E-Waste a Business Opportunity for Sustainable Smart Cities

Ms. Matangi J. Dave[1] Mr. Karankumar J. Gothi[2] Mr. Bhishma J. Bhatti[3]
[1,2,3]PG Student
[1,2,3]Department of Civil Engineering
[1,2,3]Pandit Deendayal Petroleum University (PDPU), Gandhinagar

Abstract— Tremendous growth in the use of Information Communication Technology (ICT) devices and services, faster change of technology and frequent innovations in the ICT sector, had left the world with a threat of stagnation in environmental conditions and human health as the-waste of electronic and electrical equipment, which contains hazardous components, is still handled in an environmentally unfriendly manner mainly in developing smart cities. Which is a huge challenge for smart cities to handle e-waste in a controlled manner and protect the environment. In this paper our approach is made towards assessing the present situation of E-waste management globally as well as in India, considering the present regulations and guidelines. The current practices of E-waste management in smart cities suffer from a number of drawbacks like the difficulty in enumeration, unhealthy conditions of informal recycling, inadequate legislation, poor awareness and unwillingness on the part of the corporation to address the critical issues. In developing smart cities, it can help in uplifting the status of the informal sector with help of education and employment. In addition to the technical, social and organizational aspects of the E-waste management system, it is also crucial to consider the economic aspects, if the system has to be made financially viable and sustainable along with being socially acceptable.

Key words: ICT, E-Waste, Smart Cities, Sustainable, Economical Aspects

I. INTRODUCTION

E-waste management is a common problem faced by both developed countries and developing countries. As per various numbers published by various research agencies, about 20 to 50 million tons of e-waste are generated worldwide every year [3]. E-waste comprises of more than 5% of all solid waste generated and the volume is expected to increase at a rate of 300% per annum in developing countries [3]. Electrical and electronic equipment's and gadgets such as refrigerators, washing machines, computers and printers, televisions, music systems, mobiles, i-pods, are part of every growing list of items that form part of the e-waste landscape. E-waste in India is a matter of much interest and concern, both from the point of view of the environmental aspect and from a business opportunity.

Green businesses are the key drivers of the economy in the current global business scenario. Of the various green initiatives, waste recycling creates the highest positive impact on the environment. Of all the different types of waste, electronic waste has the characteristics of:

- The fastest growing segment of waste
- Most valuable due to its basic composition
- Very hazardous if not handled carefully.

However, the sector is very new with only a few corporate players in India and globally. Most of the electronic waste management sector is currently handled by the unorganized/ informal sector in India. However due to lack of skills, knowledge, awareness, etc., the sector has remained highly labour intensive, environmentally unfriendly and unhealthy. If done in the right way, and in an organized fashion, e-waste management can become a dominant economic sector.

The purpose of this document is to present a project report on electronic waste recycling as a financially rewarding business. Find that the e-waste business is highly profitable from the economic as well as environmental perspective. However, it is perceived that the unorganized sector has a cost advantage. Hence the organized waste management remains limited. Automated or semi-automated large capacity plants require less labour can consistently work at high efficiency and produce a much better quality of the final product. Therefore, they are extremely cost effective in the long run. Thus, even if there is competition of the unorganized sector, e-waste management can be an economically viable and a high returns business for the organized industry.

II. WHY E-WASTE RECYCLING?

- Allows for recovery of valuable precious metals: Most consumer electronics contain valuable materials like copper, gold and zinc that can and should be recycled. Virgin Materials are significantly costlier than recycled materials for manufacturing.
- Protects public health and water quality: E-waste contains a variety of toxic substances, which may include lead, mercury and cadmium. When e-waste is disposed into landfills, these toxins can be released into the atmosphere or leak in through the land and have negative health and environmental effects.
- Creates Jobs: Recycling e-waste domestically creates jobs for professional recyclers and refurbishes and creates new markets for the valuable components that are dismantled.

- Toxic Waste: Mining produce toxic waste, which are linked with crop devastation and human health crises due to water contamination
- Saves landfill space: E-waste is a growing waste stream. Recycling these items will help conserve landfill space.

III. MARKET OVERVIEW

A. *Buyers:*

Main buyers are smelters, plastic recyclers, glass recyclers, metal traders, metal buyers, metal exchanges etc.

B. *Suppliers:*

The suppliers could be both household and corporate entities. It is possible to sign contracts with business houses for collection. Apart from business houses, the household waste electrical and electronic equipment (WEEE) can be collected through a network of scrap dealers, retail outlets etc.

C. *Competition:*

The informal sector forms the biggest competitor. The informal sector, mostly run by 'kabadiwalas,' accounts for 90[4] per cent of the e-waste management in India. The kabadiwalas are primarily involved in dismantling rather than recycling disposed-of products. However, it has several Systemic weaknesses. As of today with WEEE regulations becoming more effective and overall awareness increasing, collection is becoming a problem for the unorganized sector. Within the organized sector, the competition is still limited to just about 10 recyclers in India.

D. *Opportunity:*

Based on various research studies, the total e-waste production in India was about 400,000 Tons in 2009 and is likely to reach 800,000 tons in 2012. Only about 19,000 tons was recycled officially in 2009.

- PC penetration in India is estimated to be 40 per 1000 as compared to 995 in the US. This shows the immense potential for refurbished PC market.
- High technology penetration in Urban areas (>70%).
- Moderate penetration in semi urban areas but a high growth rate around 100%.
- Very low rural penetration and medium growth rate, but accelerating very fast.
- Large companies refresh PCs every 4 years' average.
- In India, organized e-Waste recycling is a nascent industry.

IV. E-WASTE AND THEIR COMPOSITION

Electronic waste, e-waste, e-scrap, or waste electrical and electronic equipment (WEEE) describes discarded electrical or electronic devices. "Electronic waste" may also be defined as discarded computers, office electronic equipment, and entertainment device electronics, mobile phones, television sets and refrigerators. This definition includes used electronics which are destined for reuse, resale, salvage, recycling, or disposal. E-Waste is categorized by the government of India under the broad class of hazardous waste. Within e-Waste, there are several categories such as Large and small household appliances, electrical and electronic toys and sporting equipment, tools, computers and related equipment etc. A detail categorization as adopted by the Central Pollution Control Board of India.

Electrical and Electronic equipment contains metallic and non-metallic elements, alloys and compounds such as Copper, Aluminum, Gold, Silver, Palladium, Platinum, Nickel, Tin, Lead, Iron, Sulphur, Phosphorous, Arsenic etc. If discarded in the open, these metals can cause a severe environmental and health hazard. It is difficult to identify the level of content of each metal. For each category of electronic equipment, each manufacturer, each model may have different composition. However, based on various studies and experiments, researchers establish average benchmarks for some products mentioned in Table-1

PCB and active electronics	20% by weight	Casing, Casting, Non EE parts*	80% by weight
Copper	16%	Plastic	30%
Gold	0.03%	Ferrous Metal	20%
Silver	0.1%	Aluminum	15%
Palladium	0.01%	Glass	20%
Lead	2%	Copper	15%
Aluminum	2%	Total	100%
Iron	5%	*Estimated	
Nickel	1%		
Solder	0.66%		
Epoxy	58%		
Other	12.2%		
Total	100%		

Table 1: Average Composition of WEEE [5]

In reality, all metals cannot be recovered due to technology limitations and commercial viability. In real world, the major metals recovered are Gold, Platinum, Palladium, Nickel, Copper, Silver, Zinc, Iron, and Aluminum. Major non-metals recovered are Lead, Phosphorous. Other items are plastic and glass. It may make economic sense to focus on only a few items and dispose the remaining.

V. E-WASTE HANDLING PRACTICE AT PRESENT

E-waste is generated in households and corporate (including private and government companies). The collection of this waste happens in different ways. The chains start from rag pickers, and move up to local scrap dealers, area aggregators and finally recyclers. Corporate business houses sell their old EEE to second-hand buyers through various means such as auction, scrap sale or open bidding.

Once e-waste is collected from its generators, it is resold or rented or donated or dismantled for parts or sold on basis of weight to scrap dealers. Most of the recycling community works in the informal sector. The aggregate WEEE is taken by a larger scrap dealer who sorts the material as per his own convenience. The non-usable equipment is dismantled manually. The easily separable parts such as plastics, glass, metal cabinets etc. are directly sold in various markets. The more complicated parts such as mother boards, assemblies, fused parts etc are usually sold to an informal recycler. These metals are sold to smelters. In most cases, the extraction techniques are so crude that the output is also contaminated. Also, the efficiency of such techniques is only about 30% [5].

From the usable part of the collected WEEE, some is sold directly in second hand sale, some is refurbished and sold as a refurbished product, some is donated to charity and some is rented.

Fig. 1: (Informal re-cycling of E-waste)

Fig. 2: (Formal re-cycling)

VI. CASE STUDY

The case study has been presented for financial viability of waste treatment facility describing the WEEE/E-waste availability, existing regulatory environment, downstream WEEE/E-waste market and treatment technology/ equipment supply conditions in India. Also risk profile for the facility has been carried out.

A. WEEE/E-waste Treatment Technology:

The proposed facility for E-waste treatment has been conceptualized as per below mentioned flow diagram

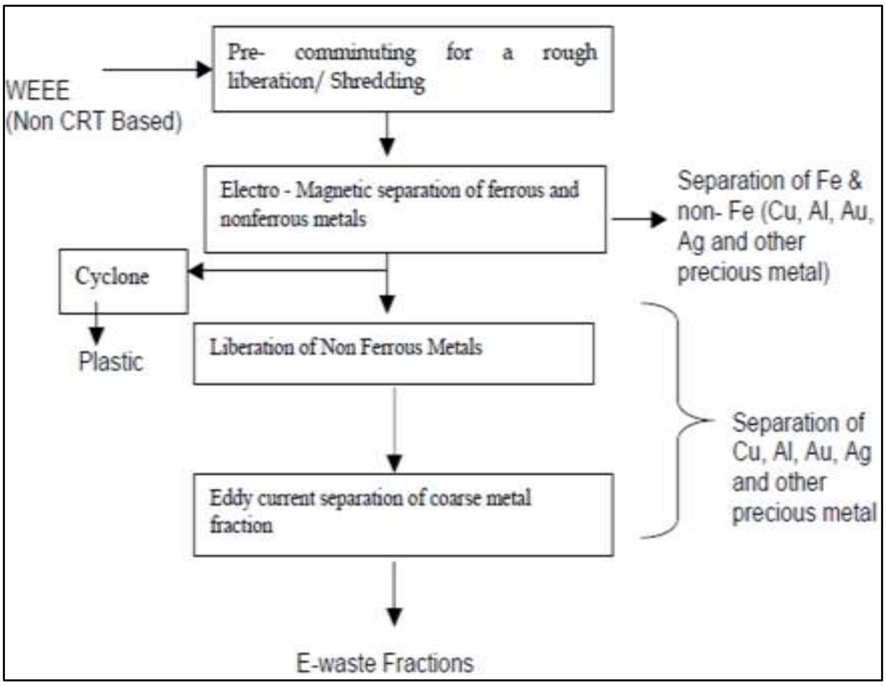

Fig. 3: (Process flow of non-CRT based WEEE/ E-waste treatment)[2]

The Salient feature of Non-CRT (Cathode Ray Tube) WEEE/ E-waste treatment technology and process are given below:

- The process will use ICT and brown goods equipment like PCs, cell phones, televisions and other electronic items and will not use white goods like refrigerators, washing machine or air conditioners.
- The process is focused on removal of three basic components.
  - Plastic
  - CRT/ Glass
  - Metals (ferrous/ non-ferrous)/ Non-metals
- There will be different lines for WEEE/ E-waste and CRT treatment.
- The proposed technology for sorting, treatment, including recycling and disposal of WEEE/ E-waste is fully based on dry process using mechanical operations.
- The process uses a combination of three unit operations for Non-CRT based WEEE/ E-waste treatment. These operations include
  - Pre-comminuting/ comminuting
  - Magnetic/ electrostatic separation
  - Eddy current separation

The pre-commenting stage includes separation of Plastic, CRT and remaining non CRT based WEEE/ E-waste. Equipment's like hammer mill and shear shredder will be used at comminuting stage to cut and pulverize WEEE/ E-waste and prepare it as a feedstock to magnetic and eddy current separation. A heavy-duty hammer mill grinds the material to achieve separation of inert materials and metals. After separation of metals from inert material, metal fraction consisting of ferrous and non-ferrous metals are subjected to magnetic current separation. After separation of ferrous containing fraction, non-ferrous fraction is classified into different non-metal fractions, electrostatic separation and pulverization. The ground material is then screened and de dusted subsequently followed by separation of valuable metal fraction using electrostatic, gravimetric separation and eddy current separation technologies to recover fractions of Copper (Cu), Aluminum (Al), residual fractions containing Gold (Au), Silver (Au) and other precious metals. This results in recovery of clean metallic concentrates, which are sold for further refining to smelters.

VII. FINANCIAL ANALYSIS:

Financial analysis has been carried out by computing the capital costs and operation and maintenance costs. Capital cost includes the total investment cost of USD ($) 5.5 million, which includes cost of land. The operating cost consists of items summarized in Table-3

Sr. No.	Items	Costs
1	Raw material	$0.4/kg for TV and 0.6/kg for PC
2	Labour	$795/day
3	Electricity	$0.102/unit

4	Collection and Transportation system	0.034 cents/km/kg
5	Maintenance Cost (100% capacity utilization)	$110000/annum

Table 3: Operating Cost [2]

In order to compute revenue stream, the selling price of the output to be exported from the WEEE/E-waste treatment facility has been taken as 75% of the price offered in London Metal Exchange while selling price of outputs to be sold in India has been taken from local commodities, metal and scrap market. The weight of TV and PC has been assumed to be 36.5 kg and 27.2 kg respectively. The analysis was carried out in terms of payback period under two scenarios at 70% and 95% capacity utilization of the facility and the results are summarized in Table-4.

Electronic Item	Television		Personal Computer	
Capacity Utilization	70%	95%	70%	95%
Scenario 1 (Years)	12	8	6.8	4.6
Scenario 2(Years)	10.7	7	5.3	3.7

Table 4: Scenario Analysis [2]

A comparative analysis of the payback period under two scenarios indicates that payback period improves if the output from the proposed facility is exported. Therefore, there is a need for long term export contract between the entrepreneur and importing company. Payback improves if the capacity utilization is higher. Capacity utilization depends upon the availability of the raw material. It is expected that WEEE/ E-waste generation from TV and personal computer in the region of influence of proposed facility is expected to exceed 14,000 tones and 29,000 tons during 2015. These quantities are more than 50% higher required for payback period of 4 to 5 years.

VIII. Conclusion

The case study shows that the first and second level WEE/E-waste treatment facility for TVs and personal computer is viable in a geographical region based on B2B model even in the absence of recycling fee/ other financial instrument and WEEE/E-waste collection and transportation infrastructure. The model works even when the recycler pays for the raw material and collection and transportation cost. There is a scope of further reduction of technology costs if the developing country has got infrastructure to for the local fabrication of machinery and equipment. Formal e-recyclers have to be supported by the central and the state governments to avoid the bottlenecks in building a better supply chain for e-waste. In the long run, formal e-recyclers will need to come together to form an influential body in this industry. They can then lobby with the government to promote some innovative methods of collecting e-waste from retail consumers and promote awareness of the environmental impact of e-waste

Considering all the above points, we hold the opinion that WEEE recycling is a highly profitable business. Precious metals are in restricted quantities and therefore to ensure maximum recovery, the process of separating metals must be such that there is minimal contamination and a minimum loss. Use of technology ensures this and pays off in the long run as compared to the unorganized sector which uses manual labour and in the process, stays with a very low efficiency, low quality of yield and therefore with a much lower profitability.

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