa at TPA Benowo Surabaya

Water Type	**Cost (IDR/Month/Person)**	**Total Cost (IDR/Year)**
PAM Water	60.000	720.000
Water Gallon	150.000	1.800.000
Water Barrel	180.000	2.160.000
Bottled Mineral Water	165.000	1.980.000
Total Cost of Clean Water Consumption		6.660.000
Average Cost of Clean Water Consumption		1.665.000
Total Population Cost of sub-district Benowo Surabaya (Total Population 78.334 * IDR1.665.000)		130.426.110.000
Total Replacement Cost Water		**130.426.110.000/year**

Source: Primary Data Processing, 2023

Based on Table 1. above, it can be seen that the replacement cost for the use of clean water by residents around PLTSa at TPA Benowo Surabaya obtains an externality value of IDR130.426.110.000 every year. This calculation is then transferred to the PLTSa at TPA Terjun Medan Marelan to be able to measure the externality value. The following is the data on the areas affected by the presence of PLSa in TPA Medan Marelan, which has a population of 185,191 people in the Medan Marelan sub-district. The results of the benefit transfer method, which was carried out using the replacement cost of clean water around the PLTSa at the TPA Medan Marelan can be seen on Table 2. below this:

Table 2. Total Replacement Cost of Clean Water Consumption Around PLTSa at TPA Terjun Medan Marelan

Water Type	**Cost (IDR/Month/Person)**	**Total Cost (IDR/Year)**
PAM Water	60.000	720.000
Gallon Water	150.000	1.800.000
Water Barrel	180.000	2.160.000
Bottled Mineral Water	165.000	1.980.000
Total Cost of Clean Water Consumption		6.660.000
Average Cost of Clean Water Consumption		1.665.000
Total Population Cost of sub-district Medan Marelan (Total Population 185.191 * IDR1.665.000)		308.343.015.000
Total Replacement Cost Water		**308.343.015.000/year**

Source: Primary Data Processing, 2023

Based on Table 2. As can be seen above, the residents of Medan Marelan sub-district who are affected by the externality of the PLTSa at the TPA Medan Marelan must pay

IDR308.343.015.000 per year as a replacement cost for clean water consumption. Because the PLTSa at TPA Medan Marelan affects a larger proportion of the population than the PLTSa at TPA Benowo Surabaya, it is only natural that this number is higher.

Replacement costs for fans, air conditioners (AC), cooler pads, and air fresheners used by residents to pay for electricity are used in calculating the impact of air pollution. Table 3 shows the results of calculating the replacement cost of clean air consumption for residents around PLTSa at TPA Benowo Surabaya.

Table 3. Replacement Cost of Clean Air Around the PLTSa at TPA Benowo Surabaya

Air Source Type	**Cost (IDR/Month/Person)**	**Total Cost (IDR/Year)**
Fan	50.000	600.000
Air Conditioner (AC)	150.000	1.800.000
Cooling Pack	100.000	1.200.000
Air Freshener	25.000	300.000
Total Cost		3.900.000
The Average Cost of Electricity Usage for Clean Air Consumption		975.000
Total Population Cost of sub-district Benowo Surabaya (Total Population 78.334 * IDR975.000)		76.375.650.000
Total Replacement Cost Air		**76.375.650.000/year**

Source: Primary Data Processing, 2023

The effects of air pollution that occurred around the TPA, made local residents use extra energy to disguise the stench around the TPA. Even local residents can spend up to IDR76.375.650.000 per year on electricity consumption so they can enjoy clean air. The PLTSa at the Falls Medan TPA bears the cost of replacing the use of clean air with the use of electricity, which also has negative externalities for residents living around the PLTSa project. Table 4 is an estimated cost of providing clean air utilization that must be provided:

Table 4. Replacement Cost for Clean Air Around the PLTSa at TPA Medan Marelan

Type of Air Facility	**Cost (IDR/Month/Person)**	**Total Cost (IDR/Year)**
Fan	50.000	600.000
Air Conditioner (AC)	150.000	1.800.000
Cooling Pack	100.000	1.200.000
Air Freshener	25.000	300.000
Total Cost		3.900.000
The Average Cost Allocated to Electricity		975.000
Total Population Cost of sub-district Medan Marelan (Total Penduduk 185.191 * IDR975.000)		180.561.225.000
Total Replacement Air		**180.561.225.000/year**

Source: Primary Data Processing, 2023

Based on the data in Table 4 above, the annual cost incurred by residents for clean air consumption reaches IDR180.561.225.000. The number of residents exposed to bad odors due to the waste recycling process at PLTSa Medan Marelan is also higher than in Benowo, so the total cost incurred by residents is greater.

Cost of Illness (COI)

The cost of illness must be borne by residents around the TPA. Health checks for residents affected by PLTSa at TPA Benowo Surabaya are included in the estimated cost of IDR5.000 per resident. This cost estimate is determined by Regional Regulation Number 45 and Regional Regulation Number 49 of 2016. The average number of sufferers for each disease is then used to calculate the number of sufferers for three years (2018 to 2020).

Table 5. Cost for Treatment of Residents Around PLTSa at TPA Benowo Surabaya

The Type of Disease	Total Patients/Year	Medical Expenses (IDR/Year)
Acute Nasopharyngitis	67.002	335.010.000
Diarrhea and Gastroenteritis	8.199	40.995.000
Cough	1.162	5.810.000
Acute Pharyngitis	5.527	27.635.000
Myalgia	21.453	107.265.000
		516.715.000

Source: Primary Data Processing, 2023

Based on Table 5 As can be seen above, the annual medical expenses incurred by residents affected by the externalities of the PLTSa project at TPA Benowo Surabaya amount to IDR516.715.000. Diseases affecting the respiratory system infect a large part of the local population.

The cost of externalities is calculated in the same way by PLTSa at TPA Terjun Medan Marelan and PLTSa at TPA Benowo Surabaya. So that the PLTSa externality cost data at TPA Benowo Surabaya can be used to carry out benefit transfers. The estimated cost of health checks for residents around PLTSa at the TPA Medan Marelan is IDR15.000. According to calculations by Medan City Regional Regulation No. 7 of 2016 regarding health service fees. Then, the average number of people affected over three years (2019 to 2021) is used to calculate the number of people affected.

Table 6. Cost for Treatment of Residents Around PLTSa at TPA Medan Marelan

The Type of Disease	Total Patients/Year	Medical Expenses (IDR/Year)
Acute Nasopharyngitis	3.585	53.775.000
Diarrhea and Gastroenteritis	580	8.700.000
Cough	265	3.975.000
Acute Pharyngitis	861	12.915.000
Myalgia	2.913	43.695.000
		123.060.000

Source: Primary Data Processing, 2023

Based on Table 6, the residents of the PLTSa area in the TPA Medan Marelan spend around IDR123.060.000 per year on medical treatment. This study can use the benefit transfer method because the externality impacts between the PLTSa at TPA Terjun Medan Marelan and the PLTSa at TPA Benowo Surabaya are found to be the same. As a result, the PLTSa residents at the TPA Terjun Medan Marelan experience the same illness, namely a disease related to breathing.

Total Externality Cost Comparison of PLTSa at TPA Benowo Surabaya and PLTSa at TPA Medan Marelan

The total loss from the estimated cost of externalities using the replacement cost method and the total impact losses from the accumulated waste at TPA Benowo Surabaya and TPA Terjun Medan Marelan can be seen in Table 7 below:

Table 7. Number of Losses Calculations for PLTSa at TPA Benowo Surabaya and PLTSa at TPA Terjun Medan Marelan

Loss Calculation	Total (IDR)	
	Benowo Surabaya	**Terjun Medan**
Replacement Cost	76.375.650.000	180.561.225.000
Cost of Illness	516.715.000	123.060.000
Total Loss	**76.892.365.000**	**180.684.285.000**

Source: Primary Data Processing, 2023

Table 7 shows that the total loss from the presence of PLTSa in the TPA Terjun Medan Marelan is much greater because more residents are exposed to negative externalities due to the presence of PLTSa in the TPA compared to PLTSa in TPA Benowo Surabaya. Which is the calculation of losses for PLTSa at TPA Benowo amounting to IDR76.892.365.000, while for PLTSa at the TPA Terjun Medan Marelan, it is IDR180.684.285.000.

CONCLUSION

Based on the results of the calculation of the externality value of the existence of PLTSa at the TPA Medan Marelan, two calculation methods are used, namely replacement costs and medical expenses (cost of illness). The calculation above also shows that the Benowo TPST project can cause a loss of IDR76.892.365.000. The benefits of these two approaches are then transferred to the benefits of PLTSa at the TPA Terjun Medan Marelan, which has the same characteristics as PLTSa at TPA Benowo Surabaya. The calculation results show that the amount of losses due to the PLTSa project at TPA Medan Marelan is IDR180.684.285.000 greater when compared to the PLTSa at TPA Benowo Surabaya. So that it can be concluded that the PLTSa project at the TPA Terjun Medan Marelan has a greater negative impact on the health and economic welfare of the people who live around the Waste Power Plant Area (PLTSa).

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