

THE STUDY OF PLASTIC WASTE FOR FORMULATION OF PLASTIC WASTE MANAGEMENT AND CONTROL STRATEGY IN BANDUNG MUNICIPALITY

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Solid waste management is becoming important problem in Bandung City, especially after avalanche tragedy of Leuwigajah final disposal site seven year ago. Law Act No. 18 of 2008 on waste management has given guidance that waste management should be balanced with a 3R concept. One of the important issues of Bandung municipal waste is presence of plastic waste. Although the composition of plastic waste only 12.3% of the total Bandung municipal waste generation reached 7500 per day, but its whereabouts is dominant because of plastic waste no easily destroyed and accumulated at a long time. For the control of plastic waste that has been study of plastic waste generation at the temporary station pooling (TPS). The study was conducted in six major TPS of Bandung City using proportional sampling method. The result of these studies indicate that plastic bag waste most dominant, reaching 50%, plastic as packaging of product 42%, and plastic without branding (clear plastic) 8%. Most waste of the plastic bag used as a garbage bag (93%). Base on result of this research Bandung City Government should make policy on the prohibition of the people not to use plastic bags as trash bag.

Key Words : *plastic waste, packaging waste, muncipal solid waste*

1. INTRODUCTION

(1) Background and Statement of Problem

Municipal solid waste (MSW) is one of critical problems at every city in Indonesia. In Bandung city MSW problems increased especially after the tragedy of Leuwigajah Final Disposal Site avalanched in 2005 which become public concerning, because not only killed about 124 scavenger but also it caused garbage form Greater Bandung not transported so thus causing the garbage piled in every corner of the city, Bandung declared as a garbage emergency city. This incident prompted Bandung City Administrative had been developing some alternative of methodology and technology to MSW management. Law No. 18 of 2008 on Waste Management stipulates that waste management is not only handling (separation, collection, transportation and processing of the final disposal site) but should be balanced with waste reduction

activities, known as the 3R's program (reduce, reuse, recycling).

One of the important issues related to MSW in Bandung City is being garbage itself both in quantity or quality. MSW generation is increasing from year to year, along with population growth and people's lifestyle, but on the other hand are more limited service capacity either because of the difficulty of finding landfill (where the final processing) as well as the limitations of transport fleet.

Today, Bandung MSW generation about 1800 tons per day. Generally there are two kinds of MSW, organic waste and non organic waste. The organic component of MSW may not be too much of a problem since that is biodegradable. However, non organic waste, especially plastic waste, is quite problematic because these is non-biodegradable and therefore stay in the environment for a considerable length of time causing all short s of problems. The treatment of plastic waste through

combustion or incineration is not environmentally friendly and sustainable since this may release carbon dioxide, major contributor for global warming. Land filling of plastic waste it not also desirable since plastic waste in non-degradable and no economic value would have been derived from the waste in that case.

Plastic waste is current critical problems of the MSW in Bandung City. From a total of generation of MSW (1800 ton per day) there are 232 tons per day of which is a plastic waste. Although the composition of plastic waste in the presentation only 12.3% (Sukandar, 2012), but because the plastic is very light and not easily destroyed the existence of plastic waste have been domination.

Given the growth of plastic waste is quite high and varied, and saw the plastic garbage can have an important impact both on the environment and economy it is necessary efforts to resolve it, either by creating and developing regulatory measures for solution. The World Packaging Organization estimates that the global packaging industry today is valued at approximately 500 billion dollars annually (Wendy, 2009). To achieve this required a study to mapping the existence of plastic waste is mainly from the volume, the type of plastic used, and the activities of people who use a lot of plastic.

(2) Purpose and Objectives of the Study

There are three objectives of this study as follow :

- a. To identify kinds of plastic waste which generated form Bandung MSW

- b. To identify composition (quantity) every kind of plastic waste
- c. To formulate the policies which must be making by Bandung City Administrative to reduce of plastic waste as a part of MSW management.

(3) Scope and limitation of the study

Solid waste management all over in the world included in Bandung City is complex one. The hierarchy as a priority for solid waste management planning released by U.S. EPA in the document "The Solid Waste Dilemma: An Agenda for Action". In this document, EPA stated that the element of integrated solid waste management should be prioritized as follow (Tchobanoglous, 2002) :

- a. Reduce the generation of solid waste.
- b. Recycle (including composting) for productive reuse as much as in practicable.
- c. Combust and recover energy for productive use.
- d. Landfill the remainder.

Main focus of this study is how to manage reduce the generation of plastic waste and how to manage plastic waste to support recycling plastic waste activity. Plastic waste into focused in this study because as previously described plastic waste poses a seriously threat of the environment in Bandung City.

Operational pattern of solid waste management in Bandung City as shown at fig. 1. Base on location, this study focused at intermediate disposal site (called TPS) or transfer station.

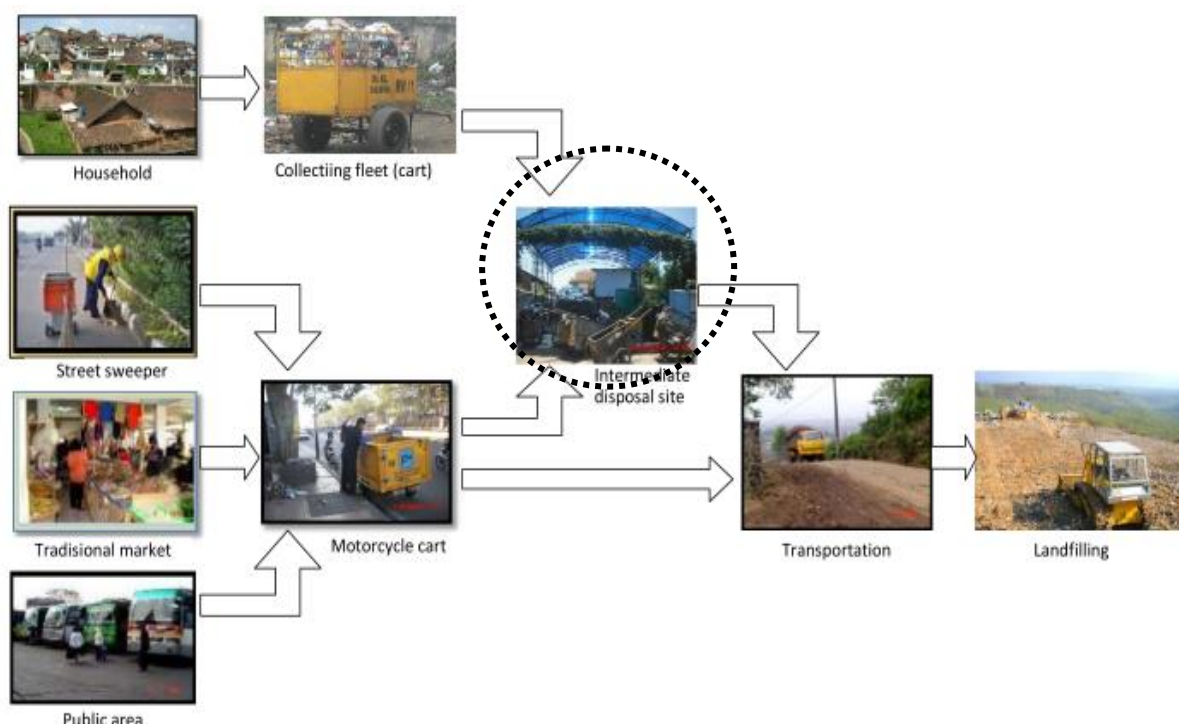


Figure 1 Operational pppattern of Bandung MSW management

(4) Methodology

This research was conducted in six major TPS's in Bandung City, that is: Ciroyom TPS, Nyengseret TPS, Antapani TPS, Gedebage TPS, Tegallega TPS, and Cibeunying TPS. Observation performed with randomly sampling of two carts at different day. Carts are selected the unloaded and selected all the plastic waste that is in it. All plastic waste then separated and grouped by kind, brand and function of plastic, and then calculated amount of each group.

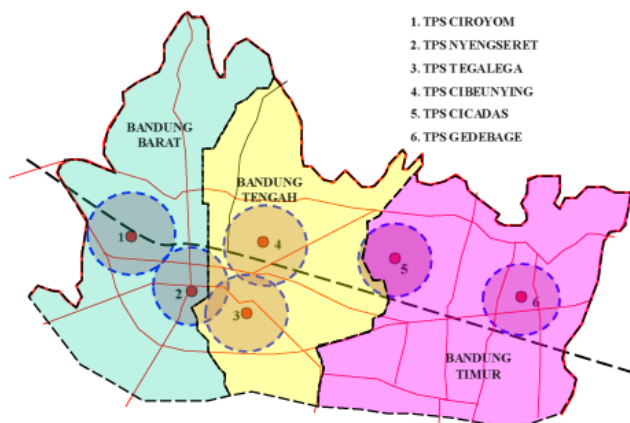


Figure 2 Location of Study

2. PLASTIC MATERIALS AND PRODUCTION

(1) History of plastic production

Plastic is a material which currently not separated from human life, because almost all of daily people activity always connected with plastic. Plastic are widely use as a packaging of product, as a bag for something, as a wrapping of foods, as a cover of books, etc. Plastic is a kind of packing or wrapping material that many people use because it is lightweight, simple, durable and inexpensive.

Plastics are materials that are produced from oil and natural gas as raw materials. Plastics can be regarded as long chain of bead in which the so-called monomers such as ethylene, propylene, styrene, and vinyl chloride are linked together to form a chain called a polymer. If type monomers similar called homopolymers, and if different monomers will produce copolymers. Polymers such as polyethylene (PE), polystyrene (PS) and polyvinyl chloride (PVC) are the end products of the process of polymerization, in which the monomers are jointed together (Wienaah, 2007). In many cases only one type of monomer is used to make the material, sometimes two or more. A wide range of products can be made by melting the basic plastic material in the form of pellets or powder

(Warmer Fact Sheet, 1992).

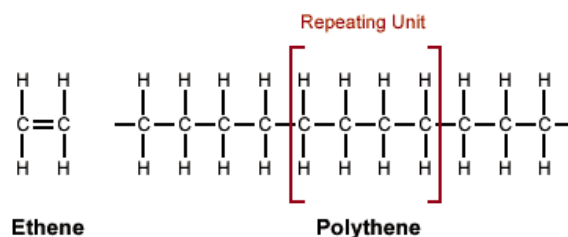


Figure. 3 Example monomers of ethane : long chain of bead

Natural polymers that we know are: cellulose, proteins, natural rubber. Etc. At first people used only natural polymer for making tools and weapons, but this situation only lasted until the late 19th century and after that up to now people started to modify the polymer into a plastic. Plastic was first made commercially is nitrocellulose. Plastic materials has grown rapidly and now has a very important role in the field of electronics, agriculture, textiles, transportation, furniture, construction, cosmetics packaging, children's toys, and other industrial products (Mujiarto, 2005).

(2) Type of plastics

Generally the plastic can be grouped into two categories, namely: thermoplastic and thermosets. A thermoplastic is materials that repeatedly soften on heating and harden on cooling. They can be melted down and made into new plastic end product. Thermoplastics a similar to paraffin waxes. They are dense and hard at room temperature, become soft and moldable when heated, dense and hard again and retain new shapes when cooled. This process can be repeated numerous times and the chemical characteristics of the material do not change (Wienaah, 2007). In Indonesia one of product made form thermoplastic is plastic bag (in Indonesia called *kresek* bag).

Thermosets, on the other hand are not suitable for repeated heat treatments because of their complex molecular structures. Such materials cannot be processed into new products unlike thermoplastics. Thermosets are widely used in electronics and automotive products.

In industrialized countries, literally hundreds of plastic materials are available commercially. In economically less developed countries however, viewer type of plastics tend to be used. In both economically less developed and industrialized countries, the four types of plastic that are most commonly reprocessed or recycled are polyethylene (PE), polypropylene (PP), polystyrene (PS), and polyvinyl chloride (PVC).

(3) Impact plastic wastes on the environment

Plastic waste has several impacts on the health of ecosystems and humans. Based on the physical and chemical characteristics of plastic waste disposed openly to the environment, it will be a very important impact on the environment. The most fundamental dangers of plastic waste are that it is not biodegradable in short time. There are many impacts of plastic waste on the health of ecosystem and human (European Commission, 2011):

a. Harm to wildlife

Although there is little research on the specific impacts of plastic waste on land-based wildlife, there is concern that incorrectly managed landfills could lead to either the escape of plastic waste or the escape of landfill leachate containing the chemicals associated with plastic. In addition, unofficial recycling methods, particularly in developing countries, can release chemicals into the environment, for example, the burning of plastic-coated wires to extract metal. UNEP (2006) claims that plastic waste causes the death of up to a million seabirds, 100,000 marine animals and countless fish through various impacts. Several cases that lead to the extinction of wildlife are: entanglement of wildlife in plastic waste and ingestion of plastic waste and microplastics.

b. Possible impact of chemical content

A lesser-known impact that could result from ingestion, entanglement and inadequate waste management is the impact of chemicals on humans and ecosystems, either contained in plastic or transported by plastic waste. Plastic is not inert, but contains several chemicals with toxic potential. It

also has potential to transport contaminants. Some chemical contents of plastic that are harmful to humans and ecosystems are: toxic monomers, plastic additives (bisphenol, phthalates, brominated flame retardants), metals (such as cadmium in children's toys), etc.

3. RESULT AND DISCUSSION

Based on field observations, types of plastic waste vary based on the type of plastic, plastic colors, functions and types of plastic products are packaged plastic. In this study, plastic waste is grouped into three types, as follows:

- Plastic bags (*kresek* bag), consisting of: (a) recycled plastic bag (usually black color), and (b) not recycled plastic bag (usually white and other color).
- Plastic of product packaging, consisting of: (a) sheet form plastic, (b) bottle form plastic, (c) cup form plastic.
- Clear sheet plastic.

Based on the results of the research as shown in Table 1, it was found that 9,658 pieces of plastic waste were generated from 12 carts. If the capacity of each cart is about 1.25 m³, then on average there are 644 pieces of plastic waste in 1 m³ of garbage. If the generation of Bandung MSW is 7,500 m³ per day, then there are 4,829,000 pieces of plastic waste generated per day in Bandung City. The composition of plastic waste, as shown in Fig. 4, is dominated by plastic bags (*kresek* bag) at about 51% of the total plastic waste, packaging plastic waste of products at about 41% and clear plastic at about 8%.

Table 1 : Plastic Waste Generation at TPS

Location of study as a sampling	Amount (sheet)						
	Plastic bag (<i>kersey</i>)		Product packaging			Clear plastic	Total
	Black/ recycled plastic bag	Non recycled plastic bad	Sheet	Bottle	Cup		
TPS Ciroyom	79	42	240	10	15	0	386
TPS Nyengseret	640	188	561	185	916	0	2490
TPS Antapani	956	670	242	60	85	208	2221
TPS Gedebage	960	422	254	65	95	356	2152
TPS Tegallega	170	297	646	0	0	93	1206
TPS Taman Cibeunying	136	358	608	5	0	96	1203
Total	2941	1977	2551	325	1111	753	9658

Source : Research in 2012



Fig. 4 Composition plastic waste on a cart

(1) Plastic bag waste (*kresek bag*)

Plastic bag waste is the most of plastic waste founded in garbage observed. From 12 carts were observed, there are 4914 pieces of plastic waste bags which recycling plastic bag or not recycling plastic bag (about 51% of total plastic waste observed). If cart capacity @ 1.25 m³ then of each garbage cart containing 321 sheets plastic bags. If waste generation in Bandung City about 7500 m³ per day then the expected plastic bag waste reaching 2.407 million sheets per day, this amount does not include a clear plastic sheet both branded and non-branded plastic. Composition of plastic bag base on recycle or not is 85% of recycled plastic bag and 15% not recycled plastic bag (see Fig. 5).

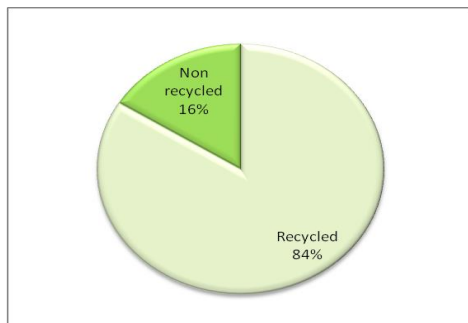


Fig. 5 Composition plastic bag waste

From the observation shows that plastic bag, especially plastic bags that are larger one, generally used as a garbage bag (93%), and other disposed as garbage (7%). It is related to the people habit of Bandung city whose wrapped garbe with plastic bags and disposed together. The composition plastic bag as it function showed at Fig. 6.

(2) Product packaging plastics

Other plastic waste founded at this research is plastic as packaging of a product. For this the product packaging we grouped to three kinds, i.e :

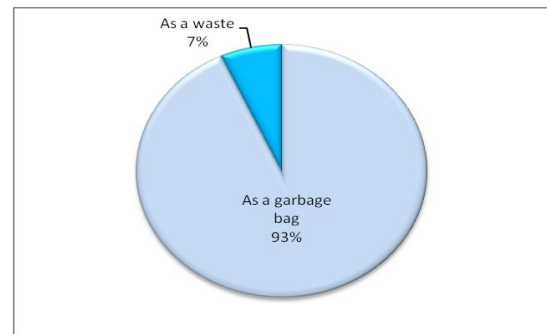


Fig. 6 Composition of plastic bag waste function

sheet form, bottle form and cup form. From this research founded that composition each other are : packaging product with sheet form is most of plastic waste i.e. about 64%, pckaging product with cup form about 28% and bottle form about 8%. Completely composition of plastic waste as product packaging showed at Fig. 7.

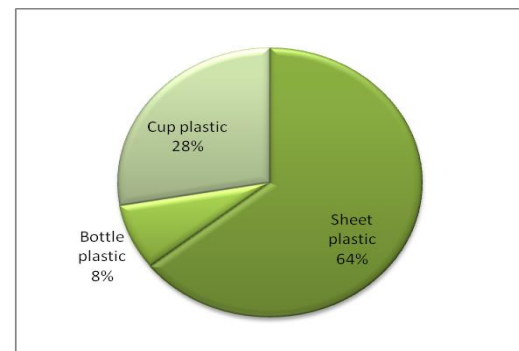


Fig. 7 Composition of packaging plastic waste

(3) Clear sheet plastic

Clear sheet plastic is kind of plastic packaging of product without coloring. Observation result of 12 carts were chosen randomly from the large TPS founded 753 clear sheet plastic sheets (usually unbranded). If the average carts capacity @ 1.25 m³ then per m³ of garbage in the Bandung City is estimated to contain 50 sheets of clear sheet plastic. If the waste generation of Bandung MSW about 7500 m³ per day then there were an estimated 376,500 clear sheet plastics.

4. STRATEGIC FORMULATION

Base on the result of this research then both of central goverment and city goverment shuld immediately formulate polies which needed to curb plastic waste generation that is likely to harm. To formulate of it we use 5W+1H method as shown at Table 2.

Table 2 Policy Maker Formulation with 5W+1H Concept

What	Why	Where	Whom	When	How
Using plastic material as product packaging	Rate of packaging plastic waste increased so the potential of environmental pollution due plastic waste increased	Packaging system industry	Head of the industry	Start from design of product and packaging	- Minimizing to using plastic material as packaging - Replace non-biodegradable plastic material with a biodegradable plastic material
		All goods industry	Head of the industry	Packaging products that have become waste at the consumer level	- Product take back and recycling - Cooperation with community to implementation 3R's program - Implementation CSR program
		Industrial Ministry	Permit affair	Permission arrangement	- Eco labeling implementation
		Environmental Ministry		Permission arrangement	- Extended Producer Responsibilities (EPR) policy
Production of non biodegradable plastic bag	Rate of plastic bag waste increased so the potential of environmental pollution due plastic waste increased	Plastic bag industry	Head of industry	Production planning	Replace non-biodegradable plastic material with a biodegradable plastic material
		Bandung City Administrative	Environmental Control Agency (BPLH)	Year 2012	Make regulation for plastic bag reduction
Using plastic bag as packaging or wrapping	Rate of plastic bag waste increased so the potential of environmental pollution due plastic waste increased	Supermarker, minimarket, restaurant and all business activity which using plastic bag as packaging	Management of supermarker, minimarket, restaurant and all business activity which using plastic bag as packaging	Along carry out activities the business	Replace using non-biodegradable plastic bag with a biodegradable plastic bag
		Bandung City Administrative	Environmental Control Agency (BPLH)	Year 2012	Make regulation for plastic bag reduction
Using plastic bag as bag and wrapping of garbage	Rate of plastic bag waste increased so the potential of environmental pollution due plastic waste increased	Household	Whole family	When will throw the garbage	- Separated organic garbage (nonperishable waste) from the other (non organic garbage) - Process organic garbage : o Make a compost by individual composter o To support biopori program o Make biogases o Make a compost at neighborhood scale - Process non organic garbage with 3R principles
		Bandung City Administrative	Environmental Control Agency (BPLH) or Cleaning Agency	Year 2013	Make major city regulations for prohibition of using of plastic bags as garbage bag and discarded

5. CONCLUSSION AND RECOMENDATION

Plastic waste has become a serious threat in the Bandung MSW, but because its generation will be accumulated in a very long time. Although many of the informal sector which recycle waste plastic but still very a few and particularly plastic waste is mixed with food waste so that recycling is not optimal yet. Consequently of these, there is still much plastic waste dumped into landfills and even scattered all over the place and a serious threat to the environment, especially floods due plastic waste clogs drains rainwater.

Base on the study, generation of plastic waste of Bandung MSW is about 4,829,000 pieces per day consist of plastic bag (51%), packaging of product (41%) and clear plastic (8%). If we see the result of the reserch shown that plstic bag had dominated, and maybe will be increasing in the future. Because the plastic waste will become a serious threat in the Bandung city, the local government should immediately take action both political will and technical measures.

Some thing that can be rekomended to be done by Bandung City Goverment are : (a) Central government up to Bandung City Government need to be made regulation to reduce and control the plastic waste; (b) Nedd to countinously campaign and implementation in one area (like in one supermrket) as a pilot project; (c) Need to be made instruments and mechanisms to control the use of plastic bags start at manufacturers level up to consumers, especially large customers such as supermarkets, trasdisional markets, food stalls, etc.; (d) For producers and corporate as large users such as supermarkets are required to make a label of the plastic bags wich are manufactured each sheet and add a moral message about the dangers of plastic waste, and implement mechanisms regulations for the return of the plastic bag and then do the recycling. Plastic return program (product take-back) can be done either by applying the concept of Deposit Refund System and working with community groups through CSR; (e) Relating to the Bandung MSW management, need to be made following the rules and mechanism : obliging to the community to separating garbage at home or at it source, with minimum standards are 3 types: non-organic waste, organic waste, and hazardous waste, prohibition to the community in the use of plastic bag (kresek bag) as organic waste bag and thrown it to the garbage collection or disposal site; (f) Need to be developed the alternative to replace the plastic bag as the packaging particularry for not

biodegradable plastic bag cooperation with universities or other research institutions such as LIPI, BPPT, etc.

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