Moving from Waste to Resource Management: A Case Study of Lake Toba, Indonesia

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Abstract

This paper presents field experience in developing local waste management plans called *Kebijakan Strategi Daerah (Jakstrada)* in the Lake Toba region, one of the popular tourist destinations in Indonesia. It examines the current waste management status and discusses key priorities and actions identified in the *Jakstradas* to improve the waste management based on resource management and 3R (reduce, reuse and recycle) principles. In partnership with public, private, academic and citizen groups, the project activities supported the development of *Jakstradas* in all seven regencies and established a resource recovery centre (RRC) as a model to practice 3Rs in the region. The key lessons learned from these project activities are discussed and some practical recommendations are identified based on a literature review, interviews and workshops with local government officials and residents. Through those opportunities, it was found that remote regencies around Lake Toba do not have environmentally sound final disposal sites, and do not have the financial or technical capacity to provide waste collection and handling services to residents, which often results in illegal dumping and open burning of waste. It was also revealed that lack of established markets for recycling value chains and citizens participation in waste separation at source had resulted in limited success for recycling and 3R activities in the region.

Key words: waste management, resource management, 3R (reduce, reuse and recycle), waste banks, Lake Toba, Indonesia

1. Introduction

Solid waste management is increasingly being viewed as a critical issue for Indonesia, which is developing rapidly and is the fourth most populous country in the world as well as the tenth largest economy in terms of purchasing power parity (World Bank, 2019a). It is also estimated to be the

world's second largest contributor of marine plastic pollution (World Bank, 2018). As such, Indonesia has pledged some ambitious targets and has been making efforts to achieve targets of 100% proper management of waste by 2025, by means of 30% waste reduction at source and 70% of waste handling as stipulated in the Presidential Regulation No.97/2017 on National Waste Management Policy and Strategy called *Kebijakan dan Strategi Nasional* (*Jakstranas*). (World Bank, 2019a). However, according to the Ministry of Environment and Forestry (MoEF), approximately 66.4% of waste ends up in landfill, 19.6% of waste is unmanaged and leaks into the environment, 11.8% of waste is treated by composting, or is converted into fuel or biogas, etc., and only 2.2% of waste is recycled (GA Circular and Ocean Conservancy, 2019).

While large cities are still struggling in improving the waste management due to the rapidly growing population and economic growth in the urban centres, small cities and remote villages are faced with the risk of unmanaged waste. According to the Indonesia National Plastic Action Partnership (NPAP), around 4% of plastic waste leaks into the environment in mega cities, but this figure rises to 12 – 15% in rural and tourist areas due to a lack of institutional systems and facilities. (Ministry of Environment and Forestry, Indonesia, 2020). This situation deteriorates further in small cities, which are tourism destinations. The National Medium-Term Development Plan (RPJMN) 2015-2019 has set aggressive targets to increase the role of tourism in the Indonesian economy (World Bank, 2019a). According to Government Regulation Number 50 /2011 of the National Master Plan for Tourism Development, there are 88 strategic national tourist destinations in Indonesia (Akhmad,S., et al., 2015). The government has also designated the top 10 most important tourist destinations. Among those, four areas were selected in 2019 as top priority tourist destinations, including Lake Toba (Cabinet secretariat of Indonesia, 2019).

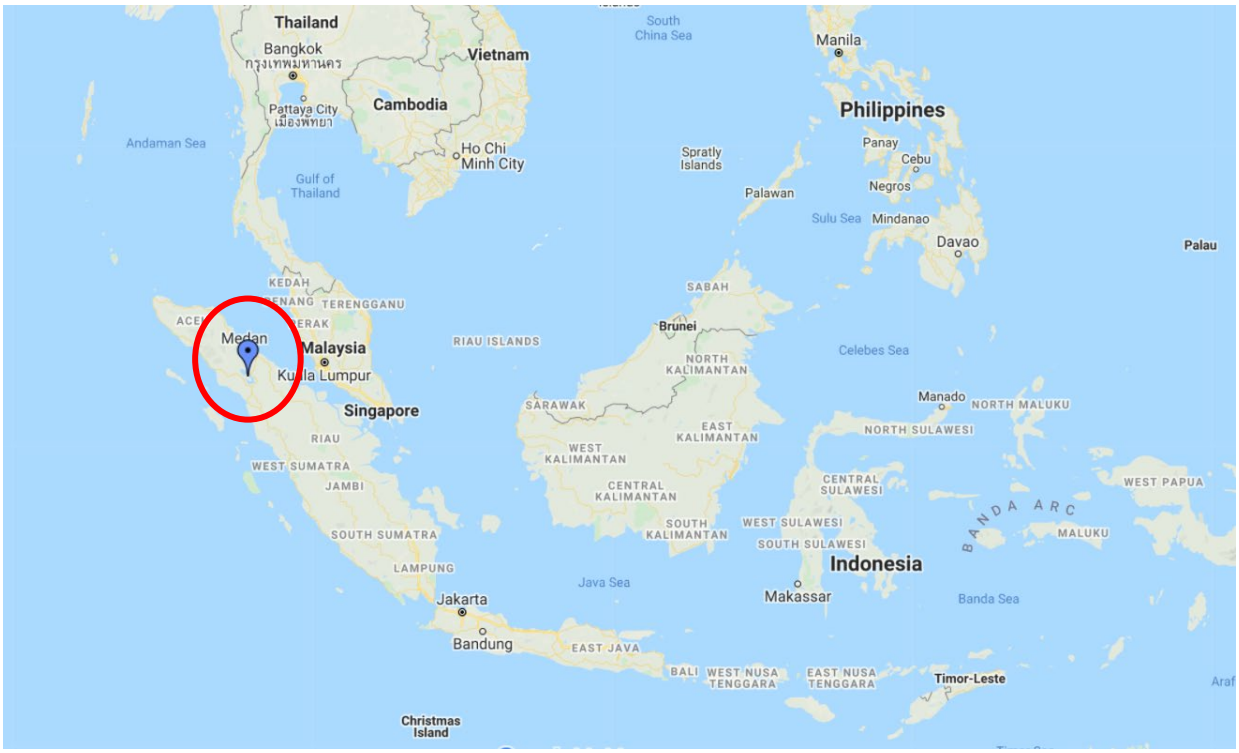


Figure 1 Location of Lake Toba, Indonesia (Google map)

Lake Toba in Sumatra is the largest volcanic lake in the world with both natural and cultural heritage. It has huge potential for the tourism industry. In this context, the President of Indonesia pledged to accelerate the development of infrastructure to boost economic development through tourism for Lake Toba. However, besides the lack of infrastructure for tourism, waste management is another major issue in the region. Most solid waste from households and tourist hotels is not properly managed, and leaks into the lake, which ruins the value of natural assets.

In order to promote proper waste management in the region, work was carried out between 2019 and 2020 to develop local waste management plans and actions at the regency level (*kabupaten)* or municipal level (smaller local government units) based on the 3R concept. These plans and actions are known as *Kebijakan Strategi Daerah (Jakstrada)*. In order to materialise the action plans, a pilot project for a resource recovery centre (RRC) was set up to create awareness and change behaviour of local residents for resource management. This paper presents the key lessons learned from those project activities and discusses how small municipalities or tourist areas in Indonesia can improve their waste management in more resource perspectives. It structures the current regional waste management issues, sets out the approach for establishing a strategy and a RRC as a pilot project to solve the issues, as well as giving the results and impact, and lessons

learned from the experience.

2. Methodology and project activities in the Lake Toba region

The study is descriptive qualitative research. Secondary and primary data collection on the waste management status in the region were conducted, then two project activities were implemented to improve the situation. The study describes the collected data and the project activities, analyses outcomes and impact generated by the project, and discusses the findings including the challenges and opportunities for better waste management in the region.

2.1 Initial data collection methods and the outline of the project activities

1) Secondary data collection

- ***Literature review*:** Before designing the field work, a literature review was carried out to understand the current waste management status, data availability, any specific policies, institutional arrangements, and key stakeholders involved in the sector at both the national level and in the Lake Toba region (project area).

2) Primary data collection via fieldwork and consultative work

- ***Fieldwork:*** As shown in Figure 2, the Lake Toba region includes seven regencies — Karo, Simalungun, Toba Samosir, Tapanuli Utara, Humbang Hasundutan, Samosir and Dairi. The study selected four out of these seven regions, namely Simalungun, Samosir, Toba Samosir and Humbang Hasundutan, and carried out fieldwork with the technical support of the Institute of Technology, Bandung, looking at the importance of these regions in terms of economic development, demography and tourism around Lake Toba.

Figure 2 Geography in the Lake Toba region

（Source: 2010 Indonesia Census, sumut-expose.blogspot.co.id)

- ***Consultative work*:** a series of focus group discussions, consultative workshops, field surveys and observations were carried out in partnership with the Ministry of Environment and Forestry (MoEF), IGES Centre Collaborating with UNEP on Environmental Technologies (CCET) and the Institute of Technology, Bandung between June and October 2019 (see Table 1). These activities were focused on gathering primary information from local residents, formal and informal service providers and local government officials in Lake Toba for the development of Jakstrada. The authors have provided technical assistance on identifying and prioritizing the local waste management issues to be solved and the development of the project planning through the series of discussion with MoEF and Institute of Technology, Bandung, based on the experience of developing the national and city level waste management development in other Asia-Pacific countries including Myanmar, Cambodia, Maldives. The authors also participated in the workshops and discussions with the officials of the targeted regencies, the provincial government, and NGOs to develop the JAKSTRADA and pilot project.

Table 1 Activities in Lake Toba

Activity	Time Period
1. Initial discussion on the development of Jakstrada with MoEF, North Sumatra provincial government, regencies in the Lake Toba region in Medan and field visit to Lake Toba	June, September 2019
2. Field visit and meeting with the regencies in the Lake Toba region	October 2019
3. Waste audit in four selected regencies 1) Simalungun, 2) Samosir, 3) Toba Samosir and 4) Humbang Hasundutan)	October 2019
4. Workshop with the province and regencies to share the waste audit result	October 2019
5. 1st Jakstrada development workshop with the regencies Discussion topics: The waste management situation in Indonesia, the importance and role of Jakstrada, how to develop/draft Jakstrada.	October 2019
6. 2nd Jakstrada development workshop Discussion topics: Follow-up of the Jakstrada development, how to succeed local waste management, financial challenges in waste management	October 2019
7. Construction of RRC started.	November 2019
8. 3rd Jakstrada development workshop Discussion topics: Further improvement of Jakstrada, support for the regencies which had not completed, waste management programmes to be included in Jakstrada	February 2020
8. 4th Jakstrada development workshop Discussion topics: Review of developed Jakstrada, budget assistance from MoEF The operation of RRC was launched.	February 2020

2.2 The current waste management in the Lake Toba region: data and information through the secondary and primary data collection

As shown in Table 2, the current waste management system is not adequate in the Lake Toba region. Similar to other remote regencies in the country, the waste collection system does not cover all areas. The estimated waste collection rates in the regencies range from 18.3% to 47.1% of the total waste generation. The lack of a waste collection service often results in illegal dumping and open burning. Field observations revealed that households, which are not covered by official waste collection services, tend to burn waste at home and use organic kitchen waste as livestock feed. In some areas, residents believe that the lake is sacred and do not throw waste into the lake,

but nevertheless waste is still sometimes dumped directly into the lake.

Table 2 Current situation of waste management

Description	Regency			
	Simalungun	Samosir	Toba Samosir	Humbang Hasundutan
(1) Population	863,693 (2018)	146,978 (2018)	185,425 (2019)	186,694 (2018)
(2) Estimated total waste generation (2019)	187,506 (t/year)	32, 331(t/year)	27,614 (t/year)	20,886 (t/year)
(3) Average Per capita household waste generation	0.28 kg/capita/day	0.20 kg/capita/day	0.20 kg/capita/day	0.20. kg/capita/day
(4) Composition of Waste	Food and garden waste 62.6%; plastic waste 15.4%; others 22%	Food and garden waste 72.5%; plastic waste 10.2%; Others 17.3%	Food and garden waste 44.2%; plastic waste 14.4%; Others 41.4%	N/A
(5) Estimated waste collection	18.3% of total waste generation	47.1% of total waste generation	37.1% of total waste generation	24.8% of total waste generation
(6) Available vehicles for waste transportation	20 trucks	10 trucks 27 motor bikes	15 trucks 9 motor bikes	N/A (Transportation by trucks are available in almost all sub-regencies)
(7) Final disposal sites	One new landfill site was developed in 2020	One disposal site in the forest located far from the city center	Two final disposal sites	One disposal site and a new landfill was developed in 2020

(8) Other information	The largest contributor of waste in the Lake Toba region (37% of the total waste in Toba area)	All drainage sites connected to the lake are equipped with waste capturing nets	TPS-3R (temporary disposal sites or temporary shelter for 3R) was established in 2018, but is not currently in operation	A recycle centre for composting was constructed by MoEF in 2018, but has not been functioning well

The regencies also do not have enough environmentally sound disposal sites, so it is common for regional environmental agencies to collect the waste and dump it on open land. There are only two official landfill sites in the Lake Toba region and they began operations in February 2020. However, fieldwork showed that the sites are not properly designed to prevent negative impacts on the local environment. They do not consider leachate treatment and methane capture, and soil cover is not carried out (see Figure 2).

Additionally, it was found that residents in the region do not separate their waste at source. Only a small number of waste pickers and junk shops in the region have been observed during the survey. Informal waste collection is not common because active recycle value chains have not been set up to buy those collected materials from the informal sector.

Figure 3 Landfill situations in the Lake Toba region
(The picture at bottom right shows a landfill sight under construction which is not properly designed to prevent negative impacts on the local environment.)

Although Lake Toba is an important water resource for the residents in the area, insufficient waste management in the region has resulted in significant and unsightly pollution of the lake, which making the area less attractive for tourists. Pollution comes from agricultural waste generated by businesses around the lake, domestic waste from households and tourist accommodation, waste from aquaculture at the lake, and from water transportation. The water quality of the lake declined from Quality Criteria Class I to Class II based on Government Regulation No. 82 of 2001 on water quality management. (Indirawati, S. and Muntaha, A. 2018) The following is information related to lake water pollution.

- According to the Lake Toba Foundation, a local NGO, waste due to aquaculture in the lake and agriculture in the surrounding area is the cause of eutrophication and red tide, as well as abnormal growth of algae and so on (Ir. Halomoan L. T., 2019, personal communication, 25 June).
- Based on information from the local community, aquaculture using floating fish cages in the lake began in 1996. According to the Directorate General of Aquaculture and Fisheries (2015), there were as many as 23,000 floating fish cages in the lake in 2014. Commercial and local scale aquaculture production expanded rapidly, which resulted in an estimated 85,000 tonnes of fish production in 2015. At the same time, extensive fish deaths have been observed in the lake due to oxygen deficiency caused by harmful algal blooms, which have been on the increase, possibly due to nutrient pollution (World Bank, 2019b).

2.3 Project implementation for shifting from waste to resource management

In order to introduce sustainable practices into the waste management sector in the Lake Toba

region, the following two activities have been carried out and summarised in below:
Activity 1: Development of local waste management plans and programmes (*Jakstrada*) for each regency based on the 3R concept in a consultative manner;
Activity 2: Programme implementation as a pilot project to establish an RRC to create a new value chain for recyclable materials

Activity 1 Development of local waste management plans for regencies (*Jakstrada*)

Based on the national level strategy or *Jakstranas* (Presidential Regulation Number 97, Year 2017) and the Regulation of the Ministry of Environment and Forestry No. P10/MENLHK/SETJEN/PLB/0/4/2018, all cities, regencies and provinces in the country are required to develop and submit their own strategy or *Jakstrada* (Kebijakan dan Strategi Daerah /Regional Policies and Strategies) to MoEF (Presidential Regulation Number 97, Year 2017). The cities and regencies have to clear various steps to achieve the targets set by the government in *Jakstranas* through the development of their own *Jakstrada* and report their progress to MoEF on a regular basis. However, in reality, many local governments have not developed their own *Jakstrada* due to lack of capacity, motivation and political leadership. According to a MoEF official, 382 cities/regencies have submitted their *Jakstrada* so far among the 502 total cities/regencies in the country as of July 2020. Considering the above national requirements, regencies in the Lake Toba region have worked together with MoEF, the North Sumatra Provincial Officials, Institute of Technology, Bandung and the CCET in developing their own *Jakstrada* and submitted them to MoEF in February 2020. The development steps and key components of the *Jakstrada* of the selected four regencies were summarised in below.

The steps for the Jakstrada development:

1) Identify potential waste generation in each regency

The annual potential waste generation in each regency was estimated for the period between 2018 and 2025 by utilising waste survey results, current population and expected population growth rates in the regencies.

2) Set the waste reduction and handling targets in accordance with the national targets stipulated by Presidential Regulation No.97/2017

According to *Jakstranas,* which sets the national targets, each plan aims to reduce waste generation by 30% and improve the waste handling by 70% based on the total waste generation by 2025. Although some regencies had difficulty in obtaining accurate data on local waste generation, the targets to be achieved were concluded as in Table 3.

Table 3 Targets for regencies

Description	Simalungun	Samosir	Tobasa	Humbang Hasundutan
Date of approve the Jakstrada	23 August 2019	8 October 2019	22 October 2019	27 December 2019
Waste reduction target by 2025 (30% of the total waste generation)	63, 348 tonnes/year	10,038 tonnes/year	9,329 tonnes/year	6, 730 tonnes/year
Waste handling target by 2025 (70% of total waste)	147, 813 tonnes/year	23,424 tonnes/year	21,768 tonnes/year	15, 705 tonnes/year

3) Identify the gap between the current waste management capacity and the waste reduction and handling targets

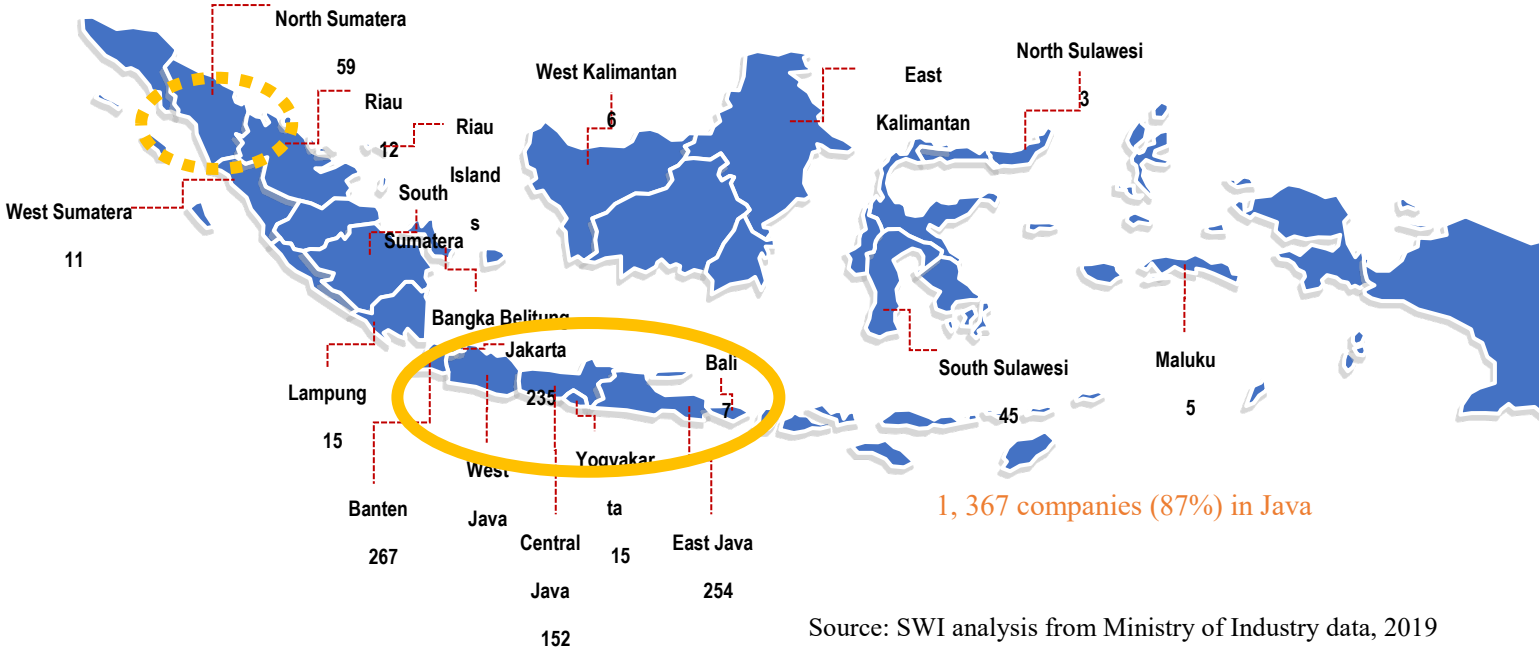
After setting the targets, the regencies identified their current capacity to reduce and handle waste by counting the number of facilities they have and their capacity in order to recognise the gap between the targets and current conditions.

4) Set the programmes to fill the gaps To overcome those limitations, a list of strategy and programmes for managing waste were identified in each *Jakstrada* based on their local circumstances. Regencies will report their performance on waste reduction and handling through the programmes to MoEF every year.

Activity 2 Programme implementation to establish a RRC with waste bank as a pilot project

As a pilot project to implement part of the programmes identified in Jakstrada for the purpose of creating awareness and changing behaviour of local residents, a RRC known as TPS-3R (tempat pengelolaan sampah), a transfer station with recycling facilities, was established with the function of waste bank. It functions as waste collection point and as a facility for waste recovery and treatment, particularly for recyclable waste. Regarding the status of recyclable waste collection and recycling, the waste recycle value chain is more active in Java where many industries exist and utilise recycled materials. For example, as shown in Figure 4, 87% of plastic industry businesses are located in Java. On the other hand, there is no such active recycle value chain in

North Sumatra including Lake Toba. There are few waste pickers or informal sectors to collect waste because there are no buyers for recyclable waste in the region.



Source: SWI analysis from Ministry of Industry data, 2019

Figure 4 Plastic industry in Indonesia

Since similar RRC did not exist before, establishing the RRC as a starting point to create the recycle value chain was the new challenge in the region. Thus, the following key factors are considered in designing the RRC in the Lake Toba region.

- **Concept of the RRC**

No waste (zero waste) principle

The basic principle of the facility is that it accepts any kind of plastic and other waste, because if rejected, such waste would end up in open dumping or improper landfill sites. Even hazardous waste will be stored temporarily at a small site made of concrete at the facility until proper treatment methods are available in the region.

Clean waste facility

The facility is designed to be operated in more environmentally friendly manner with efforts to prevent bad odours and noise, etc., in consideration of the neighbouring areas. Six infiltration wells were installed to prevent rainwater leaking into the facility, and there are septic tanks to treat any wastewater that is generated. In addition, there is even an evacuation route for staff, which is not normally included in such facilities.

- **Key functions of the RRC**

Based on a waste survey conducted by Institute of Technology, Bandung, the average amount of waste generation was 0.3kg/person/day in Balige, and the population to be covered by the facility was planned as 4,000-5,000 people (1,000 households). Thus, the capacity of the facility was designed to cover 0.3kg×5,000=1.5ton/day.

This RRC provides the following functions:

- Waste collection services to the area, with a maximum capacity of 1.5tonnes/day
- Processing of organic waste including composting
- Separation of inorganic sellable waste, especially plastic waste (PET bottles and PP glasses)
- Processing of unsellable plastic waste into diesel oil
- Temporary storage of hazardous waste, e.g. batteries, fluorescent lamps, pesticide spray cans, etc.

- **Operation of the RRC**

It is often observed in Indonesia that similar facilities are not effectively managed over the long term, and in many cases, operations end in failure due to a lack of human resources and insufficient budget at the local government level. In order to prevent this type of failure, it was agreed that the management of the facility should be less dependent on the local government and should have more involvement from the local community. For financially sustainable management, the RRC is operated by two local organisations, 1) Toba Samosir regency, and 2) a waste bank operator as a business entity. The respective services provided are as follows.

1) Toba Samosir regency

Toba Samosir regency strongly agreed on the pilot project and provided an area of land in Balige, the capital of the regency, as the location for the centre. The regency provides the waste collection services. Three employees have been allocated to collect and transport the waste from households to the facility. The regency through its annual budgets will provide their salaries.

2) Waste Bank operator

Despite waste banks being widespread and a very effective way to promote waste segregation, there were no functioning waste banks in the Lake Toba region. Thus, the newly established waste bank is expected to become a successful model and be duplicated in the region. The waste bank also aims to encourage behaviour change in the community. Residents can become involved in source separation and can bring waste to the facility, rather than throwing it away. This waste bank runs as a business so any profit can be used for its own operations. This financial resource

will help maintain the facility over the long term with less reliance on local government budget.

3. Results: outcomes and impact generated by the programme implementation to establish a RRC which is one of the Jakstrada programmes

The RRC has started involving local communities and contributed to their behaviour change toward resource management.

- Collected waste for recycling

Figure 5 and 6 show the collected waste volume at the waste bank which is part of the RRC from the operation launch in March 2020 to December 2020. When local events to promote RRC were organised or some organization members brought their waste, the volume of waste increased. Figure 7 shows the sales of collected waste by the waste bank in Medan which is the closest recycle market. Due to COVID-19, the first selling in Medan was in July 2020. The average sales of the collected waste is USD435/month in 2020.

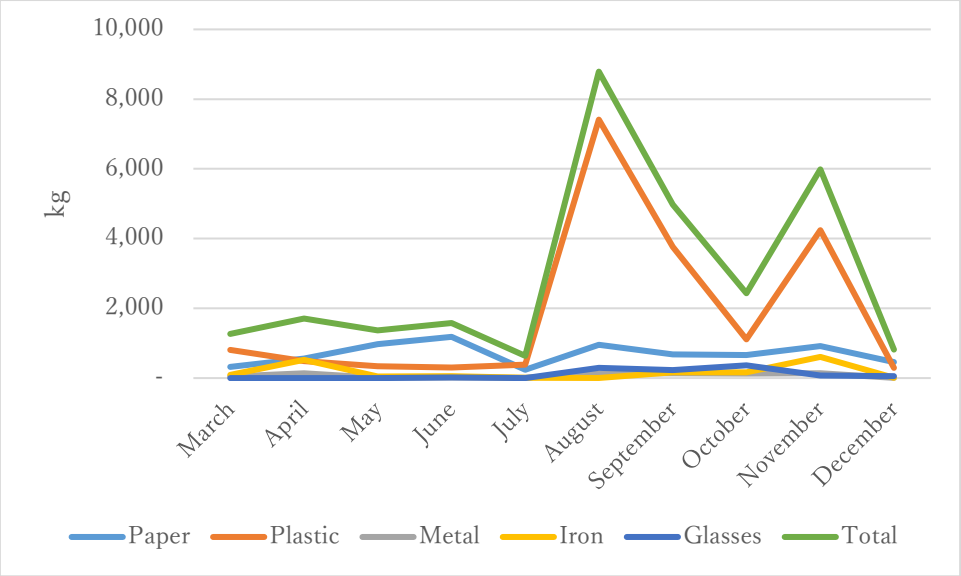


Figure 5 Monthly collected waste volume at the waste bank (March 2020 – December 2020)
*The waste bank started its operation in March 2020.

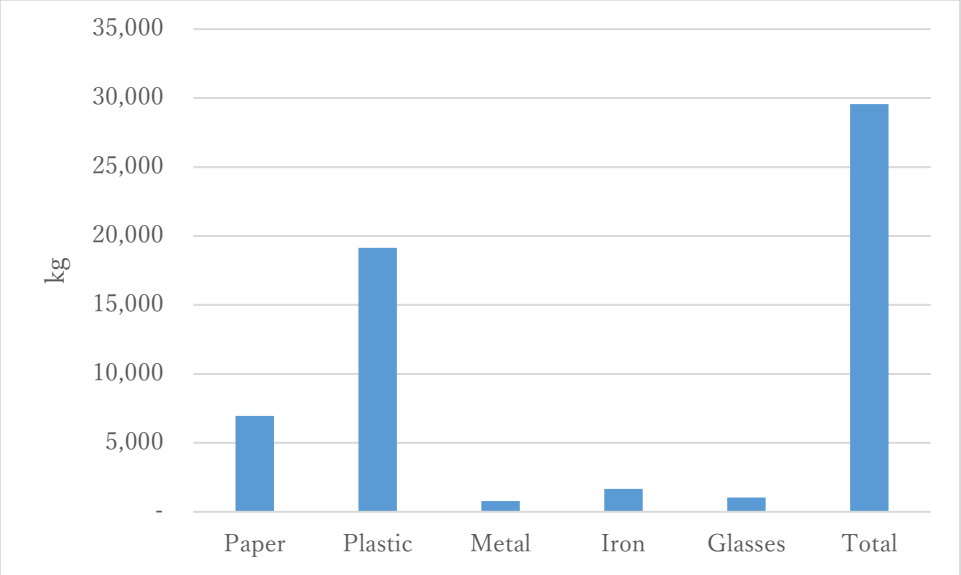


Figure 6 Collected waste volume at the waste bank (total in 2020)

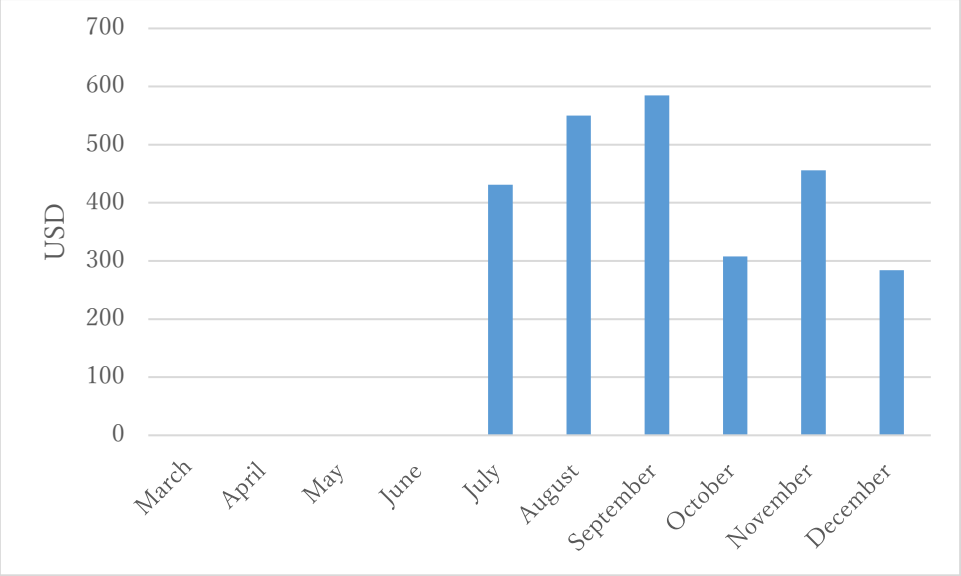


Figure 7 Sales of waste in Medan (March 2020 – December 2020)

- **Recognition, political support for scaling up the idea of pilot project**

Even though the technology itself is not remarkably advanced, its uniqueness attracted the attention of many stakeholders, from both the public and private sectors. High-ranked government officials visited the centre, from not only MoEF, but also other ministries, including the

Coordinating Minister for Maritime and Investment Affairs. He advised the Toba regent that every school and village government office in Toba should have waste banks. Moreover, MoEF was requested to develop and scale up similar facilities in other areas of the country.

- **Awareness raising in the region**

Triggered by this project, a team of young people in the local community formed the Clean Toba Movement, a local platform to encourage citizens to become involved in the project. The platform was officially launched in October 2019 with the support of MoEF. A presidential campaign on waste management called National Waste Awareness Day 2020, celebrated the launch of this RRC, and approximately 2,000 people took part in a large-scale clean-up event held at Parapat, a central tourist spot in the Toba region. There are around 80 waste bank members as of April 2021 and the number is increasing.

4. Discussion

Through the field survey, consultative discussions with the local stakeholders, and project activities, some challenges and opportunities for the better waste management in the region were identified.

4.1. Incentives to transform residents' behaviour

In the Toba region, many of the inhabitants use the natural resources of the surrounding environment for their livelihood. For example, the lake is used for drinking water, water transport, fishery (especially aquaculture), and the surrounding land is used for agriculture. Fertilizers and other chemicals are discharged into the lake water, some of the forests areas are used for open dumping. In addition, the roads are littered with rubbish.

While the government is promoting the tourism industry, many local people do not yet understand how the surrounding nature can be utilised as a source of income through tourism. Many of the local residents have been making a living by conventional style such as fishery and farming, and residents may not yet be familiar with the system of earning cash through the business of tourism. Alternatively, they need to be educated about the economic opportunities that can be created by conserving the environment, including waste management, to attract tourists. According to a local NGO, about 20 years ago, people could swim in the lake, but now there are very few due to the deterioration of the water quality. There is also a lot of rubbish around the lake, which makes it less attractive for tourists. Local residents need to understand which will bring more benefit to them in the long term, exploiting the surrounding nature to make a living, or preserving them to attract tourists. On the other hand, however, it is difficult to convince people at this point in the midst of the COVID-19 pandemic, with no prospect of increasing tourism, but it is necessary to

look beyond the pandemic and to understand that the beautification of the surrounding environment will also improve living conditions, impact on the health, etc.

While it is important for the local residents to understand the necessity of the proper waste management including recycling activities, it is also important to understand these activities can create the economic flow that ultimately leads to increase of income and improvement of their livelihoods. It might be effective to send representatives of the local communities to successful tourist destinations in the country or abroad to see how waste management can create such economic flow.

4.2 Financial sustainability of the RRC

Fortunately, several ministries have been supportive of the expansion and replication of the RRC in the region. The Ministry of Maritime and Investment Affairs has pledged financial support for the next two years to replicate the RRC, however, the financial resource for its long-term operation is a challenge. As the local government budget is very limited, the RRC needs to move away from being relying on public budget. The waste bank is a for-profit organisation run by representatives of the local community, with plans to use its revenues to cover operating costs of the RRC. However, in 2020, the total income of the waste bank through selling collected waste and the support from the private company, etc. was USD 6,025, while the expenditure including the purchase of rubbish from the residents, repayment of loans, etc. was USD 5,612, which made surplus of USD416. Although it made somewhat surplus, the surplus has not been able to cover the payment of wages to the waste bank staffs. In addition, the waste bank had installed equipment such as pyrolysis and small incineration plants, which are expensive to maintain, but it was necessary to well consider in advance how much funding was available for the operation in the long term.

The important point is that how the RRC can stablish financially independent and sustainable management within two years of the government support. Danone Indonesia and Unilever have shown interest in the RRC and have provided staff training and financial support, but it would be recommended to have not only ad hoc support, but also support in creating a management plan for long-term operation from the business perspective. For this reason, the good relationship with private companies is quite important. If the region becomes successful as a tourist destination, their business can be also expanded. It should be ensured that the RRC has a win-win relationship with the businesses, taking into account their business opportunities.

4.3 Some of the other specific issues that emerged during the implementation of the project

- ***Data collection:*** One of the difficulties in the processes of the *Jakstrada* development is data collection. Every city and regency needs to gain accurate information on the amount of waste

generation to be able to gain a good understanding of the current state of municipal waste. This amount then becomes the baseline for the strategy to fill the gap between the targets and the current situation. In a majority of regencies, accurate data on waste were not available, so the amount of waste generation is calculated based on assumed figures for the amount of waste generation and data for the population of each municipality. The central government provides certain assumed figures for waste generation (e.g. tons or m^3 /person/day), and the total amount of waste generation was calculated by multiplying the assumed figure by the population.

- ***Human resources:*** All regencies have limited capacities and experts to assist the development of *Jakstrada.* Some participants of the regencies to the workshops claimed that even the assistance team from the government did not have coherent understanding of developing process of the baseline data of waste for *Jakstrada,* which made confusion among the regencies.
- *Marketing issue access to recycle value chain:* There are two main issues for collected waste at the RRC: 1) finding buyers for the waste collected in the region; and 2) a lack of next-step collectors who would clean, separate and crush the collected waste to make other materials, such as sellable plastic flakes. At this point, there are very limited collectors and buyers of recyclable waste in the Toba region.

5. Conclusion

Through workshops and discussions during the development of Jakstrada, the regencies in the Toba region were able to identify the human resources and financial challenges of waste management in each regency. They also identified challenges through the process of establishing and running the RRCs, which is one of the programmes of the Jakstrada, to encourage people to change their behaviour. As a next step, it is necessary for the local people to discuss and make a concrete plan on how to tackle these challenge and monitor.

As mentioned in the Discussion, it is necessary to convince the local residents in a logical way that the introduction of 3R-based waste management will bring economic and other benefits to them in the medium and long term. Therefore, education from multiple perspectives is needed to show how waste management activities, the local economic growth, and improvement of the living environment, etc. are interrelated. Once the local residents understand the interconnection, it would be the strongest incentive to change their behaviour. The comparative research work on contextual factors influencing household recycling behaviours during the waste bank project in Thailand shows that the waste bank where continuing education has been implemented produces higher performance in terms of behaviour changes and longer sustainability (Singhirunnusorn, W., et al. 2011).

Once change in behaviour brings positive results to an individual or community, it would become a success story and further reinforces the motivation. Although it is small scale, the Toba RRC has attracted the attention of the central governments and private sector because of the attempt to create recycling value chain in the region. Then, this project has generated the largest movement ever in the region. In order to keep the momentum, it is recommended to establish a programme monitoring team, including representatives from all stakeholders such as waste generators, waste management service providers, and regulatory agencies.

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