

**STUDI PERSEBARAN PELAKU DAUR ULANG
SAMPAH PLASTIK AIR MINUM DALAM KEMASAN
(Studi Kasus: Kota Bandung)**

**RECYCLE PERFORMER DISTRIBUTION STUDY OF
MINERAL WATER PLASTIC BOTTLE WASTE
(Case Study: Bandung City)**

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Abstract: Mineral water plastic bottle have become one of drinking water alternative for society at metropolises such as Bandung City. Consumption of mineral water plastic bottle by society will evoke high plastic waste generation. Mineral water plastic bottle was utilize from Polyethylene Terephthalate's (PET) material and Polypropylene (PP) material. Both of plastic material is a constitutes plastic type that can be recycle. Recycle constitutes is one of the effective ways in waste management for reduce the mineral water plastic bottle waste generation at final disposal (TPA). Mineral water plastic bottle composition at TPA Sarimukti on year 2008 is 1.35% of total amount wastes generates in Bandung City. Plastic waste reduction at TPA takes down from informal sector role that consisting of, pemulung, tukang loak, lapak and bandar. Survey's result that is done at Bandung's City exists 365 recycle performer that consisting of 130 pemulung, 130 tukang loak, 44 numbers lapak, 33 bandar kecil and 28 bandar besar outgrow. According at classification bases on PD. Kebersihan service area therefore at North Bandung exists 17 recycle performer, in East Bandung exists 25 recycle performer, South Bandung exists 20 recycle performer, and West Bandung exists 43 recycle performer. Most of recycle performer exist in Western Bandung because at West Bandung's region there is a lot of available textile mills and also plant wide toy which need raw materials from recycle plastics.

Key words: Mineral Water Plastic Bottle, Polyethylene Terephthalate (PET), Recycle Performer, Bandung city

Abstrak: Air minum dalam kemasan saat ini sudah menjadi salah satu alternatif air minum bagi masyarakat di kota-kota besar salah satunya Kota Bandung. Konsumsi air minum dalam kemasan oleh masyarakat akan menimbulkan timbulan sampah plastik yang jumlahnya cukup tinggi. Air minum dalam kemasan dibuat menggunakan bahan Polyethylene Terephthalate (PET) dan Polypropylene (PP). Kedua bahan ini merupakan jenis-jenis plastik yang dapat di daur ulang. Daur ulang merupakan salah satu cara pengelolaan sampah yang efektif untuk mereduksi timbulan sampah plastik air minum dalam kemasan di TPA. Komposisi air minum dalam kemasan di TPA Sarimukti pada tahun 2008 adalah sebesar 1.35% dari total sampah yang ada. Reduksi sampah plastik air minum dalam kemasan di TPA tidak lepas dari peranan para pelaku daur ulang sektor informal yang terdiri dari, pemulung, tukang loak, lapak serta bandar. Dari hasil survey yang dilakukan di Kota Bandung terdapat 365 pelaku daur ulang yang terdiri dari 130 orang pemulung, 130 orang tukang loak, 44 buah lapak, 33 buah bandar kecil dan 28 buah bandar besar. Apabila di klasifikasi berdasarkan daerah pelayanan PD. Kebersihan maka di Bandung Utara terdapat 17 pelaku daur ulang, Bandung Timur terdapat 25 pelaku daur ulang, Bandung Selatan terdapat 20 pelaku daur ulang, dan Bandung Barat terdapat 43 pelaku daur

ulang. Bandung Barat memiliki jumlah pelaku daur ulang yang paling banyak di karenakan di daerah Bandung Barat banyak terdapat pabrik-pabrik tekstil maupun pabrik mainan yang membutuhkan bahan baku dari plastik daur ulang.

Kata kunci: Air Minum Dalam Kemasan, Polyethylene Terephthalate (PET), pelaku daur ulang, Kota Bandung

1. INTRODUCTION

Waste is a by product from human activities such as economic activities and domestic activities which have become an important issue. According to waste generation, waste can be classified to market waste, domestic waste, commercial waste, and other activity such as industrial waste. According to waste characteristic it can be classified to organic waste, anorganic waste and hazardous waste.

Bandung as a tourism and commercial city have a high consumption level, this condition will cause Bandung city in high waste generation. We can predict that a high generation of municipal solid waste has become a major problem for Bandung city.

According to Biro Pusat Statistik (BPS) data, Bandung city population is about 2.364.312 (SUSENAS 2007), this number result increasing of waste generation to 7.020 m³/day (PD. Kebersihan, 2008). Meanwhile, Final Disposal (TPA) capacity is limited. An effective way to settle the problem is recycling an anorganic waste, like plastic, paper, and metal. Recycling is an important factor in helping to reduce the demand on resources and the amount of waste requiring disposal by landfilling. Recycling involves : (1) the separation and collecting of waste materials; (2) the preparation of these material for reuse, reprocessing, and remanufacture; and (3) the reuse, reprocessing, and remanufacture of these materials (Tchobanoglous, 1993).

In Indonesia, *Polyethylene Terephthalate* (PET) plastic is a widely accepted and very popular packaging material particularly for food because of its good performance, relatively cheap cost and easy reproducibility. Despite the popularity of PET plastic in the industry, there is now a growing concern among the local PET fabricators on the disposal and recycling of post-industrial and post-consumer wastes. One way of addressing the problem is through recycling. This will extend the service life of the plastics so that they will not be detrimental to the ecosystem. Likewise, recycling PET could create income-generating opportunities. An improved and more efficient recovery system for this type of waste must first be applied before recycling could become a viable undertaking.

PET is the most common thermoplastic polyester and was first known as fiber. The basic sources of raw materials for PET resin production are crude oil and natural gas. PET is a condensation polymer derived from *terephthalic acid* (TPA) or *dimethyl terephthalate* (DMT) and *ethylene glycol* (EG). Polymerization occurs by heating these systems, typically with an antimony catalyst, and removing either water or methanol. The great acceptance of PET as a packaging material is due to its toughness, clarity, capability of being oriented, and reasonable cost, as well as the development of high-speed bottle-processing technology. Compared to glass, PET containers are lightweight and shatter-resistance. They provide an acceptable barrier and they are considered as the most recycleable plastics abroad. PET is plastic number "1" based on the *International Coding of Plastics* (Basilia, 2002).

In recycling of municipal solid waste study, material balance method is the best and simplest method so *Material Flow Analysis* (MFA) is the correct method to learn about material balance from PET and PP waste. *Materials flow analysis* (MFA) is an appropriate tool to follow substances from natural resources via mining, extraction, and manufacturing to consumption and disposal in the environment. Because *MFA* is based on the mass conservation principle, shortfalls or missing flows along substance pathways can be identified and the need for final sinks to accommodate substances that are lost along the pathway or that have no economic value at the end of the consumption cycle can be assessed. *MFA* can be controlled by simple

material balance which compared the input, goods, and output from the process. (Brunner et al, 2004).

2. METHODOLOGY

Methodology adopted in writing this final paper is by collecting field survey data combined with field observation, and interviewing performer of plastic bottle waste recycling industries with main aim to examine the existing plastic bottle waste recycling industries as a whole especially for those produced by “X” mineral water bottled industry in Bandung.

The first step undertaken is the preparation stage. The preparation stage is carried out prior the execution of field survey and distribution of the set questioner, consist of field observation of the independent field collectors of plastic bottle waste recycling industries focusing on “X” branded mineral water in Bandung. This field observation is imperative due to lack of accuracy of data on the distribution of plastic bottle waste recycling practitioner especially for those of mineral water bottle waste in greater city of Bandung. This observation consists of:

- Direct observation on the existing conditions of household and commercial waste activities in Bandung Municipality.
- Observing the existing practitioner of recycling industries in Bandung.

In addition, in this preparation stage, literature study which covers recycling waste system emphasizing on mineral water plastic bottle wastes together Analysis Method of Material Flow. Upon completion of field observation, the next step would be to identify the plastic waste characteristic under researched. In this paper the plastic bottled under research is confined into plastic glass of 220 ml, plastic bottled 600 ml and plastic color bottle 500 ml.

Methodology adopted to determine mineral plastic waste generation are interview with recycle performer and sampling in lapak and Bandar in Bandung City as described in **Figure 1**. The survey data consists of a comprehensive study of the activity of plastic waste scavenging and the plastic recycling performer (informal sector) from the scavenger to the collecting centre in Bandung. The survey is conducted in Bandung City. The survey period is between March until July 2008. The season where the survey conducted is dry and wet season. Survey is conducted using the set questioners that covering the following information, such as: length of operation, the type of goods transacted, the frequency of operation , the process undertaken, the sources of supply, the aim of the sales, the trade volume of bottled mineral water.

The secondary data which is required would be the volume of waste received at the final disposal (TPA), distribution of waste collection centre (gathered from PD. Kebersihan), and the composition of the plastic waste in Bandung (extracting from several final paper at ITB).

Calculating and processing of data covers processing of the primary data based on survey conducted to the plastic waste scavengers, debris collector all the way to collector centre as well as on the secondary data that has described above. From the processing of data and evaluation, a conclusion can be derived together with recommendations from the conclusion of the research conclusion on material flow analysis of plastic bottle waste of “X” Mineral Water in Bandung.

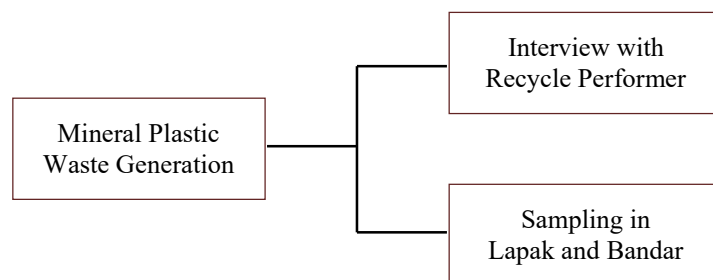


Figure 1 Flow Chart of mineral plastic waste generation data collecting in Bandung City

RESULT AND DISCUSSION

Plastic waste especially mineral water plastic bottle is an inorganic waste type that has high potency for recycle activities at Bandung City. Mineral water plastic bottle recycle performer in Bandung City is predominated by informal sector that consist of pemulung tukang loak, lapak and Bandar as shown in **Figure 2**.

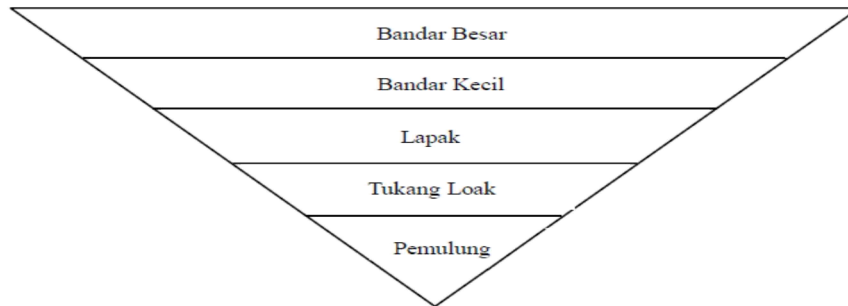


Figure 2 Recycle Performers from Informal Sector in Bandung City

Determination of recycle performer status is determined by target of goods sale. If their selling target is bandar kecil, so the recycle performer is called lapak. If their selling target is bandar besar, so the recycle performer is called bandar kecil. bandar besar is the last in recycle performer cycle which accomodating mineral bottle waste before their sold it to factory or recycle industry. The source of supply from each recycle performer is variated. In reality, there is bandar besar which very restricted with their source of supply. They only agree to accept purchasing with minimum weight definition (usually in ton), nevertheless there is also bandar besar who accept a supply from individual sources, tukang loak, and lapak. Recycle performer status determination is needed to know the distribution path and material flow from mineral plastic bottle waste from its sources till return to industry for recycled.

To determine the activity of recycle process in Bandung city, recycle performer data and mineral bottle plastic waste recycle activity is required . **Figure 3** is shown the result of survey conduct in Bandung city about recycle performer. From survey result we can see that there is 44 lapak, 33 bandar kecil and 28 bandar besar. There are also 130 pemulung and 130 tukang loak surveyed to determine the recycle performer in Bandung city.

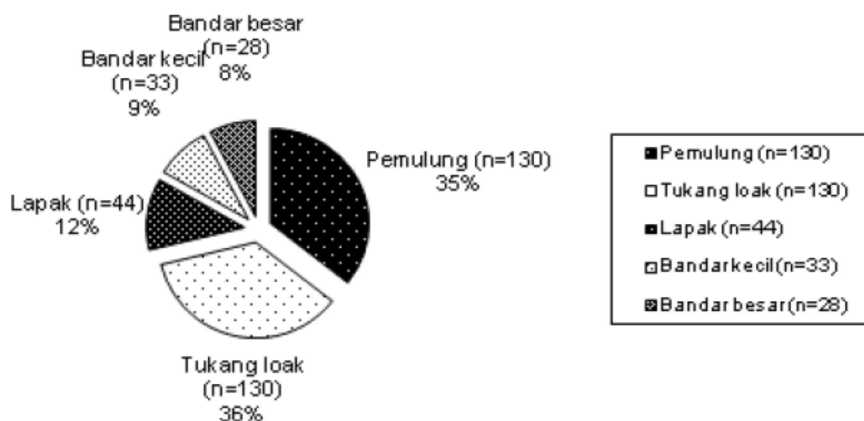


Figure 3 Percentage of Recycle Performer from Survey in Bandung City

Recycle performer distribution data in Bandung City is plotted in **Figure 4** according to survey result conducted in Bandung city. According to data recapitulation, we can determine that in 4 PD. Kebersihan service area recycle performer is distributed as shown in **Table 1**.

West Bandung area has the highest recycle performer. There are 43 recycle performer in West Bandung area that consist of : 17 lapak, 13 bandar kecil dan 13 bandar besar. This is due in West Bandung area existed many industries especially textile industries. This textile industries are the last phase in mineral water plastic bottle recycle chain where bandar besar sold their goods. In contracy, North Bandung only has 17 recycle performer that consist of : 9 lapak, 7 bandar kecil and 1 bandar besar. The result of survey that conducted not yet 100% accurate, we predict that only 70% recycle performer surveyed.

In **Figure 5**, we can see about length operation of recycle performer. Length operation of lapak is most dominated of 0-4 years. bandar kecil also dominated in 0- 4 years. Whereas at bigger gyration of length operation than 20 years olds, recycle performer is predominated by bandar besar.lapak and bandar kecil is continued increase and established no so long ago because of economic condition in Indonesia deteriorate at some years lately, as a consequence many unemployment people start to open bussiness in waste management area such as lapak. To start a bussiness as lapak or bandar kecil, the capital cost needed is lower than bandar besar, so the result is many people start to open bussiness in this area. To become a bandar besar are required capital that quite a lot because to become a bandar besar is needed some equipments like weighing-machine, press machine, chop machine and a vehile (truck).

Table 1
Recyle Performer in PD. Kebersihan Service Area in Bandung City

Service Area	Status	Quantity
West Bandung	Lapak	17
	Bandar kecil	13
	Bandar Besar	13
	Total	43
North Bandung	Lapak	9
	Bandar kecil	7
	Bandar Besar	1
	Total	17
South Bandung	Lapak	5
	Bandar kecil	6
	Bandar Besar	9
	Total	20
East Bandung	Lapak	13
	Bandar kecil	7
	Bandar Besar	5
	Total	20

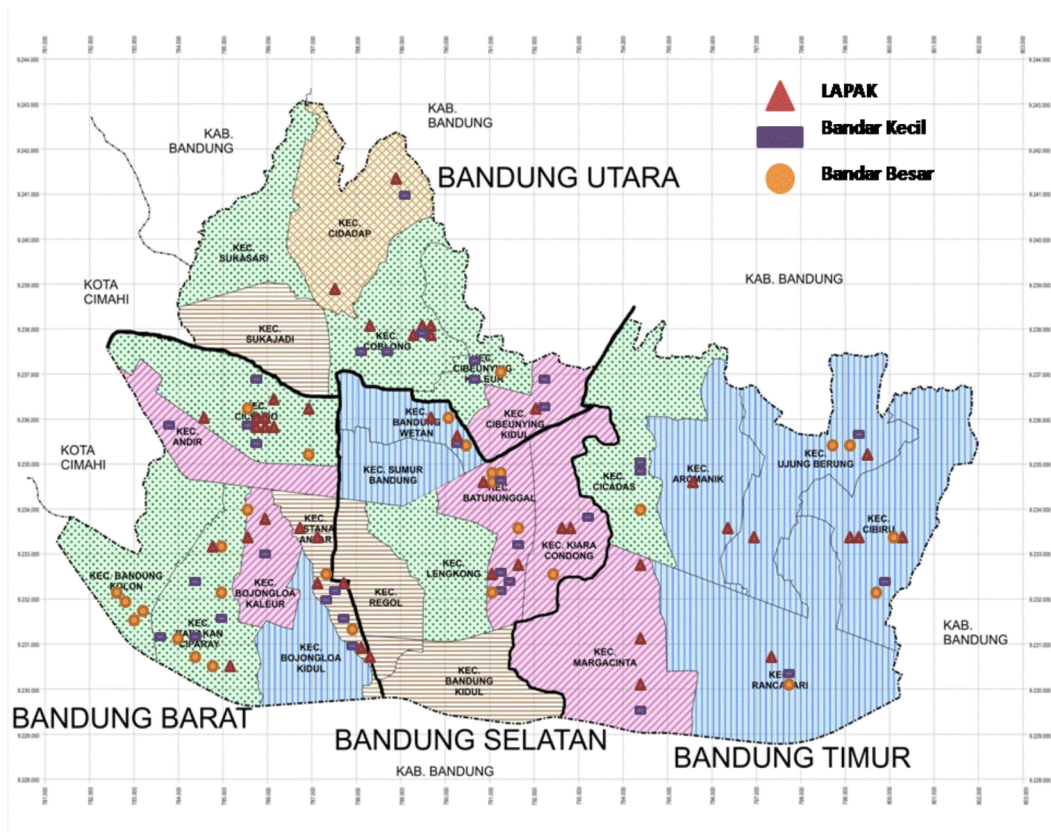


Figure 4. Recycle performer distribution in Bandung City Map

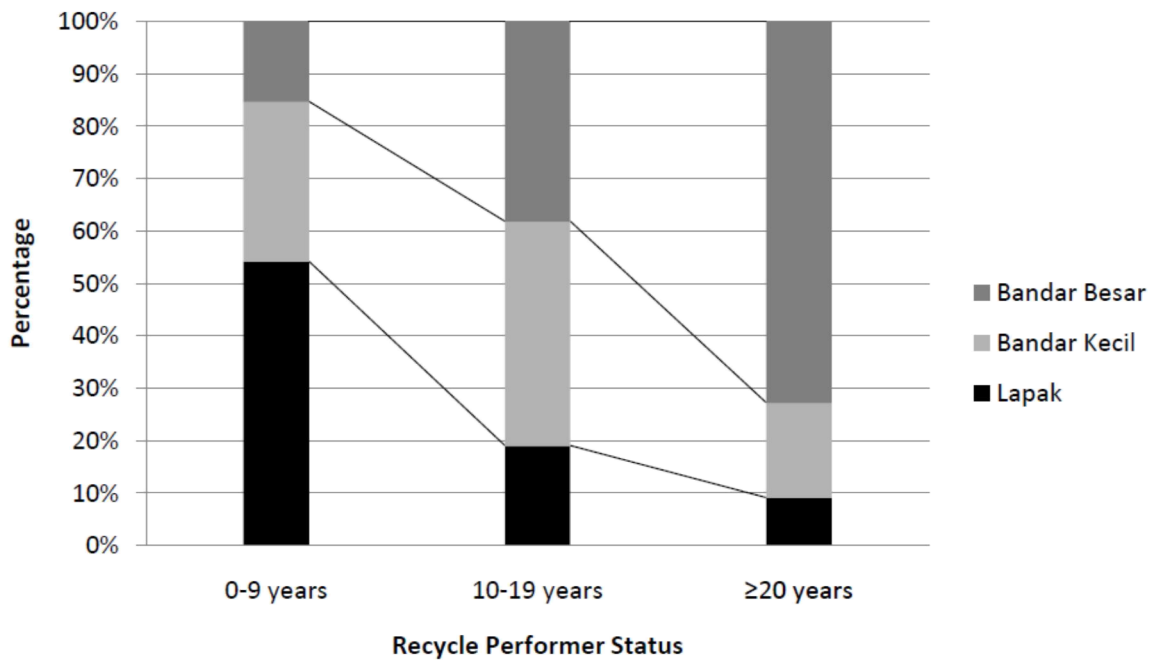


Figure 5. Length Operation of Recycle Performer

Mineral plastic bottle waste composition in pemulung 52% is dominated by mineral bottle, next 40% is plastic cup. Mineral plastic bottle waste composition in tukang loak doesn't have much difference from pemulung, 46% is dominated by mineral bottle, next 45% is plastic cup. Whereas Colored plastic bottle waste are insufficiently been hankered by pemulung and tukang loak because there is only 8% (pemulung) and 9%(tukang loak) from total of mineral water plastic bottle waste composition in pemulung and tukang loak. Colored plastic bottle waste selling price is very low (**Figure 7**) and didn't equal with their effort to collect them. Many pemulung and tukang loak combining colored plastic bottle with another plastic because the selling price is higher.

At superordinated recycle performer lapak and "bandar", mineral plastic bottle waste composition has been predominated with mineral plastic bottle especially mineral plastic bottle "X" which have percentage about 29% for lapak, 23% for bandar kecil and 32% for bandar besar from total composition. As shown in **Figure 6**.

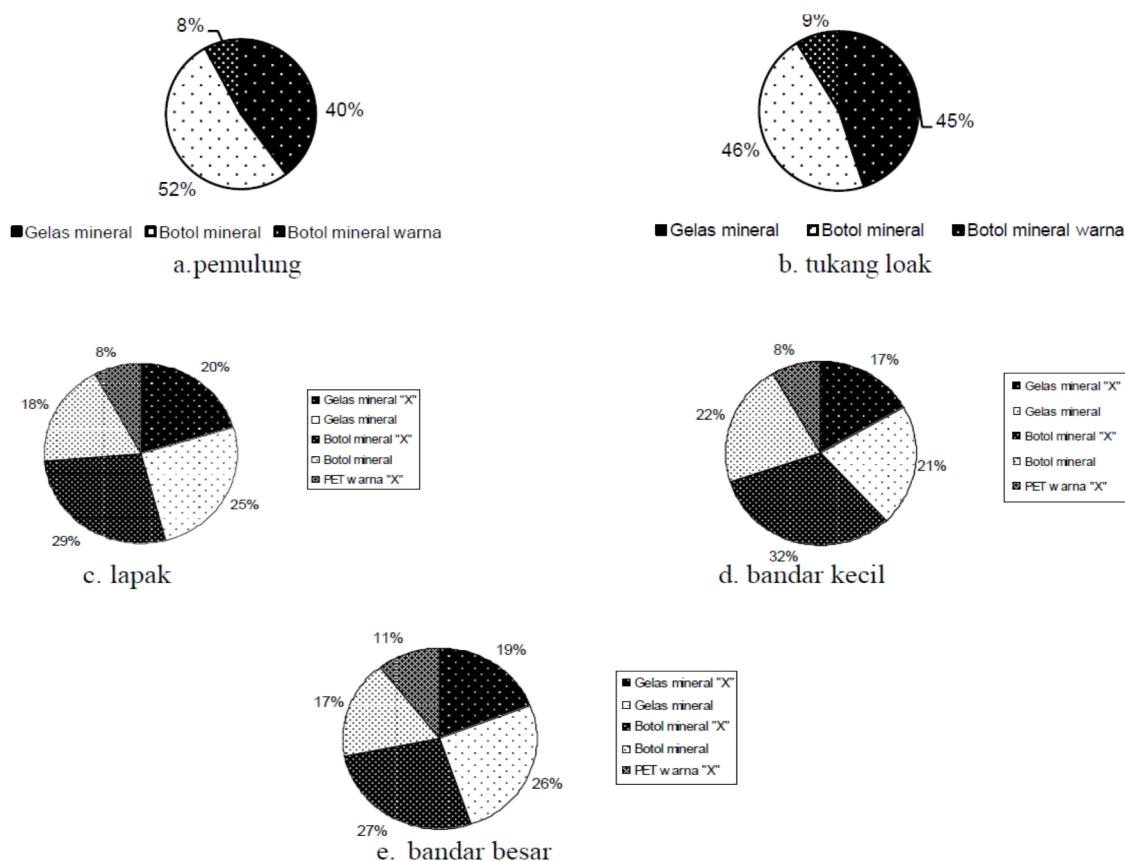


Figure 6 Composition of Mineral Bottle Waste in Recycle Performer

According to *Analysis of variance* (ANOVA) result between primary data (interview result) and sampling result for 8 day in 4 recycle performer that selected at random with hypothesis-0 is average between sampling result and interview result are similar and hypothesis-i is average between sampling result and interview result not similar shows that with $\alpha = 5\%$, RK score lower than interpolation score from F-distribution table. So zero-hypotesis accepted.

That means although there is a differences between primary data and sampling data but the difference are referred and didn't causes significant result.

Mineral water plastic bottle's trading price is influenced with quality (clean or not), amount or mass from goods and status of the recycle performer. In each level of recycle performer not all mineral water plastic bottle waste type can be found. Especially for colored plastic bottle (colored PET) that less enthused by recycle performer. The lowest buying price for mineral plastic bottle waste is in tukang loak as shown is **Table 2**. tukang loak gathered the waste directly from the sources such as residence, market, etc by doing sales transaction. Plastic quality accepted by tukang loak is better than plastic gathered by pemulung because mineral plastic bottle gathered by tukang loak come direct from the sources. But for plastic quality in lapak usually unfavourable, dirty and sometimes mixed with other plastic. Buying price range in every recycle performer is between Rp 3.000 until Rp 9.000 for mineral plastic glass, Rp 2.000 until Rp Rp 4.500 for mineral plastic bottle and for colored plastic bottle is between Rp 500 until Rp 1.700.

The most higher buying price of mineral plastic bottle waste is for clean mineral plastic glass type. Price differences for clean mineral plastic glass is between Rp 1.500 until Rp 4.500 from the selling price. Whereas colored plastic bottle (colored PET) has the lowest buying price from Rp 500 - Rp 2.600.

The highest selling price differences as shown in **Table 3** is between pemulung and bandar besar. The price differences starts from Rp 3.500 until Rp 11.000. bandar besar usually hire an employee to separate plastic according to it's criteria and also hire an employee to cleaning the mineral plastic bottle waste so the goods equal to the factory criteria. So the benefit from the selling price is utilized to pay a commision to the empolyee.

Table 2

Buying Pr ice for Mineral Bottle Plastic Waste in Bandung City 2008

No	Status	Buying price in year of 2008 (Rp/kg)				
		Clean plastic cup	Dirty plastic cup	Clean plastic bottle	Dirty plastic bottle	Clean colored bottle
1	Pemulung	0	0	0	0	0
2	Tukang Loak	5500	3000	2500	2000	500
3	Lapak	6500	4000	3700	2900	750
4	Bandar Kecil	7300	4629	4000	3100	1000
5	Bandar Besar	9000	6000	4500	3300	1700

Table 3

Selling Price for Mineral Bottle Plastic Waste in Bandung City 2008

No	Status	Buying price in year of 2008 (Rp/kg)		
		Plastic cup	Plastic bottle	Colored bottle
1	Pemulung	3500	2000	500
2	Tukang Loak	5000	3000	750
3	Lapak	8000	4800	1500
4	Bandar Kecil	9000	5100	1700
5	Bandar Besar	11000	6000	2600

Pemulung daily income is affected by work duration,waste availability at area that they pass, and other activity such as a wedding party, etc. As shown in **Figure 7** average benefit of pemulung is lower than Rp 100.000. tukang loak daily income have a little bit difference with pemulung. They must provide themself with bicycle or wagon to start the work. Their benefit isn't much difference with pemulung althought their benefit is above pemulung's benefit. lapak,

bandar kecil and bandar besar daily income is more varied than pemulung and tukang loak income. Total money issued for the transaction is between Rp 50.000 until Rp 2.000.000 as shown in **Figure 7**.

Bandar besar which have the highest mineral water plastic bottle composition also have the highest benefit. Among bandar besar in Bandung city the biggest bandar besar located in Cipamokolan street. Bandar in Cipamokolan street is a selling target for other bandar reside in vicinity and also from outside Bandung City. Comparing all the benefit from recycle performer we can predict that bandar besar is have multiple benefit from other recycle performer. This is equal because bandar besar must spend highest capital to operate. Bandar besar have a high capacity warehouse to keep their goods so they can keep the goods when the selling price not too advantageous. Large part of transportation expenses are accounted by buyer or consumer, nevertheless bandar besar also have inventories vehicle with big capacities as the reserve if supplier do not want to account delivery expense.

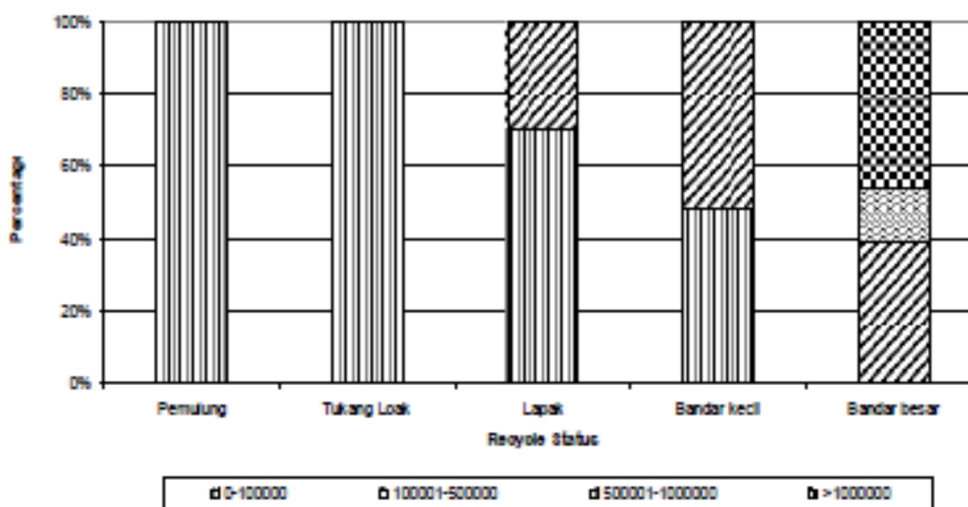


Figure 7 Average Benefit of Recycle Performers

Tabel 4
Material Flow of Mineral Water Plastic Bottle

Total amount Kg/day	Recycle Performer				
	Lapak (n=44)	Mass difference (kg/day)	Bandar kecil (n=33)	Mass difference (kg/day)	Bandar besar (n=28)
Plastic cup "X" (PP)	216.3	57.1	273.4	1571.1	1844.5
Plastic cup (PP)	270.2	81.3	351.5	2111	2462.5
Plastic bottle "X" (PET)	295	232.3	527.3	2098.2	2625.5
Plastic bottle (PET)	195.7	163.2	358.9	1319.1	1678
Colored bottle (PET)	82.5	53.35	135.85	874.65	1010.5

Material flow of mineral water plastic bottle waste is a tool to determine a mass balance of waste generation in Bandung City. **Table 4** above shown the material flow for mineral water plastic bottle waste in Bandung City.

CONCLUSION

Mineral water bottle waste recycle circle are : pemulung/tukang loak-lapak-bandar kecil-bandar besar. But this cycle was is not absolute in meaning pemulung can sold their waste directly to bandar kecil or bandar besar. From survey data about length of operation, lapak is younger than bandar kecil and bandar besar. So we can predict that lapak is established no so long ago masih lebih, at the same time bandar besar is established longer than lapak and bandar kecil. That because of economic condition in Indonesia is getting worse past few years as a consequence many unemployment people start to open bussiness in waste management area such as lapak. To start a bussiness as lapak or bandar kecil, the capital cost needed is lower than bandar besar, so the result is many people start to open bussiness in this area. The highest mineral water plastic bottle type in pemulung, tukang loak, lapak, bandar kecil, bandar besar is a mineral plastic bottle especially "X" mineral water. Next is mineral water glass. Both is hankered because of their high benefit and there is a high amount of supply in society.

Daily income of bandar besar is 52 % have a benefit above Rp. 1.000.000,00. Meanwhile the daily income of pemulung and tukang loak is between Rp. 0 until Rp 100.000. Even with lapak, 70% of lapak have a benefit between Rp 0 until Rp 100.000,00. 30% from lapak have a benefit between Rp. 100.001,00 until Rp. 500.000,00. Daily income of bandar kecil is 70% have a benefit between Rp. 100.000,00 until Rp. 500.000,00.

Data Verification must conducted in ensuring that data as used in study hereinafter is valid data. Base assessment result, data that indigenous to interview result and sampling is valid data though have difference that in its begining assumed quite significant and applicable to study hereinafter.

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