



PLANNING AND IMPLEMENTATION OF INTEGRATED SOLID WASTE MANAGEMENT STRATEGIES AT LOCAL LEVEL: THE CASE OF SURABAYA CITY

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This study identified the following factors as critical for replication:

- ❖ Bottom up meets top down approaches – city government facilitating voluntary work by stakeholders
- ❖ Capacity building – all stakeholders have undertaken training to improve skills and increase knowledge
- ❖ Public-private partnership – city government encourages investment in waste management facilities
- ❖ National level support – national government policies and guidelines have further strengthened and assisted efforts

1. INTRODUCTION

After solid waste generation peaked at 2,000 tonnes per day and the closure of one of city's landfills led to waste being piled on the streets, the City of Surabaya started implementing community based solid waste management. This started as an initial partnership on a community composting project between the city, a local NGO and the City of Kitakyushu, Japan but has since expanded to include the development of both physical and social infrastructure such as composting centres and temporary collection stations as well as greater local engagement through community contests and the establishment of waste banks. Due to these efforts and achievements, the City of Surabaya has won both national and international recognition as a model for other cities to follow despite facing a number of challenges. This case study describes the key activities carried out, major results achieved, main lessons learned and provides recommendations for future actions.

1.1. BACKGROUND

Located at the eastern end of the island of Java in Indonesia, Surabaya is the capital of Jawa Timur province and one of the largest cities in Indonesia (population 2.85m) as well as a major port. The population of the city has grown steadily in the last three decades. The official census plots the population in 1990 as 2.47m, 2.59m in 2000, 2.77m in 2010, with a projected population of 2.93m by 2020 [1]. Its strategic location and proximity to the capital Jakarta (one hour by plane) has made it an important economic hub in the region. It is also home to several major universities including Universitas Airlangga (Airlangga University) and Institut Teknologi Sepuluh Nopember (10 November Institute of Technology).

Surabaya is bounded in the north and east by Madura Bay, in the south by Sidoarjo Regency, and in the west by Gresik Regency. The city is generally lowland being

around 3 – 6m above sea level, except for the southern parts of the city which are 25 – 30m above sea level.

Indonesian cities are administratively divided into districts (kemecatan), sub districts (kelurahan), community associations (rukun warga), neighbourhood associations (rukun tetangga), and households. Community and neighbourhood associations are created by a registration process undertaken by residents. These associations are not restricted to a fixed size but a neighbourhood association must comprise a minimum of 40 households and community associations have a minimum size of four neighbourhood associations. Such associations are key actors in implementing waste management. Surabaya City consists of 31 districts and 154 sub-districts, 1,368 community associations and 9,118 neighbourhood associations [1].



Figure 1: Districts and Sub-districts of Surabaya City. Source: Surabaya City, 2016

1.2. WASTE MANAGEMENT CONTEXT

NATIONAL CONTEXT

The Republic of Indonesia is a highly diverse nation of 258 million people [2] spread over more than 17,000 islands. The largest population cluster is found on the island of Java, with a population of 130 million (Indonesia 2017). The country has the largest economy in ASEAN with a GDP in current US\$ (2015) of 861.9 billion, though this is mainly due to its large population: GDP per capita in current US\$ (2015) is US\$3,346.5 (World Bank 2017). With an urbanization rate of 4.1%, Indonesia is the most rapidly urbanizing country in Asia and expects to have 68% of its population living in cities by 2025 [2].

Such rapid urbanization is creating environmental strain and increased levels of waste generation. In response to this, Indonesia has created and implemented a variety of laws and regulations. The two acts relating to solid waste management are Act No. 18/2008 concerning Solid Waste Management and Act No. 32/2009 concerning Environmental Protection and Management.

In order to implement the national legislation, the Government of Indonesia has formulated the following related regulations and guidelines:

- ❖ Government Regulation regarding Household Solid Waste and Household-like Solid Waste Management (already promulgated as Government Regulation No. 81 Year 2012);
- ❖ Government Regulation regarding Specific Waste Management;
- ❖ Presidential Regulation regarding National Policy and Strategy of Solid Waste Management
- ❖ Ministry of Environment Regulation concerning Guideline of Land Application from Palm Oil Waste Water No 28 Year 2003)
- ❖ Ministry of Environment Regulation concerning Implementation of 3Rs through Waste Banks (Regulation No. 13 Year 2012);
- ❖ Ministry of Environment Regulation concerning Emergency Response System on Solid Waste Handling
- ❖ Ministry of Environment Regulation concerning Environmental Standard of Leachate

- ❖ Ministry of Public Works Regulation concerning (working on draft, by May 2013), Technical criteria for 3R waste treatment site (TPS 3R); Landfill closure and rehabilitation guideline; Landfill construction guideline; and Landfill

The Government of Indonesia has also undertaken the following initiatives to expand and monitor the implementation of national policies and strategies at local level, such as:

Adipura Program, a program that measures the performance of a city and regency in urban environment management including Municipal Solid Waste Management (MSWM) performance; and beyond that compliance towards becoming a sustainable city (**Adipura Kencana**)

Promotion and Implementation of the 3Rs, a program started in 2006 implementing the 3Rs (reduce, reuse, recycle) both community-based 3Rs (356 cities as a pilot project) and city-scale 3Rs; examples include a campaign and education for elementary school through a "school 3R completion".

Bank Sampah or Waste Bank, a program that educates people to reduce their waste by conducting waste separation, waste collection, and waste saving for recycling purposes. Residents join a waste bank to which they deliver separated recyclable waste and receive payment in return. The payment is then kept as a deposit (like a bank) and often used as a source of money for loans to the poor. The Government of Indonesia released guidelines for waste banks in 2012 [3]. These guidelines are not compulsory but set out good practice guidance regarding (amongst others) the handling of savings; opening hours; employee wages; construction of facilities; pricing and so on.

Landfill improvement (including rehabilitation of open dumping sites) as well as controlled landfills or sanitary landfills in 190 cities (2006-2012). As with the 3R program, landfill improvement has been promoted to fulfil regulatory requirements and to reduce greenhouse gas emissions. Landfill infrastructure has

been constructed for 190 cities (with a target 250 cities by 2014). Main infrastructure construction (such as liner, leachate treatment, gas utilization) and heavy equipment are supported by the national budget against readiness criteria (i.e. capability of the facility in terms of human resources, operations and maintenance budget, 3R development).

Campaign and education for public awareness

among cooperation with Ministry of Public Works, Ministry of Education, Ministry of Health, Ministry of Environment, Women Organisation (Solidarity of Indonesia Cabinet Wives). The selection of a National

Sanitation Ambassador every year (33 Provinces) is one of the campaign's programs to improve community awareness, especially among children.

Waste to Energy has recently become a focus of Indonesia's national waste management strategy. Under Presidential Decree No. 18 of 2016, seven Indonesian cities (Jakarta, Tangerang, Bandung, Semarang, Surakarta, Surabaya, Makassar) have been nominated as eligible for support. The waste to energy plants are required to have a minimum capacity of 1000 tonnes/day and be constructed by 2018.

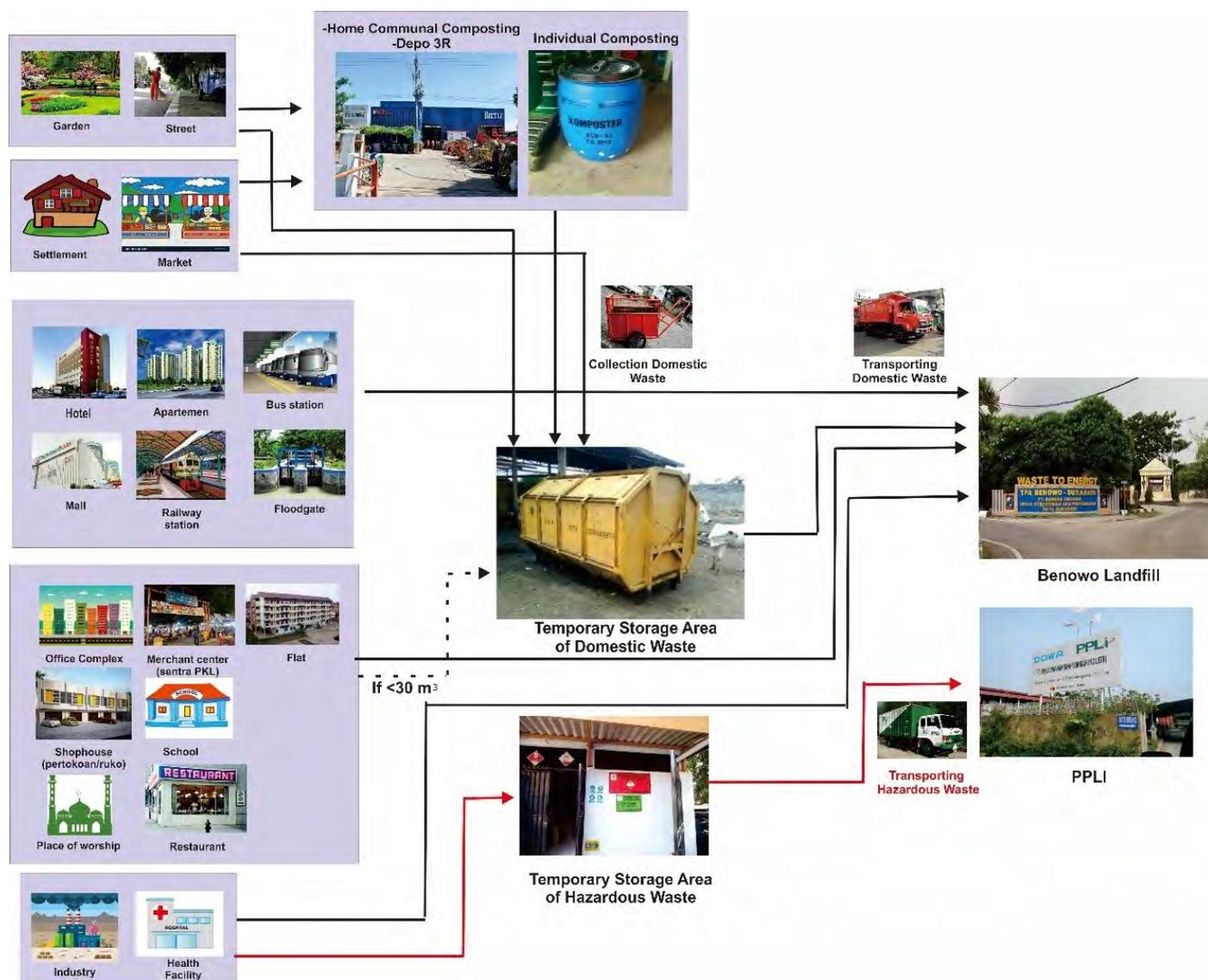


Figure 2: Surabaya Waste Flow (Surabaya City 2016)

LOCAL CONTEXT

MSW generation in the city reached its highest point in 2001, with the city producing nearly 2,000 tonnes of MSW day, disposed at the two landfill sites in the city Benowo and Keputih. The city also had to face a tremendous challenge when the Keputih landfill site was closed in 2001 due to the strong opposition from the residents in the area. This closure directly led to a solid waste management crisis in the city. In the face of this environmental disaster the city responded through a 3R (reduce, re-use, recycle) strategy through both community based initiatives and the establishment of composting and waste sorting facilities. The Benowo landfill was also further expanded in tandem with this approach.

Surabaya generates approximately 1,512 tonnes of waste per day with approximately 1,281 being landfilled giving a waste diversion rate of 15.3%. Organic waste predominates with around 57% being organic. Non-organics mainly comprise paper (14%), plastic (16%) and others (11.6%). Metal and glass are less than 2% of the total. The main source of Surabaya's municipal waste is residential waste, being 68% of the total. The other sources are markets (16%), commercial/industrial sites (11%) and streets/open spaces (litter on the streets, foliage and the like) (5%). Of the diverted waste, organics are 95.5 tonnes per day, less than non-organics which are 135.5 tonnes per day (statistics from the City of Surabaya, 2014). Waste banks divert approximately 1 tonne per day (calculated from data in Wijayanti & Suryani, 2015) [4].

The inspection activities, supervision and enforcement of legislation related to MSWM are handled by the Cleanliness and Landscaping Department of the city government. The city has recruited approximately 420 facilitators and 28,000 environmental cadres to coordinate the community-based solid waste management programs. In addition, the city government has established a variety of community initiatives detailed in the section below. In terms of facilities and waste management infrastructure, Surabaya City currently has 21 composting centres (one medium sized), over 200 temporary disposal sites, one medium sized waste sorting facility and a sanitary landfill.

WASTE BY COMPOSITION

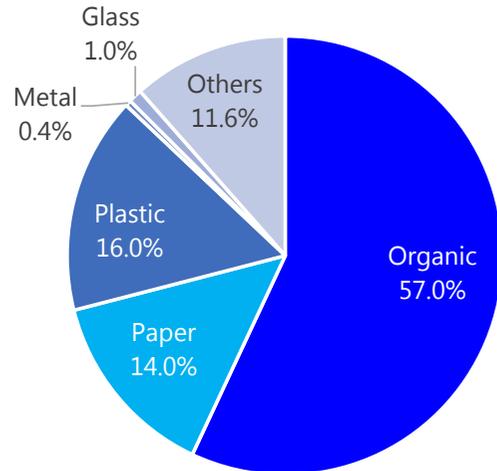


Figure 3: Waste by composition. Source: Surabaya City, 2016

WASTE BY SOURCE

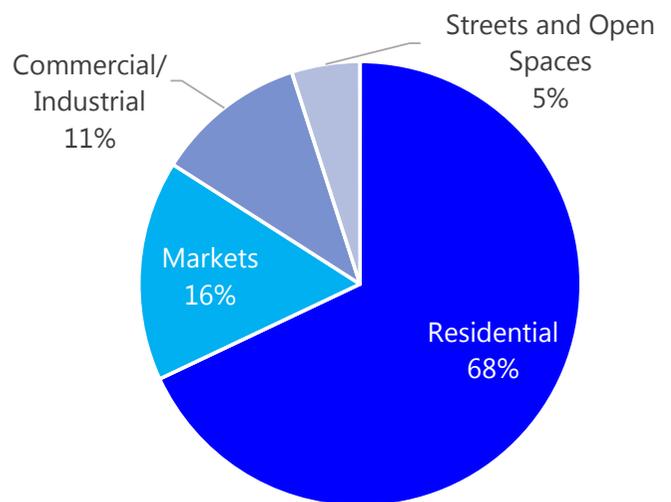


Figure 4: Waste by Source. Source: Surabaya City, 2016

The Medium-term Development Plan (RPJMD) of Surabaya City for 2010-2015 gives the guidance for MSWM in the city. It encourages community participation and involvement of private sector participation to reduce MSW with the implementation of 3Rs. The program of Community Empowerment Based Waste Management was introduced at the neighbourhood scale. The city established a supportive mechanism for the promotion of community-based MSW management program such as

socialization/counseling campaign, establishment of facilitators and cadres, assisting residents in cooperation with the environmental NGOs, and distribution of cleanliness facilities for free (Takakura baskets, composting containers, trash carts, etc.). In

addition, the city has introduced competitions, waste banks and composting centres with a view to expanding the community-based MSWM program citywide.

1.3. SURABAYA CITY WASTE INITIATIVES

INITIAL PROBLEMS

As mentioned above, prior to 2004 when Surabaya's community waste initiatives began, the city operated a simple collect and dispose model with two landfills (Keputih and Benewo) in operation. Following the closure of the Keputih site the other landfill, Benewo,

was unable to accept the increased volume of waste. Following this an initial solid waste reduction program was conducted by the Agency of Cleansing and Gardening (DKP) of Surabaya City and Unilever Indonesia Cooperation [5].

COMMUNITY INITIATIVES

A significant breakthrough was achieved from 2004 when technical cooperation was undertaken by Kitakyushu International Techno-cooperative Association (KITA) from Kitakyushu City, Japan and Pusdakota, which is a local NGO operating in Surabaya City. This project aimed to reduce the amount of waste by way of composting activities, through both the establishment of household composting activities and a composting centre. Kitakyushu City supplied technical assistance through the introduction of the Takakura Method, a quick, low-tech and inexpensive means of household composting. Following the success of the initial piloting, by 2009 over 19,000 composting baskets and 14 composting centres had been established [6].

In tandem, the Surabaya Green and Clean Program grew rapidly to achieving a peak involvement of 2,774

neighbourhood associations (of 9,118, 30.4%). Started in 2005, the program is a neighbourhood competition where communities are judged according to broad environmental concerns such as greenery (planting trees and plants in the neighbourhood) as well as waste management. This program was initiated by Agency of Cleansing and Gardening (DKP), the Java Post, and Unilever Indonesia. It was envisioned that from this program, communities can learn socialization strategies, environmental education and appreciation of community thereby boosting community participation [7]. Although community initiatives have a common origin through the city sponsored initiatives, community activities are diverse and each community approaches environmental work from slightly different angles. This is further explained in the Social Benefits section below.

DEVELOPMENT OF INFRASTRUCTURE

Following the initial activities undertaken by the communities and the establishment of local

competitions to support increased awareness and participation, the city established additional



Figure 5: Surabaya Composting Centre. Source: Authors, 2016

composting centres growing from the initial one to 21 at the time of writing. These composting centres are small scale, varying in production from 1 to 8m³ per day and with 2 to 7 workers. The total amount of compost produced is 66m³ which is approximately 33 tonnes. Surabaya has also established a large number of

temporary disposal sites, around 200 in total, varying in capacity from 8m³ to 125m³. The purpose of the facilities is to separate and classify the waste. However most of the facilities have a capacity of less than 30m³ and lack proper facilities, only being able to sort a small amount of waste.

CONSOLIDATION OF INFRASTRUCTURE; WASTE BANK

In line with the above, the city identified a need for larger scale facilities to promote more efficient waste management. In order to fill this gap the Kitakyushu City-based Japanese waste company Nishihara established a 15 tonne capacity waste sorting facility called the Super Depo in Surabaya in March 2013 under a JICA public-private partnership project. The facility cost IDR 2bn to construct (around US\$150,000 in

February 2017). The facility has 25 staff serving two villages and a market comprising around 16,000 families. It has been reported that before the establishment of the Super Depo, 2 – 3 trucks previously went from the transfer station (which Nishihara has since assumed management over); presently it is around one truck per week indicating a substantial diversion rate.



Figure 6: Nishihara Corp. Super Depo. Source: Authors, 2016

The Super Depo has a standard layout with waste being separated into various categories along a conveyor belt. Staff wear uniforms and protective equipment as necessary. Facilities are open and kept tidy. The facility was handed over to the City of Surabaya as agreed under the project in 2014.

Nishihara has also established a composting house which started operations in September 2014. The facility has a capacity of 20 tonnes per day with five staff members, and uses a simple windrow composting system. Nishihara had further plans to expand the facility to be a mixed waste separation and composting facility with a 100 tonnes per day composting capacity and 50 tonnes per day non-organic waste separation. Total staff would have been 70 people. However, there have been difficulties in making the facilities profitable due to the low tipping fees which can be received.

During this period, waste banks have also been established. Waste banks are a new innovation in Indonesia, established in 2008. The purpose is to encourage waste separation and recycling by establishing waste “banks”. Customers sell recyclable waste at the banks with their contribution being marked in a bank book. The customer either receives the money made by selling the waste or some other



Figure 7: Nishihara Composting Centre. Source: Authors, 2016

benefit, depending on the waste bank. This scheme is supported by the national government, who established waste bank guideline in 2012. Since inception in 2013, waste banks in Surabaya have grown

rapidly to 180 branches and over 10,000 accounts [4].

FINAL DISPOSAL (WASTE TO ENERGY, LEACHATE ISSUE)

As detailed above, Surabaya is eligible to participate in the national government's waste to energy program. Despite the improvements in Surabaya, the volume of waste continues to increase in line with population increases and final disposal remains a significant issue, particularly due to the increasing population and

limited coverage of community initiatives and intermediate facilities. The sole remaining landfill at Benewo is close to full capacity leading to this demand. Moreover there is a leachate management problem at the landfill due to high annual rainfall in Surabaya and inadequate drainage.

2. KEY ACHIEVEMENTS AND BENEFITS

2.1. COST DETAILS AND ECONOMIC BENEFITS

COST OF WASTE DISPOSAL

The tipping fee at the landfill is IDR140,000 (US\$10 at February 2017) per tonne, with total disposal per annum being approximately 467,565 tonnes for a total cost of approximately US\$4.7m. It is clear that disposal

remains a significant cost to the city and that there is a large savings potential to be achieved through waste reduction and diversion activities.

SIZE OF MARKET

With recyclables (organics, paper, plastic, metal, glass) making up 87.4% of the total waste generated, the potential market for recycling is significant. Prices for non-organics vary by and within type, but nevertheless indicate a significant market due to the volumes involved. Of the 460.25 tonnes of recyclables generated

daily, around 135.5 tonnes are currently diverted from landfill, meaning that 324.5 tonnes (70.5%) of recyclables are currently landfilled. Based on available data, a summary of the entire market for paper, plastic and metal is provided below. Please note the figures are indicative and not comprehensive

Table 1: Non-Organic Recyclables Market Size

Item	Amount Per Year (tonnes)	Lowest Price Paid	Highest Price Paid	Lowest Total Market Value	Highest Total Market Value
Paper	77,263	IDR 450,000 (US\$34)	IDR 3,500,000 (US\$262)	IDR 34,768,440,000 (US\$2,600,000)	IDR 270,421,200,000 (US\$20,270,000)
Plastic	88,300	IDR 450,000 (US\$34)	IDR 1,250,000 (US\$94)	IDR 39,735,360,000 (US\$2,990,000)	IDR 110,376,000,000 (US\$8,270,000)
Metal	2,428	IDR 1,750,000 (US\$131)	IDR 7,500,000 (US\$562)	IDR 4,249,476,000 (US\$320,000)	IDR 18,212,040,000 (US\$1,375,000)
Glass	5,518	IDR 125,000 (US\$9)	IDR 125,000 (US\$9)	IDR 689,850,000 (US\$50,000)	IDR 689,850,000 (US\$50,000)
TOTAL IN IDR				IDR 79,443,126,000	IDR 399,699,090,000
TOTAL IN US\$				US\$5,960,000	US\$29,965,000

Organics are harder to measure due to the varying price of compost and also the uncertainty regarding the amount of compost which can be created from a set amount of organic waste. However, assuming that one tonne of organic waste can be used to create 0.67 tonnes of compost and assuming US\$100 per tonne for compost (US\$0.1 per kg) [6] then the total maximum potential market (assuming all organic waste can be

composted) is 210,763 tonnes of compost per annum from 314,572 tonnes of organic waste. Total potential market value of compost is therefore US\$21,076,300. In giving these figures, it should be again borne in mind that they are approximate and indicative, not authoritative. What is clear however is that potential incomes amounting to millions of dollars are currently being lost through landfill disposal.

WASTE BANKS

Waste banks in Surabaya vary in their operations, ranging from compulsory to voluntary membership. For example, some banks do not require fees to join but everyone in the neighbourhood association is registered. If people do not turn up to the waste bank staff go to the relevant household and collect a IDR 5000 fine (US\$0.38 in February 2017). Loans at the However, other community run waste banks follow a different financial structure. Field observations noted that one in particular costed approximately IDR 10,000 (US\$0.75 in February 2017) to open an account, with a IDR 2,000 monthly fee. These fees are returned upon account closure. The customers receive a 10% dividend, which they generally take receive during the Ramadan holidays. 1% of waste is taken from each kg to help cover costs, however staff at the bank are voluntary. Credit is available at 5% annualised, repayment can be on a weekly basis. Loans are given on a trust basis, the maximum is around IDR 3m (US\$225 in February 2017).

Assuming that waste banks have one account per household and with an average of 3.63 people per household, then 10,000 accounts would cover approximately 36,300 people, which is 1.27% of the

waste bank can be given for 3 months at 10% interest. The bank holds IDR 500,000 (US\$37.50 in February 2017) as reserves and contingency money for emergency assistance. Up to IDR 2m (US\$150 in February 2017) of the remaining money can be lent out (in total, not per loan).

total population of the city. With a diversion rate of 1.02 tonnes/day (based on the 7.14 tonnes/week figure above) being attributed to waste banks, and assuming that the amount of waste being diverted per waste bank remains the same as waste banks scale, there is a maximum potential for waste banks to reduce waste going to landfill by 80.3 tonnes/day, which would comprise 15.6% of the 1,281 tonnes total currently. Non-organics comprise a maximum of 43% of the waste (550 tonnes), with 80.3 tonnes therefore being 14.6% of the non-organic waste. Waste banks could have a theoretical upper limit of diverting 14.6% of non-organic waste from landfill. Again it should noted these calculations are indicative but do illustrate the potential limits of waste bank activities in alleviating solid waste management issues.



Figure 8: Community Waste Bank. Source: Authors, 2014

COST OF INFRASTRUCTURE ESTABLISHMENT; WAGE COSTS

The Benowo landfill cost US\$6.5m when constructed in 2001 [6] whereas the construction costs of the 20 tonne Nishihara Super Depo was approximately US\$150,000. Constructing a number of Super Depos sufficient to cover the city would clearly cost significantly less than the construction of the landfill. Substantial savings to the city would be possible through reform of the waste management system both in reduction of waste at source and an improvement of and increased coverage of intermediate facilities.

Using Nishihara's figures as an example, the total amount of jobs that could be created are as follows. Nishihara's proposed facility would have a capacity of 50 tonnes per day for non-organic and 100 tonnes a day for organics, against total non-organic generation of 460.25 tonnes per day and total organic generation of 861.84 tonnes per day. 60 people would be hired for non-organic and 10 people hired for organic waste management. Assuming that sufficient facilities were

established to cover all of Surabaya's waste management, it would require a total of 382 people to manage the non-organic waste and 86 people to manage the organic waste, a total of 468 people. Assuming they are hired at the minimum wage, IDR

ENVIRONMENTAL BENEFITS

As illustrated by the example communities above, Surabaya City's community initiatives have noticeably improved the neighbourhoods by creating greener and tidier residential areas. Waste is much better managed and the open dumping that was seen commonly previously has now been largely eradicated due to the establishment of the temporary collection stations. Although such sites are not always well managed they provide an improvement in that waste is now concentrated temporarily in certain well defined areas. Further improvements to the local environment is possible with additional scaling of current activities.

Reduction in the amount of waste sent to landfill has been beneficial in extending the lifespan of the site. However the final disposal site is about 37ha and has needed to be expanded. It is almost full with the waste reaching a height of about 12 meters. Due to land requisition issues, the final disposal site is the sole site for now and the foreseeable future creating an immediate concern as to how to manage the waste. The recent announcement by the national government of support for waste-to-energy projects is therefore a clear potential environmental benefit in the future in terms of waste reduction. However, careful

SOCIAL BENEFITS

Although an increase in the coverage of recycling and composting activities has some benefits of increased employment opportunities such as the nearly 500 people who could be employed in intermediate facilities. The social benefits appear to be that of greater civic involvement – the community waste initiatives illustrated are not simply that of waste management, but use waste management activities as a focal point for community greening and other activities.

Two communities within Surabaya (Jambangan VII and Gunung Sari) are good examples of this approach. Jambangan VII has won awards for its efforts towards a

2.1m per month (US\$157 in February 2017), that would be a total wage cost of US\$73,476 per month or US\$881,172 per year. From the figures above, it can be seen the market value of the recyclables at the lowest end would cover such wage costs.

consideration of the use of such technology should be given to prevent potential negative impacts on 3R efforts.

The environmental impacts of solid waste management have been further explored due to the participation of the city in association with IGES in the Climate and Clean Air Coalition (CCAC) Municipal Solid Waste Initiative (MSWI), 2014-2017. The coalition aims to reduce Short-Lived Climate Pollutants (SLCPs) such as black carbon and methane which, although short-lived, have a much stronger warming effect than carbon dioxide. Within municipal waste, the main sources of SLCPs are black carbon due to open burning and methane from the anaerobic decomposition of organic waste. Open burning is not a major problem in Surabaya, though due to the disposal of raw organic waste into the landfill, methane is produced. Under CCAC activities a work plan was produced whereby it was proposed that (a) community-based SWM and 3R activities be expanded; (b) temporary disposal sites be improved; (c) organic composting be further promoted; and (d) the landfill site be improved through the assessment of the leachate problem and investigation of waste to energy technologies [8].

green and clean community. There are several aspects to their environmental efforts – the establishment and operation of a waste bank; greening of the community; and community advice and information. The waste bank is at the centre of community environmental activities.

The waste bank was originally started by a youth group who realised money could be made and that the project was beneficial. Following this initial effort, a new waste bank was opened on the 5th Feb 2012. There were 30 customers initially which has now grown to 43 from 38 houses. It is open once a week on Sunday. The previous waste bank had more customers, but the

number of waste banks locally has increased leading to a decline in the number of customers per bank.

The waste bank is flexible concerning the separation of waste. Waste is still bought even if unseparated but the price is lower, customers therefore are increasingly separating the waste. Most non-organic waste is purchased but styrofoam is not accepted as there is no recycling market for it.

The waste bank encourages customers to take out loans as it is a good source of income. Customers usually have a variety of reasons for taking a loan such as for educational purposes or a holiday.

The waste bank also has a strong educational aspect - kindergartens are often invited to have some fun activities and to be taught about waste. Children are tested by being given sweets, the staff see where the children dispose of the wrappers.

There is a water pump in the local community with a 600 litres capacity using a shallow well nearby. It provides around 100 litres to the neighbourhood per day. The community is clean and tidy, with many plants and trees. Signs displayed giving advice to the local people.

Gunung Sari Community, like Jambangan VII is a neighbourhood association which has won awards for its community efforts and also pursues similar local activities centred around the waste bank. The waste bank located there is run in a different style to the Jambangan waste bank. The waste bank was opened in April 2010, is held bi-weekly and covers 3

neighbourhood associations. As reported above, membership is compulsory and fines are administered for non-participation. The money from the waste bank is used for funding of community projects such as greening. Community holds regular meetings to discuss how to spend the money. Most customers withdraw the cash at Ramadan, no dividend is paid. The community is very green with plants and trees. Rainwater harvesting, creating fertiliser, make crafts from waste and composting are amongst activities undertaken in the community.

Surabaya has been a frequent recipient of awards and recognition – a winner of the national Adipura award from 2006 – 2013 and, internationally, the ASEAN Environmentally Sustainable City (ESC) Award in 2011 and was a member of the ASEAN ESC Model Cities Program, which aims to promote ESC regionally. Due to their longstanding cooperation, Surabaya and Kitakyushu cities became green sister cities in 2012. Surabaya's success with community based initiatives was spread internationally as part of activities under the Kitakyushu Initiative for a Cleaner Environment (2000 – 2010), which was an initiative undertaken with support from the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), the City of Kitakyushu, the Ministry of Foreign Affairs, Japan and the Ministry of the Environment, Japan with IGES as the Secretariat. Countries and cities the waste management model was replicated in include Malaysia (Sibu), Nepal (Lalitpur), the Philippines (Bacolod, Bago, Cavite, Cebu, Puerto Princesa, Talisay), and Thailand (Bangkok, Chiang Mai, Chonburi, Sankamphaeng) [9].



Figure 9: Surabaya Communities. Source: Authors, 2014

3. BARRIERS FACED AND WAYS THESE BARRIERS WERE ADDRESSED

PUBLIC AWARENESS AND INVOLVEMENT

At the heart of any 3R strategy is public involvement. This needed to be built up from zero and against a background where the only previous public participation activity had led to the closure of a landfill and a subsequent serious environmental issue of waste open dumped on the street.

This barrier was addressed through a combination of public, private and non-profit sector collaboration not just involving local actors but also engaging foreign expertise through international cooperation with Kitakyushu City. Public awareness and involvement started off with a small pilot project on household and small scale composting with activities being scaled up once the concept had been proven. Key to involving the public was the development of the Takakura Composting Method (referred to as the Takakura Method). Prior to the project, composting had been seen by the public as a complex and time consuming task. Keeping organic waste for any length of time was avoided as the public felt there was a strong risk of the waste rotting and thereby attracting insects (particularly cockroaches). The development of the Takakura Method was therefore key to the success of the project as the method is simple and could be shown to the public not to produce an unpleasant odour or attract insects. However the development of the Takakura Method was not without difficulty – due to the difference in climate between Indonesia and Japan, the initial attempts

(which worked in Japan) failed and repeated, persistent efforts were needed to finally develop a method which would work in the tropics.

Following the success piloting of the composting project, the city, with the support of local community groups, then launched the Surabaya Green and Clean Competition. This competition created a positive incentive for neighbourhoods; not only could citizens feel pride at the achievements and improvements in the winning neighbourhoods but also cash awards are given which communities can use for further activities.

Such efforts have been further supported by the establishment of waste banks in the city. Such waste banks not only provide a focal point for environmental activities, but have been helpful in providing a further incentive for involvement by providing a financial incentive.

Barriers to awareness and involvement have therefore been overcome through attacking disincentives (difficulty in composting) and the creation of incentives (pride in the community, additional income opportunities). These efforts have been growing within Surabaya and have been sustained for over a decade, strongly suggesting that these activities are now within the fabric of the city life and are likely to continue in the future.

WASTE TREATMENT CHALLENGES

Alongside the public initiatives, waste treatment facilities have grown rapidly within the city since 2001. The main achievements have been in the rapid increase in composting centres, 21 to date. Temporary disposal sites are also extremely numerous with over 200 presently found within the city. However barriers continue to exist. With composting, the main barrier is the inadequate number of composting centres – the volume of compost being produced as a proportion of the total organic waste generated is slight, and moreover due to inadequate separation prior to

shredding there is frequently small amounts of non-organic waste remaining in the compost. Such compost is acceptable if the compost is used for public greening but is unacceptable for agricultural uses significantly limiting the potential market. With non-organic waste the primary issue is that the temporary disposal sites, whilst numerous, are often very small with limited space for proper waste sorting activities. As such the waste tends to only attract scavengers who can only recover a small proportion of recyclables.

To meet this challenge, the city has supported the establishment of medium sized facilities by the Japanese company Nishihara as detailed above. These facilities have demonstrated the clear feasibility in terms of the construction and on-going management of the facilities. However regarding composting concerns remain as to the financial feasibility of operations due to difficulties in finding buyers in an

WASTE DISPOSAL CHALLENGES

The city currently has an 80 – 85% coverage for waste collection, meaning that some waste will be dumped with limited covering. The landfill at Benewo is close to capacity and additional land will need to be sourced, however the city is having significant difficulties in achieving this and what occurred at Keputih demonstrates that there are likely to be obstacles to finding more land. Moreover should it be necessary to close the Benewo landfill and open a new one, there

MARKET CHALLENGES

The main issue for both community initiatives such as waste banks and the small and medium scale facilities such as the city run composting centres and Super Depo is the lack of a suitable market. For the composting facilities one issue is the quality of the compost. However the Nishihara-run composting centre has been able to find an agricultural buyer for their compost. Questions however remain concerning how scalable composting facilities might be. For the non-organic market, buyers are easier to find as the market is well established. However, waste banks have

adequate volume and also the tipping fees which are significantly lower than those received by the landfill. Regarding non-organic waste separation although the Super Depo has been handed over to the city government and an additional facility has been planned, the coverage is still insufficient to efficiently manage all of the waste generated by the city.

would be high costs involved. This being the case, the city government is now seriously considering the waste to energy support being offered by the national government. Whilst disposing of 1,000 tonnes per day in this manner would alleviate the strain on landfill capacity, it may have a deleterious effect on Surabaya's community level initiatives and acceleration of medium scale composting activities.

found it difficult to source buyers. In order to assist, the city is considering the development of an app which would enable buyers to advertise current prices for recyclables so that waste banks could more easily locate intermediate buyers.

Whilst each of the initiatives are commendable on their own, if approached in an integrated and holistic manner waste management efficiencies could be uncovered, the market more clearly defined and barriers to entry for the necessary new entrants would be lowered.

4. CONCLUSION/LESSONS LEARNT

The case of Surabaya demonstrates clear lessons for similar cities in Southeast Asia. Firstly, with political support and the involvement of communities and related stakeholders it is possible to establish and sustain waste reduction and separation initiatives across a wide area of a city. As the majority of the waste generated within the city is organic, composting activities are a necessary area of focus. Surabaya City was successful through developing (with international assistance) the Takakura Composting Method which enabled household and community composting which is both convenient and low cost. Moreover, the windrow method utilized by Nishihara Corp. is also low tech and simple requiring little training. As compared to the cost of establishing a landfill or the ongoing tipping fees paid to the private company, composting is a very cost effective means of solid waste management.

Moreover, the broader community initiatives which have grown out of the initial solid waste programs have shown strong social benefits. Community compost has been used for greening activities and such activities, in addition to the recent arrival of waste banks in the city, are the focal point of community activities in general which do simply focus on waste management but also comprise community education and advice centres. Waste banks also give an opportunity for communities to raise funds or assist the urban poor. Such initiatives are again inexpensive to establish but require broad community support and assistance from the local governments. Such assistance can be given by official recognition of efforts by communities through competitions such as the Surabaya Green and Clean Program. These competitions require city government staff time to run (and thereby represent a cost to the

city) but are relatively inexpensive compared to landfill management.

Secondly, access to finance or proper financial incentives are required. Although it is clear that community initiatives can have a positive effect and are inexpensive to establish and run, intermediate and final disposal issues are more complex. Regardless of reduction and recycling at source, there will also be a need for final disposal. In order to scale up the number of intermediate facilities funds need to be made available. If the city government wishes to involve the private sector then appropriate incentives in terms of increased tipping fees will be needed in order that the facility can be financially viable.

Thirdly capacity building and technical knowledge transfer is necessary at all levels. Initially this technical assistance has occurred at the community level with the focus on the Takakura Method and with the intermediate facilities such as the Super Depo. Under the collaboration with CCAC MSWI a work plan has been developed to further explore the opportunities to address liquid and gaseous waste management issues through the upgrading of the landfill which would lead to improved leachate management and a reduction in SLCP emissions (both methane and black carbon).

Overall Surabaya stands at a crossroads. Although the city's waste to energy interest is understandable, there is the danger of the creation of disincentives for the community initiatives. Given the city has become known in the region for such initiatives it would be a pity to abandon them.

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