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Managing E-Waste in India: Adoption of Need Based Solutions

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ABSTRACT

Near to two decade after the Basel Convention (BC) under United Nations Environment Programme (UNEP), most of the nations are still working for Waste Electrical and

Electronic Equipment (WEEE) or E-waste disposal programme. The Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal is the most comprehensive global environmental agreement on hazardous and other wastes; which aims to protect human health and the environment against the adverse effects resulting from the generation, management, transboundary movements and disposal of hazardous and other wastes (http://www.basel.int/). In the 1990s the focus was set on the control over toxic substances by means of smart design for recycling and manual disassembly of hazardous components in the recycling phase itself. Experiences of the last ten years show that electronic waste policies should serve multiple and broader societal goals. Developments in shredding and separation technologies have led to the realisation that dismantling as such does not bring the desired toxic control, as it depends much more on the destination of disassembled components, and there are relatively high costs involved. The recovery of valuable materials and energy preservation has also become much more important. There is an obvious change in thinking and approach to WEEE (Puja Sawhney et. al. 2008). This paper presents the preliminary findings of a research study to identify the various popular methods of managing e-waste in India and reasons for employing those methods.

Keywords: **Electronic Waste; E-Waste Management; Repair; Re-use; Reduce; Recycle; Hazardous Materials; India**

INTRODUCTION

There is no universally accepted definition of electronic waste (Luther 2007) or e-waste around the world (Jang and Yoon, 2006). However, e-waste is often misunderstood as comprising only computers and related IT equipment, or worse still, mistaken as email spam (Sinha et al 2007). It is universally understood as electronic waste disposed of by end users and includes a wide range of products, from simple devices to complex goods. Therefore, e-waste comprises both white goods such as refrigerators, washing machines and microwaves, and brown goods which consist of TVs, radios and computers that have reached their ends for their current holder (Sinha et al 2007).

E-waste mainly comes from several sources: 1. Residue or leftover materials from electronic products manufacturing process; 2. Leftover parts or materials, or discarded electrical and electronic equipment generated from a repair shop; 3. Obsolete electrical and electronic equipment coming from governments, companies, and other facilities; 4. Obsolete electrical or electronic products mainly from households; 5. Obsolete electrical or electronic products brought in by smuggling (Xuefeng et al 2007). Increase in the end of life of electrical and electronic products depends on the economic growth of the country, population growth, market penetration, technology upgradation, and obsolescence rates. Besides that, due to the increase in affordability of new products and technological advancements, it is easy to purchase rather than repair outdated equipment (Arora 2008). It can be assumed that the disposal of electronic products is fundamentally driven by the production of new ones (Osibanjo and Nnorom 2008) this

implies that the growth of production results in similar growth in e-waste generation (William 2005). However, the issue on how much e-waste is generated, from where and to where it is moving, is difficult to estimate (Osibanjo and Nnorom 2008).

E-waste contains both valuable materials as well as hazardous materials which require special handling, dumping and recycling methods. It contains toxic substances and chemicals, which are likely to have adverse effect on environment and health, if not handled properly e-waste is hazardous only if it contains hazardous constituents. E-waste is hazardous in nature due to presence of toxic substances like Pb, Cr6, Hg, Cd and flame retardants (polybrominated biphenyls and polybrominated diphenylethers etc.) (Chatterjee and Kumar 2009). The e-waste recycling, however, can be made a profitable business if it is managed professionally. E-waste contains valuable materials including metal, plastics and glass, which are of the 95% of the total e-waste by weight. The populated PCBs / connectors are of 3%- 5% of the total e-waste (Gao et al., 2004) contain valuable metals like gold, silver, copper, and other precious metals like palladium, tantalum etc. In developed countries, well established processes are available for processing PCBs to extract the precious metals with highest yields (Gao et al., 2004; Xuefeng et al., 2005; Mou et al., 2004; Hanapi and Tang, 2006; Hyunmyung and Yong-Chul 2006). In contrast, the e-waste processing technologies in developing countries are not yet matured and the recycling is still being carried out in non-formal units by primitive ways. It is estimated that 95% of the e-waste recycling in India has been carried out in non-formal units (Report on “E-waste Inventorisation in India”, MAIT-GTZ Study, 2007).

On a broader scale, analyzing the environmental and societal impacts of e-waste reveals a mosaic of benefits and costs (Alastair, 2004). Proponents of e-waste recycling claim that greater employment, new access to raw materials and electronics, and improved infrastructure will result. These will further boost the region’s advance towards prosperity. Yet the reality is that the new wealth and benefits are unequally distributed, and the contribution of electronics to societal growth is sometimes illusory. Most e-waste “recycling” involve small enterprises that are numerous, widespread, and difficult to regulate. They take advantage of low labor costs due to high unemployment rates, internal migration of poor peasants, and the lack of protest or political mobilization by affected villagers who believe that e-wastes provide the only viable source of income or entry into modern development pathways (Kurian Joshef 2007).

E-WASTE IN INDIA

Despite a wide range of environmental legislation in India there are no specific laws or guidelines for electronic waste or computer waste (Devi et al., 2004). As per the Hazardous Waste Rules (1989), e-waste is not treated as hazardous unless proved to have higher concentration of certain substances. E-wastes contain over 1000 different substances many of which are toxic and potentially hazardous to environment and human health, if these are not handled in an environmentally sound manner. The growth of e-waste has significant economic and social impacts. The increase of electrical and electronic products, consumption rates and higher obsolescence rate leads to higher generation of e-waste. The increasing obsolescence rate of electronic products also adds to the huge import of used electronics products. The e-waste inventory based on this obsolescence rate in India for the year 2005 has been estimated to be 1,46,180

tonnes which is expected to exceed 8,00,000 tonnes by 2012. Composition of e-waste is very diverse and differs in products across different categories. Broadly, it constitutes Iron and steel about 50% by plastics (21%), non ferrous metals (13%) and other constituents. Non-ferrous metals consist of metals like copper, aluminum and precious metals ex. silver, gold, platinum, palladium etc.. The presence of elements like lead, mercury, arsenic, cadmium, selenium, and hexavalent chromium and flame retardants beyond threshold quantities in e-waste classifies them as hazardous waste (Ministry of Environment and Forest – 2008).

The growth rate of discarded e-waste is high in India since it has emerged as an information technology giant and due to modernization of lifestyle. In India, increased demand for the key products like PC, TV, and telephones in last 5-10 year has been responsible for the increasing amount of e-waste generation. According to the ASSOCHAM Expert Committee on Environment the total e-waste generated in India amounts to approx 150,000 tonnes per year. Sixty-five cities in India generate more than 60% of the total e-waste generated in India.
Indian economy records high growth rate after the implementation of liberalization and globalization policies, which increases the e-waste generation day by day. Recent estimate of Ministry of Finance shows that 1.47 Lakh MT of e-waste was generated in the country in 2005, which is expected to increase to about 8.0 Lakh MT by 2012. Presently their exist 23 e-waste recycling units with 0.9 Lakh MT capacity (Economic Survey 2010-11). Wide gap between required and installed capacity and high unemployment rate along with mass poverty mould the e-waste handling procedures towards a profitable business on the cost of environmental hazards and attracts the developed countries WEEE with illegal implementations.

While the world is marveling at the technological revolution, countries like India are facing an imminent danger. E-waste of developed countries is disposed in India and other Asian countries. Various studies shown that a lot of the electronics registered for recycling in the developed countries end up in Asia, where they are treated with modest or no consideration for environmental or worker's health and safety. Major reasons for unauthorized exports are cheap labour and lack of environmental and working standards in Asia along with a hope to gain financial advantages and in this way e-waste of the developed countries flooding towards the poor as well as developing nations. It is very important that developing countries specially India wake up from the strategies of the developed economies and set up appropriate standards and measures to prevent the hazards and mishaps. The current practices of e-waste management in India records a number of weaknesses like the difficulty in inventorisation, unhealthy conditions at unauthorized recycling, inadequate legislation, and unwillingness of the corporate to address the critical issues. The effects are that the hazardous materials enter in the waste stream without any special safety measures creates adverse impacts on the environment and human health along with the wastage of resources when valuable materials are dumped and disposed under unpleasant conditions during the mismanagement of e-waste.

Waste markets are increasingly physically important in an emerging capitalist, consumer economy such as India's, and they provide employment to sizeable numbers of the urban poor working in the so-called unorganized sector of such an economy (Gill, 2006). In India a hierarchy for collecting waste is well developed which spread from waste

picker to recycler and containing various structures of profit sharing. Owing to the higher value, and hence higher margins, the upper waste recycling stream supports a longer length of chain that includes numerous intermediaries between a kabadi dealer and the factory (Gill, 2004). Multidisciplinary approach and vide availability of remedies enforce the user to identify and define the need and management of e-waste in India to reach the optimum level of use and disposal without having consideration of environment and social responsibility.

METHODOLOGY AND DATABASE

The primary task of the present study is to identify the awareness of the concept among Indian entrepreneurs as well as to find out the need of policy framework which is still not in effect along with to analyze the concept of awareness in terms of things include in e-waste in the concerning organizations. The ultimate goal of the study is to evaluate the preferences towards handling e-waste in a way by which cost, time and environmental impacts can be minimize.

To fulfill the basic requirement of aforesaid study objectives, a survey has been designed to gather the information. For the term awareness and policy framework, two separate questions have been framed to identify the choice. The questions namely “Are you aware of e-waste?”, and “Do you think government should have e-waste management policy were asked to the respondents?” For the database regarding types of e-waste produced within organization – “What type of e-waste is generated in your organization?” was asked with three most possible answers namely computer related products, Electronic products, and work place facilities along with an option of open response to fulfill the criterion - any other. Management of e-waste as an ultimate task was meeting out to frame an enquiry – “Which method is best to manage e-waste?” with four categories namely repair, reduce, reuse, and recycle and asked to the respondents to rate each category in five scale like most important, second most important, third most important, somehow important and least important to assess and manage the aforesaid goal vis-à-vis to develop the e-waste management hierarchy in India.

The waste and e-waste management hierarchies available in the literature are majorly based on environmental impacts (Mark 2003), manufacturer process (King and Burgees 2005). The positive relationship between waste and per capita income (Mazzanti et al 2009) shows the higher availability of e-waste in high income countries with well regulated disposal programme convert e-waste handling in an expensive affaire while developing countries like India have a strong cost benefit factor towards (mis)management of e-waste. In India categorization of possible hierarchy of e-waste management essentially includes all three concerns to optimize the model based on environmental impacts, manufacturer process, and cost benefit, towards processing of disassembling and disposal which have been divided in four parts - repair, reduce, reuse, and recycle hereafter 4R. The given 4R are deeply rooted with manufacturers as well as users in terms to maximize revenue while minimizing cost as well as saves time vis-à-vis environment.

Repair: In terms of e-waste management, at the time when the electrical and electronic product are not functioning well then the user must try to repair the product in the possible way to reduce the waste with minimum cost and in an environmental friendly way. It was also clarified in Guidelines no. 1 on shipments of WEEE that electrical and

electronic equipment would not be considered as waste if it is for repair with the intention of reuse for the original purpose. (Karola Maxianova, 2008). On the other hand it will save the cost of the dumping of the product vis-à-vis add some value to the product to make it better. Repairing increases the life and usability and if the users do-not wish to use it they can make available the product for others.

Re-use: When the electronic and electronics are repaired or upgraded then the user must re-use the product up to the level at which it can be used, it will reduce the e-waste and will save the cost of buying new items. Reuse, in addition being an environmentally preferable alternative, also benefits the society. By donating used electronics, you can allow schools, non-profit organizations, and lower-income families to use them that they otherwise could not afford. A functional, working system will be a lot more useful and requires less upgrading than a non-working or incomplete (United States Environmental Protection Agency, 2001).

Reduce: All discarded products that have an electrical cable or battery are classified as Wastes from WEEE. These items produce complicated multi-material wastes with different proportions of metals, plastics and glass. These can be polluting if they are not adequately treated before final disposal. Material recovery from this equipment is relatively complex but can prove worthwhile when they contain precious and scare metals. Harmful products which can affect the environment should be separated from the waste stream before the final disposal and those products should be disposed off separately so their harmful chemicals do not mix with the atmosphere.

Recycle: If repair or reuse is not a viable option, households and businesses can send their used electrical and electronics for recycling. Recycling avoids pollution and increase the recovery of valuable and limited virgin resources. It also reduces the energy used in new product manufacturing (United States Environmental Protection Agency, 2001). Many public and private organizations have emerged that concept and accept electrical and electronics for recycling. Some electronics manufacturers are accepting household electronics for recycling like IBM, DELL. Asset management and recovery programs are available to big companies and large purchasers of electronic equipment for a long time. Now, electronics manufacturers are beginning to offer similar services for households and small businesses. The valuable materials recovered from e-waste lessen the disposal problem and financial costs involved. Though a good fraction of e-waste is recycled, the method adopted for material salvaging has an extremely high environment and health cost attached to it.

HYPOTHESIS TESTING AND ANALYSIS

Nominal and ordinal nature of data and requirement to identify the characteristics among various parameters of nonparametric quality signifying to choose chi-square - a test of goodness of fit establishes whether or not an observed frequency distribution is differ from an estimated frequency distribution, to test the following generalized hypotheses –

H_0: The observed distribution follows the expected (there is no preference among observed frequencies),
H_1: The observed distribution does not follow the expected (there is a preference among observed frequencies).

A survey has been done to identify the perception on WEEE in various parts of India including NCR, Mumbai, Amritsar, and Jaipur; that covers diverse business houses and firms of interest. A total of 450 respondents were targeted and 388 responses with complete information were recorded after the successful implementation of pilot test of questionnaire. Rest of the responses were either not received or were incomplete in nature,

The results based on the field survey conducted to assess the awareness of e-waste and need for regulatory framework are very dominating, 77.06% respondent were aware of the term e-waste and 90.21% respondents gave the consent that government should have e-waste management policy while only 10.03% (30 out of 299) of aware people denied the initiative from government in terms of regulatory framework shows the high requirement of legal frame work from the government of India in protection of socio-economic responsibilities and impacts. Table 1 provides the summary of responses recorded towards awareness and regulatory framework requirement;

Table – 1

Outcomes		Regulation		Summary (Awareness)	
		No (Fr)	Yes (Fr)	Total	% of Total
Awareness	No (Fr)	8	81	89	22.94
	Yes (Fr)	30	269	299	77.06
Summary (Regulation)	Total	38	350	388	100
	% of Total	9.79	90.21	100	

Source: Survey, Fr = Frequency.

E-waste contents in terms of types have been identified through the survey (summary given in table 2), indicating that utmost 73.97% respondents categories computer related products as prime source of e-waste while 42.53% responses comes for work place facilities. Surprisingly most of people (80.93%) denied that electronic products are the part of e-waste in their organization.

Table – 2

Outcomes	Yes		No		Total
	Fr	%	Fr	%	
Computer Related Products	287	73.97	101	26.03	388
Electronics Products	74	19.07	314	80.93	388
Work Place Facilities	165	42.53	223	57.47	388

Source: Survey, Fr = Frequency.

As stated above in the 4R model, respondents have the cost as well as environmental considerations; which results that 76.29% (table 3) people prefer repair as a most important outcome for e-waste handling. The effect of selection repair as first priority is clearly visible from outcomes and it has been seen that frequencies are dying out quickly

as importance level decreases. Second most important opinion given by the respondents to reduce with 45.62% having less dominating position than repair, the frequency distribution does not imply a leading situation towards the preference containing marginal difference with third choice of reuse with 47.16%. Although second and third opinion towards important outcome is clearly visible but the persistent nature of dominated responses are not visible as less than 50% people categorize it in the respected segment; while 42.53% responses goes with recycle as least important aspects again shows the mix of aspects along with reduce and reuse.

Table – 3

Outcomes	Repair		Reduce		Reuse		Recycle	
	Fr	%	Fr	%	Fr	%	Fr	%
Most Important	296	76.29	36	9.28	25	6.44	19	4.90
Second Most Important	52	13.40	177	45.62	108	27.84	37	9.54
Third Most Important	16	4.12	102	26.29	183	47.16	62	15.98
Somehow Important	15	3.87	51	13.14	55	14.18	165	42.53
Least Important	9	2.32	22	5.67	17	4.38	105	27.06
Total	388	100	388	100	388	100	388	100

Source: Survey, Fr = Frequency.

Chi square test based (table 4) based on table 1 further support the dominant nature of outcomes received. The p-value (asymptotic value of significance) which is zero up to three digits after decimal indicating very high level of significance and infer to rejecting the null hypothesis of similarity in outcomes or in other words opinions are significantly different than others.

Table – 4

Chi Square	Awareness	Regulation
Value	113.660	250.887
d.f.	1	1
Asymp. Sig. (p-value)	0.000	0.000

Furthermore calculations based on table 2 and given in table 5 for consequent support of difference in opinion based on chi square test again gives the clear indication of rejection of the null hypothesis is notable as all p-values are zero up to three position after decimal in other words preferences given for e-waste management are significantly different than equal expectation of choice.

Table – 5

Chi Square	Repair	Reduce	Reuse	Recycle
Value	783.160	206.253	244.629	176.742
d.f.	3	3	3	3

Asymp. Sig. (p-value)	0.000	0.000	0.000	0.000

CONCLUSION

Although the per-capita waste production in India is still relatively small in terms of developed countries but the total absolute volume of wastes generated is huge because of the size of population. Further, it is growing at a faster rate as growth rate of the Indian economy is continuously very high during the last decade. High unemployment rate, lower labour yield, low wages and lack of e-waste disposal and recycling rule encourage the people to be involved in the process of disposal of electrical and electronics. It has been observed and concluded that cost saving is the prime factor behind the e-waste or before e-waste treatment in terms of repairing and re-use. Contrary reduce and recycling involves financial gain but applicable only when first two options do not have any viability. Recycling involves various steps in India which generates the income on each level and generally running in micro units in unhygienic conditions and increases the bad impacts on environment.

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