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E-waste recycling in China: Environmental problem or Economic benefit?

أعادة تدوير النفايات الالكترونية في الصين: مشكلة بيئية ام فائدة اقتصادية؟

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Abstract

The amount of electronic waste has increased rapidly because of increased consumption and production of electrical and electronic equipment in the world. This study examines the situation of e-waste recycling in China. It also explores if e-waste recycling causes more environmental damage than economic benefit for China. This study examines the effective legislation of import e-waste to China. This study advances our understanding of e-waste and China. The present study was dependent on grey literature and policy documents. I then analyse these documents by using thematic analysis.

The findings from the research show that e-waste recycling in China has caused environmental problems in two sectors: formal and informal. This happens because the formal and informal sectors do not properly deal with e-waste properly. However, e-waste recycling in China achieves economic profit in the informal sector.

Keywords: *Recycling, e-waste, Economic benefit, Environmental problem*

المستخلص

ازدادت كمية النفايات االلكترونية سريعا بسبب زيادة استهلاك وانتاج النفايات والمعدات االلكترونية في العالم. **أهداف البحث** حيث تبحث هذه الدراسة حالة اعادة تدوير النفايات االلكترونية في الصين. وكذلك ركزت هذه الدراسة على مسألة فيما أذا كانت اعادة تدوير النفايات االلكترونية تسبب زيادة الضرر على البيئة أكثر من الفائدة االقتصادية في الصين. **المواد وطرائق العمل،** اختبرت الدراسة فعالية القوانين المتعلقة في استيراد النفايات االلكترونية الى الصين. وتعد دراسة متقدمة لفهم اعادة تدوير النفايات االلكترونية في تلك الدولة. حيث اعتمدت على الأدب الرمادي والوثائق السياسية. ثم تحليل تلك الوثائق باستخدام التحليل الموضوعي. **الاستنتاجات** أظهرت نتائج هذا البحث ان اعادة تدوير النفايات االلكترونية في الصين تسبب مشاكل بيئية في القطاعين الرسمي وغير الرسمي لإعادة التدوير. وهذا يعود الى ان القطاعات الرسمية وغير الرسمية لا تتعامل بصورة صحيحة مع النفايات االلكترونية. وعلى العكس من ذلك فإنها تشكل ارباح اقتصادية في القطاع غير الرسمي.

الكلمات المفتاحية: *أعادة التدوير، النفايات الالكترونية، الفائدة الاقتصادية، مشكلة بيئية*

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Introduction

Over the last few years, the technology industry has increased due to globalization and urbanization as well as increased ownership of appliances such as mobile phones, desktop computers and laptops (Yu et al., 2010). In addition, the amount of E-waste has increased because of the life span of these electronic products (Dindarian *et al*, 2012). Generally, the definition of E-waste is ‘’electrical or electronic equipment (also known as WEEE) which is waste within the meaning of Article 3(1) of Directive 2008/91/EC, including all components, sub-assemblies and consumables which are part of the product at the time of discarding” (Geeraerts *et al*, 2015). The total volume of waste is estimated to increase by around 3-5 % per year according to the United Nations Environmental Program (UNEP) in 2005 (Edwards, 2016). Electronic products are considered electronic waste when they come to the end of their life (Chi *et al*, 2014). E-waste contains a variety of materials for example, precious materials such as platinum, palladium, silver and gold, heavy metals such as mercury, cadmium, lead and CFCs (chlorofluorocarbon). In addition, it contains valuable materials such as copper, iron, plastic and aluminium (Perkins *et al*, 2014). Electrical and electronic equipment can be classified into six groups (Baldé *et al*, 2014). For instance, large equipment (copying equipment, electric stoves and clothes dryers), small equipment (toasters, electric shavers and electric kettles), lamps (LED lamps and compact fluorescent lamps), screens monitors (notebooks, laptops and tablets), temperature exchange equipment (cooling and freezing) small IT and telecommunication equipment (routers, personal computers, printers and telephones) [(Baldé *et al*, 2014).

Figure (1) shows the electronic waste

Source: Canada, H.F. of (2016) Electronic waste - Harmony Foundation of Canada. Available at: http://harmonyfdn.ca/?page_id=867 (Accessed: 11 October 2016).

Research problem and methods

The concentration of my research was on China. I have used qualitative research methods exclusively. The main reason for choosing China is because it is considered the largest recycler and importer of discarded electronic equipment, also China plays an important role in the global e-waste scene (Edwards, 2016). Furthermore, it is estimated around 80 per cent of the total amount of e-waste ends up in Asia or 90 per cent of this is shipped to China (UNODC, 2013). WEEE (2006) states that the Chinese government detected approximately 30 cases of illegal shipment between 1994 – 2007.

Methodology Approach

According to (Patterson, 2008) there are four types of narrative analysis: thematic analysis, structural analysis, dialogic/performance analysis and visual narrative analysis. In this research I will use a thematic analysis. Thematic analysis is used in qualitative research (Thomas and Harden, 2008). Policy documents and reports were coded manually by using common themes (Saldaña, 2012). I have chosen this method because thematic analysis is a popular and foundational method of analysing qualitative policy documents. It is concerned with the analysis and identification different themes and constitutes a widely applicable, flexible tool and cost-effective for exploratory research.

This includes highlighting specific words in the documents and reports. (see Appendix A for examples) and adding note codes in the margins. I copied the key words and phrases on to papers to help me to include them in the group. When I coded and grouped the data I was able to identify themes (Ways to identify themes such as repetition) and links between categories. According to (Bricki and Green, 2007) it is necessary to re-read the documents and review coding groups through an analytical process to refine interpretation of documents and check accuracy.

Research findings and discussion

My research finding will be discussed and presented in two sections. The first section investigates whether recycling e-waste has caused environmental problems and whether it has beneficial outcomes in China. The second section explores the effectiveness of enforcement legislation in China. My research findings will be discussed below, drawing on the analysis of the reports and policy documents and supported by extracts from reports and documents. The spectrum of e-waste recycling in China can be conceptualised into two categories, ranging from formal sectors to informal sectors. Informal sectors (illegal) have been divided into three categories Environment (soil, water and air), Human and Economic.

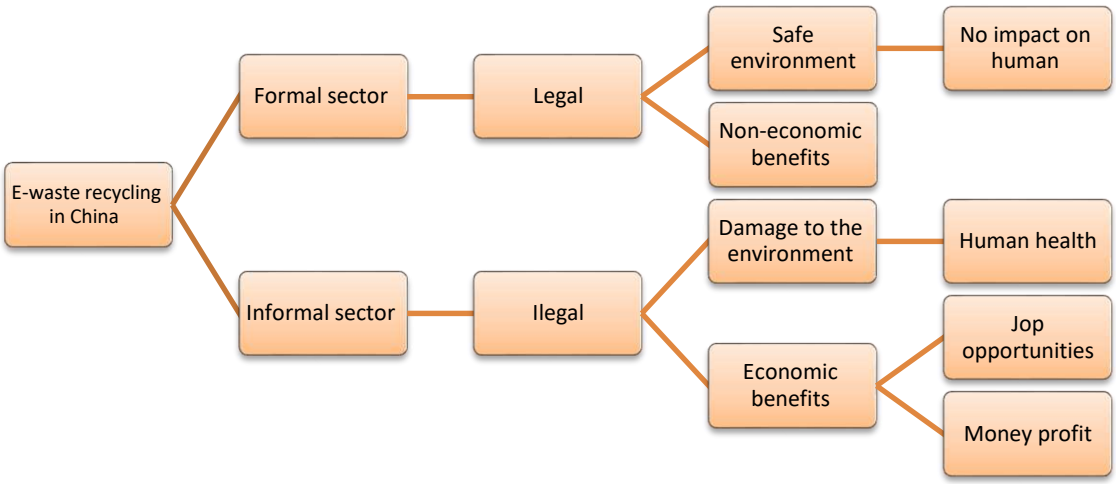

Figure 2
shows the flow of e-waste in China
The figure prepared by the researchers

Formal and informal sector in China

E-waste recycling practices can be divided into two sectors: formal and informal. The formal sector contains companies which recycle e-waste using proper equipment that allows them to extract heavy and precious metals by using safe methods (Perkins *et al*, 2014). Hence, the formal sector is legal. However, informal sectors are beyond the scope of official governance, lacking infrastructure, unregistered and illegal (Perkins *et al*, 2014). The number of workers employed in the formal sector is about 16,000 people, while the number of people in the informal sector is 700,000 in China (Duan and Eugster, 2007). The two biggest centres contained in the informal sector in China are Guiyu and Taizhou (Geeraerts *et al*, 2015). Guiyu is the most toxic place in the world (Kan, 2014) where there are 3200 recycling companies (Liu *et al*., 2014).

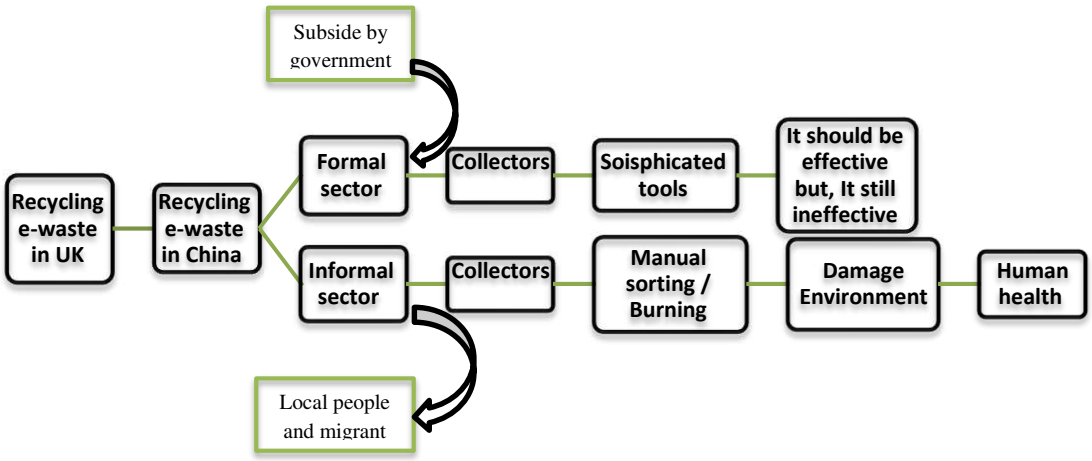

Figure 3
shows formal and informal sector in China
The figure prepared by researchers

E-waste and the Environment in China

To fully understand the relationship between e-waste recycling and economic benefit from recycling, the environment must be taken into account. In addition, it is necessary to examine whether e-waste recycling does more harm than good.

The local environment may be affected by recycling e-waste for many reasons. For instance, preventive reasons, workers who are involved in e-waste recycling do not wear protective gear or use specific tools for the e-waste process and the process is without a proper infrastructure (Feng *et al.*, 2013). Furthermore, there is poor e-waste recycling management. For instance, the stakeholders use sub-standard practices, such as dumping heavy metals directly in the soil, for example, chlorofluorocarbon (CFC) liquid (Feng *et al.*, 2013). Across the range of reports and documents reviewed, there was widespread agreement that e-waste recycling had a negative impact on the environment and health of the workers. Simply disposing of electronic equipment is not sufficient. Therefore, recycling companies are responsible for properly handling computers and other electronic equipment rather than their just being sent to a waste disposal company .

If we look at the e-waste recycling process, we can identify the harmful impact on the environment. The E-waste recycling process has different stages. According to (Greenpeace., 2005) each stage of e-waste recycling produces large quantities of toxic metals and pollutants in China. Greenpeace do not exclude any stage of the recycling process as mentioned in the report below :

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" All stages in the processing of electrical and electronic wastes have the potential to release substantial quantities of toxic heavy metals and organic compounds to the workplace environment and, at least to the extent studied, also to surrounding soils and water courses " .

Most current e-waste recycling processes depend on differential density sorting methods or manual hand sorting (EPA, 2014). Effective recycling depends on effective sorting (EPA, 2014). This means whenever the sorting process is accurate most raw materials will be extracted. Hand-sorting electronic equipment by informal methods is better than any sophisticated sorting because the workers can extract finer materials and they can isolate various fractions, purer and more concentrated. Hence this method is more economically beneficial than the sophisticated method. It seems to be one of the reasons why developed countries, send the e-waste to China. However, hand sorting affects the health of workers as mentioned above because they do not wear protective clothing (Lundgren, 2012).
Another activity or stage of recycling is open air burning to recover the valuable components such as gold from the e-waste (Brooks *et al*., 2012). Pulmonary and cardiovascular disease is linked with burning e-waste which creates fine particulate matter and leads to effects on human health. Through reading the properties of these particles it is found these chemicals are not biodegradable (Bosetti *et al*., 2007). They have the ability to persist in the environment for long periods of time (Perkins *et al*., 2014), hence increasing the exposure risk for people. Therefore, the environmental problems will continue, passing the problem on to the next generation

Several reports mentioned that formal sectors have been effectively increased by government intervention and funding (Feng *et al*., 2013). Hence the process of e-waste recycling will be better achieved environmentally and economically. However, according to Feng et al (2013) the formal sector was only partially built in China and this meant that the e-waste recycling facilities are designed by incompetent mechanical technologies .

Feng *et al* (2013) state that there are few enterprises qualified for dismantling and refining using different disassembling machinery. In my opinion, the formal sector needs to develop in China to avoid the environmental problems. In spite of overall improvements in the formal sector Feng *et al* (2013) expressed that the formal sector has little benefit for the environment, especially because of gas emissions and has not achieved a high standard of recycling. Therefore, the formal sector and informal sector are not effective and there is a lacking in the infrastructure in China.

Economics of the E-waste Industry in China

Although there are human health problems and environmental problems caused by informal sector recycling practices in some towns, China has still allowed the import of e-waste through their borders however, the Chinese government has passed laws and bans to stop the import of e-waste from other countries (this will be discussed in the next section).

Despite prevailing negative stereotypes, many reports and documents expressed positive views about the economic benefits from informal recycling, particularly that they are'' profitable'' ''economic incentives'' ''economic benefit''. Economic profit from the e-waste recycling process comes from the low cost of labour and the cost of the raw materials. According to Lundgren (2012) in China, the average wage per worker in e-waste recycling plants is less than $ 1.5 per day particularly, in Guiyu. The cost of labour in China is very cheap compared to other countries. As the cost of labour is very cheap it is an incentive to create thousands of jobs for unskilled people .

However, it also has a positive impact on the environment by reducing the depletion of natural resources (UNEP, 2013). Hence, it is considered as a resource for raw materials (Brooks et al., 2012). Furthermore, informal sectors are focused on the economic benefits by re-using materials and extracting valuable metals such as gold, silver and copper. Labour laws were generally viewed positively by reports although they are problematic for businessmen. Local businessmen do not care about the protective measures for workers and they provide them with simple tools to extract metals in the shortest time (Feng *et al*., 2013). Local businessmen's goals are to get profit in the shortest time .

"*Informal recycling focuses on extracting re-use and scrap values from e-waste without environmental protection measures, emission controls or measures to protect the health and safety of workers* " (Feng *et al*., 2013).

Nie Yongfeng, an environment professor at Beijing's prestigious Tsinghua University said " People use the least investment, the most simple equipment, the shortest time possible to get the most profit out of this business," (Chisholm and Bu, 2007).

Furthermore, Nie explained what the government does try to manage the e-waste in China but it is impossible(Chisholm and Bu, 2007). However, if the government controlled e-waste totally, the businessmen's money flow would stop. This procedure will have an effect on the businessmen's goals. Hence, e-waste recycling is not lucrative for businessmen .

Furthermore, if we compare the e-waste collection process between informal and formal sectors, the informal sector may tend to pay more money for e-waste

purchased from customers than the formal sector because the cost of labour is low (Feng *et al*., 2013). Hence, people prefer the informal sector from a financial resource perspective. The formal sector has proven to be difficult and challenging in collecting e-waste from customers and covering the costs of collecting (Geeraerts *et al*, 2015). Hence, e-waste recycling will be expensive. We can conclude there is economic profit associated with unregulated (informal) sectors.

However, the informal sector hurts the growth of national economy for many reasons. For instance, spread of administrative corruption in the banking system and undermining confidence in the local financial market. In addition, loss of the state financially due to tax evasion and this lead to encourage evasion of the law (Ouédraogo, 2017).

The legislation of e-waste in China

In order to understand the political and moral dynamics of waste electrical and electronic equipment in China, it will be helpful to examine the differences that exist between e-waste regulations and the effectiveness of laws in China.

In 1992, the Basel Convention was launched to deter exportation of hazardous waste from developed countries to developing nations for final disposal (Basel convention, 1992). Currently there are 181 members in this convention (Geeraerts *et al*, 2015). From a trade perspective, each member has the right to forbid import of e-waste as well as each member should agree to stop the export of wastes to any nation that has not consented to accept the import (Geeraerts et al, 2015). This convention puts forward a prior informed consent (PIC) mechanism The aim of this consent is to inform and get consent from the country of import to keep trans-border shipments to a minimum(Basel convention, 1992). However, there is no clear obligation on members to criminalise in Article 4 (3) and the text only mentioned members should "consider that illegal traffic in hazardous wastes or other wastes is criminal" (Basel convention, 1992). From the reports of Feng *et al* (2013) I believe that legislating and applying the law is one of the best solutions to prohibiting the import of waste from other countries (UK) to China. However, the policy systems in Hong Kong and China are different. The Basel Convention, including China as a part of this convention, means that Hong Kong should also apply this convention. According to Puckett and Smith (2002) the aim of the Basel Ban is to prohibit illegal waste imports to developing countries from developed countries) in the law of Hong Kong in 2006 .

In 2000, the Chinese government totally banned import of e-waste from developed countries. Whereas, Hong Kong has a license to import e-waste and second hand EEE. This license import means Hong Kong can import e-waste legally. Therefore, when e-waste has been imported to Hong Kong, it could re-export e-waste to other countries or the mainland China (Wang *et al*., 2013). As we

see there is a flaw in the laws and rules in China and this tends to exacerbate problems rather than solve them.

Hong Kong is considered an entry-port therefore, the exporters used Hong Kong to tranship e-waste and then tranship the e-waste to smaller ports in China (Lundgren, 2012).

In addition, the exporters can bribe the custom officers in these ports (Wang *et al*., 2013). Hence, these gaps in the Chinese legislation should be addressed.

In China, one of the objectives of the environmental policy is to preserve and protect human health and make the polluter pay (Wang *et al*., 2013). In 2006, it enacted a policy called Technical Policy on Pollution Prevention and Control of WEEE. The aim of this policy is to reduce the amount of e-waste and to increase standards for e-waste recycling. It contains four principles of Reduce, Re-use and Recycle (3R) and Polluter Pays. The polluter should pay which means that firms should pay for the cost of harm (Wang *et al*., 2013).

In addition, The Chinese government placed regulations on recycling Waste Electrical and Electronic Equipment (WEEE) such as (televisions, refrigerators, washing machines, air conditioners and computers). Producers must pay taxes on these products to subsidize the formal sectors (Feng *et al*., 2013). However, the government identified only five types of electronic equipment (Zhu, 2010). but what about other types of electronic products? I believe the government should make legislation for other e-waste. Furthermore, there are 130 enterprise companies in China, however there are only 53 enterprises that have applied the law in different cities in China. Also, these enterprises have achieved the standard requirement (Feng *et al.*, 2013). However, importing e-waste across Hong Kong is not the only issue and China will have to deal more and more with its domestic e-waste production. China generates more than 6 million tons per year, it is second highest in the world after the U.S.[30].

Policy documents report that although the Chinese government have banned these practices because they are illegal, e-waste is still flowing to China and the shipment of e-waste continues to increase illegally. It is obvious there is a lack of effective enforcement and a monitoring mechanism. E-waste recycling has declined in southern China due to local governments enforcing stricter environmental policies (Puckett and Smith, 2002). This contrasts with Guiyu, where the number of workers in informal sectors has come to exceed the total number of residents in the city(Geeraerts *et al*, 2015). In addition, As I mentioned, e-waste creates job opportunities which means that these incentives have played an essential role in preventing China from fully implementing its e-waste laws and regulations.

I believe applying e-waste law needs to co-operation between developing and developed countries as well as regional collaboration to improve e-waste

management. Hence this would lead to the protection of the environment and humans.

Conclusion

This study has examined the situation of e-waste recycling in China especially relating to economic benefit and environmental problems. It also explores the effectiveness of environmental legislations in China.

The main findings are summarized in the following list. Two specific problems are repeatedly highlighted by reports and policy documents relating to the environment and the health of workers. Furthermore, we looked at e-waste recycling firstly from the perspective of environmental harm. The other perspective is economic benefit which is a rich source of valuable materials that could be regained profitably. China give the priority to economic benefit.

One of the reasons to causing environmental problems is financial instability. It is the main challenge for informal workers in China. Most of workers have dependents and barely make enough money to live beyond a subsistence level. perhaps it is necessary to make policy changes concerning e-waste and set up new mechanisms to fill gaps in the laws and their enforcement.

Table (1)
shows comparison between environmental problems caused by formal and informal sector in China.

Environmental Problems in **informal** sector	Environmental problems in **formal** sector
• **Air pollution** The burning of e-waste for e-waste recycling leads to air pollution (Man et al., 2013) Furthermore, in Guiyu, the concentration of PBDE was around 140 and 70 times higher than those in Guangzhou (0.29 ng m−3) and Hong Kong (0.15 ng m−3), respectively (Zhang et al., 2012).	• Recycling e-waste in formal sector does take environment into account the environment therefore, no impact environment and no health issues. In China, formal sector still an effective.
• **Soil pollution** The researchers found the soil contaminated by heavy metals, (PBDEs) and (BFRs), as well as (PCBs) and other toxic compounds (Sepulveda et al., 2010) in Guiyu. They found that the concentration of (PBDEs) was 1140–2196 ng/g in soil near dumping sites (Ye et al., 2009).	
Environmental Problems in **informal** sector	Environmental problems in **formal** sector

• **Water pollution** They compared the concentration of lead in this area with the local drinking water standard and it was found to be approximately 8 times higher than standard (Wang and Guo, 2006). The concentration of fluoride, manganese, and iron were more than the threshold in the ground water. Iron was about 20 times the threshold value, and Manganese up to 5 times. Wang and Guo (2006).	
• Heath people Lead pollution has threatened the health of children who live around e-waste recycling For example, blood levels of lead in children 1−6 years old from Guiyu were (4.4−32.7 μgdL−1 with an average of 15.3 μgdL−1) which is higher than those children who are not involved in e-waste recycling activities from Chendian (Zhang et al., 2012). Over 25% of new borns in the Guiyu area, have high cadmium levels compared with the WHO standard in their umbilical cord blood cadmium (Li et al., 2010) According to Perkins et al., (2014) a high level of 8hydroxydeoxyguanosine was found in the post-work-shift urine of e-waste workers	

Table (2) shows
comparison between economic benefits in formal sector and economic benefits in informal sector.

Economic benefits **(formal sector)**	Economic benefits **(informal sector)**
• The average wage per worker in e-waste recycling plants is less than $ 1.5 per day particularly, in Guiyu.	• It is expensive because recycling e-waste need the preservation tools for workers, soisphicated tools
• As the cost of labour is very cheap it is an incentive to create thousands of jobs for unskilled people	• As well as cost of training workers and cost of re cycling machine are not cheap
Economic benefits **(formal sector)**	Economic benefits **(informal sector)**

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• In China the number of people who worked in the formal sector is 1.5 million and 2.5 million for the informal sector.	• The formal sector has proven to be difficult and challenging in collecting e-waste from customers and covering the costs of collecting (Geeraerts et al., 2015).
• if we compare the e-waste collection process between informal and formal sectors, the informal sector may tend to pay more money for e-waste purchased from customers than the formal sector because the cost of labour is low (Feng et al., 2013). Hence, people prefer the informal sector from a financial resource perspective	• Hence, e-waste recycling will be expensive. We can conclude there is economic profit associated with unregulated (informal) sectors.

Furthermore, we looked at the legislation about e-waste in China. The previous sections prove that relaxed and weak legislation enforcement and lack of coherent policy in China, with a lack of e-waste recycling strategies, lack of public awareness and absence of regulation concerning e-waste permits for electronic producers lead to a failure to deal with their waste in a proper way. Hence causing unwarranted threat to human health and the environment. China must tighten its own e-waste regulations and the Chinese government should make efforts to ensure that the regulations are enforced, especially in Hong Kong. China banned the import of electronic waste in 2000(Geeraerts et al, 2015). whereas Hong Kong is a Special Administrative Region (SAR) of China. Hong Kong allows the legal import of e-waste and it is not applying the Chinese law. Furthermore, Hong Kong is able to re-export this waste to mainland China and other countries (Feng et al., 2013). As a result of that there is difficulty in managing the illegal import of e-waste, although there is law ban importing e-waste to China

Recommendation

Future policy management should be stricter and fill the gaps in laws, especially the policies regarding to Hong Kong and make it coherent. The civil society (non- government organisation and non-profit sector) should have the effective role in making people aware of the effect of e-waste recycling practices on the environment and human health and children.

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