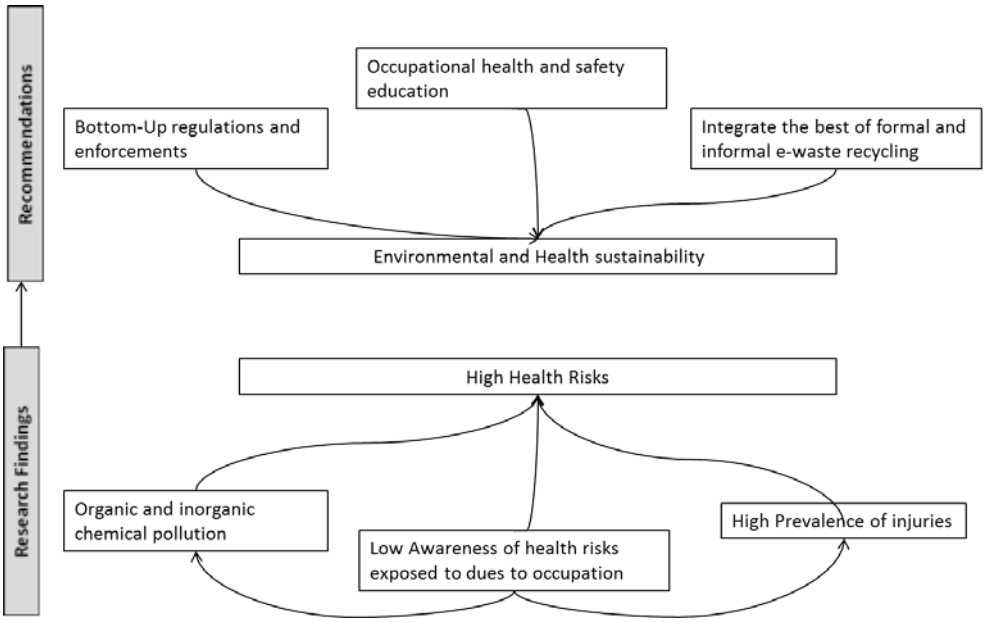
Environmental and health impacts of informal electronic waste recycling

Ohajinwa, C.M.

General Summary



General Summary of this Research

General Summary

Across the world, electronic or electrical devices have become indispensable in our daily lives. This growing importance and demand for electronic or electrical devices coupled with rising obsolescence due to rapid technological advancements and decreasing lifetime of electrical electronic equipment (EEE) has led to an exponential increase in the volume of EEE which are at the end- of-life, also known as electronic waste (e-waste) generated around the globe, making it one of the fastest growing municipal waste streams in the world. Globally, in 2016, 45 million metric tonnes were generated, and an estimate of 50 million metric tons will be generated in 2018. On the average the global e-waste growth is about 7%.

Only 20% of the e-waste generated are documented to be collected and properly recycled, the remaining 80% are not documented, their fate is unknown and they are informally recycled in developing countries in Asia (such as in China, India) and in Africa (such as in Ghana and Nigeria), usually with general waste without segregation. The informal e-waste recycling is on-going because these countries lack the infrastructure for e-waste recycling, there are no e-waste management legislations or weak enforcement of the legislations, and people are not aware of the dangers associated with informal or unsafe recycling of e-waste. In addition, volumes of e-waste internally generated in developing countries are increasing as more people use EEE and EEE has become indispensable in our daily lives. Although *e*-waste recycling industry is a young industry, it is rapidly growing, it has created (1) many employment opportunities; (2) affordable access to electronics and (3) parts used for repairs; (4) a continuous supply of raw materials to manufacturers; (5) conservation of natural resources and (6) conservation of energy required to manufacture new electronics from virgin resources.

Informal recycling involves labour-intensive manual dismantling, isolation of materials, open burning of plastics from electronics, heating of circuit boards, use of toxic acid baths for metal recovery as practiced in Asia, and the remaining are dumped at the open dumpsites or landfills. These unsafe activities are carried out using crude methods to recover valuable materials without or with very little technology to minimise exposure, thus allowing the emission of dangerous chemicals. Occupational safety and environmental protection are clearly not prioritized. These activities have a negative impact on the health of the workers and people around the e-waste recycling vicinity and on the environment, polluting the soil, air, dust, water. The chemicals from the e-waste can also affect the plants and animals in the environment (soil and water). The chemicals can also

bioaccumulate in the food chain and end up in fish, meat, eggs, and milk, potentially causing health problems for humans.

This research was set up to investigate the current impact of informal e-waste recycling in Nigeria. Informal e-waste recycling in Nigeria happens on a large scale, Nigeria imports the largest volume of new and used electronic and electrical equipment in Africa. About 50% of electronics used in Nigeria are imported as second-hand (used) electronics. In 2014, Nigeria generated 219 kilo tonnes. In 2016, the e-waste generated increased to 277 kilo tonnes. This is 20% increase, which is more than the global increase. And the majority of the e-waste is recycled in an unsafe manner.

Insight into the impacts of the various informal e-waste recyling activities (open burning, dismantling, repair) in developing countries is important, as it may offer opportunities for appropriate e-waste recycling management strategies suited for low resource settings to reduce the environmental and health effects of unsafe e-waste recycling. Currently, some developing countries that recycle *e*-waste in large quantity have *e*-waste legislations but enforcement of the legislations are weak such as in Nigeria. Nigeria is a signatory to international e-waste treaties and also has its own national regulations, policies and guidlines, but the enforcement is weak. This gave rise to the questions addressed in this research: Are the e-waste workers aware of these legistlations and policies? Are e-waste workers aware of the dangers associated with their daily jobs? Do they know that their jobs affect their health and the environment as they struggle for livelihood for themselves and their families? Nigerians are happy people who also love quality life, but why are people engaged in health risky jobs? Is the environment contaminated as a result of e-waste recycling? Are the workers exposed to adverse health risks?

Chapter 2 of this thesis unveils the awareness level of the workers, showing that informal workers often underestimate the health risks associated with their jobs. The majority (88%) of e-waste workers are unaware that e-waste contains hazardous chemicals which could pose a risk to their health. Health risk awareness level of the e-waste workers were significantly lower compared with their counterparts (butchers) in the same informal sector. Compared to their counterparts, the *e*-waste workers had poorer knowledge (88%), more negative attitudes (74%), and more unsafe practices (58%) regarding the potential health risks inherent in their jobs. The majority (51%) of e-waste workers are more concerned about making more money, and less about their health. The major factors that influenced workers' awareness level were type of job performed, location, and workers' position in the business.

Chapter 3 reveals the injury prevalence, patterns and factors associated with occupational injuries among e-waste workers. There was a high injury prevalence of 38% (dismantlers 25% and repairers 13%) and 68% (dismantlers 37% and repairers 31%) in 1–2 weeks and 6 months preceding the study, respectively. Despite the high occurrence of injury, only 18% of the workers use any personal protective equipment (PPE) either occasionally or most of the time. The main reasons for not using PPE were 'perceived unimportant, discomfort, cost and unavailability.

Chapter 4 and 5 reported on the environmental impact of various informal e-waste recycling activities (burning, dismantling and repair) on the environment (in top soil and various dust samples including floor dust, roadside dust, and direct dust from inside and outside the electronics). Electronic and electrical equipment contains over 1000 different substances, some of which are hazardous elements such as lead, mercury, cadmium, arsenic, beryllium and persistent organic pollutants such as Polybrominated Diphenyl Ethers (PBDEs). These mixtures of different substances are released into the environment during informal e-waste recycling which may consequently pose significant threats on the environment and human health. We found very high concentrations of toxic metal (chapter 4) and PBDEs (chapter 5) at e-waste recycling sites which exceeded the concentrations at the control sites and the Nigerian standard guideline values by 100s to 1000s times. Burning sites showed the highest pollution level, followed by dismantling sites, and then repair sites (burning > dismantling > repair > control sites). Our findings show that informal e-waste recycling is a major source of metal pollution in Nigeria.

We went further in chapter 6 to estimate the likelihood of adverse health effects (non-cancer and cancer risks) resulting from exposure of *e*-waste workers to metals and PBDEs over a specified time period. Exposure to e-waste chemicals (PBDEs and metals) can occur via three main pathways: (a) direct inhalation of vapour or atmospheric particulates through mouth and nose; (b) dermal absorption of PBDEs in particles adhered to exposed skin; and (c) ingestion of atmospheric particulates due to their deposition/mistaken ingestion. The exposure risk was in the followng order: dermal > ingestion> inhalaltion. E-waste workers are exposed to potential adverse health effects via dermal contact and ingestions of contaminated top soils and dust at all the e-waste recycling sites in all the locations. Dermal contact is the dominant route of exposure. This effect is hightened because the e-waste workers do not use adequate PPE at work, and they are not aware of the health risks associated wit their daily jobs.

Cognisant of the urgent need for safer e-waste recycling, I recommend more effective strategies to implement the e-waste regulations and policies:

1. Collaboration between enforcement agencies and informal sector associations during formulation of the regulations to ensure inputs from the informal e-waste workers are considered.
2. Regulations should not impede the workers' livelihood, as this will encourage the workers to cooporate with the government and enforcement agencies
3. Health and safety education of the e-waste workers on the dangers associated with crude e-waste recycling, and enforced use of PPE
4. Enforce the elimination of open burning as an e-waste recycling activity
5. Enforce alternatives to burning activities.
6. Integrate the best of informal and formal recycling methods to mitigate environmental damage while sustaining the social benefits and livelihood that e-waste recyling provides
7. Further toxicological and epidemiological studies on the e-waste workers and their families