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The economic potential of paper waste recycling activities on the informal sector in Grobogan District a case study: Purwodadi Sub-district

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Abstract. Waste is a serious issue, not only in Indonesia but also in other countries. The governments have conducted various attempts to reduce waste, for example, by recycling waste. One of Indonesia's regions that done recycling is Purwodadi Sub-District, where the activity of waste utilization is mostly conducted in the informal sector. This research aims to estimate the economic potential and the expense of the existing system of paper waste management and analyze the benefits of paper waste management activity by the informal sector in Purwodadi Sub-District economically and environmentally. The method used is interviews and questionnaire surveys toward 31 recyclers consisting of scavengers, waste banks, garbage collectors I and II, and the dealers. Based on the research result, each recycler's economic potential in the enterprise of paper waste recycling was different. By applying for the paper waste 3R program in the informal sector, the benefits are divided into economic and environmental benefits. The economic benefits are profits from selling paper waste taken from recyclers. In contrast, the informal sector's environmental services as paper waste management reduce the percentage waste reduction of 15.9% in Purwodadi Sub-District.

1. Introduction

Currently, waste is a serious issue that still happens in Indonesia and other countries. Waste issues have been universal phenomena in every state, with different points in how much wastes are produced in each country [1]. This waste issue becomes severe in Indonesia; one of them is in the Grobogan District, Purwodadi Sub-District.

Grobogan District is one of the districts located in Central Java Province with measuring 1,975.86 km² and a total population of 1,351,429 people [2]. Purwodadi Sub-District was chosen as the study case region in this research because, in this sub-district, there are the complete informal recycler sectors among other sub-districts in Grobogan district. Purwodadi sub-district also has the largest population in Grobogan district, which is 139,296 people [2]. The paper waste generation in Purwodadi Sub-District is 13,796.42 kg/day. With vast amounts of paper waste generation, waste management must be done, such as recycling to reduce the amount of that paper waste generation [3].

Wastes disposed can be worse for households whose garbage is not collected by the officers or taken to the *TPS* because the solid waste is usually left, burned, and even dumped into the river causing pollution of water bodies and disasters such as flooding [4]. There is a program is realized in the form



of waste minimization, waste reuse with recycling, alternative energy use, reduction of greenhouse gas effects and many other concepts [5]. Waste recycling activities are quite effective ways of reducing the amount of waste generation. As of that case according to Damanhuri and Padmi (2010), most of the recycling activities or reutilizing of the economic value of wastes in many cities in Indonesia conducted by the informal sector that consists of garbage collectors in the neighborhood, scavengers in the community, scavengers in the waste dumps, scavengers in the landfills, waste sites, waste dealers, and the recycling and composting factories [6]. Based on the research from Raihan et al. (2009), regarding tetra pack recycling, it is known that the economic potential of tetra pack waste with its recycling cycle started from scavenger – peddler – the small dealer – huge dealer. While the price of tetra pack waste can change based on customer demands. That research shows an opportunity to understand the economic potential in other cities and point out the benefits of paper waste recycling [7].

This research aims to estimate the economic potential and the cost of the existing system in paper waste management by the informal sector in Purwodadi Sub-District and analyze the benefits of paper waste management by the informal sector informally along with environmentally.

2. Methodology

This research was designed and conducted from December 1st, 2019 until May 31st, 2020, in Purwodadi Sub-District, Grobogan District, and Tawangharjo Sub-District, the east by Pulokulon Sub-District, the west by Penawangan Sub-District, and the south by Toroh Sub-District. The methodology applied is divided into some steps: the preparation phase, data collection, and data analysis.

The data collection method used is primary data collection and secondary data collection. To get preliminary data, surveys, questionnaires, and interviews were conducted with the recyclers. Secondary data is obtained by studying the related literature used as guides, such as accessing the internet to get data and documentation in Grobogan Central Bureau of Statistics.

3. Results and discussion

3.1. The condition of waste management existing system in Purwodadi Sub-District

Purwodadi Sub-District waste management activities included sweeping, containerization, collection, moving, transporting, waste reduction, and final processing. In the waste-reducing activities, the informal recycler sectors have roles in reducing the waste by collecting recyclable wastes and the wastes that have economic values in the residential areas or waste dump. The waste collected by the informal recycler sectors is plastic waste, paper waste, and metal waste.

3.2. The Analysis of economic potential and the cost of paper waste recycling by the informal recycler sectors

3.2.1. *The analysis of the existing condition of the recycling in Purwodadi Sub-District.* Based on the researchers' surveys, there are 31 informal recycler sectors in Purwodadi Sub-District that consist of 3 scavengers, 14 waste banks, and 14 wreckage businesses.

Table 1. The classification of the informal recycler sectors.

| Recyclers | Waste Weight (kg/day) |
|-----------------------|-----------------------|
| Waste Banks | ≤ 30 |
| Scavengers | ≤ 50 |
| Garbage collectors I | 50-500 |
| Garbage collectors II | 500-1000 |
| Dealers | >1000 |
| Millers | >1000 |

3.2.2. *The analysis of the waste generation and composition in Purwodadi Sub-District.* The sampling of the waste generation in Purwodadi Sub-District based on the Indonesian National Standard (abbreviated *SNI*) 19-3964-1994 regarding the generation sampling and measuring method and waste compositions. Data regarding the result of the Purwodadi Sub-District waste generation composition is presented in this following table 2.

Table 2. The Purwodadi Sub-District waste generation composition.

| Components | Amount (kg/day) | Average (kg/day) | Total (kg/day) | Percent (%) |
|------------|-----------------|------------------|----------------|-------------|
| Plastic | 0.75 | 0.1875 | 14,781.88 | 18.75 |
| Paper | 0.7 | 0.175 | 13,796.42 | 17.5 |
| Metal | 0.45 | 0.1125 | 8,869.129 | 11.25 |
| Organic | 1.5 | 0.375 | 29,563.76 | 37.5 |
| Glass | 0.05 | 0.0125 | 985.45 | 1.25 |
| Rubber | 0.2 | 0.05 | 3,941.83 | 5 |
| Wood | 0.2 | 0.05 | 3,941.83 | 5 |
| Cloth | 0.15 | 0.0375 | 2,956.37 | 3.75 |

Table 2 shows that paper waste generation composition in Puwodadi Sub-District is 13,796.42 kg/day or 17.5%.

3.2.3. *The recyclers manage the paper waste weight.* Various paper wastes are collected and sold by the recyclers in Purwodadi Sub-District, such as white papers, boxes, cardboards, books, newspapers, magazines, paper cement, and scratchpads.

Table 3. The amount of average weight of paper waste collected.

| Kind of waste | The average weight of paper waste collected (kg/day) | | | | |
|--|--|------------|--------------------|--------------------|----------|
| | Waste Banks | Scavengers | Garbage collectors | Garbage collectors | Dealers |
| | | | I | II | |
| White Papers | 1.69 | 2.67 | 37.57 | 60 | 225 |
| Boxes | 4.20 | 4 | 61.43 | 113.33 | 775 |
| Cardboards | 1.56 | 2 | 22.86 | 65 | 116.25 |
| Books | 1.15 | 0 | 13.33 | 10 | 45 |
| Newspapers | 0.25 | 0 | 5 | 5 | 11.67 |
| Paper cement | 0.32 | 0 | 6 | 30 | 31.25 |
| Scratchpads | 0 | 0 | 5 | 5 | 10 |
| Magazines | 0 | 0 | 5 | 5 | 15 |
| The average weight of paper waste (kg/day) | 9.18 | 8.67 | 156.19 | 293.33 | 1,229.17 |

3.2.4. *The purchase and sale price of the paper waste.* The recyclers in Purwodadi Sub-District have various levels of purchase and sale prices. If the price levels are ranked starting from the lowest price to the highest price, the raking is the scavengers, waste banks, garbage collectors I, garbage collectors II, and the dealers.

3.2.5. *The price comparison of each recycler.* Every recycler starting from scavengers, waste banks, garbage collectors I, garbage collectors II, and the dealers have different sale prices, so the rising of paper waste price in each recycler can be understood.

3.2.6. *The cost analysis of paper waste management by the informal sector.* The recycling implementation analysis conducted by the informal sector in Purwodadi Sub-District can be reviewed economically.

3.2.6.1. *Basic calculation assumptions.* The cost analysis based on the research using the survey result average of 28 recyclers in Purwodadi Sub-District consists of 15 waste banks, seven garbage collectors I, three garbage collectors II, and four dealers, so each recycler in Purwodadi Sub-District starting from garbage collectors I to dealers are considered typical. Investment depreciation is calculated using the straight-line method, such as milling/crusher machine lifetime is for five years, press tools lifetime is for five years, truck lifetime is for ten years, pick up lifetime is for ten years, 500 kg scale lifetime is for five years and other tools lifetime is for two years.

3.2.6.2. *Investment cost calculation.* The informal sector's investment cost in paper waste management is all cost spend on the facilities and infrastructure.

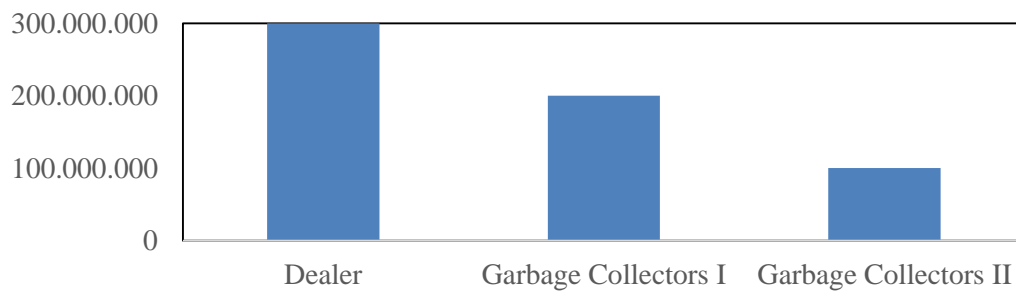


Figure 1. The amount of investment cost (rupiah) of paper waste management diagram.

The Investment cost in every level of the recyclers can be concluded in figure 2 below.

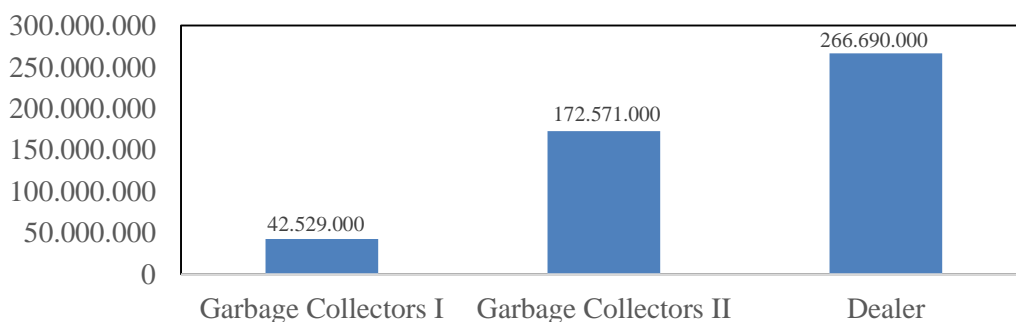


Figure 2. Diagram of investment cost (rupiah) on every recycler operational cost calculation.

Fixed cost is the cost spend every year that its amount is not directly affected by the number output produced. The depreciation cost is calculated using the assumption that the goods are 5% decreased every year.

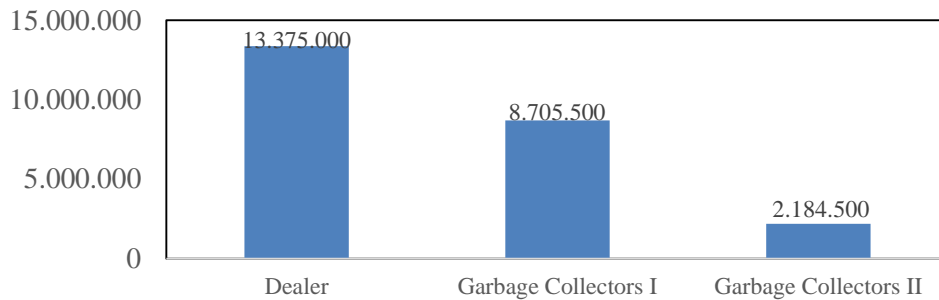


Figure 3. Depreciation cost (rupiah) in the levels of dealers and garbage.

The operational cost of paper waste management in the dealers and garbage collectors in Purwodadi Sub-District can be seen in figure 4.

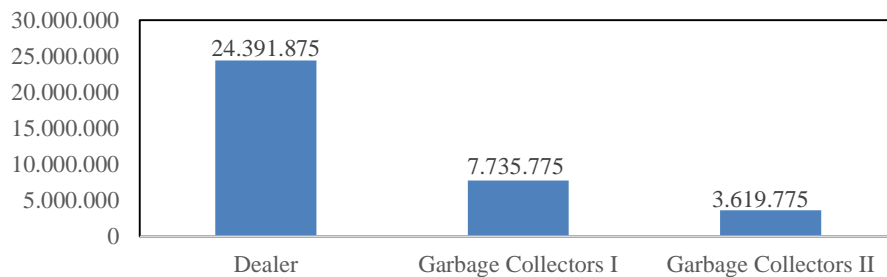


Figure 4. The monthly operational cost (rupiah) of the dealers and garbage collector.

3.2.6.3. *Unit cost analysis.* Unit cost analysis is a division between the total operational cost and the amount of waste managed simultaneously.

On the levels of garbage collectors I, the calculation of the unit cost of paper waste managed by the garbage collectors I may be written as:

$$Unit\ Cost = \frac{Rp. 3,619,775/month}{11,739.93kg/month} = Rp. 308.33/kg$$

On the levels of garbage collector II, the calculation of the unit cost of paper waste managed by the garbage collectors II is typified as follows:

$$Unit\ Cost = \frac{Rp. 7,735,775/month}{23,690kg/month} = Rp. 326.54/kg$$

On the levels of dealers, the calculation of the unit cost of paper waste managed by the dealers is as follows:

$$Unit\ Cost = \frac{Rp. 24,391,875/month}{77,915.5kg/month} = Rp. 313.06/kg$$

3.3. *Analysis of the paper waste recycling benefits by the informal recycler sector.*

The implementation of the waste 3R program gives benefits divided into two, which are economic benefits and environmental benefits. The economic benefits are come from the sales of paper wastes as the result of the recyclers' processing. The process of paper waste utilization to be recycled implies those wastes' adding value. The value of paper wastes will change on every

Table 4. Gross of each recyclers.

Gross of each Recyclers (Rupiah/Kg)

| kind of paper waste | Scavengers | Waste Banks | Garbage Collectors | Garbage Collectors | Dealers |
|---------------------|------------|-------------|--------------------|--------------------|---------|
| | | | I | II | |
| White Papers | 1,500 | 200 | 400 | 400 | 400 |
| Boxes | 1,200 | 100 | 400 | 400 | 400 |
| Cardboards | 400 | 100 | 400 | 400 | 400 |
| Books | 0 | 200 | 400 | 400 | 400 |
| Newspapers | 0 | 600 | 500 | 500 | 1400 |
| Paper cement | 0 | 0 | 600 | 600 | 1000 |
| Scratchpads | 0 | 0 | 500 | 400 | 700 |
| Magazines | 0 | 0 | 1200 | 400 | 400 |

$$\begin{aligned} \text{The reduction of Waste Generation} &= \frac{\text{Paper wastes that are reduced}}{\text{Total of Paper Waste Generation In Purwodadi Sub-District}} \times 100\% \\ &= (2,113 \text{ kg/day}) / (13,796.42 \text{ kg/day}) \times 100\% \\ &= 15.9\% \end{aligned}$$

Based on the calculation above, it is known that the recyclers in Purwodadi Sub-District can reduce 15.9% waste generation.

4. Conclusion

The result concludes that the paper wastes in Purwodadi Sub-District have the economic potential to be recycled by the informal recycler sector located in Purwodadi Sub-District. The average weight estimation of paper wastes collected by each recycler is about 8.67 kg/day on the scavenger levels, 9.18 kg/day on the waste bank levels, 156.19 kg/day on the garbage collector I levels, 293.33 kg/day on the garbage collector II levels, and 1,229.17 kg/day on the dealer levels. The unit cost to manage waste operational based on the discussion is Rp. 308.33/kg on the garbage collector I levels, Rp. 326.54/kg on the garbage collector II levels, and Rp. 313.06/kg on the dealer levels. Paper waste 3R programs implemented in the informal sector besides providing economic benefits of paper waste selling profits as the result of the recyclers' processing also give environmental benefits, which is the reduction of paper waste in Purwodadi Sub-District by the paper waste reduction percentage of 15.9%.

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