

# **sustainable Waste Management and Recycling**

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Victor Bonn

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Edited by Victor Bonn



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# **Sustainable Waste Management and Recycling**

## Preface

The purpose of this book is to deal with various facets of waste material recycling. It contains different sections that elaborate on the roles of stakeholders, both informal and formal sectors, in post-consumer waste activities; waste collection programs for recycling; analysis tools for recycling system; recycling process and optimal production. This book aims to transmit both the necessity and the mode for recycling, as well as resource conservation activities to a wide audience at the academician and professional level. It also contributes to the formation of a sound material-cycle society.

Significant researches are present in this book. Intensive efforts have been employed by authors to make this book an outstanding discourse. This book contains the enlightening chapters which have been written on the basis of significant researches done by the experts.

Finally, I would also like to thank all the members involved in this book for being a team and meeting all the deadlines for the submission of their respective works. I would also like to thank my friends and family for being supportive in my efforts.

**Editor**

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# Section 1

## Post-Consumer Waste and Recycling





# The Role of Informal Collectors of Recyclable Waste and Used Goods in Indonesia

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## 1. Introduction

Municipal Solid Waste (MSW) is a problem in Indonesia, particularly in big cities, and is one of the most challenging urban issues for city administrators. Population growth and ever-increasing activities in major cities mean the increase of waste generation and all the inherent consequences. It was estimated that of the entire urban wastes generated in 2006, at most only around 60% to 70% could be transported to final disposal by the institutions responsible for handling wastes. The community were expected to handle the rest themselves.

According to the latest census in 2000, Indonesia's population was 205.8 million. An intercensal population survey in 2007 revealed a total population of 224.9 million with a population density of 117.6 people per sq. km. Provinces in Java Island had a higher population density than provinces outside. The province with the highest population density was Jakarta (11,968.8 people per sq. km). Provinces in Papua had the lowest density of 5.9 people per sq. km. Although the absolute number of the population was increasing from census to census, its growth was decreasing, from 2.32% in the period from 1971 to 1980 to 1.49% in the period from 1990 to 2000 (Ministry of Health, 2007).

Until the early twentieth century, the urban population in Indonesia was well distributed. According to the 1920 census, 6.6% of Java's population lived in cities. This pattern changed when the urban population of Java started to grow more quickly than the total population of the other islands. It could be said that the larger the city, the quicker the growth. During the 1960s and 1970s inter-provincial migration also began to increase. The main targets of the movements were the Javanese towns, and in particular Jakarta, to which 40% moved immediately, whereas others reached the capital city only after first settling in smaller towns (BPS-Statistics Indonesia, 2004).

It is evident that none of the Indonesian cities was prepared properly to absorb the newly arrived rural migrants as far as employment and housing, including public utilities, were concerned. Once the natural absorption capacity was exhausted, the newcomers established themselves in slums located along railway tracks, waterways, etc. The primary motive behind the rural-urban migration was the lack of employment in the villages (push factor) and not so much the attraction of city life (pull factor) (Donner, 1987).

Though such migrants are not contributing more than their poverty to the cities, they feel that they can make a living in the towns rather than in their villages, although their quality of life will be worse. The number of formal working places is not growing at the same speed as the number of job seekers. In addition, most of them cannot offer any qualifications whatsoever. It is the informal sector that absorbs the bulk of unemployed migrants without capital or professional qualifications. These informal employments are normally not recorded and therefore never appear in any official statistics.

With the increasing growth of population and economic activities, the volumes of waste to be handled increase accordingly. Rapid population growth in urban areas, socio-cultural classes' heterogeneity and community participation that is generally not well directed and well organized have caused complex MSW problems for municipalities. On the other hand, the funding situation and relatively low priority in waste handling among local governments are general trends, along with the limitations in proper human resources, adding to the low performance of municipalities in handling the sanitation and waste in urban areas. Many factors are involved in inadequate MSW management, some of which are lack of support for municipalities to address waste problems systematically, integrally and comprehensively, lack of standard policies that are comprehensive and consistent in matters of waste handling, and lack of discipline among waste managers in terms of applying proper technical procedures (Damanhuri, 2005).

The problems of waste management in developing countries, such as Indonesia, have a number of aspects associated with them, such as technical, institutional, financial, environmental and social aspects. To overcome this problem effectively and efficiently a holistic approach to developing solutions is required. The impact of these aspects varies markedly depending upon the income levels and socio-economic factors of individual countries or cities. Higher per capita income levels in developed countries provide the financial means to maintain appropriate collection systems, treatment and disposal management. The generally higher education levels of the population in developed countries also provide support for the implementation of the mantra 'reduce, reuse and recycle' (3Rs) for waste programmes, public education and strict environmental regulations. Eventually it has become clear that sustainable improvement can be reached only by the integration of socio-economic and socio-cultural elements into the whole scheme. In Indonesia, proper waste management has been a major challenge, but concerns about gradual waste reduction through recycling have been raised in recent years. During the last few years, because the problems of solid waste disposal are all too obvious, public pressure and growing environmental awareness have also caused a change in the policy concerning waste management.

This report will discuss used goods and waste recycling activities, especially among informal sectors, emphasizing discussions on actors' roles and the linkage of one informal sector stakeholder with another in the performance of their activities as waste and used goods collectors, and how material flows and qualities are applied in economic transactions by informal sectors in Indonesia.

## **2. Municipal Solid Waste (MSW) issues**

Indonesia is a country located in South East Asia, which comprises more than 13,000 large and small islands. Administratively, the country is divided into 33 provinces and more than

465 municipalities which consist of 14 metropolitans (one million population or more), 15 big cities (500,000 up to a million population), 56 medium-sized cities (100,000 up to 500,000 population), and 380 small cities (20,000 up to 100,000 population). Indonesia is located at the equator, and it has two seasons every year (dry and rainy seasons) and because of the monsoon rains each season lasts six months. The rainy season is also the fruit season and fruits produce an enormous amount of waste in the city.

Municipal solid waste (MSW) management in Indonesia is the responsibility of municipalities (local government). There is a city/district cleanliness division within the municipality organization. Some big cities contract out part of the services to third parties. In fact, most of the municipalities still give low priority to solid waste services.

The general method currently observed in waste management is collect-transport-dispose. The authorities in urban municipalities transport the waste from designated collection points to a location for its final dumping. Most of the local authorities practise crude open dumping, creating a desperate situation at the landfill sites. The potentials for reuse and recycling have not been fully realized because of a multitude of problems.

The principal source of MSW in Indonesia is households. They generate about 50 to 60 % (wet weight) of the total quantity of MSW per day. Some cities provide their generation data by conducting surveys and sampling but many other cities usually estimate their waste volume by using the estimated generation rate of 2.5-3.0 L/capita/day based on standard national MSW figures. According to a survey of the Bandung area in 2005, the estimated MSW generated in this area was 0.59 kg/capita-day (Damanhuri et al., 2009). In a questionnaire survey conducted in 2007, it was estimated that MSW generation of all municipalities in Indonesia in 2006 was 38.5 million tonnes, as presented in Table 1.

The amount of MSW is normally dominated by organic matter (more than 55% by weight) that mainly comes from food waste. This amount contributes to about 65% of the water content of MSW. This waste consists mainly of food scraps, yard waste, and wrapping materials. It is a mixture of all kinds of waste, organic and non-organic, recyclable and non-recyclable, even hazardous and non-hazardous materials. The other sources are traditional markets, commercial activities/areas, industries (non-hazardous categories), public gardens and streets. Plastic and paper are the two next commonest items. They mainly comprise packaging/wrapping materials and food, beverages, etc. Wood and textiles are the next two important components. According to a survey in 2007 of Bandung metropolitan areas, the average amount of organic MSW taken at transfer stations was around 60% (by weight), as presented in Table 2. The amount of inorganic waste was around 40% (by weight), and about 6% (by weight) was classified as recyclable inorganic components.

Waste collection is the first subsystem of the technical system of MSW management which is part of the municipalities' services. Some households can afford a waste bin made of concrete, plastic or steel built in front of their houses. Others simply store their waste in plastic bags or in used cartons or boxes in front of their houses. These wastes are then picked up by a community collector cart, a small truck, etc. depending on the arrangement in the neighbourhood community. Some large and medium-sized cities have been contracting out part of the collection and transportation to private firms. In the year 2006, collection of MSW in Indonesia covered about 130 million inhabitants or 56% of the total population (Table 3).

ISLANDS	MSW Generation (thousands tonnes)
Sumatera	8.7
Java	21.2
Bali and Nusa Tenggara Islands	1.3
Kalimantan	2.3
Sulawesi, Maluku and Papua	5.0
TOTAL	38.5

Source: Solid Waste Statistics year 2008

Table 1. MSW generated in Indonesia, 2006.

Item		% wet-weight	
		TS-1	TS-2
Recyclable components	Hard - papers	0.92	0.95
	Archives (white) Papers	0.14	0.34
	Bottle - glass	1.77	0.50
	Drinking bottle-plastic	0.29	0.19
	Drinking glass - plastic	0.17	0.34
	Can	0.22	0.32
	PE - plastic	0.03	0.42
	Divers - plastic	1.63	0.47
	Aluminum	0.06	0.05
	Cartoon/cardboard	0.33	0.31
	Newspapers	0.13	0.16
	Metals		0.03
Total of Recyclable Components		5.69	4.08
Organic Component	Food waste	33.90	58.04
	Leaves etc.	12.32	2.21
	Tissue-papers	11.02	1.78
	Textile	0.89	0.90
	Wood	1.98	0.70
Total of Organic Components		60.10	63.62
Others: an-organic non-recyclable		34.21	32.30

Source: Municipal Solid Waste Management in Indonesia, 2010

Table 2. Composition of MSW at transfer station (TS) at Bandung (2007).

ISLANDS	Population (million inhabit)	Population served (million inhabit)	% population served
Sumatera	49.3	23.5	48
Java	137.2	80.8	59
Bali and Nusa Tenggara Islands	12.6	6.0	47
Kalimantan	12.9	6.0	46
Sulawesi, Maluku and Papua	20.8	14.2	68
TOTAL	232.7	130.3	56

Source: Solid Waste Statistics year 2008

Table 3. Population served by municipalities in Indonesia in 2006.

Like any other collection system in developing countries, where the municipal waste from household sources is commonly collected through labour-intensive services (Cointreau, 1982; Joseph, 2010), in urban areas in Indonesia waste is collected by handcarts drawn by one or two crew members. Typically, waste generated by households is accumulated in small containers and placed on the ground to be shovelled manually or left in plastic bags, open cartons or baskets to be picked up by hand. These waste crew collection workers have significant direct contact with solid waste, so they are more likely to encounter potentially toxic and hazardous materials. Containers used for household storage of solid wastes are of many shapes and sizes, fabricated from a variety of materials depending on the economic status of the waste generator. The wide variety of types and shapes commonly encountered within a community creates difficulty in establishing and operating an efficient solid waste collection system (Joseph, 2010).

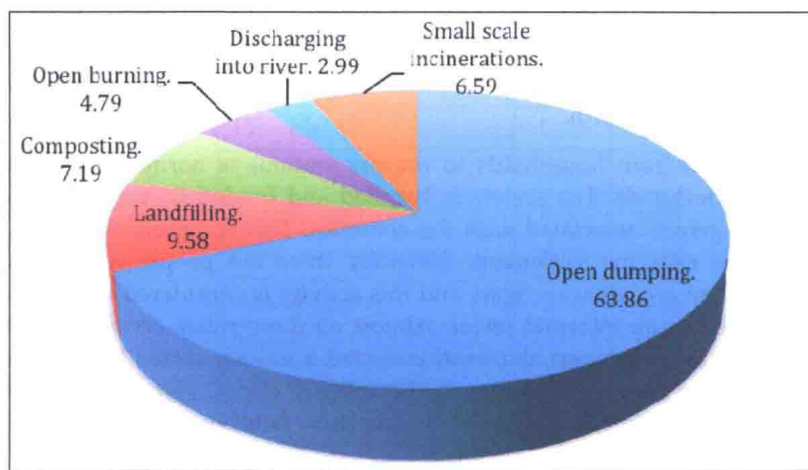
The waste collection from households to transfer stations is normally organized by the respective neighbourhoods. The system is handled and funded by the communities, who can afford the expenses associated with the activities. This community employs a person who usually lives near the settlement. Generally these are people who do not have a permanent job. They are not scavengers and this activity is considered legal, but the waste crew is categorized as an informal sector. Almost all these waste crews perform valuable waste segregation. In many cases, the waste collected is already sorted by the generator and given to these waste crews. All wastes in the transfer depot, along with non-residential wastes, will be subsequently transported by trucks to landfills by city cleansing division crews.

Collection of waste is conducted by several methods, namely:

- Communal collection: where the community bring their own waste to a temporary collection point whence transportation is carried out by trucks. This method is usually applied in the very thickly populated areas. In certain places, the community bring their waste to vehicles which move along their routes while playing a traditional song, rather like an ice-cream cart.
- Individual indirect collection: where collection of waste is conducted by small vehicles or carts from door-to-door, and brought to the transfer depot where the waste is transferred onto trucks and transported to disposal/treatment sites.

- Individual direct collection: where garbage is collected door-to-door by trucks and directly transported to disposal/treatment sites. This type of collection is conducted in the high-income areas or commercial areas where a large amount of waste is generated.
- Temporary disposal sites are provided and managed by municipalities. From these facilities, collected MSW is transported to final disposal sites.
- Street sweeping is carried out to collect waste from public places and main streets by manual sweepers as well as sweeper vehicles.

So far, most of the existing MSW management systems in Indonesian municipalities have relied on the existence of landfills. The excess has been handled by the community in regular ways, such as burning, burying, composting, and other less regular ways such as recycling or disposal at inappropriate sites, including ducts or drainage channels. Another method of treating MSW in some cities is incineration. There are several small-scale incinerators in operation in different cities, each with a capacity of about 100-200 kg/hour and operating eight hours per-day. Therefore, the system is only able to handle a small percentage of the total MSW generated. Composting of organic waste has also been introduced as part of waste treatment. Compostors are located, normally, in final disposal sites. In principle, the composting system comprises a centralized sorting and shredding system, and thereafter composting of the organic matter is done by means of a simple composting method. According to a questionnaire survey conducted in 2007, the mode of handling of MSW in Indonesia in 2006 is as shown in Figure 1.



Source of data: Source: Solid Waste Statistics year 2008

Fig. 1. Percentage of MSW handling in Indonesia in 2006.

There are three groups of waste materials that serve as the main objects of recycling activity (Damanhuri et al., 2009):

- Wet waste, especially organic waste, to be converted into compost.
- Dry wastes, especially those with the potentials to be recycled, such as papers, plastics, aluminium, etc.
- Used goods resold by traders.



In 2008 Indonesia introduced the Law of Solid Waste Management (Law No. 18/2008). Some of the central issues of Law No. 18/2008 are as follows:

- Extended producers' responsibility (EPR); every producer should provide a label on their product packaging and/or their final products about reducing and proper handling of waste; and they should also be responsible for the packaging of products that are difficult to decompose by means of natural processes (biodegradable).
- Application of waste reuse and recycling through the entire chain of waste transport, from origin to final disposal.
- Selection of waste processing and dumping technologies that are safe and healthy, and conform to the Indonesian situation. Open dumping and open burning are forbidden and five years after the passing of the law open dumping will be completely banned.
- Prohibition on importing waste into Indonesia territories or mixing waste with other hazardous wastes.

The basic aim of this new law is waste reduction through the 3Rs (reduce, reuse and recycle) as the first priority, and the next priority is waste handling. This concept is considered as a new paradigm to replace the collect-transport-dispose concept which is usually adopted in most Indonesian cities. All of the involved parties agreed that the new concept is the best available measure to reduce wastes, and active involvement on the part of the community and other waste generators to reduce waste volume is the key to the success of any waste management system. One of the important mandates in Law No. 18/2008 is the implementation of waste recycling. Any recyclable waste is collected from its respective sources, such as residential areas, commercial zones, temporary collection facilities and the final processing facilities. Wastes are recycled into useful raw materials for production processes (i.e. reprocessing and remanufacturing activities). Activities related to community involvement consist of separation, composting (at source and communal), and recycling. The municipality is then responsible for the transportation of the residue to disposal sites.

A national policy has been established with an initial target of 'reduction of waste as much as possible starting from its sources'. The government has set a target of waste reduction of up to 20% by the year 2014. Some strategies besides 3R education and campaigns have also been formulated to promote the reduction of waste from its sources, starting with households. The Ministry of Environment and the Ministry of Public Works facilitate recycling activities performed in several regions in the country. The top priority in the implementation of these activities is the recycling of organic wastes into either individual or communal level composting facilities. In order to accelerate the multiplication of such activities, the Ministry of Public Works has launched recycling activities in more than 200 locations in 150 cities since 2006 by adopting cost-sharing mechanisms with the local community, NGOs, and municipalities. Components of the project are a composting hall, a plastic crusher, a rotary screen and other ancillary items. Some difficulties arise especially in the formation of a local institution to run the project, and the limited capability of the local community to pay the collection fee among others.

### **3. Informal sector and waste recycling**

Waste definitions as well as MSW definitions vary in different countries. Among developed countries, for instance, the definition of an MSW will encompass any goods that would be



defined among developing countries as used goods that still have economic value. In developed countries, the elimination of used electronic appliances, furniture and fixture, used newspapers, used magazines, and used clothes, etc. incurs a disposal cost. Thus in developed countries, these goods are defined as waste, tend to generate problems and require further handling. Conversely, in developing countries, these are regarded as valuable goods and could still be used after being repaired or their components recovered in such a way that they could be reusable. Most Indonesian people of all economic levels have different perceptions of the end-of-life of goods, including consumer goods. These materials are perceived as used objects that still have an economic value, to the extent that they are rarely found in municipal waste management chains, for the reason that these items are actually saleable, or could be donated to others of lower income.

A positive impact derived from the current solid waste management systems in developing countries and economies in transition is the high level of recycling of the inorganic components of MSW. Although the methods employed for sorting and separation of MSW in these countries are considered inappropriate for solid waste management systems as defined by developed countries, these existing methods not only provide an income stream to the hundreds of thousands of people involved in this informal sector but also ensure a far greater amount of MSW generated is recycled. In most countries, plastics, glass, paper, and metals are collected by either the informal sector or municipalities, and these materials are recycled. There are two main recycling flows. In the first flow, collectors, including those in the informal sector, collect recyclable materials at sources. In the second flow, these materials are separated and recycled by the municipality after MSW collection. Recycling activities in this context are all activities reusing objects that have previously been called 'waste', either by directly reusing them or by selling them to waste traders.

Like other major cities in developing countries, the informal sector in Indonesia plays an important role in any recovery effort regarding the usable materials of waste. Recycling of dry waste (inorganic waste) is common practice in large cities in Indonesia. It is known that the recyclable material is reduced en route to the transfer points and to the final disposal. Many stakeholders are involved in the reduction process, e.g. sorting at the solid waste sources, scavenging. Many people treat the informal sector engaged in used goods and waste economic transactions or trading in Indonesia as scavengers. Indeed, it is the group that has attracted most attention owing to its association with social issues faced by most urban areas in developing countries. Actually, the latter is just one of the multiple stakeholders in recyclable collections. The recycling sector includes housewives, waste workers (from the cleansing division), vendors of used articles, and waste pickers (scavengers). Middlemen or intermediary traders are found in all corners of Indonesian cities buying used articles directly door-to-door. These waste recovery activities practised in many cities in Indonesia are mostly done by the informal sectors, consisting of handcart crews, mobile scavengers, transfer depot scavengers, final disposal scavengers, waste traders, recycling business people, and composting units at several points over a city, as presented in Figure 2. So far, the informal sectors' waste recovery activities have not been well organized.

Informal waste recycling is a common way to earn income. Studies suggest that, when organized and supported, waste picking can encourage grassroots investment by poor people, create jobs, reduce poverty, save municipalities' money, improve industrial