

Economic Benefits vs. Social Costs: Balancing E-Waste Recycling in Developing Nations

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Abstract—The growth in the use of the electronic equipment is harming the environment in a way that is alarming and creating challenges and innovation opportunities majorly in the developing countries regarding E-waste. Therefore, this paper aims to assess the economic advantages and social impacts assumed by these regions for e-waste recycling. Economically, e-waste recycling is full of profits in terms of reprieves of precious scrap metals and employment opportunities in the recycling industries. Nevertheless, social implications are quite significant, mainly manifested in negative impacts on health coming from the insufficiently controlled handling of dangerous materials, and negative impact on the environment as an outcome of ineffective recycling procedures By analyzing case studies from various developing nations, this study aims to balance these competing factors, proposing strategies to enhance the economic benefits of e-waste recycling while mitigating its social and environmental costs.

Keywords— Circular Economy: Developing Nations: E-waste: Recycling: Social Costs: Sustainable Management.

I. INTRODUCTION

Technology in the modern world today has advanced at a very fast pace, and this has been accompanied by the use of the electronic devices hence resulting to e-waste. E-waste consists of used or end-of-life electronics items such as computers, mobile phones, video and other electrical gadgets, TVs, refrigerators, air conditioners, and others. The managing of e-waste has its challenges and opportunities differently distributing in the developing nations than those in the developed nations. However, in other aspects, there are profits generated from e-waste recycling, including job creation, and the alleviation obtained from precious and rare metals. On the other hand, the social impacts that relate to environmental degradation and health wise are very critical and cannot be underestimated.

Realization of the economic advantages and social disadvantages of e-wastes recycling in the developing countries is one of the most important challenges in the relations of the policy makers, industries and communities. This means that the most common players in management of e-waste in these regions are the informal recyclers who practice what has been referred to as the recycling without borders methods, all of which are very dangerous to human health and the environment. At the same time, a large number of people still get employment in the informal business sector which is very significant for the local economy. In this regard, this paper answers the questions; what are the economic gains and social costs and gains of e-waste recycling in developing countries? It also explores how the integrated informal sector

to the economy, assess the social and health implications of the current recycling methodology it advances reasonable solutions for sustainable development. In case and empirical analysis, the paper aims at offering an informed learning of how these developing nations can realize on the opportunities of e-waste recycling without regretting on the losses in social and environmental impacts.

II. METHODS

Peer-reviewed publications on e-waste from the last ten years were compiled using searches on academic research publication databases such as PubMed, Science Direct, and Google Scholar. Publications, government and regulatory agency reports, and directives were obtained through both formal and informal means. The following keywords were used to search the literature: e E-waste, Recycling, Social Costs, Sustainable Management, Developing Nations, and Circular Economy.

III. ECONOMIC BENEFITS OF E-WASTE RECYCLING

A. Job Creation and Economic Growth

The recycling of e-waste can create a lot of employment opportunities for people. The stages involved in recycling includes collection, sorting, disassembly, and processing which activities need skilled personnel. Recycling, in general, and e-waste recycling, in particular, could generate employment to millions of people globally, particularly those living in the developing countries where most of the inform of recycling is practiced [6].

B. Resource Recovery and Revenue Generation

E-waste could contain precious materials such as gold, silver, palladium etc., which can be recovered and sold. Every gadget has multiple numbers of metals and plastics used in its making, which are derived from various resources found in the nature. That is why the disposal of old electronics is not only followed by the need to mine for these materials, but also with a detrimental effect on the earth. Proper recycling of electronics avoid exaggeration of the utilization of some resources and prevents e-waste from polluting the environment.

Electronic waste is relatively non-biodegradable and therefore a threat to the environment and humans, when disposed irresponsibly. Recycling if done efficiently offers the manufacturers an environmental friendly substitute to the metals and the plastics that they use in production of the new goods. For instance, aluminum pulled from hard drives can be

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used in the automotive industry. Thereby managing resources, reducing e-waste and is in agreement with the paperless policy. Recycling of those material from e-waste is also a plus to the economy of developing nations, this is according to Kahhat and Williams, 2009).

C. Prevention of Landfill Use and Protection of Water Bodies from Toxic Waste

Adverse disposal of e-waste results in the growth of dangerous landfills hence becoming a major cause of their growth. Recycling e-waste also means that there is less need for these landfills, hence minimizing the effect of these on the environment, especially water resources. Professional recyclers make sure that components of products that can be recycled are processed appropriately so that dangerous chemicals are not polluting ground water and fresh water. It assists in maintaining water pure and fit for use for drinking by people as well as livestock. Collection and recycling of ewaste is very important because it reduces pollution of water sources and cases of chemical poisoning through the landfill leachate.

D. Electronic Recycling Promotes the Integrity of Agricultural Soil

E-waste recycling encourages the health of agricultural Soil, this is because recycling of the electronic wastes help to avoid leaching of toxic chemicals that are hazardous to plants with regard to growth. It also minimizes the emission of toxic gases and dust particles to the environment as a result of mining, hence conserving the nearby agricultural fields. As it has been observed that farming remains one of the sources of income for a major part of the world's population, it is crucial to preserve rich and safe farmland. Thus, supporting e-waste recycling can lead to improving the structure of the ground surface, supporting agriculture production, and contributing to the development of natural green resources for plants, animals and even human beings. These are general and straightforward benefits, which include; due to a green environment, the air quality will be improved which in turn will help to improve the quality of the living environment for all.

E. Reduce Environmental Health Hazards

E-waste recycling helps protect the environment from detrimental and toxic things that can affect users of natural resources. Proper recycling measures avoid the exposure of harms such as emission of metals, gases, and dust, which the wrong methods like burning may cause. This also helps to lower air pollution and the diseases caused by it, in turn. When old and unused electronics are discarded and recycled appropriately then the emission of bad gases in the atmosphere is avoided; thus, quality of air in the atmosphere is preserved.

IV. SOCIAL COSTS OF E-WASTE RECYCLING

A. Health Risks and Occupational Hazards

Torch-bearing e-waste recycling is dangerous to human health because of toxicity comprising of mercury, lead, cadmium, poly-brominated flame-retardants, barium and lithium among other components found in unwanted electronics. These substances can result in serious side effects of the human body affecting the brain, heart, liver, kidney, and skeletal system. It can also cause diseases in the nervous and reproductive system causing sickness to the patients and birth of deformed children. The dissection of e-waste is a global concern pointing to the need to raise awareness and find the solution to the problem.

As much those people who are assumed to have strong immunities including the youth, pregnant women, elders, lowly wage earners, and other vulnerable groups, their exposure to these toxic chemicals in e-waste-polluted soil exposes them to higher risk. Such population groups stay close to the locations where e-waste is dumped, or where illegal recycling of e-waste takes place, which weakens their immune systems to the toxic chemicals leaching from the hulk of dismantled electronics into the soil. Children are among the most susceptible due to their habits of putting their hands on things and playing on unhygienically dirty surfaces. They are; children are more vulnerable since they are small in stature, and have growing bodies that can easily be affected by pollutants in ways that alter physiological functions, and lead to long-term health complications. Research carried out in Indonesia and Vietnam established that children affected by lead (Pb), chrominum (Cr), arsenicum (As), and mercury (Hg) based heavy metals exhibited high carcinogenic risk [14].

In informal collection and recycling there are a lot of health and safety issues arising. Those who work with the heavy and broken devices are exposed to physical pressures, and cuts from sharp fractions of wastes are experienced. Employees dealing with cathode ray tubes (CRTs) that are to be recycled express severed hands and injuries occasioned by breaking CRTs, and hence cadmium dust is let out. As if the burning of cables to get copper and the roasting of plastic sections to minimize waste mass were not enough, sudden death causes enhanced health effects by liberating POPs such as dioxins and furans. That's why those emissions cause critical environmental and health impacts, emphasizing the problem of safer recycling methods and proper protection of recyclers.

B. Environmental Degradation

When electronics products reach the end of their life, they often are recycled informally usually in developing nations with grave consequences to the environment since primitive techniques are used to extract the valuable materials from the waste. This practice has numerous environmental as well as health effects that are occasioned by poor regulation as well as poor recycling system.

In informal recycling, methods like burning of the e-waste through incineration releases toxic gases and pollutants into the environment thus increasing the level of pollution. Other than polluting the immediate environment by degrading soil, air, and water, open burn affects significant portions of the earth's atmosphere and transports pollutants to various stations. For instance, during the burning of PCB and other plastic constituent parts of electronics, highly dangerous dioxins and furans are emitted, which is dangerously



threatening vital ecosystem commodities (Titobi, 2024). In the areas where open burning occurs various e-waste components are dispersed in the form of dust or fumes that become the major pathways of human uptake through the respiratory system, ingestion and dermal contact. Contaminants in soil arise from various factors, including leaching from e-waste disposal sites, wind direction, erosion, and the progressive release of toxins from degrading electronic equipment. Chemical pollutants from e-waste may disperse in the direction of the prevailing wind surrounding waste electronic and electrical equipment (WEEE) processing plants. Soil samples demonstrate an enhanced concentration of germanium (Ge) in areas downwind from the emitter position. Various studies have provided evidence of the effect of leaching on the upper soil layer, with the potential consequence of contaminating the subsoil profile. This risk is notably heightened during the rainy season, marked by substantial rainfall [2]. After soil contamination, heavy metals from ewaste, such as mercury, lithium, lead, and barium, can leach further into the earth, eventually reaching groundwater. When these heavy metals contaminate groundwater, they can travel into ponds, streams, rivers, and lakes. Through these pathways, acidification and toxification of the water occur, making it unsafe for animals, plants, and communities even miles away from recycling sites. Clean drinking water becomes problematic to find.

V. BALANCING ECONOMIC BENEFITS AND SOCIAL COSTS

- I. Formalizing the E-Waste Sector: The government can formalize e-waste recycling by coming up with policies to regulate the industry. This entails the accreditation of appropriate centres for recycling and also availing protection gears and trainings to the personnel involved in the recycling processes as well as the appropriate environmental disposal of the recyclable products.
- II. *Public Awareness and Education:* Educational campaigns aimed at the individuals involved in informal e-waste recycling can change the actual behavior. Awareness campaigns, educational courses and workshops can also create public and informal workers' awareness of proper approaches and resources for recycling.
- III. *Economic Incentives:* In this regard, it is critical to support initiatives by offering further appealing economics like tax exemptions, subsidies, and grants.
- IV. *Regulation and Enforcement*: This means that implementing strict measures and enforcing them can help in eliminating the uncontrolled informal sector's dangerous operations. This has a bearing in enforcing classication and punishment on the unlawful dumping of ewaste and hazardous methods of recycling.

VI. POLICY RECOMMENDATIONS

It is recommended that developing nations should put in place laws and standards that will support safe and environmental correct recycling processes. There are fundamentalist measures which for example the Basel Convention that assist to fight against the dumping of e-waste illegally [16]. Thus, the authorities should provide rather considerable stimuli for the development of the recycling sector, such as subsidies and tax relieves, the access to superior technologies necessary for a formalised sector which adheres to standards of safety/ environmental responsibility [8]. Thus, it is crucial to launch public awareness campaigns and deliver educational programs to explain potential hazards linked to the inadequate e-waste management and the advantages of proper recycling. The training intended for the workers will enhance safety and effectiveness on the matter of recycling [11].

There is also the availability of human resource, financial structures and other forms of support from developed nations as well as international organizations. They might assist in establishing long-term and efficient e-waste management systems in the developing countries [12].

VII. CONCLUSION

E-waste recycling in the developing countries is indeed lucrative from economical point of view but is heavily charged with social implications. Yet the special sustainable management of e-waste require a comprehensive solution which comprises of effective regulatory environment, advancement of the formal sector, enhanced awareness, and international partnership. If the development countries take measures that can satisfy both the economic and social fractions of the e-waste recycling, then it can bring the maximum of advantage and remove the negative sides. Generally, environmentally sound management of e-waste must be seen as a need and at the same time, a window for the developing countries to revolutionalise the whole world towards the concept of circular economy.

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