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Research article

End-of-life (EoL) mobile phone management in Hong Kong households

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ABSTRACT

A questionnaire survey and interviews were conducted in households and end-of-life (EoL) mobile phone business centres in Hong Kong. Widespread Internet use, combined with the rapid evolution of modern social networks, has resulted in the more rapid obsolescence of mobile phones, and thus a tremendous increase in the number of obsolete phones. In 2013, the volume of EoL mobile phones generated in Hong Kong totalled at least 330 tonnes, and the amount is rising. Approximately 80% of electronic waste is exported to Africa and developing countries such as mainland China or Pakistan for recycling. However, the material flow of the large number of obsolete phones generated by the territory's households remains unclear. Hence, the flow of EoL mobile phones in those households was analysed, with the average lifespan of a mobile phone in Hong Kong found to be just under two years (nearly 23 months). Most EoL mobile phones are transferred to mainland China for disposal. Current recycling methods are neither environmentally friendly nor sustainable, with serious implications for the environment and human health. The results of this analysis provide useful information for planning the collection system and facilities needed in Hong Kong and mainland China to better manage EoL mobile phones in the future.

1. Introduction

Developments in information technology have created increased demand for electronic equipment such as TVs, PCs, fax machines, mobile phones, music players and a host of other products. At the same time, fierce competition in terms of technological advancement has shortened the useful life of those products. The special treatment of electronic waste (e-waste) needs to be considered to prevent the loss of valuable materials and rare elements. Such materials as gold and palladium can be recovered more effectively from e-waste than from mining, and with fewer overall effects on the environment (Chancerel, 2010). Waste from mobile phones and computers contains more valuable substances, including Cu, Al, Au, Fe, Ni, Si, Cd, Cr and Pd, than any other e-waste material (Robinson, 2009). Because mobile phones are small and have the shortest lifespan of any information and communication technology (ICT) device, they are more likely to be disposed of and end up in landfills undetected. It is therefore important to ensure that obsolete, or end-of-life (EoL), mobile phones be removed from households before they find their way to landfills (Jang and Kim, 2010). Whilst the number of mobile phones in industrialised countries has begun to level off at around 126 per 100 inhabitants, ownership in developing countries is still increasing rapidly, and currently stands at about 90 per 100 inhabitants (ITU, 2014). Discarded ICT materials end up as e-waste (Deng et al., 2006, 2007; Wong et al., 2007). Consumer demand for mobile phones is greater than that for any other electronic device, and, because such phones have a relatively short lifecycle and (perceived) built-in obsolescence, the large number discarded constitutes a significant and growing problem. In Korea, an average of 14.5 million mobile phones were retired annually in the 2000–2007 period, a large number of which were stored at home awaiting disposal (Jang and Kim, 2010). In Indonesia, an estimated 9500-plus tonnes of waste

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are produced annually from mobile phones alone, and the amount is steadily increasing (Panambunan-Ferse and Breiter, 2013). Globally, more than 50 million tonnes of e-waste are produced annually (Ni and Zeng, 2009). Taking advantage of the lower labour costs and less stringent environmental regulations in developing countries and regions, such as southeast China, developed countries generally send their EoL mobile phones to them for recycling (Deng et al., 2006, 2007; Leung et al., 2007; Wong et al., 2007; Shen et al., 2009; Gu et al., 2010). Various pollutants, including persistent organic pollutants (POPs) and heavy metals, are released into the environment (the air, water and soil) during the crude recycling of EoL mobile phones, posing serious health risks to workers and residents of surrounding areas alike (Deng et al., 2006, 2007; Liu et al., 2012). These issues are exacerbated in less-developed areas where poverty is also an issue and the technology and infrastructure to handle waste properly are lacking. Approximately 80% of all e-waste is exported to Africa and such developing countries as mainland China and Pakistan for so-called recycling, resulting in extraordinary levels of environmental pollution (Lau et al., 2013).

In Hong Kong, e-waste is one of the fastest growing components of municipal solid waste, with a growth rate of more than 2% per year (HKEPD, 2011). According to statistics from the Hong Kong government, 80,000 tonnes of e-waste are generated annually, and 51,000 tonnes of that generated in 2011 was exported to developing countries for recycling, with only 10,000 tonnes recycled locally (HKEPD, 2011). The monitoring of the trans-boundary movement, treatment and recycling of EoL mobile phones remains a difficult task. Prior to the study reported herein, no systematic study of the destination and recycling of Hong Kong's EoL mobile phones had been conducted. This study adopted material flow analysis (MFA) to analyse information on the flow of EoL mobile phones in Hong Kong to inform the planning of a system and facilities to better manage those phones in Hong Kong and mainland China. Guiyu in Guangdong province, a hotspot for the recycling of e-waste, and Taizhou in Zhejiang province, where uncontrolled recycling and disposal take place, were the two primary locations of study on the mainland (Gu et al., 2010). As noted, numerous pollutants, including POPs and heavy metals, are released into the air, water and soil during the crude recycling of EoL mobile phones, posing serious health risks (Deng et al., 2006, 2007; Liu et al., 2012). Due to limitations in treatment capacity and environmental protection, as well as economic and social factors, the trans-boundary movement of e-waste from Hong Kong has increased significantly in the past decade. As the majority of EoL mobile phones contain valuable metals of commercial value, they make up a considerable proportion of the e-waste that makes its way from Hong Kong to southeast China.

MFA is a quantitative procedure used to account for the flow of materials and energy used in production, consumption, recycling and disposal (Brunner Paul and Rechberger, 2004). It is an efficient tool for investigating material inputs, transfers and outputs. In addition, MFA allows the assessment of whether flows of material are sustainable in terms of the environmental burden they impose by identifying and quantifying the flows, sinks and sources of substances in a given region. Such analysis is used primarily to track products within an economy. MFA can be used to manage regional and national economies and the flows of materials, products and substances (Chancerel, 2010; Liu et al., 2012). MFA has been shown to be efficient for environmental management, and is increasingly being applied to waste management, although previous such studies have failed to assess the environmental effects or health risks, the main concerns in waste management, during each phase of the flow. Several MFA studies have traced the lifecycle of a particular type of electrical waste or e-waste, and time-series analysis of the material flow of EoL PC systems in California made use of an MFA model (Kang and Schoenung, 2006). The market supply method has also been used to estimate the flows of waste from electrical and electronic equipment in Mangalore, India (Kang and Schoenung, 2006). In a Japanese study, the amount of domestic waste from households and business enterprises was estimated as the inflow and outflow of an MFA system (Osibanjo and Nnorom, 2008).

Lau et al. (2013) carried out the first systematic MFA study of e-waste on five types of household e-waste: televisions, washing machines, air conditioners, refrigerators and personal computers (TWARC). Their results showed that approximately 65,000 tonnes/year, or 80%, of all household-generated TWARC waste in Hong Kong is exported overseas by private e-waste traders. To date, the application of the MFA methodology to the management of other types of e-waste, including EoL mobile phones, remains limited. Hong Kong is an important centre for the import, export and flow of such phones, and hence the study reported herein has important implications for Hong Kong policymakers.

2. Methodology

To address the dearth of studies on the EoL management of mobile phones in Hong Kong, this study used questionnaire surveys, interviews and site visits to obtain more detailed information on such management. Mobile phones were chosen as the focus of study because they constitute one of the most rapidly increasing categories of discarded devices in Hong Kong. The study was conducted from October 2014 to March 2015. Two surveys were devised to obtain information on the generation and recycling of EoL mobile phones. The first survey, the household survey, queried mobile phone users in households in all 18 Hong Kong districts to obtain information on their disposal preferences, and the second, the trader survey, was aimed at e-waste traders and non-governmental organisations (NGOs) involved in the collection of EoL mobile phones. Interviews with informed individuals were also carried out to retrieve data in an exploratory manner and to discern the material flows during the trans-boundary movement and recycling of EoL mobile phones.

2.1. Household survey of disposal patterns

To investigate the behaviour and habits of consumers across the region with respect to mobile phone usage and disposal preferences, a survey questionnaire was distributed to households in all 18 districts of Hong Kong. The questionnaire had six major parts, including background information on the household, the lifespan of mobile phones, the number and model of mobile phones stored at home, awareness of issues relating to mobile phone recycling, the value placed on obsolete mobile phones by consumers and options for dealing with obsolete phones. Copies of the questionnaire were distributed via Facebook, WhatsApp, the Environmental Protection and Global Climate Change Bulletin Board System (BBS) in Hong Kong and the Uwants BBS at the Hong Kong Institute of Education. Snowball sampling was used when respondents were willing to introduce others to the research team. The final sample totalled 204 valid responses involving 204 households and 893 individuals collected from all 18 districts: nine from North district; five from Tai Po; 12 from Sha Tin; 12 from Yuen Long; 34 from Sai Kung; six from Tuen Mun; nine from Tsuen Wan; 32 from Wong Tai Sin; seven from Sham Shui Po; five from Yau Tsim Wong; 16 from Kwai Tsing; 12 from Kwun Tong; 12 from Kowloon City; eight each from the Central and Western districts; 15 from Eastern; four from Southern; and three each from Islands and Wan Chai (Fig. 1).

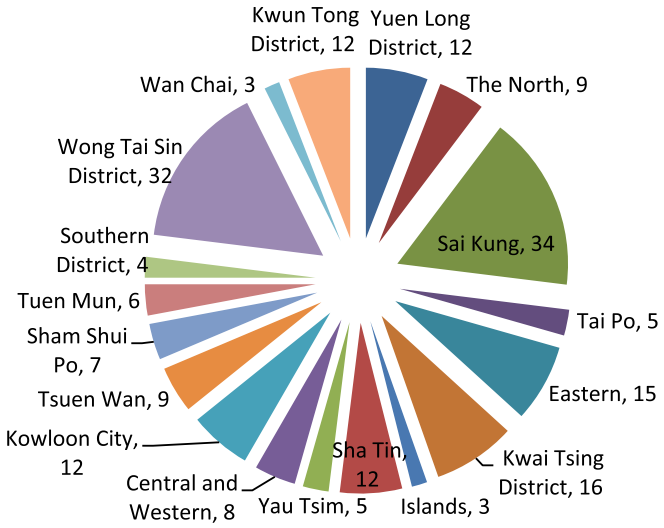

Fig. 1. Numbers of sample collection in 18 districts of Hong Kong.

2.2. E-waste trader survey

To trace the flow of EoL mobile phones after their disposal by a household, a second questionnaire, supplemented by face-to-face interviews, was administered amongst mobile phone dealers to obtain information on their trading practices. The targeted interviewees (n = 18) were the owners or staff members of retail outlets, second-hand shops and after-sales shops, distributors, and mobile phone recyclers in Hong Kong and the mainland Chinese city of Shenzhen, as well as representatives of NGOs responsible for the trade and management of waste in Hong Kong. Most traders of second-hand mobile phones are not registered and generally do not have a permanent location for their operations. These traders were thus invited for interviews when they were encountered on the street engaged in the collection of EoL phones. To increase the number of such interviewees, the investigators visited areas known to host an abundance of second-hand mobile phone trading, namely, Mong Kok Street, Ap Liu Street, Sham Shui Po and Chungking Mansions in Hong Kong and Huaqiang North in Shenzhen. The latter is the main exporter of second-hand mobile phones from Hong Kong, and plays an important role in the transboundary movement of such phones between Hong Kong and mainland China. Snowball sampling was again used when respondents were willing to introduce other suitable traders to the research team. The trader survey was administered to establish: (1) the flow of EoL mobile phones after collection by e-waste traders and (2) the trade practices of the private recycling sector. Most of the interviews with e-waste traders were conducted in Cantonese. Ten charity organisations that accept e-waste donations were also interviewed using the same questionnaire.

3. Results and discussion

3.1. Mobile phone usage in Hong Kong

Statistical results from the questionnaires show the 839 respondents who use mobile phones to own 1033 such phones. The number of mobile phones exceeds the number of families surveyed, and the mean number of phones per capita in Hong Kong is 1.2. Statistics from the Hong Kong Communications Authority released at the beginning of 2015 show the number of subscribers to mobile network operators to stand at 17, 445, 581, whilst the total population of Hong Kong is just 7.2986 million. Although the data may not be completely representative of the actual number of mobile phones in the territory because each phone can be used with multiple service plans, the trend is consistent with our findings. Hence, the number of mobile phones currently used in Hong Kong is potentially more than 17.4 million.

Table 1
Mobile phone lifespan in various locations.

Location	Lifespan (month)	References
Hong Kong	23	This research
Hong Kong	21.3	CUHK (2012)
Korea	28	Jang and Kim (2010)
Nigeria	96	Osibanjo and Nnorom (2008)

Survey data on respondents' mobile phone habits were used to calculate the number of obsolete mobile phones per household in the past five years (2011–2015). The lifespan of a phone was calculated as the number of people who had abandoned a phone in each year (3,304,509) divided by the total Hong Kong population aged 11–79. That age range was selected because individuals 10 and younger and those older than 80 generally do not own mobile phones. The parents interviewed mentioned they offered mobile phones to their kids at ages 10 or 11 above because most of them can text at that age. Furthermore, among the oldest seniors (those aged 80 years of age or older), mobile phone adoption sits at 61% in US according to a study by Pew Research Center's Internet Project. Assuming that the mean mass of each mobile phone is 0.1 kg (Gaidajis et al., 2010), it can be estimated that Hong Kong generates at least 330 tonnes of potential e-waste every year from mobile phones alone. The survey results show the average number of abandoned phones per user per year to be 0.521. During the 2013–2015 period, people in Hong Kong abandoned a mobile phone approximately once every two years (every 23 months). This result is consistent with that of a survey carried out by the Chinese University of Hong Kong (CUHK) in 2012 showing that the average lifespan of a mobile phone in Hong Kong in 2011 was 21.3 months. Monteiro et al. (2007) reported nearly a decade ago that mobile phones were used for an average of 18 months in developed countries before being replaced by a model with a more modern design and/or newer technical features. In Korea, the average lifespan is estimated to be 2.4 years (Jang and Kim, 2010), whereas it is four years in Nigeria (Osibanjo and Nnorom, 2008) (shown in Table 1). The discrepancy can be attributed to differences in cultural behaviour, economic conditions and sales strategies.

Government statistics also offer detailed information on the number ofobsolete mobile phones and median monthly household income (Fig. 2) in each district of Hong Kong (C&SD, 2014).

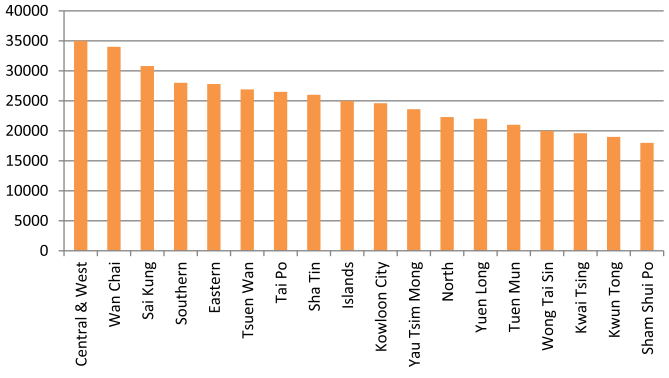

Fig. 2. Median monthly household income (C&SD, 2014).

Table 2
Top 6 districts with the most abandoned mobile phones.

District	Median monthly household income (HK$) (C&SD, 2014)	Abandoned mobile phones per person each year
Tai Po	26,500	1.373
Tsuen Wan	26,900	0.885
Tuen Mun	21,000	0.851
Eastern	27,800	0.618
Wan Chai	34,000	0.579
Sai Kung	30,800	0.547

According to the results shown in Table 2, the six districts with the greatest number per resident are Tai Po (1.373), Tsuen Wan (0.885), Tuen Mun (0.851), Eastern (0.681), Wan Chai (0.579) and Sai Kung (0.547). Population and household statistics (C&SD, 2014) reveal Tai Po, the district with the most obsolete phones, to rank seventh in Hong Kong in terms of household income, whilst Tsuen Wan ranks sixth. Wan Chai ranks fourth in the number of obsolete phones and second in average family income. Conversely, the residents of Sai Kung discard fewer phones even though they enjoy a higher average family income. These results demonstrate that the number of abandoned mobile phones per person per year is not correlated with annual income. Furthermore, the number of phones abandoned annually in each district is not positively correlated with that district's population. For example, the residents of Tuen Mun, Tai Po and Eastern discard 379,130, 371,447 and 325,790 mobile phones per year, respectively (Fig. 3), whilst the populations of the three districts total 445,511, 270,537 and 527,169, respectively (C&SD, 2014).

3.2. EoL management of mobile phones in Hong Kong households

To better understand how Hong Kong households deal with obsolete mobile phones, the researchers designed a questionnaire to track their phones. When asked how they dispose of those phones, most respondents gave more than one answer (Fig. 4). More than 75% (154) of the 204 respondents stated that they preferred to keep the phones due to the low price for second-hand phones in the second-hand market. Another reason cited for keeping phones was use as a backup. Nearly half of the respondents to the above-cited CUHK survey stated that they preferred to keep obsolete mobile phones because they worried that the personal information stored within them could be accessed. Overall, the CUHK survey results are similar to those reported herein. The latter part of the current survey questionnaire asked respondents their opinion of a government-mandated scheme to collect all obsolete mobile phones. More than 80% said that they would not be in favour of such a scheme, as they would worry about the leakage of personal data.

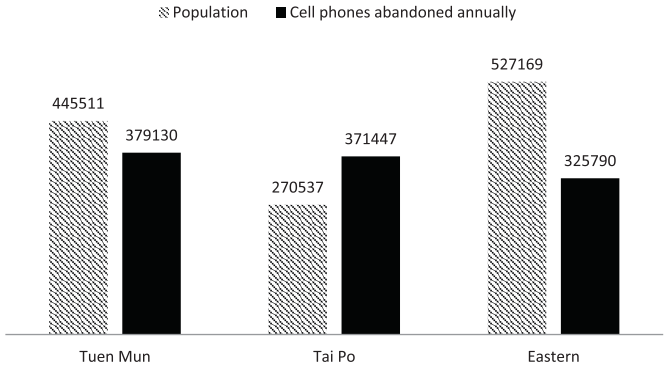

Fig. 3. Top 3 districts with the most abandoned mobile phones each year.

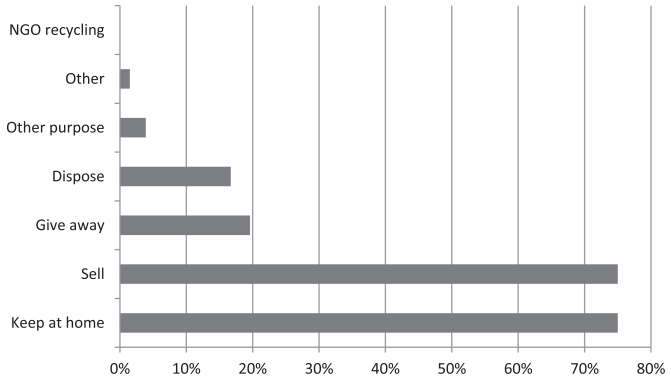

Fig. 4. Treatment of obsolete mobile phones.

Seventy-five per cent of respondents (152) said they sell their obsolete mobile phones on the second-hand market even though they receive relatively little for them. Some said they sell them in shops or to second-hand traders for recycling. Local suppliers and retailers of mobile phones often offer consumers economic incentives to return their old phones when they buy new ones. Some of the respondents also reported selling their obsolete devices to individual second-hand buyers. Just under 20% (40) indicated that they generally pass on those devices to relatives or friends, and 16.7% (34) that they dispose of them in the trash. These results differ from those obtained in a similar study conducted in Indonesia (Panambunan-Ferse and Breiter, 2013). Due to the relatively low price obtainable, only 11% of respondents said they would choose to sell obsolete mobile phones on the second-hand market. The preferred option was to keep the phones rather than selling them or passing them on to friends and relatives. Also, obsolete mobile phones were perceived to be old-fashioned and cheap with outdated technology, and thus no longer desirable (Panambunan-Ferse and Breiter, 2013).

The questionnaire also surveyed consumer attitudes towards recycling methods (Fig. 5). Most respondents (84.3%) indicated that the most important consideration in selecting such a method is price, whilst others cited “ease of execution” (15.6%), “ease of contact” (1.4%), “ease of finding the location” (8.8%), “appropriate method of treatment/mobile phone recycling” (5%) and “service time” (0.5%). It is clear that price is paramount when consumers consider recycling their old and obsolete mobile phones, although several other factors come into play. Most of the respondents indicated that as long as they would receive a sufficiently high price for offering a phone for recycling, they would overlook a remote recovery outlet location, difficulty of making contact and undesirable treatment/recycling method.

3.3. Types and role of e-waste traders in Hong Kong

To obtain detailed information on the lifecycle of obsolete mobile phones in Hong Kong, the investigators engaged in conversations with traders in four well-known second-hand mobile phone recycling markets in Hong Kong. The results are shown in Fig. 6. Most of these traders indicated that local users were the predominant source of second-hand mobile phones, although a small number are imported from Europe. Some shops re-polish and repair the phones themselves, and others send them to third-party refurbishing shops before selling them to consumers at prices lower than the original. Many phones are transported to Huaqiang

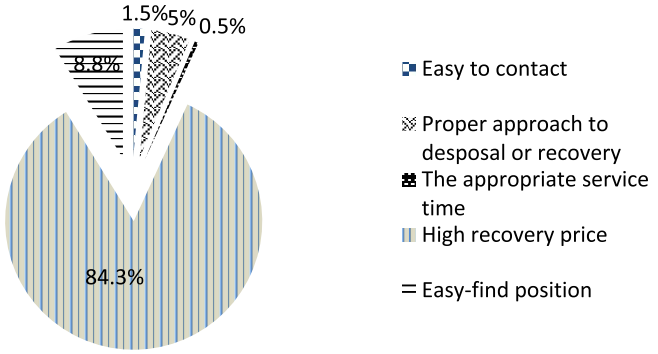

Fig. 5. Factors in choosing mobile phone recyclers.

North in Shenzhen for resale or renovation. One merchant noted that in the current market, only popular and newer models are worth repairing or renovating. If a mobile phone is in poor condition and not of sufficient value to refurbish or repair, traders extract the usable parts and then sell the remainder of the material as e-waste. The estimated ratio of the three methods of recycling is approximately 15%:40%:45%.

A number of traders indicated that they export repaired and refurbished mobile phones to developing countries in Africa, South Asia and the Middle East. Three said that they look for logistics companies with related business through which to market refurbished phones. Only one said that he had set up a logistics business himself, and had signed an agreement with Turkish Airlines to transport phones. The results of a survey of agents operating out of Chungking Mansions said that most of the mobile phones they sell or transport do not come from local households, but rather from "auctions" held by people in the industry. They said there is also an undisclosed website selling second-hand phones from Europe and that Hong Kong is used only as a transit station for phones on their way to developing countries.

3.4. Flow of EoL phones in Shenzhen

Shenzhen is an important transit point through which most of the second-hand mobile phones disposed of in Hong Kong pass. The city is home to numerous stores and factories that process EoL phones. According to the results of interviews with traders in the Huaqiang North area of Shenzhen, there are several processing steps, including classification, testing, disassembly, reassembly and packaging. Companies import second-hand phones from Hong Kong, and then categorise them based on brand, model, age and condition. Newer phones, which are easily refurbished and can be sold for higher prices, are resold, whilst obsolete models are generally sold as e-waste as there is no value in refurbishing them. Broken phones are sent for repair by low-cost labour using inexpensive materials or disassembled into parts to be sold separately or reassembled and packaged in counterfeit boxes or combined with other unofficial materials. Counterfeit licences can be prepared to make it difficult for potential customers to distinguish refurbished phones from legitimate, new versions of the same model. There are thousands of small shops and sales counters in the second-hand markets of Huaqiang North. Most reassembled mobile phones are sold as new products, constituting what are called "grey imports" from Hong Kong to Shenzhen. However, the quality of these products is obviously not guaranteed by the original manufacturers. Mobile phone parts that cannot be used for the reassembly of "new" phones or the repair of damaged phones are sold as e-waste in Guiyu in Guangdong province or Taizhou in Zhejiang province at a much-reduced price of approximately RMB1.2/kg.

Mobile phones are typically composed by weight of about 40% plastic, 32% non-ferrous metal, 20% glass and ceramics, 3% ferrous metal and 5% other materials (Basel Convention, 2011). They are a useful source of rare earth and other metals in short supply, including copper, gold, silver and palladium, amongst others, and their recycling is thus of value. From an environmental perspective, the recovery and recycling of these metals also has a positive impact (eco-efficiency). Eighty per cent of a mobile phone can be recycled or recovered as energy. However, in Guiyu and Taizhou, the disposal methods used in small, family-owned shops are primitive, inefficient and environmentally damaging. Dismantling is usually conducted manually, and plastic parts and other waste materials are disposed of by open burning. Metals are recovered through the use of uncontrolled open smelting. In fact, open burning to recover such metals as copper, steel and aluminium from plastic-insulated wire and other components of mobile phones is seen as an informal practice with one of the most direct and severe impacts on human health and the environment due to the resulting toxic emissions such as dioxin and carbon monoxide. The health of workers and the residents of surrounding areas is at risk. Previous studies have found elevated levels of PBDEs, PCDD/Fs and such toxic metals as lead, cadmium and mercury in surface soil samples and waterways in Guiyu (Leung et al., 2007; Wong et al., 2007), and soil samples in the Taizhou area have also been found to be heavily polluted (Shen et al., 2009).

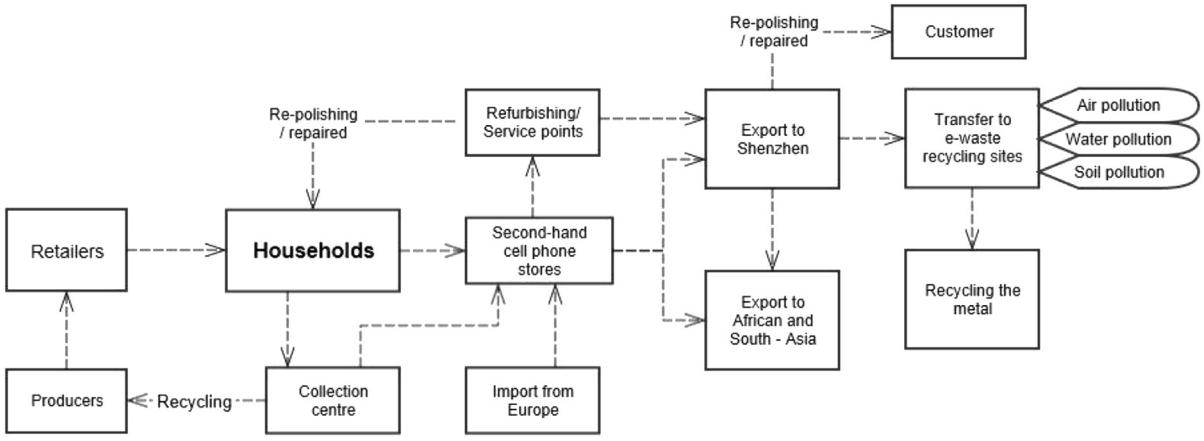

Fig. 6. Lifecycle of a second-hand mobile phone in Hong Kong.

3.5. Potential problems with current methods of handling e-waste in Hong Kong

With a predicted increase in the generation of e-waste by both households and businesses on the horizon (Lau et al., 2013), Hong Kong faces a potential crisis over its lack of capacity to handle such waste in an environmentally sound manner. The United Nations Environment Programme (UNEP) has reported that 1 billion mobile phones had been sold in 2007 globally and predicted that e-waste production in China and South Asia will increase by 200–400% before 2020 (UNEP, 2010). Hong Kong has implemented a framework for e-waste recycling, such as the WEEE Recycling Program began in 2005, and the Computer Recycling program was launched in 2008 (HKEPD, 2011). Despite all this, according to Greenpeace, between 10 and 20% of Hong Kong's e-waste still end up in landfill (Greenpeace, 2012). Critics suggest that Hong Kong 's e-waste program isn't working as well as it potentially could due to a lack of public participation and faltering government regulation (Greenpeace, 2012). There are also environmental concerns over the trans-boundary movement of EoL mobile phones. Many of the hundreds of millions of such phones retired each year, both refurbished models exported for sale and discarded models exported for recycling and disposal, end up in developing countries with little or no infrastructure in place to ensure that they are processed, and ultimately managed, in a manner that protects public health and the environment (Most, 2003).

Observations and interviews conducted in Hong Kong for this research suggest that, in addition to legitimate brands, many of the mobile phones sold constitute a mix of original, authentic devices, replicas and second-hand devices of unknown provenance. The retailers interviewed confirmed that not all phones on the market are original because second-hand components are often mixed with original, authentic parts. These off- or no-brand products are sold for less than their original counterparts sold by official retailers. The government concedes that second-hand electronic devices are being illegally imported into Hong Kong, with negative effects on the domestic market and the environment.

E-waste from households and service centres alike is currently accumulating in Hong Kong's landfills even though much such waste is exported across the border or to other countries. For example, 10–20% of discarded computers still end up in 3 landfills of Hong Kong (Greenpeace, 2012). Every year sees a dramatic increase in the amount of local e-waste (C&SD, 2014), and if no good solution is found soon it is bound to become a problem for the government.

Mobile phone producers have set up collection points in most districts in Hong Kong, providing a voluntary take-back option in the absence of government regulation (HKEPD, 2015). These collection centres are offered primarily by internationally recognised brands. However, because there is little publicity, most Hong Kongers are unaware of their existence, thus severely limiting their effectiveness. Eighty-five present of citizens we investigated did not know the collection points locations and recovery programme. Although the number of mobile phones in Hong Kong has increased tremendously in recent years, and they now constitute the largest proportion of potential e-waste in volume terms, the low rate of collection of other ICT devices in the absence of e-waste regulation is also worrying. One potential way forward would be to learn from industrialised countries such as Germany, where producers must meet target recycling rates. They must report the quantity of mobile phone devices entering the market to a registration agency for further calculation of those rates, which are their responsibility (Deubzer, 2011). Another potential model is that of the Netherlands, whose government obliges producers to prepare proposals on how they plan to manage their electronic devices at the post-consumer stage, including take-back, recovery and funding mechanisms. The proposals must then gain government approval before the products are allowed to enter the market (OECD, 2011). However, in Hong Kong, because space is limited, every effort must be made to reduce waste and the contamination that comes from it. Hence, a more rational, organised and centrally controlled plan is called for. Whilst there is money to be made from recovering valuable materials from e-waste, to discourage the illegal reuse of parts and minimise the release of contaminants into the environment, at a minimum the government should license and regulate the lifecycle of materials used to manufacture electronic devices such as mobile phones. The cost of such licensing and regulation could be borne by users through an excise tax levied on all electronic devices sold in Hong Kong. Also, similar to the scheme used to assure that obsolete automobiles do not accumulate in Hong Kong, a refundable charge could also be levied on each device. All or part of that charge could then be returned to the user upon the proper disposal of the device through a sanctioned recycler. The end result would be reduced waste, less pollution from the uncontrolled recovery of materials and a check on the illicit trade in counterfeit devices.

4. Conclusions

The average lifespan of mobile phones was 23 months in Hong Kong during 2013–2015, which was shorten than Korea and Nigeria. Shenzhen China was the major receiver of EoL mobile phoes generated in households of Hong Kong.

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