E-Waste Management: An Analysis of The Transition of E-waste Management in China

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

Have you ever had trouble recycling your e-waste? I have around 50 used batteries left at home for more than one year, and I was not intentionally collecting them. The only place in Charlottesville I know that recycles used batteries is at Clemons Library, and I have been waiting to recycle all the batteries at one time, since I would not put in 30-minute efforts to go to Clemons every week. Back in primary school, even before plastic recycling was widely stressed, I learned that batteries can cause serious, irreversible pollution to land and water due to the heavy metals contained, and the polluted land can hardly grow crops anymore.

Besides batteries, discarded electrical or electronic devices that could contain potentially harmful materials such as lead, arsenic, cadmium, mercury, or brominated flame retardants, are also known as e-waste. E-waste has become a global phenomenon due to proliferation of electronic devices in recent years. With the proliferation of personal digital devices, electronic devices including PCs, cell phones, earphones, etc. have become more accessible to users in terms of price and supply. At the same time, the quantity of disposed electronic devices is also increasing rapidly. Such acceleration is the result of the shorter lifespans of electronic devices and the still expanding market.

With the benefits and convenience the various electronic devices provided, they also posted an enormous challenge for every country. E-waste is especially hard to manage and recycle among all the wastes because it contains harmful components, which could lead to intoxicity to workers while processing it. In addition, some of the electronic wastes, such as

lithium-ion batteries, lack intrinsic monetary value for recycling, while recycling companies that run private businesses are not required by regulations to manage such wastes.

In spite of the unprofitable nature of most e-waste and difficulty in managing it, China had been taking and processing waste from other countries for almost 20 years. According to a report published by United Nations University, in 2012 China imported 500 million tons of e-waste that year, accounting for more than 70 percent of the total disposed e-waste around the globe (Wang et al.). However, in December 2017, China banned importing wastes from other countries due to non-negligible threats to its environment (Lee, 2018).

In addition to banning waste imports, China promoted a set of more stringent waste recycling practices in 46 major cities in 2019 (Duan, 2019). This new recycling standard required citizens to accurately classify waste into 4 categories: dry waste, wet waste, recyclable waste and harmful waste. The practice was promoted with large efforts from the government, and 30 cities had already incorporated the new waste classification into local ordinances. While China has been actively practicing a reform of municipal solid waste management, in the US the single stream recycling is still the dominating recycling strategy. Single stream recycling is defined as a recycling system in which all recyclable wastes are mixed and collected. According to Eileen Berenyi of the solid-waste research-and-consulting firm Governmental Advisory Associates, almost half of the 570 recycling facilities in the U.S. now have single-stream operations (Berenyi, 2013). In this paper, I will first describe the gradual transition of management of e-waste and its impact in China, and will then discuss the existing strategies and plannings that have supported the rapid transition of e-waste management. The key momentum identified then can assist stakeholders that are interested in the reform of e-waste management.

Literature Review

Processing E-waste Posts threats to Workers' Health and Environment

At the beginning of the strategy of importing waste, China was far behind other countries in economy and technology and was in dire need of fast development. Although China had most labor force and was one of the largest producers of plastics, this enormous production capacity was far from meeting vigorous domestic demand, leaving the Chinese government with no choice but to rely on imports. Importing waste gave China access to cheaper than virgin raw materials and of higher quality than domestically-generated waste, imports of waste plastics were rising exponentially (Yoshida, 1995). However, while importing waste granted China benefits and improvement in manufacturing technology, in China the recycling lacked a central, stable and flexible intermediate between waste generation and landfill like recycling centers to transform the waste into recycled secondary construction materials (Zhao et al., 2010). In addition, the recycling technology was still immature when handling a massive amount of waste (Huang et al., 2009). In China, it was found that nearly 60% of the e-wastes were sold to private business companies and processed with informal recycling procedures (Liu et al., 2006). Guiyu, a small town in Guangdong Province, is one of the final destinations of the imported e-wastes. Nearly 60–80% of families in Guiyu have engaged in waste operations managed by family-run workshops (Huo et al, 2007). However, the processes and techniques used during the recycling activities in Guiyu were very primitive. Wastes were mostly dismantled by hand, and non-detachable wastes, such as circuit boards, were processed by melting on coal stoves. E-wastes containing gold and palladium were dissolved in sulfuric acid to extract the valuable metals, while the solutions after washing were directly disposed into rivers. Furthermore, process residues were dumped in workshops, open fields and rivers and it was found that released hazardous chemicals from the process residue resulted in elevated blood lead levels of children

in Guiyu (Huo et al, 2007). Soaring levels of toxic heavy metals and organic contaminants in samples of surface water were also evidenced in Guiyu (Wang & Guo, 2006). Guiyu is just one example among all the towns where its community relies on waste processing for most of its income. But such economic benefits were in exchange with the health of the community members and its environment quality.

Current E-waste Management Approaches

The Extended Producer Responsibility (EPR) has been the paradigm for e-waste management in many developed countries. Most countries of the Organisation for Economic Co-operation and Development (OECD) (Lindhqvist, 2000), 25 states in the US ("State Legislation", n.d.) and Japan (Tojo, 2004) have passed legislation mandating e-waste recycling, and the concept of EPR is also spreading to developing countries. Among the 25 states in the US, 23 employed the EPR strategy ("State Legislation", n.d.). EPR was first introduced in 1990 and then redefined by Thomas Lindhqvist (2000) as " an environmental protection strategy to reach an environmental objective of a decreased total environmental impact of a product, by making the manufacturer of the product responsible for the entire life-cycle of the product and especially for the take-back, recycling and final disposal". This clearly points to a future direction that e-waste management recognizes the importance of including manufacturers and government into the practice of reducing the life-cycle cost of an electronic product. However, applying this paradigm as an environment policy for producers can be difficult. The governments might encounter various impediments. For example, the e-waste management under guidance of EPR creates incentives for recyclers to over-report the amount of collected e-waste in order to receive more subsidies (Kojima et al., 2009). In addition, such a procedure requires large investment to initiate an infrastructure for recycling which could hardly be accomplished by small-scaled

private businesses, and could hinder the development of small to medium-scaled technology companies economically.

Methodology

As the world is becoming more connected with the development of technology of all kinds, the paradigm "new mobilities" is being promoted as the new paradigm within social sciences. While enjoying benefits from a globalized network that carries almost all materials, many lives and organisations are subject to the risks of too little movement or too much, or of the wrong medium or at the wrong time (Sheller & Urry, 2006). While we are able to taste fresh tuna caught in the morning from the Atlantic, Covid-19 spreads across continents. The waste some put into the trash room traveled thousands miles away, and ended in some places where the others rely on that to make a living. With the power of mobility the world has established a network that reflects and reproduces global patterns of social and environmental injustice (Khoo & Rau, 2009). In the case of e-waste management, the emphasis is not mobility but immobility. According to Sacquet (2005, pp.48-49), the future of waste is its disappearance, but the nature of hazard e-waste does not allow for that. This paper will follow the mobility paradigm as a framework, discussing the following issues outlined by Khoo and Rau (2009): the movement of e-waste, how it brings impact to the recipients of the e-waste and in the end, and how has the actions of the recipients' community developed and reshaped the global network of waste management.

Case: Government Initiated the Game Change in Guiyu

The e-waste that traveled across continents used to end in numerous suburban villages in China. After being dismantled and processed, it stayed in the air, river in the form of hazards and in the form of serious illness on the workers. To mediate the polluted environment and to relieve

negative anthropogenic impact, Chinese government implemented several strategies. According to a piece of newsletter by Shi (2018), beginning in March 2010, governments of Guangdong and Guiyu together planned and built an industrial zone of circular economy and have banned over 2000 unqualified e-waste processing workshops since 2012. A total of 1.25 billion yuan was invested in the industrial zone with waste transportation stations, sewage treatment factories, centralized buildings for dismantling and cleaning e-wastes. To attract the small private business groups to move into the zone, taxes and fees for using the processing equipment were offered with high discounts. By the end of 2015, 49 medium sized e-waste processing companies made up of over 1000 small groups had moved into the zone. Such transition had successfully shifted Guiyu's unregulated e-waste business to a well organized, centralized and systematic business supported by technology. In 2018, according to the data recorded by Guangdong's Environmental Protection Administration, air quality in Guiyu was largely improved, with more than 90% of days of air quality passing the standard and pH values in rivers returned to normal. In Guiyu's case, the government realized the severity of the issue and the importance of correcting Guiyu's situation immediately.

What happened with Guiyu was a typical example of how policies and support from local governments can lead to a radical transition of waste management, even in a place that was poor and highly underdeveloped. Starting from reconstruction of infrastructure for processing waste, governments established an industrial zone with systematic centers for processing e-waste, a 1.5 billion yuan investment that showed their resolution to remediate Guiyu's unordered e-waste recycling business. Besides the specific zone, local governments also put in efforts to educate the people on the right methods of recycling. The governments had to persuade people in Guiyu to move their business into the zone. Some business groups were reluctant to move because they

were worried about charges of using the equipment offered in the zone. To relieve the concern, the governments offered favorable policies for joining in the zone including reducing taxes and discounted fees for processing sewage. In addition, the zone implemented one single standard for every company inside, any wasted water, gas or metals were controlled and monitored before they could be released. The one standard made sure no pollution was made outside the zone. In Guiyu's example, the interaction between the government and the small e-waste recycling business groups is mutually effective. Governments showed determination and helped guide the right direction, put in resources and efforts that built confidence for the private business groups to completely change their business model. They reacted to the governments' policies with updated business models and improved technology for processing e-wastes. A company located in the industry zone, China Energy Conservation and Environmental Protection Group (CECEP Shantou), engages in recycling circuit boards. CECEP Shantou now has the ability to process 6000 tons of circuit boards with leading technology in China and has 7 patents in dismantling e-wastes. Such achievement of patents demonstrated a total transition for China from a passive collector of waste to a role that is actively researching on technologies for improvement of e-waste management.

Even though the business of recycling e-waste requires large investments at the very beginning, once the initial investment and the infrastructure of e-waste management have been achieved, this is a business that can sustain and profit. Combining research for better recycling technology, industry and government, e-waste management benefits not only us but also future generations with a sustainable environment.

Consumers and social media: a win-win interaction

Besides e-waste recycling companies, Chinese government has also required the engagement of people in large cities, who buy digital devices and throw them away much more frequently than the people in suburban areas. In 2019, Chinese President Jinping Xi announced a plan which aims to set a new standard waste sorting system by 2020. Because the new sorting system is rigorous and a fine of 200 yuan will be applied to wrong classification, the new standard for sorting waste won consumers' notice and became a trend on social media, where citizens shared their experiences classifying the waste. On Weibo, the Chinese version of Twitter, the hashtag "waste classification" had been searched most for quite a while. Waste classification related topics, such as "tourist guide teaches visitors to Shanghai a pithy phrase for waste classification rules", reached 1 billion times views as shown in *Figure 1a.* In addition, quizzes asking questions about which type of a certain waste belonged to also became popular and lots of Wechat users forwarded their quiz scores to their Friends Circle as shown in *Figure 1b*, which enhanced the learning of sorting waste.

Figure 1. (a) A screenshot shows that the topic "tourist guide teaches visitors to Shanghai a pithy phrase for waste classification rules" reached 1,925,529 points of popularity on July 20th, 2019. Image acquired from Takefoto.cn (2019) (b) People forwarding and sharing scores of completing quizzes for testing one's knowledge about the new waste classification rules (Chen et al, 2019).

One of the biggest hurdles in e-waste recycling is the engagement of consumers in classifying and recycling their own wastes. Except for forced implementation of regulations, this example has proved that eliciting the public's interest can effectively motivate participation in active recycling. Recognizing the influence of social media, China pushed the rigorous waste recycling rules into the public's daily life through the platforms of attention and transformed a responsibility into a trendy action. Social media applications helped point to most useful and interesting ideas of ways of fast learning the classification rules while gaining enormous flow and thus profit. The public, on the other side of the win-win trade, gained access to entertainment

and learning simultaneously, while interacting with others. Furthermore, there were accounts created that focus on waste recycling and collected millions of followers during the trend. These accounts continued to offer new ideas for waste management and have been reminding followers about the importance of carefully sorting their own waste.

Discussion

The global network of waste management constructed through the political circumstance has led to excessive mobility of waste from developed countries to developing countries and underdeveloped countries in Asia. The waste did not magically disappear in the one-direction pattern of movement but accumulated in the destination countries, while providing them with short-term economic benefits, eventually became a serious environmental problem and developed into a threat to the recipient community due to the nature of materiality of waste and its processed residuals. While China used to play a role that was passively ignoring the problem of immobility of waste, it is now fighting back. China has experimented various strategies against troubles in recycling e-waste. From importing waste all over the world, to an underdeveloped, unorganized recycling system and to now a rigorous and complete recycling system with strong infrastructures, both of the cases above testified the effects of political change in the reform of e-waste management. When China initiated the ban of imports of waste, the network was gradually shifting: Thailand, Malaysia and Indonesia have also introduced limitations on waste imports. Countries that used to export most of its waste were forced to rethink methods of managing waste, but the inherent injustice continued as the problem of immobility of waste eventually arrived to the recipient communities.

Many communities in the US have switched to single stream recycling in the past several years (Jamelske & Kipperberg, 2006). However, single stream recycling only benefits the consumers by simplifying the recycling process, but it brings bigger trouble to e-waste recycling companies and the government and posts threats to the environment. From the previous analysis, it is clear that governments have the power to initiate a game change by reconstructing the infrastructure of e-waste management and by encouraging transition of business mode for e-waste recycling companies. The governments can also implement strategies that require strict classification of waste categories from consumers to reduce pollution stemming from random throw-away. But to keep the transition momentum, the move of governments alone is not enough. E-waste recycling companies should respond by actively following guidance the governments offered and by attempting to improve the technology used for recycling from their daily experiences. Meanwhile, consumers and social media software, should seek ways to engage in or enhance the sense of responsibility for sorting and managing personal waste. Each actor in the e-waste recycling network plays an equally important role for promoting and keeping a sustainable e-waste recycling system. However, even with all the efforts described above devoted, the issue with e-waste management would still arrive at the unsolvable complexity of immobility. The future of total disappearance of e-waste is still intangible, and more efforts are needed.

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