Modeling of Operational Costs (Tipping Fee) and Incentives to Improve Solid Waste Management Services in Indonesia

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ABSTRACT
Waste management needs in each region are increasing every day as a result of population growth. However, this is not supported by the ability of each region to process its own waste, so it uses a third party and pays a number of tipping fees charged to the regional budget. This tipping fee is paid to third parties in order to transport waste from one area to another. One ideal step that can be done is to do schematic calculations related to tipping fees that are adjusted to the characteristics of waste in Indonesia. To maximize the scheme, the government offers investors who want to participate so that they are able to repress the regional budget. The government in this case also estimates the total costs that will be before, during and after operations using life cycle cost analysis. The entire activity resulted in a mass decision-making decision guide for waste management in Indonesia. Local governments are expected to be able to conduct financing independently without relying on the available budget by performing tipping fees in a life cycle cost analysis.

KEYWORDS
Tipping fee, Incentives, Solid Waste Management

1 Introduction
According to Indonesian regulation on solid waste management, solid waste problems are a national problem that must be carried out thoroughly from the initial process to the final process that is influenced by various factors and the government has the task to ensure the implementation of good solid waste management with financing and incentives, whether originating from a state budget or a regional budget [1]. There are several factors that cause solid waste problems as national issues including an increase in uneven population growth, gross domestic product growth (GDP), and a population consumption pattern that causes increased volume, diversity of types, and characteristics of solid waste itself [2]. The relevant ministry stated that the national solid waste amount reaches 175,000 tonnes per day and if calculated annually to 64 million tonnes per year with the presentation of and characteristics of solid waste of 50% organic, 15% plastic, 10% paper, and 25% other solid waste [3]. State leaders undertake an agreement to jointly address the world's problems relating to poverty, gaps, and the environment in order to ensure sustainable consumption and production patterns by reducing waste production through prevention, reduction, reuse [4]. According to the relevant ministry, there are several provinces that have not done budget calculations relating to solid waste and the use of national budgets for solid waste issues of only 1.1%, so for facilities and infrastructures and management units has not been well facilitated [5]. Indonesia has a solid waste with a lot of amount and potential when managed properly. Therefore, the government needs to do a scheme of cooperation with the private sector to tackle this national problem, so it does not impact the losses in the later days. Identify of problems is there must be a reference to the cost of solid waste management in order to continue to serve the needs of the community broadly and thoroughly. In addition, community participation is needed in solid waste management efforts ranging from the selection of solid waste, sorting at baseline, and household recycling efforts, thereby generating additional revenue from increased value added.

Research objective is development of models for operational costs and incentives in improving solid waste management in Indonesia, development of investment feasibility model for operational cost and incentives to improve solid waste management in Indonesia, and identify how the relationship of the model for operational costs and incentives in the improvement of solid waste management in Indonesia.

2 Literature Reviews
Solid waste is all solid waste sourced from human and animal activities in the form of normal solids and disposed of due to undesirable solid waste or reusable by the owner. The source can be derived from residential, commercial, institutional, construction and demolition, urban services, waste management units, industry, and agriculture [6]. The current solid waste treatment paradigm is still referring to the old paradigm where solid waste processing is the collection, transport, and disposal. [7]. Currently, solid waste management pattern is still carried out consist of several ways with the transport and the disposal of solid waste of 69%, solid waste
burial by 10%, the posting and recycling of solid waste by 7%, burning solid waste by 5%, solid waste disposal to the river by 3%, and solid waste management by 7% [8].

3. Research Methods
This research uses a benchmarking method that can be defined as a benchmark for measuring something, from a quality aspect or a value that is both of the same size. [9]. As a follow up to the benchmarking activities, in this research conducted a mathematical calculation of life cycle cost Analysis (LCC) which is an economic assessment of an object, system or facility, considering all the significant cost of ownership of economic life, which is stated to be equal to the dollar/euro [10]. If you have done mathematical calculations on Life Cycle Cost Analysis, then in the next process is done by using expert validation so as to produce a recommendation of solid waste management fee [11]

4. Data and General Review
Indonesia is located between 6°04'30" north latitude and 11°00'36" south latitude and between 94°58'21" to 141°01'10" east longitude [12].

Indonesian population projection 2010 – 2035, the population of Indonesia is 261,890,900 with a percentage of people living in West Java province with a percentage of 18.31%, East Java province with a percentage of 15.10%, and the province of Center Java A percentage of 13.15%. [14]

Indonesia has had the final processing place (TPA) of solid waste with an area of about 2,927 ha with a solid waste shelter capacity of 33,317,193 m³/year. For that capacity, it is actually enough to accommodate the amount of solid waste that goes to the final processing place (TPA) of solid waste as much as 19,638,697 m³/year. But the unfortunate thing is that the spread is not good. [18].

The city of Surabaya is one of the successful city in its solid waste management. With its excellent solid waste management, in the year 2019, the city of Surabaya received an award from the Ministry of Environment and Forestry. In addition to the management of its solid waste, the city of Surabaya also able to produce energy from solid waste of 1-2 MW and Target 11 MW in the year 2031. Within the budget of 474.9 billion rupiah, it covers the construction of solid waste management facilities with 3R technology (reduce, reuse, recycle), solid waste transport from temporary end management (TPA) place to the final management site (TPA) Solid waste, and community involvement in cleanliness [19].
There are at least six regulations governing the management of solid waste in Indonesia including Undang-undang No. 18 Tahun 2008 about Pengelolaan Sampah, Peraturan Pemerintah Republik Indonesia No. 81 Tahun 2012 tentang Pengelolaan Sampah Rumah Tangga dan Sampah Sejenis Sampah Rumah Tangga, Peraturan Menteri No. 13 Tahun 2012 tentang Pedoman Pelaksanaan Reduce, Reuse, dan Recycle Melalui Bank Sampah, Peraturan Menteri No. P.59/Menlhk/Setjen/Kum.1/7/2016 tentang Baku Mutu Lindi Bagi Usaha dan/atau Kegiatan Tempat Pemrosesan Akhir Sampah, Pedoman Pelaksanaan Surat Edaran Menteri LHK Nomor : SE.1/MenLHK/PSLB3/PLB.0/1/2018 tentang Kerja Bersama Untuk Peningkatan Penanganan Smapah Dalam Rangka Hari Peduli Sampah 2018, dan Surat Edaran Nomor: SE.1/MenLHK/PSLB3/PLB.0/1/2018 tentang Kerja Bersama Kerja Bersama Untuk Peningkatan Penanganan Smapah Dalam Rangka Hari Peduli Sampah 2018.

Indonesia has enormous potential in the aspect of the writing process and recycling solid waste with the condition of processing can be done well from the source. With a percentage of 60%, organic is able to be converted into compost or other energy sources such as biogas, compost and electricity. Then with a percentage of 14%, plastic is able to be converted into electrical energy and mix asphalt even tiles with good management. And lastly, with a 9% percentage of paper can be turned into row material for the production of the next paper [21].

DKI Jakarta as the capital of the Republic of Indonesia has a land area 662.33 km² and ocean 6, 977.5 km² [27]. The population of DKI Jakarta in 2019 reaches 10.9 million people with an increase in population from the previous year reaching 0.73%. The data is divided into females of 5.3 million people and male population of 5.2 million. Compared to its land area, DKI Jakarta is a fat province where the density reaches 19,516 population/km square [28].
Jakarta's population doubled from 4.5 million in 1970 to more than 10 million in 2017, while the Jabodetabek population has grown from 8.2 million to more than 30 million over the same period of time. The growth rate of this area far exceeds the government's estimate and the national average, as much as 1% from 2000 to 2010, compared with a 3.6% increase in the Jakarta area [30].

| Tahun | Jumlah Populasi | Tingkat Pertumbuhan (%) | Pertumbuhan |
|-------|-----------------|--------------------------|-------------|
| 2030  | 11,310,000      | 9.71                     | 1,223,000   |
| 2025  | 11,034,000      | 11.43                    | 1,291,000   |
| 2020  | 10,645,000      | 5.98                     | 638,000     |
| 2017  | 10,374,200      | 3.26                     | 337,000     |
| 2015  | 10,177,900      | 7.20                     | 693,000     |
| 2010  | 9,640,400       | 7.14                     | 642,000     |

Tabel 1. Indonesia Population Growth Projection (Million Inhabitants) [31]

Bantar Gebang Integrated Garbage Disposal (TPST) that began in operation in 1989 is located in RT 002 RW 005 Ciketing Udik Village, Cikiwul village, and Sumur Batu village Bantar Gebang subdistrict, Bekasi City 17153. Integrated garbage Disposal (TPST) Bantar Gebang has an area of 110.3 Ha with an effective area of 81.91% or about 90.35 Ha and the rest with extensive facilities and infrastructures such as entrance, Office Road, and processing installation Lindi amounted to 19.95% or about 19.95 Ha [32]. The amount of solid waste in DKI Jakarta in 2014 as much as 7,147.36 tons per day. The highest area with solid waste production per day is in West Jakarta administrative City with a total production of 1574.92 tonnes with the amount of solid waste of 1111.68 tons and the amount of solid waste is not carried out by 19.78 tons [33].

| No | Nations       | Types Of Solid Waste Treatment |
|----|---------------|-------------------------------|
| 1  | Indonesia     | Sanitary Landfill             |
|    | Singapore     |                               |
|    | Austria       |                               |
|    | South Korea   | Waste to Energy               |
|    | Japan         |                               |
|    | Sweden        |                               |

Tabel 3. Garbage Production Data 2010-2014 [37]

In the year 2011, Integrated Garbage Disposal (TPST) Bantar Gebang received solid waste with an average amount of weight of solid waste reaches 5172.84 tons per day. In 2012 it experienced an increase in the average weight of waste in the Bantar Gebang's Integrated Garbage Disposal (TPST) which reached 5263.30 tonnes per day [35].

5. Results And Discussion

This benchmarking activity is done in countries that are able to answer the problem of solid waste such as Sweden, Singapore, Austria, Japan, and South Korea. These countries are chosen to see how solid waste is produced and how to process solid waste done, so it can be applied and implemented in Indonesia which in this case DKI Jakarta as a pilot project Model.

Management of solid waste of the region independently prioritizes the principle that solid waste management must be managed in solid waste sources. The concept of solid waste management area offered is the integrated infrastructure concept that we named "JAWARA" (Jakarta Waste Management Area). In this area there is a waste separation system (including Ecojoz Junior/Tomra),
Plastic solid waste management (pyrolysis machine converting waste), paper solid waste management (paper recycle system), organic solid waste management (Bio Methanisation plant), solid waste combustion (incinerator), and recycle creative hub.

| Unit                               | Land Needs | Input          | Output          |
|------------------------------------|------------|----------------|----------------|
| Waste Separation System (Include Ecojos Junior/Tomra) | 195.00 m² | All of Type    | Solid Waste by Type |
|                                    |            | 10.000 ton/day | 10.000 ton/day  |

| Unit                               | Land Needs | Input          | Output          |
|------------------------------------|------------|----------------|----------------|
| Pyrolysis Machine Converting Waste | 18.900 m² | Plastic        | Diesel/Solar    |
|                                    |            | 1.350 ton/day  | Fuel           |
|                                    |            |                | L/day          |
|                                    |            |                | 22.500          |

| Unit                               | Land Needs | Input          | Output          |
|------------------------------------|------------|----------------|----------------|
| Bio-Meth Plant                     | 302.400 m²| Organic        | Biogas, Compost, Electricity |
|                                    |            | 5.400 ton/day  |                |
|                                    |            |                | 810.000 m³/day, 900 ton/day, 63.000 kWh/day |

| Unit                               | Land Needs | Input          | Output          |
|------------------------------------|------------|----------------|----------------|
| Paper Recycle System               | 78.000 m² | Paper          | Paper raw       |
|                                    |            | 1.500 ton/day  | Materials      |
|                                    |            |                | 1.350          |

| Unit                               | Land Needs | Input          | Output          |
|------------------------------------|------------|----------------|----------------|
| Waste to Energy Plant              | 150.000 m²| All of Type    | Electricity     |
|                                    |            | 1.695 ton/day  | 98.113 kW      |

| Unit                               | Land Needs | Input          | Output          |
|------------------------------------|------------|----------------|----------------|
| Recycle Creative Hub               | 1.500 m²   | Recycled Solid Waste | 120 ton/day |
|                                    |            |                | Handicraft, Training Softskill, Training Hardskill, Exhibition |
|                                    |            |                | 20 units, 1 act, 12 act, 4 act |

| Equipment                          | Land Needs | Type | Volume  |
|------------------------------------|------------|------|---------|
| Waste Separation System            |            |      |         |
| Pyrolysis Machine Converting Waste |            |      |         |
| Bio-Meth Plant                     |            |      |         |
| Paper Recycle System               |            |      |         |
| Waste to Energy Plant              |            |      |         |

Figure 9. The Cost of Capital Expenditure (CAPEX), Operational Expenditure (OPEX), and Revenue

Based on the results of the calculation of cash flow conducted on the scheme with the government 80% and private 20%, government 70% and private 30%, government 60% and private 40%, government 60% and private 40%, and government 70% and private 30%, the estimated sales increase by 5% per year compared with the previous year. In addition, the cost of operating expenses is estimated to increase operating expenses by 10% per year compared to the previous year. From the financial analysis that has been done, both the cash flow calculation, Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period, and Profitability Index (PI) with the cost scheme as follows government 80% private 20%, government 70% private 30%, government 60% private 40%, government 40% private 60%, government 30% private 70%, and government 20% private 80%. Here’s a resume related to the financial feasibility analysis that has been done.

Figure 10. Financial Feasibility Analysis For All Schemes

Because of the large amount of investment needed for this project, it is necessary to have a good cooperation scheme between the Government and the business entity. In the implementation of investment in this garbage processing system, it is advisable to apply the scheme of government cooperation and business entity
(KPBU) or commonly known as the Public Private Partnership (PPP) scheme with the Build-Operate-Transfer (BOT) system. Based on the table above can be known that the financing scheme that is done will be better when using the share of government 40% and private share 60% then will get WACC 13.00%, IRR 33.11% with the estimated Payback Period in the 5th year More than 122 days and has an RPC (Repayment Capacity) of 423% assuming the loan can be paid to third parties with a ratio of 423%.

6. Conclusion

1. How is the modelling of operational costs (tipping fee) and incentives to improve solid waste management in Indonesia? This benchmarking activity is done in countries that are able to answer the problem of solid waste such as Sweden, Singapore, Austria, Japan, and South Korea. These countries are chosen to see how solid waste is produced and how to process solid waste done, so it can be applied and implemented in Indonesia which in this case DKI Jakarta as a pilot project Model.

2. How are investment feasibility modeling from operating costs (tipping fee) and incentives to improve solid waste management in Indonesia? Based on the table above can be known that the financing scheme that is done will be better when using the share of government 40% and private share 60% then will get WACC 13.00%, IRR 33.11% with the estimated Payback Period in the 5th year More than 122 days and has an RPC (Repayment Capacity) of 423% assuming the loan can be paid to third parties with a ratio of 423%.

3. How is the modelling influence of operational costs (tipping fee) and incentives to improve solid waste management in Indonesia? Solid waste management Model with waste to energy method The conclusion is worth the investment with the scheme that has been simulated before.

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