

IDENTIFICATION OF ELECTRONIC WASTE AND POTENTIAL HEALTH PROBLEMS TO ELECTRONIC WASTE COLLECTORS IN PAMULANG DISTRICT, SOUTH TANGERANG CITY, INDONESIA

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Abstract. Electronic waste (e-waste) contains various hazardous materials and affects human health, and e-waste is increasing worldwide and in Indonesia. Electronic waste collectors (e-waste collectors) are people or groups who receive used electronic goods from other people or institutions. E-waste collectors pose a health risk to e-waste. This study aimed to identify the types of e-waste collected and the potential health problems for e-waste collectors in the Pamulang District. The study was a descriptive study with a cross-sectional approach. The accessible population was e-waste collectors encountered during the study. The sample size in this study was ten respondents obtained by non-random method, by accident, followed by snowballing. The instruments used were validated and reliable questionnaires, observation sheets, and GPS that corresponded to the study objectives. Potential health problems due to e-waste were assessed via the respondents' subjective health complaints using questionnaires. Data on the type of e-waste and potential health problems were presented descriptively by making a frequency distribution table. E-waste found (in units) were 286 lamps, 53 temperature exchange equipment such as air conditioners, 98 screens, monitors, and equipment containing screens having a surface greater than 100 cm^2 such as television, 202 small informatic technology and telecommunications equipment such as smartphones, 194 small equipment such as rice cookers, and 79 large equipment such as washing machines. E-waste collectors receive 5 kg - 8 tons of e-waste weekly. Potential health problems experienced include low back pain and metal fume fever symptoms, such as lethargy, muscle aches, sweating, and headaches. It concluded that the e-waste found in e-waste collectors dominated by the lamp category and potential health problems often found in e-waste collectors are symptoms of metal fume fever. E-waste

collectors who experience it can rest and treat symptoms that arise. Further research is needed to ascertain the link between health problems and e-waste.

Keywords: E-waste, health, collectors, metal fume fever

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INTRODUCTION

The increasing demand for electronic devices is not accompanied by sustainable disposal, thus making electronic waste the fastest growing solid waste stream in the world. E-waste is mainly processed and handled by the informal sector. This electronic waste can be one of the driving forces of the economy. Still, it contains hazardous chemicals such as Cadmium (Cd), Lead (Pb), and Arsenic (As) which can contaminate collectors and the environment, such as the body of water as well as food sources (Takyi *et al*, 2021). Globally, the demand for e-waste continues to increase. Contributors of electronic waste come from household appliances, lighting, toys, and sports equipment, to medical devices (Sharma *et al*, 2021).

During 1989-2018, most categories of electronic waste continue to increase in demand for imports and exports. The small equipment category is the leader in the highest total net weight in kilotons, and small-IT is the category with the lowest total net weight and tends to decline. Small equipment included cooking utensils, hair dryers, *etc*. Then examples of small informatic technology (IT) include mobile phones, printers, keyboards, and others (Marizal *et al*, 2021).

The total amount of electronic waste generated in Indonesia is estimated 49,627,917 units (487,416 tons) by 2028 (Santoso *et al*, 2019).

Until 2021, South Tangerang City has no solid database regarding the existence of electronic waste collectors. In addition, the local government has no programs that support their safety and health and the surrounding environment. The EwasteRJ community successfully collected as much as 119 kg of household electronic waste from January to June 2021, and the number of e-waste tends to increase (EwasteRJ, 2021).

Several health centers in four sub-districts in Pamulang District reported the diseases such as hypertension, visual disturbances, and muscle pain. Maybe these diseases were related to exposure to Arsenic (As), Nickel (Ni), Mercury (Hg), Lead (Pb), Cadmium (Cd), and others (Mallongi, 2019). However, the type of electronic waste and health complaints experienced by e-waste collectors in Pamulang District, South Tangerang City, are not yet known. Therefore, this study aimed to identify the types of e-waste collected and the potential health problems for e-waste collectors in the Pamulang District, South Tangerang City.

MATERIALS AND METHODS

The research design used in this study was a quantitative descriptive study with a cross-sectional approach. The target population in this study was all electronic waste collectors located in 8 sub-districts in Pamulang District. The accessible population in this study were electronic waste collectors found at the time of the study. Ten respondents were obtained using a non-randomly sampling method, basically by accidental meeting and agreeing to become respondents, followed by snowballing, asking the whereabouts of other collectors in the same sub-district. The research instrument was a questionnaire to identify subjective health problems, observation sheets to identify the amount and type of electronic waste and a global positioning system (GPS) for the location of collectors. The data were collected by filling out questionnaires which took about 1 hour. While in this process, the researcher asked electronic waste collectors to avoid differences in perception. They then continued by observing the electronic waste stall area to collect information about unit amounts according to the existing categories.

Data on the type of e-waste and potential health problems were presented descriptively by making a frequency distribution table. Mapping the location of e-waste collectors and potential health problems of respondents using the ArcMap 10.8 software (esri: Environment Science Research Institute, Jakarta, Indonesia). Distinguishing high and low potential health problems for each region used color gradations. In addition, for the analysis process related to health problems, an analysis of the combined composite variables was carried out, where all problems from each body system could be narrowed down, in the end, to conclude what health problems might occur, such as metal fume fever. The Commission on Health Research Ethics of the Faculty of Public Health of Universitas Diponegoro approved the study design (no.70/EA/KEPK-FKM/2022).

RESULTS

The research location is in 8 sub-districts in Pamulang District, South Tangerang. The total area of Pamulang District is 26.82 km². Electronic waste collectors get goods from door-to-door collectors or individuals who sell their goods directly. They will sell to subsequent consumers, such as suppliers for factories, then sell to the factory until there is an export and import opportunity. Most of the electronic waste collectors have a high school/equivalent educational background, where most of the time, they have worked as collectors and are relatively new. Most e-waste collectors have achieved above the minimum wage rates in South Tangerang City (IDR 4,280,214.51) and are also active smokers. The sources of electronic waste come from households, but some collectors do not cover goods from industry or imports. Types of electronic waste are shown in Table 1.

Electronic waste collectors also did not use complete personal protective equipment (PPE) during work, with details contained in Table 2. Personal protective equipment includes safety helmets, safety glasses, masks, gloves, rubber boots, and safety shoes.

Electronic waste collectors had potential health problems based on subjective health complaints shown in Table 3.

Table 1
Examples of coding processes

Type of electronic waste	Frequency <i>n</i> (%)	Example of goods
Lamps	283 (31.13)	LED, fluorescent, and neon
Temperature exchange equipment	53 (5.83)	Refrigerator, freezer, heat pump, air conditioner, cooled dispenser, and water heater
Screen, monitors, and equipment containing screens having a surface greater than 100 cm ²	98 (10.78)	Flat panel display TV, tablet, laptop, personal computer, monitor computer, tube TV, and power bank
Small IT and telecommunication equipment	202 (22.22)	Cellphones, printers, accessories (mouse and headphones), GPS, Telephone, cables, CCTV, and walkie talkie
Small equipment	194 (21.34)	Audio recorder, FM transceiver, playstation, molar, sewing tool, rice cooker, grinder, power supply, iron, radio, blender, vise, hair dryer, car tape, battery, speakers, wall clocks, watches, mosquito rackets, camera, mic, scales, and remote TV, etc
Large equipment	79 (8.69)	Electric stoves, electric fans, washing machines, speakers, automatic dispensers, treadmills, fax machines, scales

CCTV: Closed-Circuit Television; cm²: square centimeters; GPS: Global Positioning System; IT: Information Technology; LED: Light-Emitting Diode; TV: Television

Table 2
Personal protective equipment used by electronic waste collectors

Types of PPE	Frequency of wearing PPE <i>n</i> (%)
Head protective equipment	1 (10.00)
Eye Protective Equipment	1 (10.00)
Respiratory protective equipment	4 (40.00)
Hand Protective Equipment	6 (60.00)
Foot protective equipment	4 (40.00)

PPE: Personal Protective Equipment

This study found ten electronic waste collectors, with the distribution of the locations shown in Fig 1.

Two areas successfully continued with snowballing after meeting the first respondent accidentally in the same sub-district. Another area that contains only one respondent indicates that only an accidental search was carried out in the sub-district and could not proceed to snowball because the respondent did not have the information needed by the researcher.

The lamp categories were found at most in the Pamulang Barat sub-district, with 218 units.

DISCUSSION

Types of electronic waste are divided into six categories (The European Parliament and The Council of The European Union, 2012), shown in Table 1. The study found two types of lamps, namely light-emitting diode (LED) and fluorescent lamps. Fluorescent lamps harm the environment and public health due to toxic mercury vapor from damaged or used fluorescent lamps. The processing of fluorescent lamps needs to consider. It should not be carried out outside a specialized facility, as mercury vapors and aerosols can expose to e-waste collectors and the surrounding environment

Table 3
History of potential health problems from various body systems in electronic waste collectors

Subjective health complaints	Number of subjects with symptoms (%)
Excretion system (Sweating)	9 (90.00)
Respiratory system (Anosmia, sore throat, shortness of breath, and chest pain)	4 (40.00)
Digestive system (Nausea, diarrhea, tooth discoloration, heartburn, and loss of appetite)	7 (70.00)
Nervous system (Anxiety, headache, delirious, tremor)	6 (60.00)
Endocrine system (Headache, muscle aches, tremors, nausea, fatigue, and diarrhea)	9 (90.00)
Reproductive system (erectile dysfunction, premature ejaculation, low libido, and lump on testicle)	0 (0.00)
Sense system (Skin itching and visual impairment)	6 (60.00)
Circulatory system (Dizziness, headache, chest pain, fatigue)	9 (90.00)
Movement system (Muscle pain, pain in leg joints and spine)	8 (80.00)
Immune system (Diarrhea, fatigue, fever, chills, headache, and joint pain)	10 (100.00)
Others (Cough, backache)	8 (80.00)

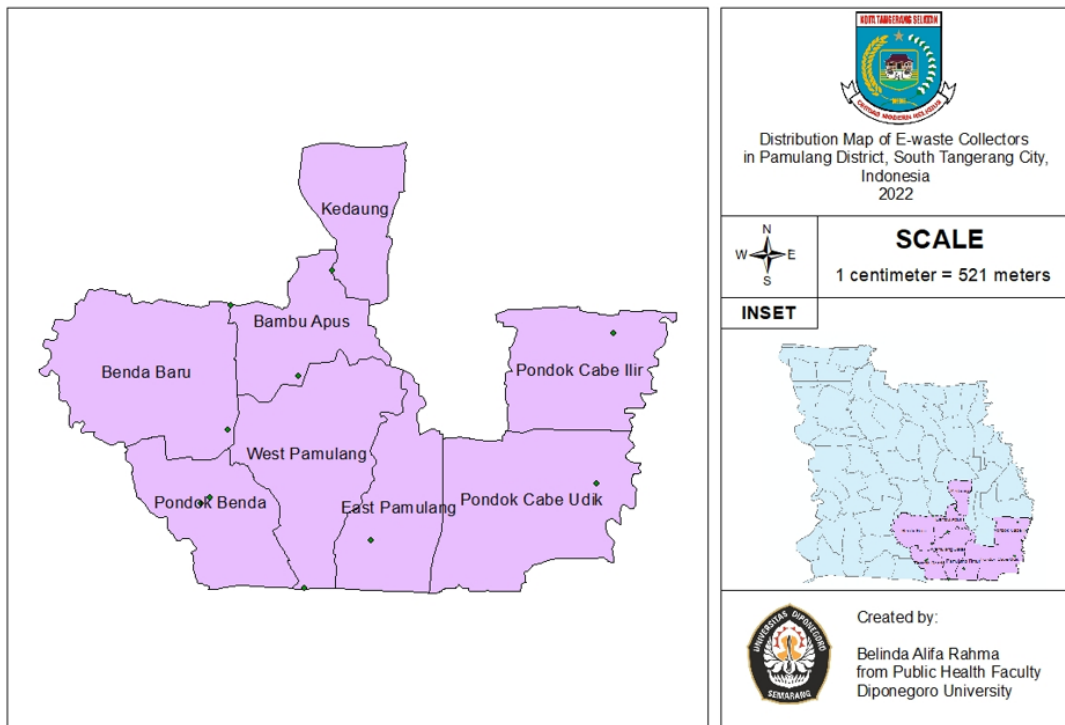


Fig 1 - Distribution map of electronic waste collectors in Pamulang District

(Lucas and Emery, 2006). The mercury can have an impact on accumulating hazards in the food chain. Exposure to mercury vapor (Hg) can harm women because there is a high possibility of menstrual disorders to infertility. If entered through food consumption (eg, containing 0.5 mg/kg mercury), it can impact male fertility due to a decrease in the percentage of spermatozoa due to the levels of both organic and inorganic mercury (Kadam *et al*, 2019). Visible light from LED lamps also emits infrared that can reach the retina. The increase in temperature can induce denaturation of many proteins in the retina, causing limited thermal damage to the pigment epithelium and damage to the retinal layer (Behar-Cohen *et al*, 2011).

Not all electronic waste collectors are aware of the dangers that lurk in the work they do. Six of 10 respondents know potential health problems due to exposure to hazardous materials in e-waste. It needs to consider

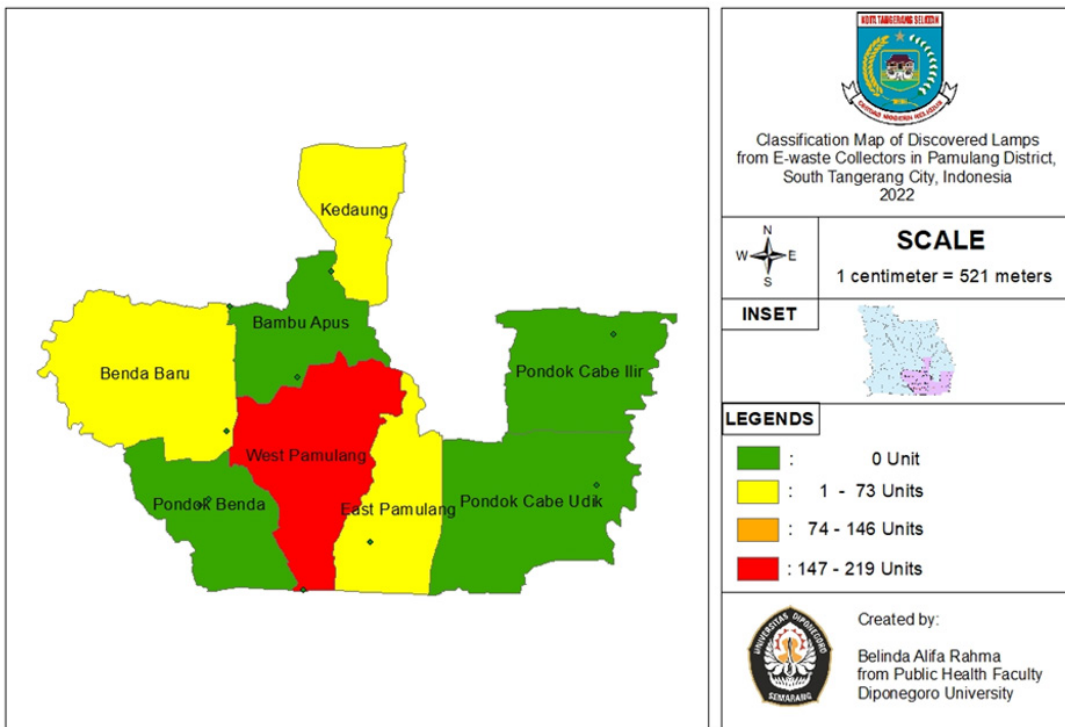


Fig 2 - Classification map of electronic waste findings in the lamps

educating about the potential for health problems due to exposure to hazardous materials contained in electronic waste because most do not yet know. It is necessary to carry out preventive interventions to minimize the harmful impacts. The material of information included knowledge about what electronic waste is, why it is dangerous, how it can be a hazard to humans and the environment, what the dangers are, and most importantly, how to prevent it. Wearing PPE is essential to protect e-waste collectors from the hazardous material in e-waste.

In the Table 3, an analysis of a composite variable, where the number of complaints was narrowed down and led to metal fume fever. Subjective health problems included metal fume fever symptoms where you feel lethargic, weak, chills, muscle pain, sweating, headache, and a burning feeling in the chest, which can use by cadmium (Cd) found in television

(Savvilotidou *et al*, 2014). Electronic waste collectors also complain of anosmia that can occur due to Cadmium (Cd) which is contained in batteries, chips, cell phones, and so on (Ankit *et al*, 2021). Health problems in the form of metal fume fever, such as flu, can heal on their own with symptoms that can feel immediately after 3-10 hours of exposure. Respondents who have metal fume fever do not require specific treatment. They can do prevention by using personal protective equipment and avoiding it to minimize long-term exposure (Wardhana *et al*, 2014).

Further analysis in the Benda Baru Sub-district, as the leader of 6 complaints on the endocrine system, found the dominance of the category of electronic waste, namely lights. Two types of lamps, namely fluorescent and LED lamps. Fluorescent lamps are made of low or medium-pressure mercury. The effects on human health are fatigue and tremors (Wastensson *et al*, 2006).

In addition, cadmium can also impact pain in the joints of the spine and legs, backache, cough, fever, and tooth discoloration. Most e-waste collectors are smokers, so another possibility for this phenomenon is that it comes from cigarette stains (Abu-Hayyeh *et al*, 2001; Alkhatib *et al*, 2005). The feeling of shortness of breath and chest pain may affect by exposure to Arsenic (As) by inhalation after 2-24 hours. The arsenic element can identify in the LED or Integrated Circuit (Kumar *et al*, 2019; Ankit *et al*, 2021). Other subjective health problems, such as sore throat, can be exposed to Copper (Cu) by inhalation in the same period. Nausea is also affected by Mercury (Hg), Nickel (Ni), and Arsenic (As) which threaten through inhalation and oral routes, even causing diarrhea. Loss of appetite, delirium, and itching of the skin (Kapaj *et al*, 2006; Mochizuki 2019; Li *et al*, 2020) can also be affected by exposure to inhalation from dust or smoke containing Arsenic (As), and itching on the skin can also be caused by contact with Nickel (Ni) on the skin (Mallongi *et al*, 2019).

E-waste collectors often feel headaches and anxiety. These symptoms can be caused by inhalation of Arsenic (As) or Cadmium (Cd) (Zhang *et al*, 2021; Cybulska *et al*, 2021). The e-waste collectors also feel the dizziness that can affect Arsenic (As). Complaints on the sensory system also occur in

decreased vision, then symptoms of complaints of health problems in several body systems (Mallongi *et al*, 2019; Freund *et al*, 2020). E-waste collectors also feel tired (lethargic and weak), which can be caused by polychlorinated biphenyls (PCBs), which have an impact on suppressing the immune system, or because of Cadmium (Cd) (Ebrahimi *et al*, 2020).

The lamp may contain hazardous substances that may pose a risk to health problems. The limitation of the research is the potential health problem only using subjective complaints following e-waste collector feelings. A medical assessment is better to diagnose health problems, for example, metal fume fever. Moreover, exposure to hazardous material, such as heavy metals in e-waste, to the e-waste collectors needs examining the laboratory with specific biomarkers.

In summary, this research found 912 units of electronic waste with lamps as the category found most. E-waste collectors had subjective complaints of symptoms such as headaches, sweating, fatigue, and so on based on the combined composite variable of all complaints. The subjective complaints are then narrowed down and lead to metal fume fever. Efforts to prevent it can be using complete personal protective equipment during work. The Department of Environmental of South Tangerang City can educate and disseminate information about electronic waste and its dangers to minimize the risks to health and the environment. Further research must ensure the linkage of health problems with electronic waste using valid medical assessments and laboratory methods. To conduct the rate of waste generation from electronic waste so that it can be seen how much and can increase the urgency of the issue of electronic waste for handling immediately.

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CONFLICT OF INTEREST DISCLOSURE

The authors declare no conflicts of interest.

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