

PRELIMINARY IDENTIFICATION OF REUSE AND RECYCLE ACTIVITIES OF MOBILE PHONE E-WASTE IN SECONDHAND SECTOR IN BANDUNG CITY

IDENTIFIKASI KEGIATAN DAUR ULANG *E-WASTE* TELEPON SELULER PADA SEKTOR *SECONDHAND* DI KOTA BANDUNG

Mutiara Triwiswara¹ and Enri Damanhuri²

Environmental Engineering Department
Faculty of Civil and Environmental Engineering, Bandung Institute of Technology
Ganesha Street No. 10 Bandung 40132
¹triwiswara@gmail.com and ²e_damanhuri@ftsl.itb.ac.id

Abstract: Nowadays, mobile phone can not be separated from the modern social life. Like other electronic tools, mobile phone has lifetime of use, in the moment in time the mobile phone will dead and become a waste. Waste from the mobile phone is usually called by mobile phone e-waste. As there is no specific regulation regarding with e-waste in Indonesia, hence until now the waste can be disposed of together with municipal solid waste. However, the fact shows that mobile phone e-waste can not be found in TPA Bandung. It indicates that there are numerous processes that extend the life time of mobile phones. The secondhand sector plays a significant role in expanding mobile phone life time through the efforts of reusing and recycling mobile phones and its components. The current paper discusses result of the study of reuse and recycling activity of mobile phone waste in secondhand sector in Bandung City. The results show 59% secondhand traders interviewed still use secondhand components to repair damaged mobile phones. Furthermore only 33% of respondents dispose mobile phone used components, while others choose to save, sell or return it to the consumer.

Key word: mobile phone, e-waste, secondhand, electronic components, reuse and recycle

Abstrak: Sekarang ini, telepon seluler (ponsel) tidak dapat dipisahkan lagi dari kehidupan masyarakat modern. Seperti halnya alat elektronik lainnya, ponsel memiliki masa pakai, suatu saat akan mati dan menjadi limbah, Limbah dari ponsel ini biasanya di kenal dengan e-waste ponsel. Karena tidak ada peraturan khusus yang mengatur tentang e-waste di Indonesia, hingga sekarang sampah elektronik dapat dibuang bersama sampah rumah tangga. Kenyataannya, tidak ditemukan e-waste ponsel di TPA Bandung. Hal ini mengindikasikan ada berbagai proses yang memperpanjang life time ponsel. Sektor secondhand berperan penting dalam memperpanjang life time suatu ponsel melalui upaya reuse dan recycle ponsel dan komponen-komponennya. Makalah ini membahas hasil studi mengenai aktivitas daur ulang ponsel bekas pada sektor secondhand di Kota Bandung. Hasilnya menunjukkan bahwa 59% pelaku usaha secondhand yang diwawancara masih menggunakan komponen bekas. Selain itu hanya sebagian kecil pelaku usaha secondhand yang membuang sampah sisa kegiatan servis langsung ke pembuangan sampah, sedangkan yang lainnya memilih menyimpan, menjual atau mengembalikannya pada konsumen.

Kata kunci: e-waste, telepon seluler, secondhand, komponen elektronik, reuse dan recycle

INTRODUCTION

The number of mobile phone users in Indonesia was increasing rapidly every year. Information and communication are increasingly been perceived as basic needs, whatever economic status the user will be. If in the early years the use of mobile phones was still limited among middle income communities or higher, and among the professionals requiring fast and instant communication, recently, the use of these communication means is prevailing in most of all Indonesian regions covered by the mobile phones services. (Damanhuri and Sukandar, 2006)

About 450 million new mobile phones are manufactured every year. In Indonesia itself, on 2008 there are 116.144.392 users, which are the sixth rank in the world (Suryadhi, 2008). Sooner or later, all of them have to be discarded. In fact, mobile phones are usually taken out of use well before they cease to operate. They are replaced by new phones because their owners want newer features, or the older phones are incompatible with new service carriers, or solely for personal preference. The result is that hundreds of millions of mobile phones are taken out of use each year (Osibanjo and Nnorom, 2007). The potential life span of a mobile phone is over 10 years but due to technological and fashion obsolescence most of the users upgrade their phones around four times during this period (NOKIA, 2005).

There are many different models of each type of electrical and electronic equipment (EEE) and each model may have different components and different requirements for dismantlement and recycling. A typical mobile phone consists of 500-1000 components. One of the main findings of the environmental assessments of mobile phones conducted by Nokia and stakeholders is that PWB (Printed Wiring Board), Integrated Circuit (ICs), and Liquid Crystal Display (LCD) are components with the highest environmental impact in the life of mobile phone (NOKIA, 2005). The PWB and LCD of mobile phones account for about 98% (59% and 39% respectively) of the handsets' environmental impacts in production and recycling (Osibanjo and Nnorom, 2007).

The United Nation Environmental Programs (UNEP) has estimated that every year at least 650 millions of mobile phones e-waste are generated all around the world. Mobile phone is one of the most rapid increasing e-waste. The volume increasing was three times of municipal solid waste. It is known that the discarded electronics will soon end up in landfill sites or incinerators where they will release toxic materials such as mercury, cadmium, lead, arsenic, dioxins and other hazardous materials into the air, soil or water. Many of these harmful substances can persist in the environment, bioaccumulate through the food chain, and pose a risk of causing adverse effects to human health and the environment (Wu et.al., 2008).

In developing countries, including Indonesia, there is a high rate of repair and reuse of used mobile phones. There can be found many repair and maintenance shops in the secondhand markets. Workers in such repair shop look for components that are damaged or worn out and replace them with new components made locally. Those components that are seriously damaged and incapable of being reused, however, still have a positive sales value because they can be recycled (Shinkuma and Huong, 2008).

The role of refurbishment/repair is very important in extending the end-of-life of any electronic equipment, generally through replacements of out-of-order electronic components by the new ones or through cannibal system, i.e, through the uses that are still functioning electronic parts of the unusable electronic equipment. These mechanisms are the answer of the question: why the electronic equipments are rarely found within the urban waste chain (Damanhuri and Sukandar, 2006).

METHODOLOGY

This research is conducted by direct observation, interview and distribution of questionnaire.

Research Area

The study area is Bandung City. Based on PD Kebersihan, its work area covers the administrative area of Bandung, which includes North Bandung, West Bandung, South Bandung and East Bandung.

For secondhand mobile phone business, the survey was also conducted in the three largest electronic centers of Bandung, those are Bandung Electronic Center (BEC), Bandung Electronic Mall (The Mall), and ITC Kebon Kelapa, because those three places were the largest mobile phone sales center in Bandung. In addition, the survey was also conducted on the actors of secondhand phone business outside the electronic center, in various regions of Bandung.

The Number of Samples

- Mobile Phone Users

The data collection about mobile phone usage pattern and treatment to used mobile phones in Bandung City was conducted by questionnaire and interview to the consumers.

To determine a representative number of samples, we can use Slovin method which usually is used for social and economic research (Prasetyo and Jannah, 2008). The Slovin formula is shown in **Equation 1**.

$$n = \frac{N}{1 + Ne^2} \quad (\text{Equation 1})$$

n = sample number

N = population number

e = error probability (assumed)

It is known that:

Bandung City population = 2.329.928 (PD Kebersihan Kota Bandung, 2008).

Error probability (e) is assumed 5%

Then:

$$n = \frac{2.329.928}{1 + (2.329.928 \times 0.05^2)} = 400 \text{ samples}$$

In consideration of the researcher's ability, time, and cost, sampling is done by cluster sampling method where the population is divided on the basis of PD Kebersihan work area, and then for each region it is taken 30 samples, because the estimation of population characteristics can be done quite well if the sample size is not smaller than 30. Besides, it is also used method of proportional stratified random sampling where the population is divided based on economic levels (lower-middle-upper), then samples are taken from each economic level in every area evenly. The samples selection was also based on the education level.

- Secondhand Sector

Data of population involved in secondhand electronic products sector, in this case are the reparation agents, merchants and both of them is not recorded by Department of Trade and

Industry Bandung in January 2007 (Budi Mulyadi). Based on Business Information Guide Book – Yellow Pages Bandung for 2008-2009 periode which was released by PT Telkom Indonesia, there are 471 mobile phone stores in Bandung. However, in these data there is no classification based on types of products traded, whether new or second products. Classification of business activities such as merchant or service also is not known.

Therefore, random sampling (probability sampling) is not possible. There is no choice but sampling is done by nonprobability sampling, but the consequences are the results can not be generalized. So in this study, it was decided to select judgment sampling method, where the sample is selected based on researcher assessment that the object are the best parties to be research samples (Mustafa in Mulyadi, 2007). Therefore sample size was decided by the researchers themselves, with consideration the object is a person who can provide the best information. So far in this study it has taken 71 samples. As of 71 samples taken, the largest portion of respondents is located in the electronic centers which are well known to Bandung society, so the researchers assumed they are qualified as samples.

- Informal Recycler

To follow material flow of electronic device component, the survey is also conducted in the informal recycling actors in Bandung. Samples are taken from each area in Bandung evenly. The number of scavenger samples is determined using the Slovin equation as mentioned above in the **Equation 1**.

For tukang loak, lapak and bandar, the number of population is not known for certain. Determination the sample number for tukang loak is done in as the way to survey scavengers. As for the lapak and bandar, survey is conducted to recycling actors that can be found in Bandung City.

Based on the availability and completeness of the obtained data, the topic discussed in this paper is only about the activities in the secondhand sector.

RESULTS AND DISCUSSION

From the survey to 71 secondhand mobile phone businessmen in Bandung area, the result shows mostly the respondents perform trading and repair (59%), followed by trading only and repair only (respectively 36% and 5% see **Figure 1**).

It indicates that mobile phones trading are considered more profitable than repair/refurbishment. This fact is due to rapid obsolesces in societies because of either malfunction or rapid development of new and desired features. Many people change their phones even though they generally remain functionally normal.

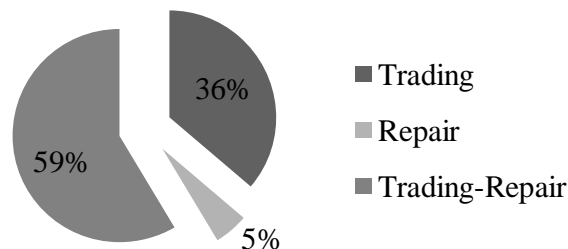


Figure 1. Respondents' business activities

Based on the operation age of their secondhand mobile phone business, the majority of respondents start their businesses 1 to 3 years ago, with 48% percentage. Followed by 3-5 years of business age 31%, more than 5 years 9%, less than 6 months 7% and 6-12 months of age 5% (**Figure 2**). According to the respondents, mobile phone market began to show promising progress about 5 years ago, namely in 2004, along with the increasing demand for mobile phones in community. While the amount of business that has operated for more than 5 years only 9%. Most of those businesses are located in the BEC and the ITC Kebon Kelapa, who opened their business at the same time with the opening of those two electronic centers, namely in 2001 and 2002.

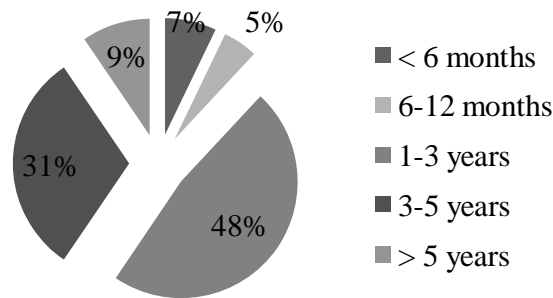


Figure 2. Respondents' operation age

Secondhand Mobile Phones Trade Activities

Besides trading secondhand mobile phones, most of respondents also sell new mobile phone products as well. 77% respondents trade both new and secondhand mobile phones, while the remaining 23% trade secondhand mobile phones only (**Figure 3**). But they still rely on secondhand products trading as their main income, for the consumers typically prefer to buy new products directly from dealers or distributors because the price is relatively cheaper than those offered by these merchants.

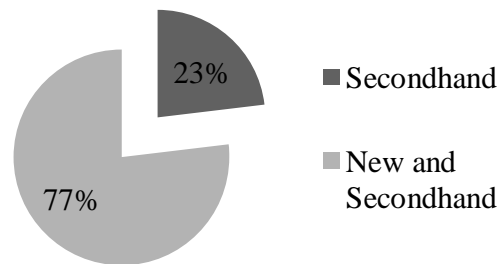


Figure 3. Items accepted by respondents

The main sources of secondhand mobile phone are consumers who sell their used phones (53%), 28% got secondhand mobile phones from another traders, 9% of respondents stated that they also hunt their products at mobile phone shops in various parts of Bandung, while the remaining 3% gain the stuffs from outside Bandung such as Jakarta. The percentage can be seen in **Figure 4**.

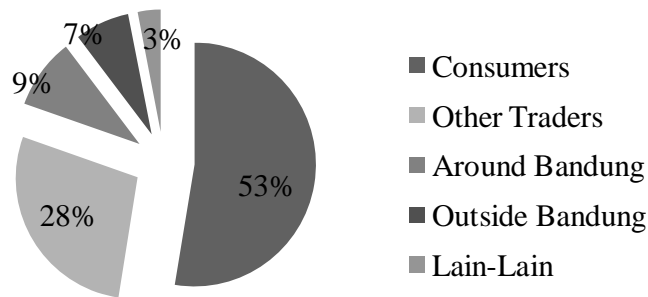


Figure 4. Secondhand mobile phones sources

In **Figure 5** we can see the percentage of conditions of accepted secondhand mobile phones. 43% of the respondents are willing to buy secondhand phones with minor damage. The tolerated damages usually occur to the external hardware, such as LCD, casing and battery, which did not require complicated effort, long time or expensive cost to be fixed. It is only 39% of respondents that would like to accept only the products in good condition and ready to use. Some of them even require that they only receive the phones that are still in warranty period given by manufacture. The remaining 18% are willing to accept the goods with all conditions including totally dead phones, as long as the consumer agrees with the given price for those broken phones. Prices for a dead cell phone ranged between 5000 IDR to 50.000 IDR depending on the type of phone.

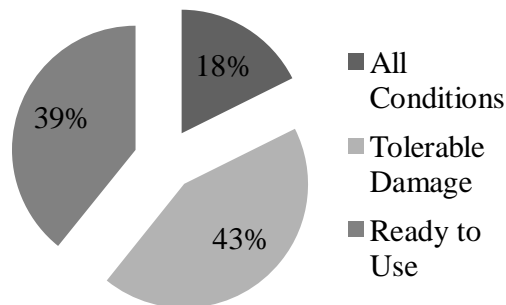


Figure 5. Conditions of accepted secondhand mobile phones

The total damaged phones are still acceptable in secondhand trader because some of its components are still usable for repair or refurbishment activities. The partially damaged phones usually are repaired first and then resold with higher prices. Those activities extend life span of mobile phone products.

Percentage of the maximum duration to store an item is shown in **Figure 6**. It indicates that the mobile phone is electronic goods with a rapid circulation in secondhand market.

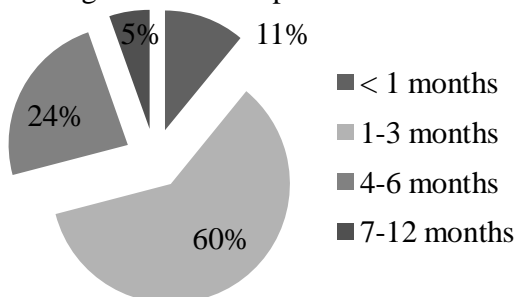


Figure 6. Maximum duration of products storage

Most of respondents store a product maximum for 1-3 months, with 60% of percentage. They adjusted to the changes of mobile phone general trend which usually happen during that period. But there are also respondents who stored their products for 4-6 months and 7-12 months, respectively for 24% and 11%. This is especially done by merchants outside of electronics centers for the consumers are not as much as in the electronic centers. A little part of respondents, namely 5%, saves items less than 1 month. After the items are stored for 2 or 3 weeks they choose to sell it even in low prices to keep the profits cycle continues.

Mostly respondents choose to sell their unsold products with lower price, often the same as or even lower than the price when they bought it. 57% of them prefer selling their unsold products to the consumers, and only 16% sell to another trader. In their opinion, the other traders are usually also reluctant to buy items that have been stored in a long time because it indicates that those items are less desirable by market. While 21% of respondents choose to keep it because they were quite sure that the products would be sold in a short time (see **Figure 7**).

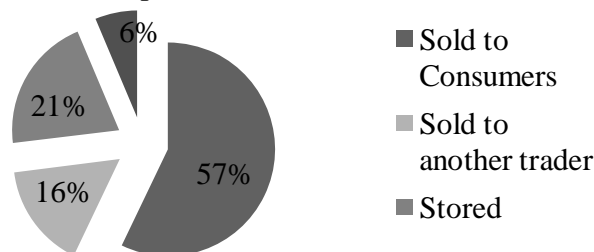


Figure 7. Respondents' treatment to unsold products

Mobile Phone Repair/Refurbishment Activities

Repair/refurbishment is an important part of mobile phone e-waste flow in secondhand sector. In this business, a lot of e-wastes are generated in the form of mobile phone components which have been damaged and unusable.

The repair shops do not always fix broken phones themselves. Based on the survey, the percentage of respondents that repair mobile phones themselves is 38%. 46% of respondents do some repair activities themselves to a certain level of damage, but for the damage that is considered heavy, the works are transferred to third parties. The remaining 16% is only an intermediary between consumers and other repair worker (see **Figure 8**).

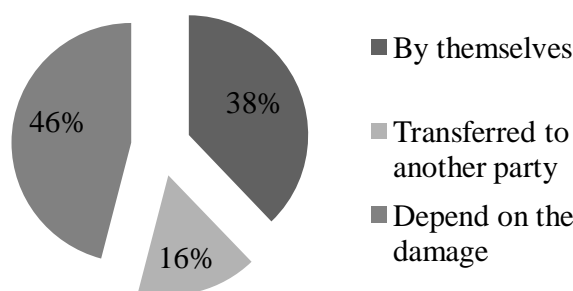


Figure 8. Repair activities does

The most often complaint from the consumers is damage of external components (49%), followed by internal components (31%) and software (20%). As for the external components, the

most often damaged part is the LCD (53%), speaker (23%), flexible cable (10%), and the microphone and buzzer respectively 7%. For internal components, the most often damaged are IC CPU (44%) and RF IC and Flash IC each are 28%. The percentages of most often broken components are shown in **Figure 9**.

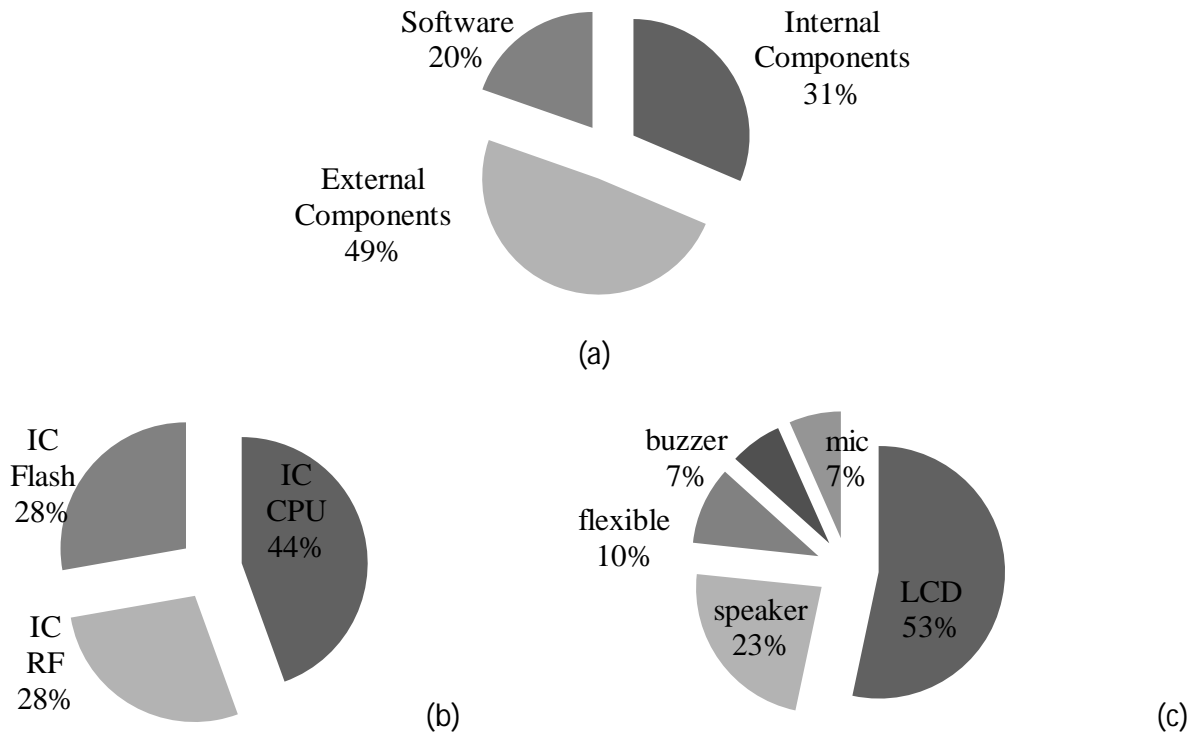


Figure 9. (a) Most Often Damaged Mobile Phone Components; (b) Most Often Damaged Internal Components; (c) Most Often Damaged External Component

Mobile phone spare parts are more easily found nowadays. Various brands of artificial ones with cheaper prices but the quality is not much different from the original version, are found easily in the market. However, among service agents, the usage of the secondhand component is still common, although the frequency is not too often. Percentage frequency is shown in **Figure 10**.

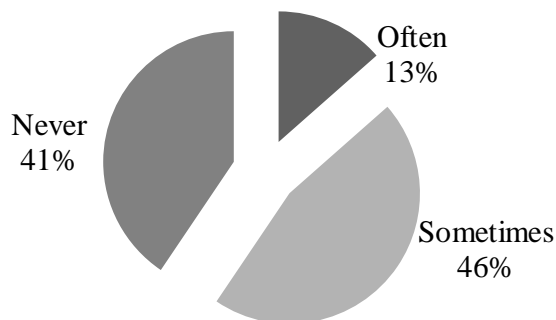


Figure 10. Frequency of secondhand component utilization

The main reason of using secondhand components is for economic reasons. Usually consumers want to use original parts but they also demand a cheap service cost. Since the original product price is relatively high, the service agents take components from a dead cell phone and use it to repair the phone. Thus the service fee could be reduced. However, they usually ask for consumers' approval first. Another reason is because the mobile phone repaired is an old model one which parts are not available in the market anymore.

The respondents get the secondhand components among other from:

- remaining of the previous service activities
- dead mobile phone sold by consumer
- dead mobile phone sold by the dead phone collectors
- damaged phone that getting worse while in reparation process, as a form of responsibilities to the consumers, the service agents usually purchase that cell phone.

The repair/refurbishment process generates electronic scraps. Most of these scraps are not disposed directly along with municipal waste. The majority of respondents, ie 44%, choose to keep all of the electronic scraps. They admit that they do not have any special reasons why saving those residue. Some respondents said they just do not want to throw these things because it may still usable. Others deliberately keep the components residue to be fixed, so they can improve their service skill. Components which are often stored usually are internal components such as PWB/PCB. 33% of respondents choose to dispose the scraps. The most often disposed components are external components such as LCD and casing, because they can not be repaired or reused. They dispose the remaining components of the service not in a specific place, but mixed it with other domestic wastes. The percentage is shown in **Figure 11**.

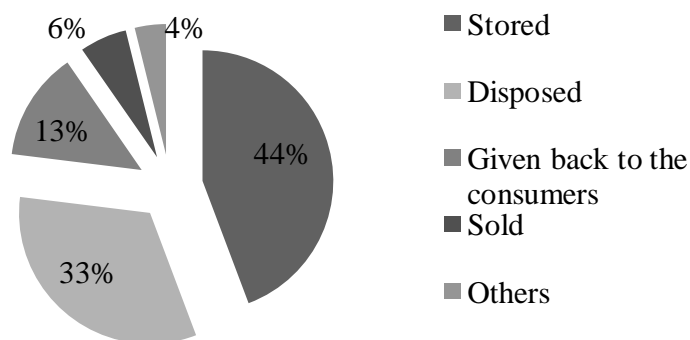


Figure 11. Treatment to mobile phones scraps

The third treatment is to be returned to consumers as a proof that the damaged parts had actually been replaced. This treatment was chosen by 13% of respondents. Actually, almost all services will offer to give back the broken component to the consumer first, but most consumers do not want to take it and handed it to the service agents. Another 6% of respondents choose to sell secondhand components in kilogram units. They stated that there are people who regularly visit their stores to buy the remaining components of the service. The most wanted items are casing, PCB and the battery. Casing valued IDR 10,000 for a plastic bag full of amount. According to traders, the casing will be melted and recycled into plastic. PCB is priced IDR 35,000 per kg. The respondent do not know exactly what the use of broken PCB is, but some suspect the PCB will be fixed into a new PCB and are used for repair activities or sold as imitation spare parts. But none of the respondents interviewed mention the exact addresses of these informal recyclers.

According to Fishbein in Osibanjo and Nnorom, 2007, PCB is component with the highest environmental impact. In secondhand markets, PCB is considered as one of the most valuable components. The demand of used PCB is relatively high. In the positive side, it will reduce the amounts of heavy metals in PCB that contaminate environment. In the other side, reuse and repair activities performed in secondhand sector were practiced without any proper operating procedure, especially concerning with safety and health protection to the workers.

Actually the secondhand sector workers have already been aware about the hazards of electronic components to health and environment. This is indicated by the survey results in **Figure 12**, where 35% of respondents believe that mobile phones components are harmful. According to their opinions, the most harmful component is battery because it is flammable and explosive, followed by the PCB because they contain hazardous chemicals and the casing that is made of plastic and can not be degraded naturally. Yet there are more opinions that mobile components are not harmful to the environment (38%). Respondents who said that they do not know is 27% of percentage.

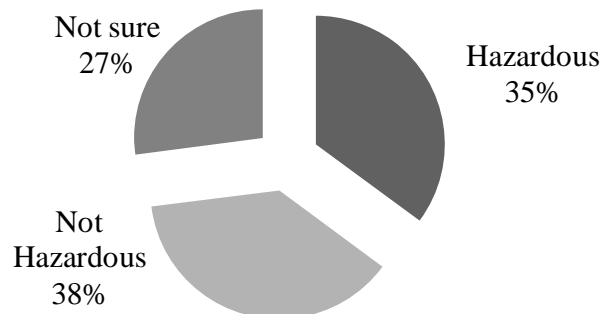


Fig. 15 Respondents' Knowledge About Mobile Phone Components Hazards

Although some of the respondents are already aware of mobile phone components' hazards, they do not repair, store or discard those components safely. They do not wear any protection device when repair damaged phones and the broken components are discarded along with municipal waste. Some literatures stated that these activities open possibilities of inhaling of any dangerous component by the respiratory after long-time exposure.

CONCLUSION

Secondhand mobile phone market is a great economic potential sector and is still growing despite the new mobile products increase rapidly in the market. Business actors in the secondhand mobile phone sector are made up of traders (36%), repair shops (5%) and trader=repair (59%). E-waste generated from this sector of the remaining components of the cell phone reparation activities. Treatment of respondents to the e-waste is: stored 44%, 33% discarded. 13% given back to the consumer, 6% sold by kilogram units, and 4% suggested other answers. It indicates that the electronic wastes of mobile phone have not existed physically so real yet in Bandung City. However, in the process of storage and utilization of used mobile phone components, there are negative impacts which will probably felt by secondhand market workers.

PREFERENCES

- Damanhuri, E. and Sukandar. 2006. *Preliminary Identification of E-Waste Flows in Indonesia and Its Hazard Characteristics*. 3rd NIES Workshop on E-Waste – Tsukuba 15-16 Nov-2006.
- Mulyadi, Budi. 2007. *Studi Pendahuluan Secondhand Electronic di Kota Bandung*. Bandung: Tugas Akhir TL-ITB
- NOKIA. 2005. *Integrated Product Policy Pilot Project. Stage I Report*. Espoo, Finland: NOKIA Corporation
- Osibanjo, Oladele and Nnorom, Innocent Chidi. 2006. *Material Flows of Mobile Phones and Accessories in Nigeria: Environmental Implications and Sound End-of-Life Management Options*. Environmental Impact Assessment Review vol. 28, p. 198-213.
- Prasetyo, Bambang and Jannah, Lina Miftahul. 2008. *Metode Penelitian Kuantitatif*. Jakarta: Rajawali Press.
- Shinkuma, Takayoshi and Huong, Nguyen Thi Minh. 2009. *The Flow E-waste Material in The Asia Region and A Reconsideration of International Trade Policies on E-Waste*. Environmental Impact Assessment Review vol. 29, p. 25-31.
- Suryadhi, Ardhi. 2008. *Pelanggan Seluler Indonesia Terbesar ke-6 di Dunia*. <http://www.detikinet.com/read/2008/09/17/111659/1007664/328/pelanggan-seluler-indonesia-terbesar-ke-6-di-dunia>. Accessed January 13, 2010.
- Sutarto, Ekowaty. 2008. *Identifikasi Pola Aliran E-Waste Komputer di Kota Bandung*. Bandung: Thesis TL-ITB.
- Wu, B. Y. et.al. 2008. *Assessment of Toxicity Potential of Metallic Elements in Discarded Electronics: A Case Study of Mobile Phones in China*. Journal of Environmental Sciences vol 20, p. 1403-1408.