Advances in Earth and Environmental Science

Assessment of Current Situation of Electronic and Electrical Waste Management: A Case of Toul Kork, Phnom Penh, Cambodia

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Submitted : 9 Sept 2024 ; Published : 24 Sept 2024

Citation: Mongtoeun, Y. (2024). Assessment of Current Situation of Electronic and Electrical Waste Management: A Case of Toul Kork, Phnom Penh, Cambodia. Adv Earth & Env Sci.; 5(3):1-7. DOI : https://doi.org/10.47485/2766-2624.1057

Abstract

The increase of population and purchasing power, supported by the development of technology, give consequence to the generation of E-waste with impacts. The result from 63 shops in Toul Kork showed that the management and behaviour is still limited, both in terms of storage and disposal. Protective equipment during the disassembly and repair of EEE, most of the repairers or dismantlers are still unaware of the impact. The amount of waste of electrical and electronic equipment is worrying due to its increase from year to year. According to the results obtained from the study, the electronic waste (phone-85% and computer-15%) generated 0.36 kg/day/shop on working day and 0.9kg/day/shop on holiday or weekend, while amount waste generated from electrical shop is lower (0.2kg/day/shop) and there is no any differentiation between working day and holiday. However, in this study indicated that waste from electrical is mainly AC and refrigerator accounted for 35.7% and 42.9%, respectively, while electronic generated phone waste and computer waste accounted for 74.3% and 25.7%, respectively. Regarding to waste storage, both electronic and electrical shops keep the waste by mixing up to 80%, while electronic waste was disposed with other waste (46%), keeping (22%) and selling (32%) and electrical waste was disposed with other waste (32%), keeping (43%) and selling (25%).

Keywords: Solid Waste; E-Waste; Electrical; Electronic; Recycling

Introduction

Phnom Penh is the capital city of Cambodia with the area of 678.46 square kilometres. Not only is it the capital, but it is also the largest in terms of population. Phnom Penh's 2024 population is now estimated at 2,352,680 (Fig 1). In 1950, the population of Phnom Penh was 364,000. Phnom Penh has grown by 71,482 in the last year, which represents a 3.13% annual change.

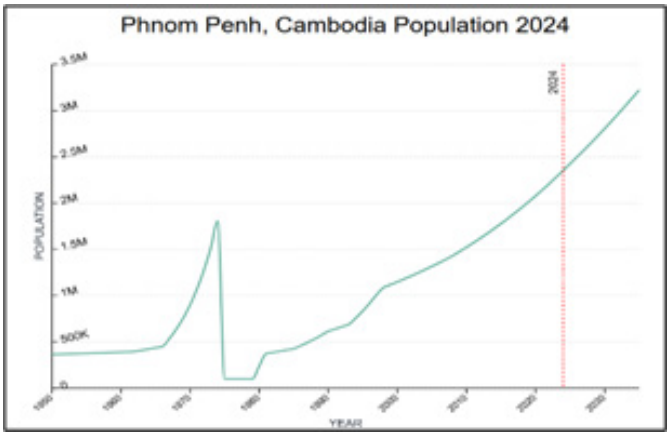

Figure 1: Population projection in Phnom Penh.

Amount of Municipal Solis Waste in Phnom Penh

Currently, the amount of urban solid waste is increasing year by year in the cities of developing countries, including Phnom Penh, Cambodia. Although solid waste management involves and collaborates with many stakeholders, management is still flawed. In fact, urban solid waste management in the city center and suburbs of Phnom Penh has encountered a number of obstacles and challenges, which are factors that need to be addressed urgently. Seeing these problems, the government has decided to reform the urban solid waste management in Phnom Penh in 2019. After the reform, the provision of garbage collection, transportation and cleaning services in the city center and suburbs has changed significantly, with the city center receiving 95% of its garbage collection services and the suburbs receiving services, collected 80% -85%. Figure 2 shows the amount of municipal solid waste (MSW) collected in the last 10 years.

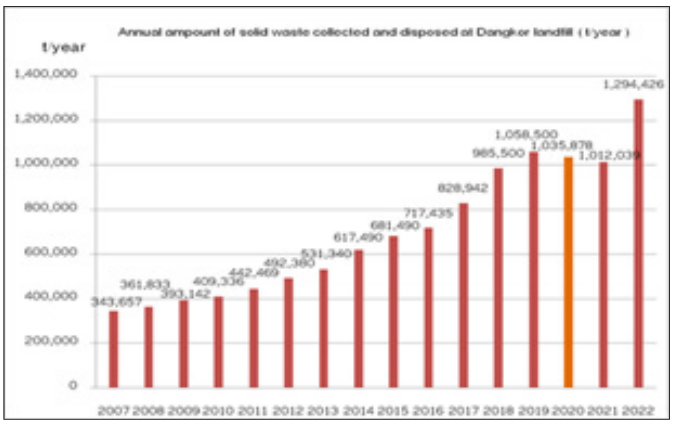

Figure 2: Amount of Waste collected in last 10 years.

The projection of MSW remains increased drastically until 2030 (Fig 3) in which the actions need to be taken accordingly.

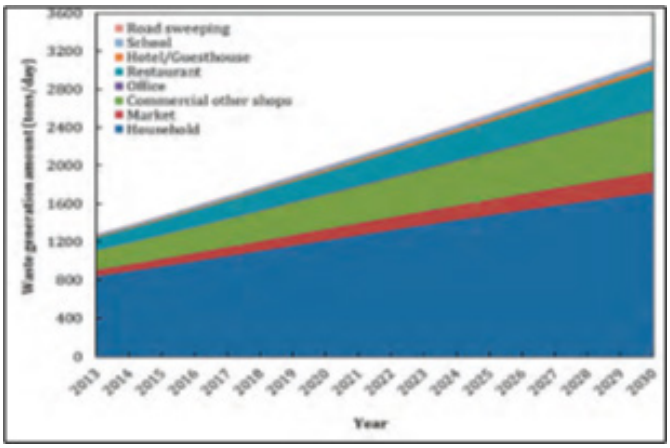

Figure 3: Projection of Waste Generation trend in Phnom Penh until 2030.

Global E-waste Generation

Globally, especially developing countries use huge amount of electronic and electronic devices (EEE) which strongly linked to the economic development and contribute to the improvement of people's lives. Improved living standards, higher incomes, growing cities and the growth of modern technology industries around the world have led to an increase in the number of electronic devices (Vanessa et al., 2020).

In 2019, the world generated a striking 53.6Mt of e-waste, an average of 7.3kg/cap and is projected to grow to 74.7Mt by 2030 due to higher consumption rates of EEE, short life cycles, and few repair options (Fig 4). Asia generated the highest quantity of e-waste in 2019 at 24.9Mt, followed by the Americas (13.1 Mt) and Europe (12Mt), while Africa and Oceania generated 2.9Mt and 0.7Mt, respectively. Europe ranked first worldwide in terms of e-waste generation per capita, with 16.2kg/cap. Oceania was second (16.1kg/cap), followed by the Americas (13.3kg/cap), while Asia and Africa generated just 5.6kg/cap and 2.5kg/cap, respectively. Regarding to recycling of e-waste, Europe is the first (42.5%) followed by Asia (11.7%) while Africa is the lowest one (0.9%) (Vanessa et al., 2020).

Figure 4: Global E-waste Generated by year.

In middle- and low-income countries e-waste is managed mostly by the informal sector causing severe health effects to workers during handling. In particular, in Cambodia, many kinds of used products, especially electrical equipment and electronic waste are being widely used everywhere. The imported items From 2000 to 2006, TVs were 309,334 units (172,192 colours and 632,043 black-and-white units), 193,391 air conditioners, 91,935 refrigerators, 140,10 computers, telephones. 343,033 units and 30,941 washing machines (Sothun, 2012).

The inventory of E-Waste (Figure 5) for the six major EEE items, from the year 2009 till 2019 were estimated. E-Waste generation in Phnom Penh was expected to grow exponentially during the coming years. TVs is expected to grow most, followed by PCs, refrigerators, air conditioners, washing machines, and mobile phones; while in terms of numbers of units, mobile phones have the largest share, which is expanding rapidly (Ministry of Environment, 2009). Currently, the updated one for the inventory seem not verified or very limited.

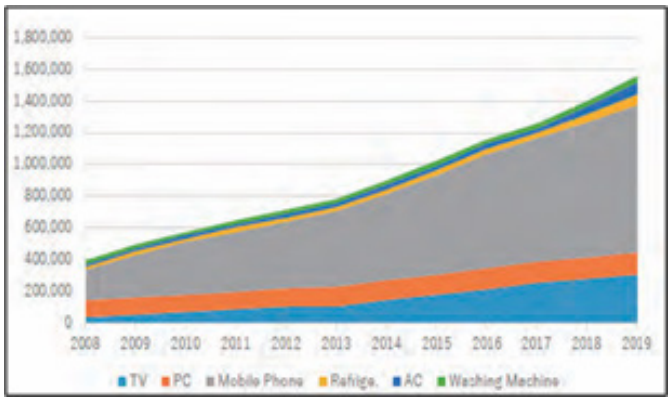

Figure 5: Estimated E-Waste Generation in Phnom Penh in Units.
Source: (Ministry of Environment, 2009).

Inventory studies show that the potential for e-waste generation ranges from 6,672 tonnes in 2008 to 22,443 tonnes in 2019 (Ministry of Environment, UNEP-DTIE. 2009). Cambodia, the Philippines and Vietnam emit the least amount of electronic waste, less than 1.5 kg per capita. Electronic waste in Cambodia increased by 70% between 2010 and 2015. 17,000 tons of electronic waste in Cambodia in 2015

was collected and sold to a repair shop for disassembly that is still good to use. The remaining waste is dumped into the city waste management system, burned by consumers, or dumped in landfills or landfills (The Phnom Penh Post, 2017).

In Thailand, E-waste generation in 2019 was 421,335 tons and in which only 500 ton of domestic e-waste were reported to be collected and managed in environmental sound by 19 local governments as mentioned in Table 1.

Table 1: Domestic E-waste Generation in Thailand in 2019

Type	Amount of e-waste (ton)
Television	99,447.71
Air conditioner	77,653.41
Refrigerator	65,995.07
Washing Machine	62,807.60
Computer	59,711.41
DVD player	32,830.77
Telephone/mobile phone	12,915.30
Digital Camera	9,973.73
Total	**421,335.00**

Source: Hazardous waste situation report, 2019, Pollution Control Department

The imported E-waste from 2014-2018 was drastically increased but in 2018 was decreased due to Department of Industrial Works temporary ban the import of E-waste in 2018 as indicated in Table 2.

Table 2: Imported E-waste from 2014–2018, Thailand.

Year	Amount of imported e-waste (ton)
2014	907.86
2015	1,626.50
2016	1,986.55
2017	54,260.60
2018	38,404.05

Source: www.basel.int, 2019.

National Policy, legislation and regulation on E-waste

Since 2014, the number of countries that have adopted a national e-waste policy, legislation, or regulation has increased from 61 to 78. However, regulatory advances in some regions are slow, enforcement is poor, and policy, legislation, or regulation does not yet stimulate the collection and proper management of e-waste due to lack of investment and political motivation. With these, 71% of the world's population is currently covered increasing by 5% from 66% in 2017. But the coverage rate can be misleading, as it gives the impression that there is little left to do in terms of regulating the management of e-waste in many countries, policies are non-legally binding strategies, but only programmatic ones. Across Africa and Asia, for example, there are 19 countries with legally binding legislation on e-waste, 5 countries with an e-waste policy but non-legally binding legislation, and 31 countries with policy in development (GSMA, 2020). India and China have national e-waste regulation, but official take-back legislation covers only around 4 billion people and still very limited and not cover all e-waste (Balde et al., 2014).

In Cambodia, there are several sub-decrees related to solid waste management however it is limited to E-waste, there is only one sub-decree on E-waste (Sub-decree 16 on E-waste management, 2016).

Health Impacts of E-waste by improper management

It was found that adverse health effects strongly associated with improper e-waste management. Improper management of e-waste also contributes to global warming. Recycling of e-waste can substitute the primary raw materials and reduce greenhouse gas emissions from extraction and refinement of primary raw materials. However, in recycling process, the refrigerants that are found in some temperature exchange equipment are greenhouse gases. A total of 98 Mt of CO_2-equivalents were released into the atmosphere from discarded fridges and air-conditioners that were not managed in an environmentally sound manner. This is approximately 0.3% of global energy-related emissions in 2019 (IEA). E-waste is an 'urban mine', as it contains several precious, critical, and other non-critical metals that, if recycled, can be used as secondary materials. The value of raw materials in the global e-waste generated in 2019 is equal to approximately $57 billion USD. Iron, copper, and gold contribute mostly to this value. With the current documented collection and recycling rate of 17.4%, a raw material value of $10 billion USD is recovered in an environmental sound way from e-waste globally, and 4 Mt of raw materials could be made available for recycling. The recycling of iron, aluminium, and copper contributed to a net saving of 15 Mt of CO_2, equivalent to emissions from the recycling of secondary raw materials substituted to virgin materials.

Since the publication of the previous e-waste monitor in 2017, the number of studies on the adverse health effects from e-waste have increased. These studies have continued to highlight the dangers to human health from exposure to well-studied toxins, such as lead, mercury, cadmium and nickel and organic compounds such as CFCs, PAHs and PBDEs. Recently, research has found that unregulated e-waste recycling is associated with increasing numbers of adverse health effects. These include adverse birth outcomes (Zhang et al., 2018). altered neurodevelopment (Huo et al., 2019). adverse learning outcomes (Soetrisno et al., 2020), DNA damage (Alabi et al., 2012). adverse cardiovascular effects (Cong et al., 2018), adverse respiratory effects (Amoabeng et al., 2020). adverse effects on the immune system (Huo et al., 2019), skin diseases (Decharat et al., 2020; Seith et al., 2019). hearing loss (Xu et al., 2020), and cancer (Davis & Garb, 2019). A study by Alabansa based on GOOD, BAD and UGLY outcome indicated that the GOOD is the jobs and the use of e-waste as a source of raw materials; the BAD is the exacerbation of the already poor environmental conditions in developing countries; the UGLY is the negative impact on the health of workers (Alabansa et al., 2021).

Relation Between Purchasing Power, Income and E-waste Generation

It is really related between income and e-waste generation. As shown in Fig 6, more income more purchasing power with more e-waste generation so it easy to understand that the developed countries produced more e-waste than developing countries due to their higher income.

Figure 6: Global average number of selected appliances owned per capita, by country's income level.

Objectives

The overall purpose of this study is to study the management and their level of awareness regarding waste of electrical and electronic equipment in Toul Kork district, Phnom Penh. There are three main objectives which including as the following:

- To assess the current situation of E-waste management and
- To understand their level of understanding related to waste management, electrical and electronic equipment.

Methods

This study will focus on interviewing vendors of shops selling and repairing electrical and electronic equipment in Toul Kork district, Phnom Penh, Cambodia. However, due to the lack of information related to the specific number of shops, sales and repairs in Toul Kork district, the team went directly to the location along the street by counting with X,Y coordination number. The study divided the two types of shops into electrical appliances (N=28) and electronics (N=35). Number of electronic and electrical shops is mentioned in table 2 and locations in Figure 7. The shops owners or workers who know about e-waste management in the shops were interviewed and the waste from each shop was collected two times a week (working day and weekend) for consecutive two weeks to be categorized as mentioned in Table 3.

Table 3: Number of samples for electronic and electrical shops:

Types of shops	No of shops	Samples for interview	Sample for waste analysis
Electrical Shops	28	28	16
Electronic Shops	35	35	21
Total	**63**	**63**	**37**

Study Area

Reasons for choosing a research area

Phnom Penh is divided into 14 Khans (district) with 105 Sangkats. Toul Kork is one of the 14 Khans in Phnom Penh with 10 Sangkats and 143 villages with an area of 8.43 square kilometers and a population of 145,570 (2019). Toul Kork is a large district located in the center of the capital, known as the most popular area for living after Boeung Keng Kang and Changkar Mon districts. The Cambodian electronics wholesaler said that the country's electronics market has been growing daily for the last decade due to high demand, especially home appliances which the importation is increasing year by year. According to the report of Phnom Penh City Hall (2019), the total population in Toul Kork district is 145,570 people with a density of 17,268 people / square kilometer. In addition, it is the largest and richest electronics stores in Phnom Penh, including the five major electronics stores: Depot Market, Khleang Romsev Market and Kampuchea Krom Road.

Methods for selecting study area and sample

In choosing a specific study area, it is important to study because it can determine a target area that we want to study. Selection of Tuol Kork district based on the current study location in waste management of electrical and electronic equipment at repair shops in Tuol Kork. In the selection of Tuol Kork, the team set only 10% of the bias level in the study area. Purposive method was used of selecting the study area and the number of stores were determined by counting and samples for interview and waste samples were randomly selected.

Figure 7: showed the locations of samples (electronic and electrical shops) collected for the study in Toul Kork district.

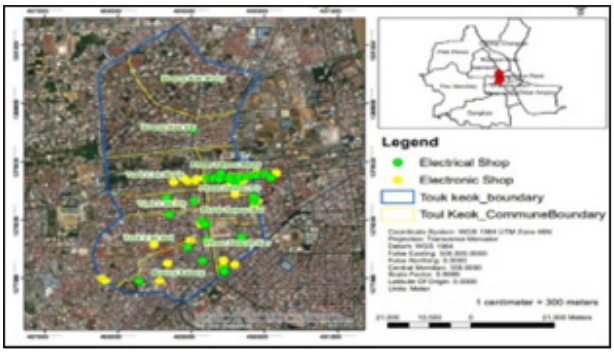

Figure 7: Location of Electronic and Electrical stores.

Results

E-waste management in developing countries has similar constraints. Import of e-waste from developed countries is usually found in developing countries since e-waste is considered as a kind of livelihood by the residents. Lack or absence of formal recycling facilities makes the informal waste treatment thrived near residential areas. The backyard processes in informal treatment facilities were done manually and without adequate resources and knowledge on the hazard which affects the environment and human health. Some developing countries, for example, Cambodia has not specified the law for e-waste management. Lack of data such as the material flow of e-waste and lack of awareness becomes other constraints in e-waste management.

Table 6: Generation Sources of E-waste:

Electrical Equipment (%)			
Air Conditioner	Refrigerator	Washing	Television
35.7	42.9	14.3	7.1
Electronic Equipment (%)			
Mobile Phone		Personal Computer	
74.3		25.7	

Regarding to waste storage, both electronic and electrical shops keep the waste by mixing up to 80%, while electronic waste was disposed with other waste (46%), keeping (21%) and selling (33%) and electrical waste was disposed with other waste (32%), keeping (43%) and selling (25%).

Table 4: Disposal Methods of E-waste

	E-waste Disposal (%)		
Sources	With MSW	Keeping	Selling
Electrical	32.1	42.9	25
Electronic	46	21	33

Table 5 shows that the owners normally store their waste before disposal by mixing accounted for around80% and separation accounted for 29%.

Table 5: Storage method of E-waste before disposal

Storage Method before Disposal (%)		
Storage Method	Electronic	Electrical
Mixing	85	76
Separate	15	24

Heath protection and types of PPE during repairing

Regarding to health protection, it seems that majority of people know about health impacts caused by the e-waste that why most people used personal protection equipment (PPE) (Fig 8). However, still many do not use PPE so it means that they are lacking of knowledge or they don not care.

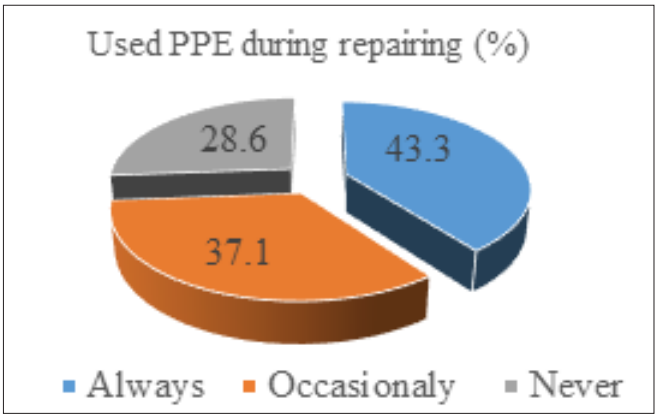

Figure 8: Used PPE during repairing

Types of PPE they are using is only mask which contains until 77% as it is cheap and easy to use and followed by gloves. PPE used might be not followed the standard or a type of specific PPE which are suited for hazardous substance protection; however, PPE have been used during repairing somehow (Fig 9).

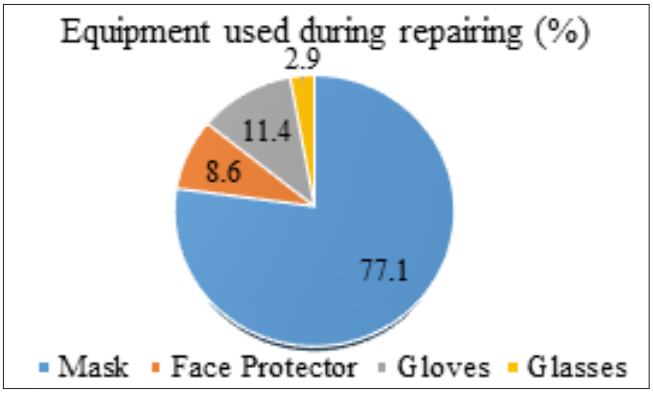

Figure 9: Types of PPE used during repairing:

Understanding of impacts of e-waste

Figure 10 shows about the level of knowledge of respondents regarding to health impacts by e-waste and most of them do now know about the impacts caused by the e-waste (Fig 10) so the training is need to provide the basic knowledge to all those who work closely with e-waste.

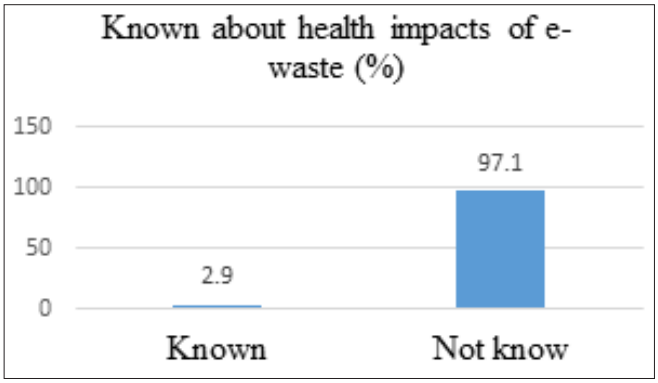

Figure 10: Knowing about health impacts of e-waste:

The result shown that all of the respondents never receive any training course on the impacts on e-waste on health. So it is alert that it is really important for the policy makers or stakeholders who are in charge of the e-waste management, especially the ministry of environment should consider on how to provide training to them.

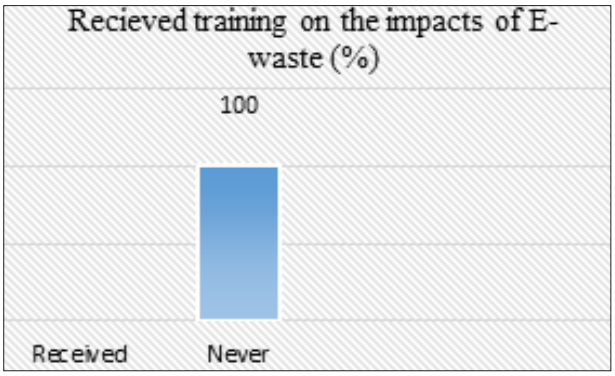

Figure 11: Receiving training on impacts of e-waste:

Conclusion

Among 63 shops in Toul Kork, the management and behaviour are still limited, both in terms of storage and disposal. Protective equipment during the disassembly and repair of EEE, most of the repairers or dismantlers are still unaware of the impacts. The amount of waste of electrical and electronic equipment is worrying due to its increase from year to year. According to the results obtained from the study, the electronic waste (phone-85% and computer-15%) generated in the working day is 0.36 kg/day/shop on working day and 0.9kg/day/shop.

on holiday or weekend, while amount waste from electrical shop is lower (0.2kg/day/shop) and there is no any differentiation between working day and holiday.

Informal sector plays a crucial role in E-waste management such as repairing and dismantling. The reusable parts are kept for sale, and the recyclable materials are then sold to local scrap yard owners for export. The residues are then disposed of through municipal waste systems, burned by owners or discarded in dumpsites or landfills. In recent years, through various projects and pilots, the Ministry of Environment, Cambodia (MOE) has worked with the informal sectors to upgrade their methods and techniques for environmentally sound management of e-waste and has developed a strategy for developing a national e-waste management system, taking into account the informal e-waste sector, but it seems very slow progress.

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