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Village-Based Waste Management System: The Study Case in Borobudur Sub-District, Indonesia

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Abstract: Waste problems are challenges for tourism areas, including the Borobudur sub-district. To mitigate these problems, the central government and state-owned enterprises built temporary landfills, or TPS 3R, in 12 of the 20 villages in the Borobudur sub-district. This study observes the TPS 3R's effectiveness in the Borobudur sub-district in reducing household waste unloading in a final landfill. The TPS 3R is the local government program to manage waste problems in residential areas. The Ministry of Public Works and Housing and state-owned enterprises built the TPS 3R in the Borobudur sub-district, which was then activated and operated by the village government. On one side, the TPS 3R burdens the village authorities and the environmental regulatory agency to manage and supervise the TPS 3R. Despite that, the involvement of some village authorities at the managerial level results in a financial burden for TPS 3R. TPS 3Rs are self-sufficient with less

support from the local authorities, which affects the worker's welfare. Accordingly, the TPS 3R tends to raise the levy fee annually to cover daily activities. In addition, the absence of SOP and the managers' lack of experience in waste management resulted in some infrastructure being idled. However, the TPS 3R effectively minimizes household waste unloading to a final landfill.

Structured abstract. This study aims to observe the effectiveness of TPS 3R as a village-based waste management system in the Borobudur sub-district in reducing the amount of municipal waste transported to a final landfill. We conducted the study in Borobudur sub-district, Indonesia, from 2022 to 2023, utilizing semi-structured interviews and focus group discussions. The interviewees consisted of managers and employees of TPS 3R and waste banks from twelve villages in the Borobudur sub-district, a head of the Borobudur sub-district, a head of the Environmental Agency, and a head of the Development Planning Agency. A focus group was held with Empowering Family Welfare members and health workers in the Borobudur sub-district. The data collected from the interview and focus group was then analyzed narratively. The TPS 3R was built by the Ministry of Public Works and Housing and state-owned enterprises on village land. The TPS 3R was equipped with infrastructure such as a biodigester, a compost shredder, and two garbage collection tricycles. The TPS 3R operates independently with less financial support from the local government, resulting in low welfare for the workers. Also, the largest type managed by TPS 3R is organic waste, which requires a longer time to compost but has a low selling price. Accordingly, TPS 3R revenue depends on the household levy fee. However, the levy fee tends to increase each year to cover the TPS 3R activities, which results in a decrease in customer numbers and threatens TPS 3R sustainability. On the other side, the involvement of some village authorities at the managerial level loads up the TPS 3R budget. Also, the on-site manager, a volunteer, manages the TPS 3R as usual, resulting in some infrastructure being idled. However, the TPS 3R reduces the amount of household waste dumped in a final landfill. Village-based waste management systems are not widely applied yet in Indonesia. As the Borobudur sub-district is one of the top tourist destinations, the central government built TPS 3R at the village level to overcome waste problems in the future.

Keywords: waste management; household waste; TPS 3R; Borobudur sub-district; tourism.

JEL Classification: Q53; Z32.

Introduction

The Borobudur sub-district is famous for a Buddhist temple, namely the Borobudur temple. The temple has become one of the most attractive tourist destinations in Indonesia. Before the COVID-19 pandemic, more than three million tourists visited the temple annually (Statistics Indonesia of Magelang Regency, 2022). Meanwhile, in 2022, one and a half million tourists visited the temple (Statistics Indonesia of Magelang Regency, 2023). The Borobudur sub-district is in Magelang Regency, Indonesia, and comprises twenty villages. The sub-district was inhabited by 62,970 people in 2019, with a population density of about 1,141 people per km^2 (Statistics Indonesia of Magelang Regency, 2020). Permanent and temporary residents in the Borobudur sub-district generate waste of at least 35.485 tons per day (The Regional Development Planning Agency of Magelang Regency, 2019; Statistics Indonesia of Magelang Regency, 2020).

1. Research Background

In Indonesia, each regency has a final landfill managed as an open-dumping, semi-sanitary, or sanitary landfill, including the Magelang regency, where the Borobudur sub-district is located. However, a landfill in the Magelang regency has been overloaded, resulting in environmental problems. A temporary landfill, or TPS 3R, is an alternative to managing household waste in a densely populated area. The TPS 3R is a place to collect household waste and practice 3R (reduce, reuse, and recycle) to minimize the amount of municipal waste dumped into a final landfill. In the Borobudur sub-district, the TPS 3R was built at the village level by the MoPWH in cooperation with state-owned enterprises (SOEs) through a community social responsibility (CSR) scheme. However, the TPS 3R is only built in twelve of the twenty villages in the Borobudur sub-district. However, the TPS 3R is only designed to cultivate household waste from a maximum of 400 head families. The TPS 3R in the Borobudur sub-district is subjected to handling waste problems, mainly from tourism, in the future. Moreover, the central government is rapidly building infrastructure to support tourism in the Borobudur sub-district.

Another waste management scheme applied in the Borobudur sub-district is the waste bank. The waste bank is established in every village in the sub-district. The manager and employees of the waste bank are women group members of a social organization, namely *Pemberdayaan Kesejahteraan Keluarga*, or Empowering Family Welfare (EFW). They work voluntarily for the waste bank, although the local government allocates a budget for the waste bank operation and human resource capacity building. However, the waste banks provide training and activity budgets for their activists and members. Meanwhile, the TPS 3R manager is also a volunteer and usually involved in EFW, or waste bank activism.

In contrast to waste banks, TPS 3R has not received much attention from central and local authorities. The TPS 3R does not get funding from the local government. On the other hand, the Magelang Regency head's regulation No. 38, the Year 2018, mentioned that household waste management strategy was held through coordination between the regency and village authorities. The regulation also said that the executive and legislative branches should commit to providing budgets for handling household waste and the like. TPS 3R finances their daily activities from their revenue, which is mainly from waste levy fees. The waste bank is a program initiated by the Ministry of Environment and Forestry to reduce and recycle inorganic waste, and the ministry allocates budgets for the program, which the regency's environmental agency can access. However, TPS 3R is a program by which the MoPWH mandates that regencies or city governments cultivate household waste in residential areas. The TPS 3R is under the authority of the local regency or city government where it is located, and not every regency or city in Indonesia provides the TPS 3R to manage household waste. However, some TPS 3Rs in Bandung Regency, West Java, are inactive because of run-off operating costs (Zafira and Damanhuri, 2019). This study aims to observe the effectiveness of TPS 3R as a village-based waste management system in the Borobudur sub-district to reduce the amount of municipal waste transported to a final landfill.

2. Method

The study was held in Borobudur sub-district, Indonesia (Figure 1), in 2022–2023, using semi-structured interviews and focus group discussions. The interviewees consisted of managers and employees of TPS 3R and waste banks from twelve villages, namely Kembanglimus, Ngargogondo, Tuksongo, Borobudur, Tanjungsari, Ngadiharjo, Wringinputih, Majaksingi, Karangrejo, Wanurejo, Candirejo, and Karanganyar; a head of the Borobudur sub-district; a head of the waste management division of the Environmental Agency; and a head of the research and development division of the Development Planning Agency. However, the TPS 3R in Ngadiharjo and Karanganyar villages has been inactive for over two years, and the village authority has less data about the TPS 3R. Therefore, we excluded the TPS 3R in Ngadiharjo and Karanganyar villages in Figure 2 and Table 1 below. A focus group was held with EFW members and health workers in the Borobudur sub-district. The data collected from the interview and focus group was then analyzed narratively. The levy rates and worker salary calculations were based on a conversion rate of US$1, which is equal to Rp 15,649.

Figure 1. A map of the Borobudur sub-district. The location of the Borobudur temple is shown by a pentagon shape, and the locations of the TPS 3Rs listed in Table 1 are shown by a pinned picture.

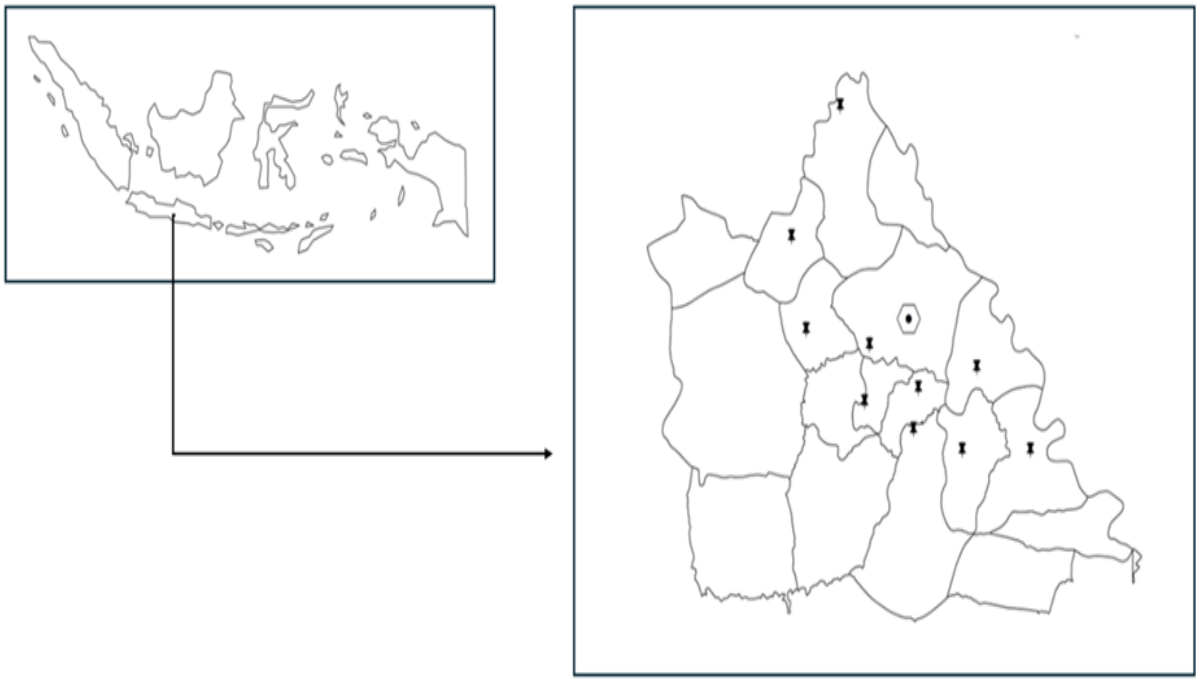
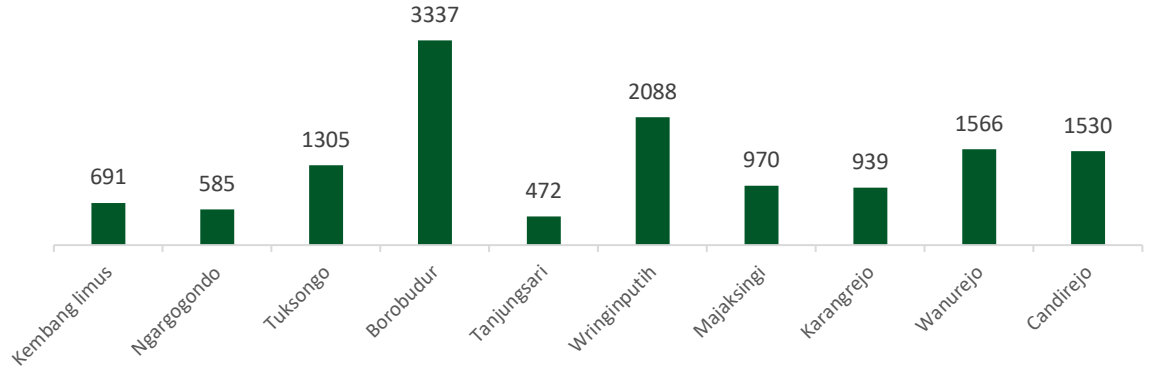


Figure 2. Number of head families of villages in the Borobudur sub-district that have been installed with TPS 3R.



Source: Population and Civil Registry Office of Magelang Regency, 2021.

3. Research Results

Table 1. Characteristics of TPS 3R in the Borobudur sub-district.

Village	Number of workers	Worker salary	Waste collection Days	Number of customers	Levy rates	Waste production of the customers	Residues dumps in a final landfill.
	person	US$/ month	days/ week	Head of family	US$/ family/month	ton/month	ton/month
Kembang limus	4	54.32	7	160	0.97	8.64	1
Facilities	A biodigester, a compost shredder						
Ngargogondo	3	38.76	3	124	1.29	6.7	0
Facilities	A biodigester, a compost shredder						
Tuksongo	5	50.4	3	250	1.29	13	4
Facilities	A biodigester,a compost shredder, a plastic shredder machine						
Borobudur	6	58	5	265	1.62	15	8
Facilities	A biodigester, a compost shredder, a sieveing machine						
Tanjungsari	3	63.84	3	200	0.97	10.8	1
Facilities	A biodigester, a compost shredder, a plastic shredder machine, a pelletizer machine						
Wringin Putih	5	63.84	4	250	1.28	30	20
Facilities	A biodigester,a compost shredder, an oven, a sieving machine						
Majaksingi	4	47.76-76.56	6	139	0.96	14	8
Facilities	A biodigester, a grinder, a sieveing machine						
Karangrejo	4	53.2-70	7	211	1.28	12	4

Village	Number of workers	Worker salary	Waste collection Days	Number of customers	Levy rates	Waste production of the customers	Residues dumps in a final landfill.
	person	US$/ month	days/ week	Head of family	US$/ family/month	ton/month	ton/month
Facilities	A biodigester, sieving machine						
Wanurejo	7	44.52	7	310	1.28	18	2.7
Facilities	A biodigester, a compost shredder, a sorting equipment, a composter, an incinerator						
Candirejo	7	70.32	3	425	0.64	16	8
Facilities	A biodigester, a composter, a compost shredder,						

Figure 3. A typical TPS 3R building in the Borobudur sub-district consists of an employees' room in the front and a hangar in the back (a); household waste manual sorting in the TPS 3R hangar (b); an idled biodigester located in the TPS 3R backyard (c); and maggot cultivation feeding with food waste (d).

The TPS 3Rs in the Borobudur sub-district were built by SOEs and the MoPWH, equipped with two garbage collection tricycles, a biodigester, and a compost shredder (Figure 3.a.). As the TPS 3R runs, sometimes the manager buys other infrastructure through an aid program or self-reliance, such as an incinerator, a pelletizer, or a plastic shredder. TPS 3Rs that collect household waste daily are in Kembang Limus, Karangrejo, and Wanurejo villages. Each TPS 3R serves 160 – 425 households, composing 7.9% – 42% of the head families per village. However, the customers of TPS 3Rs in the Borobudur sub-district only account for twelve per cent of the total head families in the sub-district. Most Borobudur sub-district inhabitants cultivate their household waste by disposing of it or burning it in their backyards. Customers of TPS 3Rs in the Borobudur sub-district are town people who do not have a large yard to cultivate their household waste. However, some FGD members who are also customers of TPS 3R claimed the current disposal charge was too expensive. They argue that household waste is worthless material. Nowadays, the levy rates for household waste range from US$ 0.64 – US$ 1.62 (family per month). Other TPS 3R customers include stores, schools, hotels, and villas, and the levy varies from US$ 3.19 to US$ 25.5. However, the number of these types of customers is small. According to the TPS 3R

managers, the gross revenue of TPS 3R ranges from US$ 127 to US$ 510. However, the managers should allocate US$ 3.5 to US$ 63.7 (per month) to pay a tipping fee for a final landfill. To reduce residue unloading at a final landfill, some TPS 3Rs build incinerators. However, the manager should provide an operational and maintenance budget for the incinerator, which will affect their revenue.

Meanwhile, the TPS 3R workers' salary is under the regional minimum wage of the Magelang regency, where the Borobudur sub-district is located, which is US$ 142.934 per month. The TPS 3R workers' salaries range from US$ 38.76 to US$ 76.56 (per month), with workdays ranging from three to seven days per week. The workers collect household waste using a three-wheel motorcycle with a garbage bucket. The customers provide a waste container in their front house, and the workers pick up household waste in the morning to unload at the TPS 3R. The waste dumped in the bucket is separated by a board for organic and inorganic waste. However, a separation of organic and inorganic waste wrapped in a plastic bag occurs in TPS 3R. Usually, household waste is a mix of organic and inorganic waste. According to the TPS 3R manager, sorting inorganic household waste is time-consuming and the most expensive stage in TPS 3R because the process is held manually (Figure 3.b.). The workers separate plastic, paper, and glass waste into different containers, which are then sold to garbage collectors. In the meantime, organic household waste is cultivated for compost, maggot cultivation or incubated in a biodigester for bioenergy production (Figure 3.d.). However, the workers are wearing the minimum safety equipment. The gloves and boots provided are not suitable for the workers. In the interview, the workers mentioned that during waste separation, they must wear some layers of gloves made of fabric or latex and boots made of rubber because the waste contains sharp materials. The workers should work with great caution because the TPS 3R does not provide medical compensation, although the village authority has provided social health security for the workers.

The customers of TPS 3R produce waste ranging from 6.7 to 30 tons (per month). The TPS 3R reduces and recycles household waste through inorganic waste sorting and organic waste composting. However, some household waste is difficult to recycle, such as baby diapers, sanitary napkins, and dangerous toxic stuff that can amount to one to twenty tons (per month). This waste is categorized as residue and is usually dumped in a final landfill. However, to dump the residues, the TPS 3R should pay a tipping fee to the landfill, about 0.35¢ per kg. To avoid the tipping fees, some TPS 3R cultivate the residue by burning it, such as the TPS 3R in Ngargogondo and Wanurejo villages. However, TPS 3R in Wanurejo village still sends some of the household residue to a final landfill.

Meanwhile, the TPS 3R in Ngargogondo village generates zero residues and is also the only one that operates a biodigester by utilizing food waste to produce biogas. The biogas is sold to houses around the TPS 3R for a fee of 64.64¢ per month. The TPS 3R's compost product is also in demand among many customers. Unfortunately, at most TPS 3Rs located in the Borobudur sub-district, workers can rarely operate some of the infrastructure installed in the TPS 3R and some of the installed machines under the required TPS 3R capacity. Therefore, the installed infrastructure, such as a biodigester, a shredder, and a composting machine, is unused (Figure 3.c.).

The village authorities and a volunteer govern the TPS 3R’s managers. However, the managers, composed of village authorities, are not involved in the TPS 3R daily operational activities. They link between the TPS 3R managers and the head village to access a village fund or another aid program. However, some TPS 3R managers who are composed of volunteers mentioned that the managers, composed of village authorities, lack responsiveness to the workers' problems. Meanwhile, the workers say that the lack of infrastructure to meet the daily waste production capacity burdens their work. The workers also sometimes must explain the TPS 3R policy changes or respond to customer complaints about the service, which they assume should be the management’s duties. On the other hand, a manager who stays in the TPS 3R is usually a volunteer and manages the TPS 3R’s revenue for utility expenses, which consists of workers’ salaries, gasoline, electricity, and tipping fees. However, according to the on-site TPS 3R manager, the revenue is insufficient to cover infrastructure and building maintenance.

The refuse collection fee is paid in cash per month, and the person who takes the levy is a worker who picks up their waste. A treasurer then manages the cash collected by the levied person. However, some customers refuse to pay the bill on time, which harms TPS 3R. In the meantime, the TPS 3R in Tuksongo village has implemented online bill payment to make the revenue more accountable. The TPS 3R cooperates with a local digital wallet called DANA. According to the TPS 3R manager, when revenue exceeds expenses, the treasurer will keep the money to anticipate low revenue. However, some TPS 3Rs are often facing revenue deficits, such as in Kembang Limus, Wringin Putih, and Majaksingi village, because of the tipping fee to unload residues in a final landfill. Meanwhile, insufficient revenue to pay the workers occurs in TPS 3R in Candirejo

village, causing the TPS 3R manager to frequently ask the head village for a village fund to cover the workers' salaries. However, when we did the interview, the TPS 3R manager said that they had no support from a village fund for two months to pay the workers, and the workers were to quit TPS 3R if they had not paid at the end of the month.

Although some TPS 3R managers claim that waste banks reduce the workload of the TPS 3R, others consider the waste banks to be competitors. The waste banks' members and managers are commonly EFW members. The EFW members involved in FGD mentioned that three of the six waste banks in a village are inactive. Compared to TPS3R, waste banks are funded by the sub-district and village authorities. The waste bank collects the inorganic waste from its members, pays for it, and then sells it to garbage collectors. In the Borobudur sub-district, some waste banks gather inorganic waste from the EFW members and pay it at the end of the year so the members can save from selling inorganic waste to the waste bank. According to some EFW members, the earnings from waste banks are then invested in gold for long-term savings. However, only a few EFW members are interested in volunteering to manage waste banks because they have jobs or are busy carrying children.

The Regency Environmental Agency, on the other hand, suggested that areas for TPS 3R and waste banks should be separated in the future to reduce a conflict between the TPS 3R and waste banks. The agency plans to separate village areas for TPS 3Rs and waste banks. Inorganic waste has a good selling price; hence, the TPS 3R prefers to collect recyclable inorganic waste to increase revenue. Since the waste bank also collects inorganic waste, the TPS 3R and the waste bank are usually in conflict. They compete with the waste banks in accumulating recyclable inorganic waste to sell to garbage collectors. However, as the waste banks buy the inorganic waste from the customers, they are more advanced than TPS 3R in collecting the materials. On the other side, TPS 3R accumulates the materials from a dump. The Regency Environmental Agency, responding to another waste problem related to littering, mentioned that they will implement social sanctions for inhabitants who litter. However, the kind of social sanction will be discussed later with the authorities about waste management at the sub-district and village levels.

4. Discussions

The TPS 3R can reduce the waste volume in a landfill and extend its final landfill life. However, the absence of a standard operational procedure (SOP) and inexperienced managers resulted in suboptimal TPS 3R management. The lack of SOP causes some infrastructure, such as biodigesters, to be idled because no one can be the operator. Therefore, organic waste is cultivated for compost, and food waste is used for maggot feed. However, compost made from organic waste has a low price. On the other side, the larvae of black soldier flies are slow at digesting food waste, and the rotting food waste causes a smelly odor that disturbs settlements near the TPS 3R. In the meantime, organic waste can be cultivated for clean energy in a biodigester, and the digestate is used as a soil fertilizer. The lack of SOP for customers and workers also burdens waste management in the TPS3R. At the customer level, the waste bins are usually provided without a cover, which causes the waste to become damp and heavier. At the same time, during the waste picking, the workers unload the waste into a tricycle without providing a cover that can accommodate rainwater wetting the waste. At the managerial level, the inexperienced TPS 3R managers manage the waste as business as usual, and some installed infrastructure is unutilized. On the contrary, a TPS 3R located in Ngargogondo village is managed by a provincial waste extension counselor manager experienced in cultivating organic and inorganic waste. The TPS 3R in Ngargogondo is the cleanest, and the waste is cultivated efficiently; food waste is for biodigester feeds, leaf litter is shredded and cultivated for compost, food waste is for bioenergy, plastics are separated into wet and dry before being sold to garbage collectors, and the waste residue is burned.

According to the on-site manager, the workers working days and salaries are determined by the village authorities, who are also TPS 3R managers. The village authorities' role as managers has advantages and disadvantages for TPS 3R management and workers. The benefit of involving the village authorities in TPS 3R management is that they have budgeting power at the village level and have information from the regency and central government levels about programs and aid related to waste management. The authorities in Candirejo and Karangrejo villages support TPS 3R by allocating a budget of village funds or village-owned enterprise funds. The village authorities, who are also TPS 3R managers, report the TPS 3R activities to the head village, which is also part of their duty as village authorities. However, most of those village authorities are inadequate managers, and they get double salaries from the TPS 3R and the head village for their jobs in the TPS 3R and at the village office. The number of village authorities as TPS 3R managers sometimes exceeds the number of workers, resulting in high payment expenses, although the salary is less than that of the workers. On the other hand, the

on-site manager stays at TPS 3R, manages routine activities, and gets a salary from the remnant revenue after the routine expenses that are usually less than the worker's salary.

The TPS 3R manages the village's waste independently, and the regency and sub-district authorities do not allocate budgets to help the TPS 3R business. The TPS 3R activities depend on earnings from refuse fee collection, selling inorganic waste, and composting. The TPS 3R depends on the managers' creativity to generate revenue. Some TPS 3R managers in the Borobudur sub-district try to get additional income for the TPS 3R activity by planting vegetables and fruit trees. Even some TPS 3R managers utilize the idled biodigester to breed catfish. However, the waste banks can threaten the TPS 3R by competing to gain inorganic waste. In the meantime, the inorganic waste selling price fluctuation can also increase or decrease TPS 3R revenue. Therefore, the managers often raise the levy to support the TPS 3R activity, particularly to cover waste transportation from customers to TPS 3R and the workers' salaries. However, the increasing levy fee causes some customers to quit membership. Most managers mentioned that the TPS 3R's income is inadequate to maintain and repair broken facilities. The EFW members who are also customers of TPS 3R mentioned that the present fee is US$ 1.28 per month, and they consider the levy expensive. The customers added an ideal fee levy for household waste of around 64¢ per month.

The sub-district and SOEs support the TPS 3R by providing aid, such as to the TPS 3R in Borobudur village and Tuksongo. Both Borobudur and Tuksongo are villages with a highly populated density. The sub-district authority supports an occasional budget for TPS 3R, located in Borobudur village. Meanwhile, the SOE provides a CSR for TPS 3R in Tuksongo village to repair broken facilities and purchase new facilities. The CSR is a donation from an SOE that built the TPS 3R and assisted in its operation. However, an SOE that built the TPS 3R in Borobudur village no longer facilitates the TPS 3R activities, as do other SOEs that built another TPS 3R in the Borobudur sub-district. In the meantime, the head villages of Ngargogondo and Ngadiharjo plan to allocate the village fund, tax revenue sharing fund, or retribution profit sharing fund to support the TPS 3R in the future. Meanwhile, the head village of Tanjungsari explained that the village fund has no budget mechanism for TPS 3R activities, which makes the village authority doubtful about determining the fund spending for TPS 3R. On the other hand, the village fund has a budget mechanism for waste bank activities at the village and sub-village levels.

Another challenge faced by TPS 3R management is conventional bill payment collection and low worker welfare. During the payment collection, the workers levy the fee on houses where they pick up their household waste daily and do not make recordings. The new or old customers who want to register or quit a membership only tell the workers directly when they pick up the waste, and then the workers will inform the TPS 3R managers about the new data. The refuse fee collected in cash, unrecorded payments, and long-chain collection are vulnerable to losses and less accounted for because some customers pay the bill late, whereas, on some occasions, the customer delinquently pays for months. The collected cash from customer bill payments is susceptible to theft, and the salary payment in cash becomes the treasurer's burden. However, most TPS 3R managers and workers are unfamiliar with the banking system for levy fee payments. However, TPS 3R in Tuksongo village was assisted by the SOE to use an e-wallet for refuse fee payment.

Meanwhile, the workers lack safety equipment, and there is no employment insurance from the TPS 3R, indicating low worker welfare. The TPS 3R managers said they are concerned about the workers' safety; however, they cannot provide proper equipment due to the income shortage. The managers assert that their main target is to allocate the revenue for routine expenses such as workers' salaries and utility bills. However, as there is no employment insurance, workers who get injured during working hours should be self-medicated. Meanwhile, workers who operate tricycles and accidentally damage other vehicles during working hours should be self-responsible. However, the managers who work daily in TPS 3R are in a similar situation as the workers. The managers are sometimes paid under the workers' rate because their salaries are based on the remaining routine expenses. However, when the revenue exceeds expenses, the manager will keep the remaining revenue to support TPS 3R activities when there is a lack of income. Meanwhile, the tipping fee policy causes the TPS 3R managers to provide expenses to unload residues to a final landfill, despite the Regency Environmental Agency facilitating the carrying of the residues to a final landfill. However, some TPS 3Rs try to reduce the tipping fee by burning the residues in an incinerator; for example, TPS 3R in Wanurejo village has succeeded in installing and operating incinerators.

Meanwhile, most TPS 3R managers in the Borobudur sub-district claimed that waste banks reduce the workload for TPS 3R in managing the village's waste. Also, the TPS 3R managers said that waste banks educate the villagers to recycle and reuse household waste. However, most TPS 3R and waste banks run separately at the village level. The village heads mentioned that TPS 3R in Borobudur village is under the responsibility of the

regency's Environmental Agency, although TPS 3R is in their villages. However, the Regency Environmental Agency prefers to use gasification technology to manage the regency's municipal waste in a final landfill. The different interests of the regency environmental agency and TPS 3R in managing the waste cause TPS 3R to be more self-sufficient. Meanwhile, the TPS 3R managers are commonly selected from volunteers actively involved in village events and mandated by the village head to take care of the TPS 3R. Those managers are not linked to the regency's Environmental Agency, generating a lack of communication between those two entities about the TPS 3R obstacles.

According to the regency and village authorities, the TPS 3R program in the Borobudur sub-district was established by the MoPWH without previously discussing it with them. Consequently, they consider the program a burden and exclude TPS 3R from their work planning. However, since the head village is mandated to run the TPS 3R by the MoPWH, some TPS 3R managers are village authorities. The village authorities then chose EFW, or waste bank activists, to manage daily activities in the TPS3R. Before the TPS3R program was initiated in the Borobudur sub-district, the sub-district and village authorities empowered the EFW to operate waste banks. In the meantime, despite the Regency Environmental Agency's plan to separate working areas for TPS 3R and waste banks, the local authorities should support TPS 3R by providing funds because most of the household waste cultivated by TPS 3R is organic. According to Jain (2017), the municipal solid waste in Indonesia is 60 per cent organic. Moreover, organic waste cultivation requires more energy and time, but the product's selling price is low.

Conclusions and Further Research

The TPS 3Rs in the Borobudur sub-district can reduce the amount of household waste unloaded to a final landfill. The program is effective in tackling waste problems at the village level. However, less support from the local government threatens the TPS 3R's sustainability in the future. The village government does not consider household waste a serious problem and has no urgency for waste management at the village level. The TPS 3R works independently, but most managers run the business as usual, resulting in inefficient management. However, the TPS 3R is likely difficult to hire professional managers interested in waste management, particularly at the village level. In the future, it would be better for the TPS 3R and waste bank to operate under one organization; the TPS 3R manages organic waste and the waste banks handle inorganic waste. However, there should be an incentive fund for the TPS 3R if they only cultivate organic waste. Also, research on communication types between villages, local government, and central government is important because some central government programs have not received attention at the grassroots level, including waste problems.

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Credit Authorship Contribution Statement

Siti Wahyuningsih: Conceptualization, Investigation, Writing – original draft.
Tuti Susilowati: Conceptualization, Investigation, Methodology, Supervision.
Hadi Ashar: Investigation, Methodology, Validation, writing-original draft.
Avry Pribadi: Data curation, Writing – review and editing.
Teguh Satyaji: Funding acquisition, Writing – review and editing.
Sukamsi: Funding acquisition, Writing – review and editing.
Purwati: Project administration, Writing – review and editing.
Dhanik Ernawati: Visualization, Writing – review and editing.

Declaration of Competing Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies

During the preparation of this work, the authors used QuillBot grammar checker and Google Translate in order to improve the language and readability of their paper with the appropriate disclosure. After using this tool or service, the authors reviewed and edited the content as needed and took full responsibility for the content of the publication.

References

[1] Jain, A. (2017). UN Environment Summary Report: Waste Management in ASEAN Countries. Thailand. https://www.unep.org/resources/report/waste-management-asean-countries-summary-report

[2] Prabowo, R, S. (2022). 'Borobudur produces 4 tons of waste every day, the mountain of waste at a final landfill Pasuruhan is higher than Borobudur Temple'. Suara Jawa Tengah, 22 August 2022. https://jateng.suara.com/read/2022/09/22/190007/borobudur-hasilkan-4-ton-sampah-tiap-hari-gunungan-sampah-di-tpsa-pasuruhan-lebih-tinggi-dari-candi-borobudur (in Indonesian)

[3] Zafira, A. D. and Damanhuri, E. (2019). Analysis of TPS 3R sustainability strategies to minimize waste transportation to a final landfill (Case Study: TPS 3R program Bandung Regency, West Java Province). Jurnal Teknik Lingkungan Hidup 25(2): 33 – 52. https://core.ac.uk/download/481318216.pdf (in Indonesian)

[4] Population and Civil Registry Office of Magelang Regency. (2021). Number of Family Heads and Ownership of Family Register: Borobudur Sub-district. Magelang, Central Java, Indonesia. https://pusaka.magelangkab.go.id/penduduk/agregat/kartuKeluarga (in Indonesian).

[5] Statistics Indonesia of Magelang Regency (2020). Borobudur Sub-district in Numbers. Magelang, Central Java. https://magelangkab.bps.go.id/publication/2020/09/28/b54a3e212a64f3a81076c0fd/kecamatan-borobudur-dalam-angka-2020.html (in Indonesian)

[6] Statistics Indonesia of Magelang Regency (2022). Number of visitors to the Borobudur Temple tourist attraction according to tourist origin and month in Magelang Regency, 2020-2022. Magelang, Central Java, Indonesia. https://magelangkab.bps.go.id/indicator/16/327/1/pengunjung-candi-borobudur.html (in Indonesian)

[7] The Regional Development Planning Agency of Magelang Regency (2019). Waste Management in Magelang Regency. Magelang, Central Java, Indonesia. (in Indonesia)

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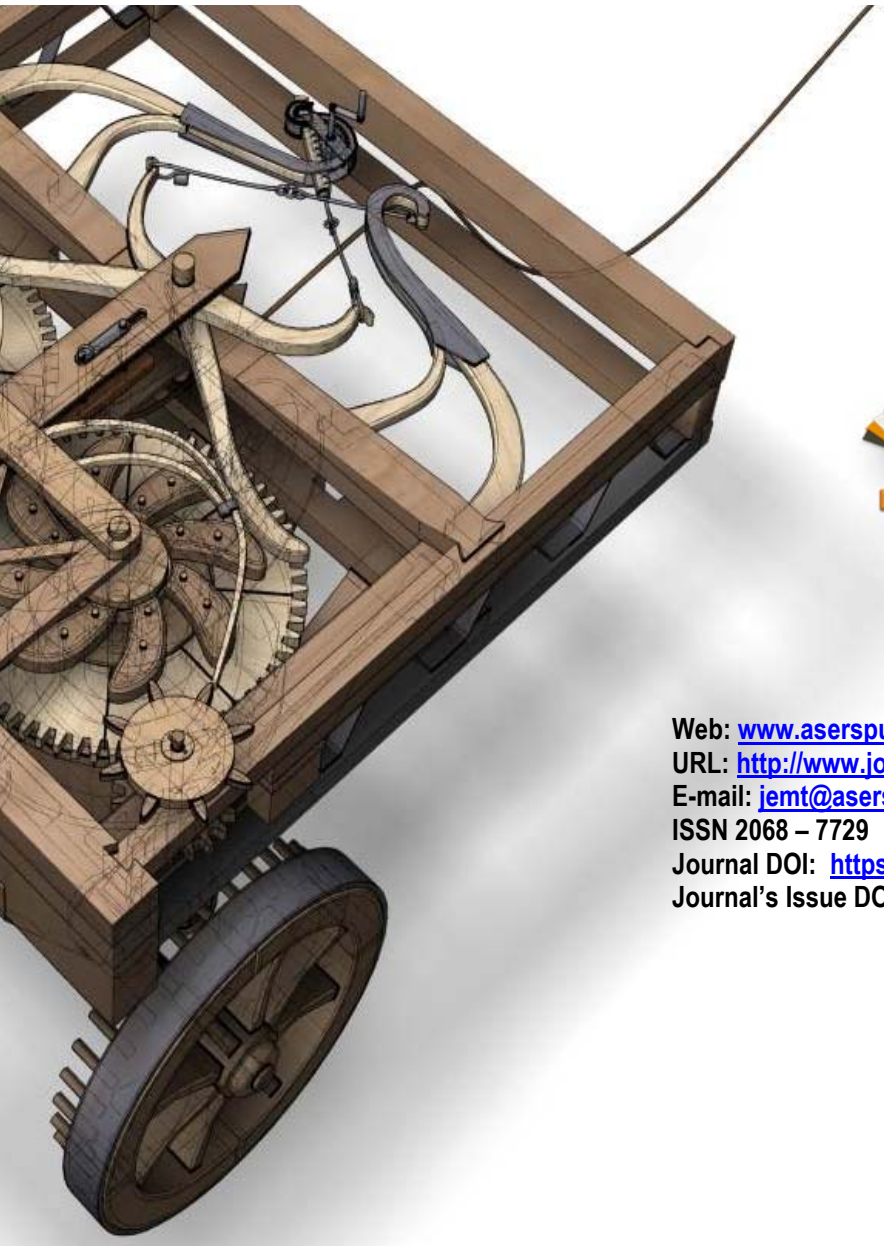

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