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Technical and Economic Study of Feasibility of Waste Management Business: Case Study of Waste Management in Batu Putih Village Lombok-Indonesia

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ABSTRACT: The problem of garbage in Batu Putih Village is a serious problem to be addressed immediately. Garbage if disposed of carelessly will be a source of environmental pollution and disease for humans. To maintain cleanliness, a waste treatment facility will be built. In making a business there must be a value of investment issued. Soto avoid a large investment increase but the business does not generate profits, it is necessary to calculate the investment fund budget in accordance with the amount of raw material for waste to be managed.The results of the study showed that the waste produced by Batu Putih Village was organic waste 1,430.86 Kg/day, plastic 146.29 kg/day and non-organic besides plastic 1,011.25 kg/day produced from household and non-household waste sources. Producing compost products as much as 772.66 kg/day and obtained produce counts of 116.95 kg/day. Obtained NPV waste count processing with a 5-year investment life of Rp 7,121,913 (> 0). With the internal rate of return method, the calculation of the IRR = 13,6% > MARR = 12%. From the calculation of the payback period method is in the 8th month because the value of the investment has returned to full with a value of more return of Rp 2,936,120. After doing economic studies with the NPV, IRR and payback period methods, the waste processing business is feasible.

KEYWORDS: Production Capacity, Business Feasibility, Waste Management, Net Present Value, Internal Rate of Return, Payback Period.

I. INTRODUCTION

Waste is a serious problem to be addressed immediately. Garbage when disposed of carelessly will be a source of environmental pollution and disease for humans. Decomposing garbage is a source of diseases such as bacteria, viruses, protozoa, and worms [1]. [2].

Various efforts have been made by the government to deal with the waste problem. DKP Badung Kuta base optimizes the process of transporting waste with fixed containers as much as 34 rates / day. Recommendation to the Sidoarjo district government to involve young people as cadres for socialization of 3R-based waste management (Reduce, Recycle, Reuse) in each village. Mataram City DPRD member Kartini Irwani also emphasized "the need for community participation in overcoming waste problems" [3]. [4]. [5].

Waste recycling business is one solution to help the government in waste management. The potential reduction of restaurant / stall waste by 53% can be processed into compost, and 17% will be recycled by doing self-processing or sold to containers. As a business venture, recycling and composting activities provide an average economic benefit of Rp.593,224 per ton and provide employment opportunities to 13,687 scavengers, and can reduce the volume of waste by around 41.65% [6]. [7].

Batu Putih is a tourism destination on Lombok Island that will be developed by the government. To maintain cleanliness while getting added value in terms of economy, a waste management business will be built. In making a business, especially the waste recycling business, there will definitely be an investment value that will be spent. A feasibility study is a study to assess whether a business is feasible or not established. The main goal is to avoid the continuation of large investments but the business does not generate profits. Therefore, it is necessary to calculate the

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investment fund budget in accordance with the amount of waste raw materials to be managed in Batu Putih Village. Data on the generation, composition and characteristics of waste is very supportive in compiling a waste management system in an area. The data must be available in order to develop an alternative good waste management system [8]. [9].

II. METHODE

The research method used is a study method through direct observation and measurement, which includes observations and interviews with the people of Batu Putih Village related to technical and economic data.

Data Collection

The place for collecting waste generation and waste processing data is in Batu Putih Village, Sekotong District, West Lombok.

Data Analysis and Discussion

In analyzing the data, an assessment is carried out based on technical and economic aspects.

Waste Generation Measurement

The amount of waste generation is obtained from the results of direct measurements in the field. Sampling of waste composition was carried out for 8 consecutive days at the same location, in accordance with the procedures in SNI 19-3964-1994 (Method of Taking and Measuring Samples of Generation and Composition of Urban Waste).

1. Technical Studies

In the technical study, the waste treatment system will be analyzed including waste generation, production capacity, machine capacity.

1.1 Waste Generation

For waste generation analysis using the formula:

QT = Qd + Qnd (1)

Qd = qd x Pd atauqd x Rt

Qnd = qnd x A

where:

QT	=	Total waste generation (l/h atau kg/h)
Qd	=	Discharge of household waste generation (l/h atau kg/h)
Qnd	=	Discharge of household waste generation (l/h atau kg/h)
qd	=	Household waste generation unit (l/o/h atau kg/o/h) atau (l/kk/h atau kg/kk/h)
qnd	=	Non household waste generation unit (l/unit/h atau kg/unit/h)
Pd	=	Number of household population (org)
Rt	=	Number of households (kk)
A	=	Determination of the number of samples and measurement of waste generation.

1.2 Production Capacity

The production capacity of shredded plastic and compost is determined using the following equation [12]:

$$P = \frac{Pg}{(1-p)} \quad (2)$$

where:

P=The desired number of products or raw materials to be processed.

Pg=Number of good quality products (good parts).

p =Percentage of defective parts (%).

1.3 Machine Capacity Calculation

The capacity and number of machines are determined using the following equation:

$$N_m = \frac{T}{60}\frac{P}{D\,E} \quad (3)$$

where:

N_m	=	Number of machines or operators needed for production operations
T	=	Total processing time required for production operation process (minutes/unit of product)
P	=	Number of products to be made by each machine per working time period (product units/year)
D	=	available machine working hours, where for one work shift D = 8 hours/day, two work shifts D = 16 hours/day, and three work shifts D = 24 hours/day
E	=	Machine work efficiency factors caused by set up, break down, repair or other things that cause IDLLE. The commonly taken price in this case ranges from 0.8 – 0.9.

2. Economic Studies

In conducting economic studies the criteria used are as follows:

2.1 Net Present Value (NPV)

NPV = PWB – PWC (4)

$PWB = \sum_{t=0}^{Ni} Cb_t(FBP)_t$

$PWC = \sum_{t=0}^{Ni} Cc_t(FBP)_t$

dengan [13]:

Cb	=	Cash flow benefit (Rp)
Cc	=	Cash flow cost (Rp)
FBP	=	Faktor bunga present (%)
t	=	Time Period
Ni	=	Investasion life (year)

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2.2 Internal Rate Of Return (IRR)

$$IRR = iNPV_{+} + \frac{NPV_{+}}{|NPV_{+} + NPV_{-}|}(iNPV_{-} + iNPV_{+}) \quad (5)$$

Dengan [13]:

IRR = Internal rate of return (%)
$iNPV_{+}$ = Interest with a positive NPV yield (%)
$iNPV_{-}$ = Interest with a negative NPV yield (%)
NPV_{+} = Nilai NPV hasilpositif (Rp)
NPV_{-} = Nilai NPV hasilnegatif (Rp)

2.3 Payback Period

$$K_{(PBP)} = \sum_{t=0}^{K} CF_t \geq 0 \quad (6)$$

where[13] :

K = Payback period (years)
CFt = Cash flow period to t

If the cash flow benefit and cost components are annual, then the formula becomes:

$$K_{(PBP)} = \frac{\text{Investasi}}{\text{Annual Benefit}} \text{ x time period}$$

III. RESULTS AND DISCUSSION

1. Results of Technical Studies

Waste generation

The results of collecting and processing data on the generation of household and non-household waste obtained a waste weight of 2,594.43 kg / day and a waste volume of 18,528.1 liters / day. Of the total waste generation, it consists of the composition of organic, plastic, and other inorganic waste as shown in table 1.

Table 1. Composition of household and non-household waste

No	Resaurces	Organic (kg/dy)	Plastic (kg/dy)	Anorganic (anothers plastic) (kg/dy)
1	household	1.404,92	135,96	997,04
2	shop	13,8	2,76	10,35
3	School	1,0230	2,64	0,6820
4	ofice	0	0	0
5	Traditional market	0,12	0,22	0,07
6	road	11	4,71	3,11
Jumlah		1.430,86	146,29	1.011,25

Production Capacity

1) Plastic Chips

The amount of shredded plastic can be calculated by equation 2 as follows:

$Pg = P_0$ x(1-p)

where:

P_0 = the amount of initial raw materials.
Pg = good parts.
p = defective parts.

Then the calculation of plastic chopping production capacity is:

1. Products of the 1st process stage (sorting)

$Pg_{,1} = P_0$ x (1-15%)
$Pg_{,1}$ =146,29 kg/dy x (1-15%)
$Pg_{,1}$ = 124,35 kg/dy

2. Product from the 2nd process stage (chopping)

$Pg_{,2}$=124,35 kg/dy x (1- 5%)
$Pg_{,2}$= 118,13 kg/dy

3. Products of the 3rd stage of the process (drying)

$Pg_{,3}$ =118,13 kg/dy x (1-1%)
$Pg_{,3}$ = 116,95 kg/dy

4. Products from the 4th process stage (packaging) Pg,4= 116,95 kg/dy
5. The product of the 5th stage of the process stage (sales) is the same as the product in the 4th stage of the process (packaging), because there is no shrinkage that causes the product to be equal in quantity.

2) Compost

From table 1, it is known that the generation of organic waste in Batu Putih village per day is 1,430.86 kg / day. By equation 2 can be calculated the output of the product is as follows:

$Pg = P_0$ x(1-p)

where:

P_0 = the amount of initial raw materials
Pg = good parts.
p = defective parts (%).

where:

P_0 = 1.430,86 kg (raw materials)

p = 45,7 % (Depreciation in the composting process)

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so :
$Pg = P_0$ x (1- p)
Pg = 1.430,86 kg x (1- 45,7 %)
Pg = 772,66 kg /dy = 23.179,93 kg/month

a. Machine Capacity Calculation

The capacity of the machine needed to chop plastic and organic waste in Batu Putih Village is as follows:
Known:
Machine working efficiency (E) = 0.9
Operating hours of one shift (D) = 8 hours/day
processing time in the enumeration process (T) = 0.597 kg/min
Number of organic shredded products to be made (P2) = 1,430.86 kg/day Number of shredded plastic products to be made (P2) = 124.35 kg/day
so:

1. Calculation of organic waste shredding machine capacity

Number of machines (N) = $\frac{T}{60}\frac{P2}{D\ E}$

Number of machines (N) = $\frac{\frac{0,597\ menit}{kg}}{60} x \frac{1.430,86\ \frac{kg}{hari}}{8\ jam\ \frac{}{hari} * 0,9}$

Number of machines (N) $= 1,98 \approx 2unit$

Machine capacity = $\frac{1}{T}$ x 60kg/jam
Machine capacity = $\frac{1}{0,597}$ x 60kg/jam
Machine capacity = 100kg/jam

2. Calculation of plastic waste shredding machine capacity

Number of machines(N) = $\frac{T}{60}\frac{P2}{D\ E}$

Number of machines (N) = $\frac{\frac{0,597\ kg}{menit}}{60} x \frac{124,35\ \frac{kg}{hari}}{8\ jam\ \frac{}{hari} * 0,9}$

Number of machines(N) $= 0,171 \approx 1unit$
Machine capacity = $\frac{1}{T}$ x 60 kg/jam
Machine capacity = $\frac{1}{0,597}$ x 60 kg/jam
Machine capacity = 100 kg/jam

This means that to chop up organic waste, 1 machine with a capacity of 200 kg / hour is needed and to chop plastic waste based on calculations using a machine with a capacity of 100 kg / hour with a number of machines of 0.171 units which can be equivalent to 1 unit of plastic shredding machine with a capacity of 17.1 kg / hour.

In its implementation will be carried out for every 3 days. So in order to be able to chop up organic waste raw materials, a machine with a capacity of 600 kg / hour and a plastic shredding machine with a capacity of 60 kg / hour are needed. With the capacity of the waste shredding machine, an organic waste shredding machine with a power of 6.5 PK and a capacity of 600 kg / hour for IDR 14,500,000 and a plastic shredding machine with a power of 5.5 PK and a capacity of 60 kg / hour for IDR 14,500,000.

2. Economic Studies

a. Cost Analysis

Cost analysis in waste shredding processing consists of fixed costs and non-fixed costs.

1) Fixed cost (FC)

Fixed costs in the processing of shredded garbage consist of depreciation costs of shredding machines, land rent and the cost of work equipment. From the results of data processing, it is known that the fixed cost in processing plastic chops each year is Rp. 15,548,800 per year.

2) Variable cost (VC)

The results of data processing are known to be the non-fixed costs of plastic shredding processing consisting of operational costs and maintenance costs. The operational costs are known to be Rp.280,621 per day. Because the machine operates once in 3 days, the operational cost is Rp. 2,806,210 per month. Maintenance of the shredding machine is carried out on the power transfer belt which is classified as very often replaced due to installation errors and operating errors, the average amount of maintenance costs incurred in one month is Rp 196,666 per month. Based on the calculation of operational costs and maintenance costs, it can be known that the variable costs for processing shredded waste are:
Variable cost (VC) =operational cost + maintenance cost
Variable cost (VC) = Rp2.806.210 + Rp 196.666
Variable cost (VC) = Rp 3.002.876 permonth. So that the total non-fixed cost is Rp. 36,034,512 per year.

b. Waste Treatment Revenue Analysis

The amount of income generated in waste shredding processing per month is the selling price of waste processing production multiplied by production capacity, as shown in table 2:

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Table 2. Revenue from waste processing.

items	Production capacity (kg/month)	price (Rp/kg)	revenue(Rp/bulan)
Plastic chips	3.508,5	4.000	14.034.000
compost	23.179,93	300	6.953.979
Total			20.987.979

c. Cost of investment

The amount of investment made is by adding fixed costs and preoperational costs with a typical positive flow value, as evidenced by cash flow and loan capital results that must be made amounting to IDR 65,653,039, on bank X loans rounded up to the amount of IDR 70,000,000 with monthly installments of IDR 2,224,444 per month for 3 years.

d. Net Present Value (NPV) analysis

It is known that the present interest factor (FBP) obtained from MARR is 12%, cash flow cost (Cc) in waste processing is IDR 12,135,483 / month in the first month to the 36th month and IDR 9,911,039 in the 37th month to the 60th month, cash flow benefit (Cb) in waste processing is IDR 22,283,712 / month and the remaining investment value is IDR 12,000,000 with an investment duration of 5 years, length of time period of 60 months.

From the calculation results as in annex 5, an NPV for waste shredding processing with an investment life of 5 years of IDR 7,121,913 (>0) is obtained, meaning that the waste processing business is feasible because it will be feasible.

e. Internal Rate of Return(IRR)

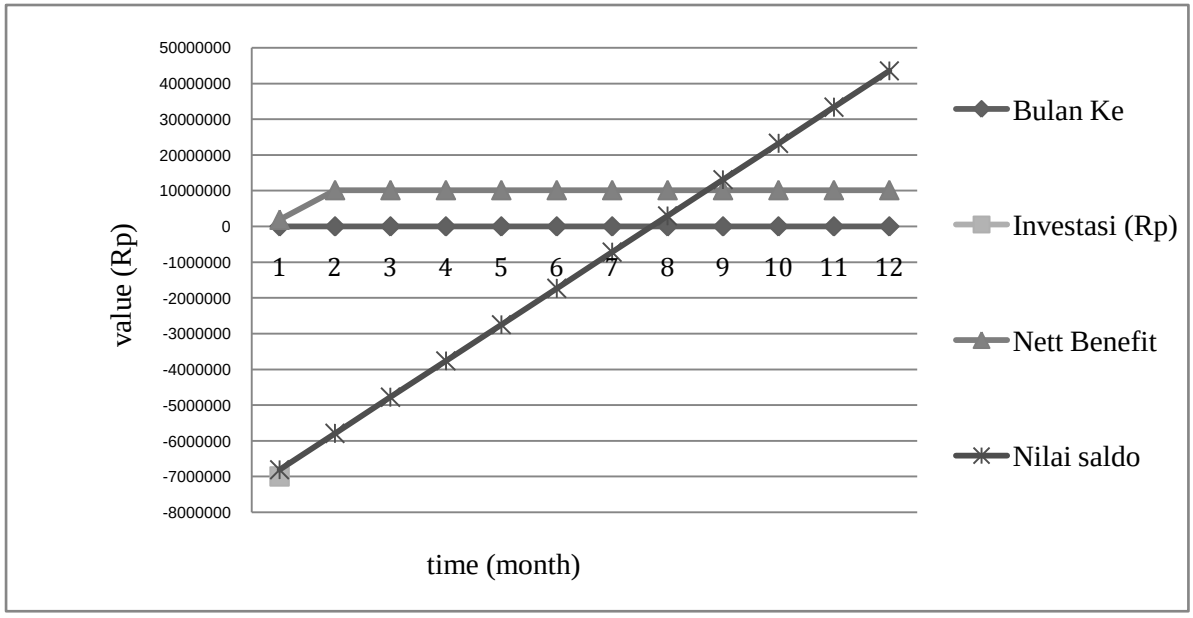
It is known that, with an investment age of 5 years, with a discount factor / present interest factor (pv) value of 10% obtained NPV value = IDR 24,335,201 while for the present interest factor of 15% obtained NPV value = IDR -9,438,051 Then:

$$IRR = 10\% + \frac{24.335.201}{|24.335.201 + 9.438.051|}(15\% - 10\%$$

IRR = 0,1360 = 13,6 %

f. Payback Period (PBP)

The payback period value is in the 8th month because the investment value has returned in full with an excess value of return of Rp 2,936,120. So the waste processing business with a payback period value of 8 months is feasible with an investment life of 5 years. The following is a picture of the payback period of the waste processing business within 12 months.



Gambar 1.Grafikpayback period.

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IV. CONCLUSION

From the results of data analysis and discussion, several conclusions can be drawn as follows:

1. The waste generation produced by Batu Putih Village is organic waste as much as 1,430.86 kg / day, plastic waste 146.29 kg / day and non-organic waste other than plastic as much as 1,011.25 kg / day.
2. The production capacity of organic waste is 1,430.86 kg / day, and produces compost products as much as 772.66 kg / day and plastic waste production capacity of 146.29 kg / day, producing chopped products as much as 116.95 kg / day.
3. Feasibility of waste processing business:

a. Net Present Value

Based on data analysis, the value of the calculation results obtained the NPV of waste shredding processing with an investment life of 5 years amounting to Rp 7,414,728 (>0), meaning that the waste processing business is feasible to be carried out because it will be profitable (feasible).

b. Internal Rate of Return

It is known that, with an investment age of 5 years, with a discount factor (DF) value of 10% obtained NPV value = IDR 24,335,201 while for discount factor (DF) 15% obtained NPV value = IDR -9,438,051 with the interpolation method in the calculation of IRR value = 13.6% > MARR = 12%, then the investment plan is recommended.

c. Payback Period

From the calculation results, the payback period value is in the 8th month because the investment value has returned fully with a return of IDR 2,936,120. So the waste processing business with a payback period value of 8 months is feasible with an investment life of 5 years.

Economic studies using the net present value (NPV), internal rate of return (IRR) and payback period (PBP) methods show that the waste processing business is feasible to be established and in terms of existing raw material capacity techniques in accordance with the machines used, the waste processing business in Batu Putih Village is feasible to be established.

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