

Simultaneous Analysis of WEEE Management System Focusing on the Supply Chain in India, UK and Switzerland

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Abstract—Waste Electrical and Electronics Equipment(WEEE) is the fastest growing waste stream and alarming to be a possible threat. Rapid product growth with rapid product obsolescence is the main reason behind it as the short innovation cycle is the driving force. As per the prediction of a report by United Nations, by 2020, WEEE from old PC would jump by 500 per cent on 2007 levels in India. The key elements of the developing nations are the proper implementation of the rules like EPR, ARF etc and a proper supply chain network (SCN). It has been observed that the overall management system of WEEE in the developed nations like Switzerland is organized and follows a proper framework but the developing nations like India is still struggling to establish proper management system. There exists proper WEEE management system in UK but still there are a few drawbacks. This paper presents comparative review of the WEEE management system of India, UK and Switzerland particularly focusing on the supply chain network and the legislation. The issues and challenges in SCN have been addressed and possible solution has been suggested. The result will be helpful for further development of WEEE management in the countries to move forward with WEEE management.

Keywords—WEEE, Supply Chain Network, EPR, Reverse Logistics.

I. Introduction

‘WEEE’ means electrical or electronic equipment which is waste including all components, subassemblies and consumables which are part of the product at the time of discarding [1].

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WEEE is piling up all over the world and its management is gaining importance in different countries every day. WEEE is the fastest growing waste stream with a

growth rate of 3 - 5% per year and perhaps is the biggest challenge to sustainability [2,3,4,5]. Globally, about 30 - 50 million tons of WEEE is disposed each year and based on the present growth rate it is predicted that WEEE generation will reach 40 - 70 million tons per year by 2015 [6,7]. India produces nearly 1.3 million tons of WEEE every year [8]. According to Ogondo et. al. (2011), per capita generation of WEEE in UK is more than 16 kg per annum [9].

WEEE contains a lot of highly toxic and hazardous materials (Lead (Pb), Cadmium (Cd), Chromium (Cr), Mercury (Hg), Polybrominated diphenyl ethers etc) as well as a lot of noble metals (Gold (Au), Silver (Ag), Copper (Cu) etc) [10,11,12,13]. Effective and efficient disposal and recycling of WEEE is hence a necessity. It calls for both environmental and economic along with the social aspects to be taken care. However, the buzz will remain only utopian unless an efficient reverse logistics supply chain is established in compliance with the proper implementation of rules pertaining in the corresponding countries.

Supply Chain Network of WEEE is pretty complex yet very much interesting. The whole system of SCN is organized and works nicely. In India, due to less initiative from the government, people are unaware of the hazards posed from WEEE and as a result the most of the WEEE ends up in the hand of informal sector. The existence of formal sector is evident with the presence of ninety seven WEEE recyclers in India approved by CPCB (Central Pollution Control Board), but their SCN is not robust to have a sustainable business. Proper collection centres, their availability and their proper functioning raise questions with no particular answer. The trans-boundary shipment of e-waste in India also boosts the informal sector in spite of the existence of the legislation [14]. In the UK there is no informal sector which is very good thing. The SCN of the UK is well organized. However, the practice of sub-contracting with small firms and loopholes of EPR has become a noose for the formal recyclers which question the legislative implementation [15]. Switzerland is the first country in the world to have established a formal system to manage WEEE [16]. In Switzerland there is no division of formal and informal sector. The overall thing is undertaken by two Producer Responsibility Organisations (PROs)—SWICO and S.E.N.S. Each and every stakeholders of the WEEE value chain is under the supervision of the PROs. The SCN of this country is much more organized. Material and Cash flow is controlled very efficiently at every stage.

Countries like India and UK emphasize on the EPR i.e. the Extended Producer Responsibility concept along with their WEEE handling rules, whereas, Switzerland is using the EPR system as well as the ARF (Advanced Recycling Fee) concept to reach the goal. But where there is a rule there is always some ways to find its loopholes and simply that is why trans-boundary movement of WEEE is taking place in the name of charity – which calls for rules to be revised and stringer. However, in Switzerland since the overall thing is undertaken by PROs (Producer Responsibility Organisations), the loopholes are scanty. India is a developing country and it lags behind in many aspects of WEEE management including Supply Chain management and implementation of laws. In the UK, there is no such informal sector but there are a few loopholes of the EPR which makes the business of WEEE to run in break even. Switzerland leads the world in addressing environmental challenges, according to the 2014 Environmental Performance Index (EPI) [17]. 62.6% of the citizens of Switzerland wanted the government to place more emphasis on environmental issues [18]. The existing WEEE management system in Switzerland is one of the best. India is now becoming a major business hub in the globe and it needs to adopt the best practices in WEEE management systems. In developed countries like UK, Switzerland has matured WEEE management system and hence this comparison may evolve with some developmental scope in countries having weaker WEEE management.

To this end, following research questions are formulated: What are the issues and challenges in the SCN of WEEE management system in these countries? How their effectiveness can be improved? How this business can run sustainably in compliance to the WEEE handling rules pertaining in these countries? How the benchmark practices learnt from these countries can be implemented to improve the WEEE management system in other countries. From literature, it has been observed that almost no research work was carried out to compare the WEEE supply chain in India, the UK and Switzerland.

II. Objective

The objective of this paper is to discuss the WEEE management system of India, UK and Switzerland. It focuses on the supply chain network and the legislation in these countries. This paper also analyzes the SCN of these three countries. Also it addresses the issues and challenges in SCN and suggests possible solution.

III. Review Methodology

The review in this study is limited to the published literature including books, conference proceedings, and literature obtained from electronic sources. Google Scholar, Science Direct, Wiley, Springer databases were explored for literature with the keywords such as 'WEEE recycling', 'WEEE reverse logistics', 'WEEE closed-loop supply chains', 'WEEE green supply chain', 'e-waste supply chain'. The publications were found in the areas of WEEE logistics management, recycling and supply chain. The references cited in each relevant literature were

examined to find out additional sources of information. In this research, conference proceedings and 90 journal publications have been reviewed. The search shows that only 20 articles were published between 1990 and 2004, 42 articles were published between 2005 and 2009, and 40 articles between 2010 and 2014. All the literature has been studied and referred properly.

IV. WEEE management system in India and UK

The informal sector is a small-scale, labour-intensive, largely unregulated and unregistered, low-technology manufacturing or provision of services. Informal sector entrepreneurs or enterprises do not pay taxes, have no trading license and are not included in social welfare or government insurance schemes [19]. The collection of e-waste is generally done by the 'Kabbadiwalas'. These people purchase WEEE and other items (news papers, books, plastic scraps, broken glassware etc) from both commercial sector and individual consumer. The Kabbadiwalas sell the collected waste to some small traders who partially segregate them and sell to the big traders called wholesalers [20]. They sort out the materials and separates out the reusable ones. The reusable items are then repaired before sending them to the second hand market. The waste materials are dismantled manually using chisel and hammer and are segregated in terms of metals, plastics and glasses. The most valuable things to them are printed circuit boards (PCB), IC's and wires. These are recycled in very crude ways like acid leaching which pose health hazards to the people associated with it. This is the reason informal recycling is called 'backyard recycling'. Precious metals like gold, silver, copper etc from the WEEE are recovered and are sold to the 3rd party customers like smelters, plastic recyclers, glass manufacturers etc. The inert from these processes ends up in landfill. These informal activities are carried out in some hot spots in many of the cities. Few such places are –"Chadni Chowk" in Kolkata [20], Nayandahally, Mysore Road in Bangalore and in e-waste centres in Delhi (Chadni Chowk etc.), NCR, Meerut, Firozabad, Mumbai and Chennai [20,8] in India.

Formal sectors are associated with environment friendly collection, dismantling and recycling of WEEE. Operating units in formal sector usually employ ISO 14001 and OHSAS 18001 management system standards globally. However, in India, due to lack in implementation of e-waste (Management and handling) rules 2011, the informal sector overrules the formal sector. WEEE smuggling also boosts the informal sector. In India, most of the formal recyclers collect e-waste from corporate sectors and from auctions and they give in for contractual practises with different institutions and collect their E-waste periodically [21, 22]. Individual people are not willing to pay for disposing their e-waste as the Kabbadiwalas are paying to buy the e-waste which is an important constraint. But, the good news is that formal recycling is gaining pace in India. Awareness is spreading among the people.

The existing e-waste (Management and Handling) rules 2011 have been in the revision stage which is pending approval, speaks about spreading awareness amongst the people as well as the responsibility of the consumers of EEE [23]. There are total 97 authorised recyclers in 12 states of India – Karnataka (27), Maharashtra (18) and Uttar Pradesh (15) being the top 3 states having the max number of recyclers. Not more than 30 % of the authorised WEEE recyclers are working the country. Endeavour by the government in both the central and state level is being made to install more number of formal WEEE recycling units including the collection facilities in different location in India.

The UK is a developed country. The directives EU2002/96/EC on WEEE was implemented from the year 2003, informal sectors are not present in UK. The whole business is controlled by the formal sectors. The citizen carries their WEEE to the centre by themselves and drop the same in designated bins at free of cost. The collection centre, with or without pre-treatment sends the WEEE to the recyclers or dealers as a part of their business. The AATF approved collectors collect WEEE from houses and offices. There exist a lot of collection agencies. Often the recyclers use their services. They offer free of cost collection from home and offices and sometimes they pay the customer for the WEEE which is restricted to PC's only.

Transportation is done in closed vans i.e. in an environment friendly manner. The collected WEEE is tested and sorted. The pre-processing techniques include sorting, testing and secure data destruction PAT (Portable Appliance Testing) testing is done before any dismantling operation. Eddy current separators, Overband magnets are used for dismantling and sorting. There are some refurbishers also. The reusable items are repaired and packed to be sold elsewhere and for export. The rest of the WEEE is shredded and a manual segregation of metals and non-metals (glasses, fire retardant plastic and other polymer substances) is carried out. The segregated products (metal, non-metal etc.) are then recycled separately in respective plants. In many locations, waste collection and recycling centre receives different types of wastes including WEEE.

v. WEEE management system in Switzerland

The Swiss law on waste management stresses the “polluter pays principle” and has encouraged the reduction, reuse and recycling of waste. There are several systems in place for segregating and collection of different kinds of waste such as glass, paper, plastic bottles and aluminium, among others, to facilitate better recycling. Switzerland is also the first country in the world to have established a formal system to manage e-waste and it is highly effective waste management system. The effective collection of e-waste in Switzerland is primarily due to the efficient management of the waste stream by two

Producer Responsibility Organisations (PROs)—SWICO and S.E.N.S. Along broad lines, SWICO manages “brown goods”—electronic equipment such as computers, TVs, radios, etc., while S.E.N.S handles “white goods” such as washing machines, refrigerators, ovens, etc. The e-waste management program is based on the principle of Extended Producer Responsibility (EPR). This policy places both the physical as well as the financial responsibility of an environmentally sound disposal of end-of-life electronics with the manufacturers and importers of these products. The entire operative responsibility is however with the two PROs—SWICO and S.E.N.S—who manage and operate the system on behalf of their member producers. This also ensures that there is a clear definition of roles and a demarcation of responsibilities. The system depends upon certain pillars for effective functioning and one of the most important pillars of the system is secured financing for the collection and recycling of the waste and this is done by collecting the Advance Recycling Fee (ARF) which is charged on all new appliances. The ARF is used to pay for the collection, the transport and the recycling of the disposed appliances.

Setting a recycling fee that is at the same time easy to understand, transparent to administer and yet does not cross-subsidise product categories or cause consumer resentment is indeed a difficult task. The Swiss ARF is an intergenerational contract between appliances purchased in the past and those that will be purchased in the future, akin to a pension system. The risk of setting such an intergenerational fee is that it requires accurate estimations of how much waste will be generated and how many new products will be sold. While the ARF model has so far been successful, there is a danger that the fees collected on new appliances may not be sufficient to recycle the discarded appliances. The other drawback of an ARF could be that there is a cross subsidisation of products among different categories—a situation where, for example, PC buyers pay for the recycling of tape recorders. To avoid such discrepancies, both SWICO and S.E.N.S have distinct categories of products according to the approximate cost of recycling them. SWICO and S.E.N.S had 500 official collection points (in 2003) around Switzerland in addition to the thousands of retail locations which have to take back old equipment free of charge, irrespective of the brand or year of manufacture, thereby making it easier for consumers to dispose of their e-waste at appropriate locations. By having common collection points, the PROs are better able to manage logistics, benefit from economies of scale and provide a consumer friendly, all-inclusive solution instead of a prohibitively expensive brand specific one. Another pillar that facilitates the smooth functioning of the system is the multiple levels of independent controls which are able to check free riding and pilferage as well as to ensure that the recyclers maintain quality and environmental standards. Both material and financial flows are controlled at every stage, as can be seen in Fig. 3. The independent controls not only deter free riders, but also give credibility to the entire system, thereby also ensuring the participation of retailers and consumers and rigorous controls also prevent

the illegal import and export of e-waste to and from Switzerland [16].

VI. Discussion and Conclusion

The WEEE management systems of India, the UK and Switzerland have their own advantages and disadvantages. In India, the major issue is the formal e-waste collection. The communication gap and unawareness creates space for informal sector to thrive at the cost of environmental and economical parameters. Conflict between the formal and informal sectors with respect to the risk of survival of the informal sector is predominant in the supply chain. The stake holders in the loop of EPR are not acting properly to collect WEEE and very few collection centres have been established. However, the unawareness of the civilians makes thing difficult for the EPR providers to act properly and somewhat making things economically unfeasible in the individual basis. Waste segregation is also another problem. Apart from these, Trans-boundary WEEE smuggling is a very important issue in India that is boosting the informal sector in spite of the existence of the legislation. According to Ministry of Environment and Forests, the import of WEEE from other countries is illegal. However, media reports and NGO's confirm the illicit trade of WEEE. In most of the cases the Used Electronic and Electrical Equipment (UEEE) which have been repaired and those which are almost in their end of life state are sent to India in the name of charity which contributes to the increasing amount of e-waste only after reaching its end of life.

The UK has a very good supply chain network. The best thing in the UK is the non-existence of the informal sector. EPR has been implemented strictly in this country but recyclers mentioned about some loopholes of this system. There are some collection agencies in UK who are appointed by the OEM to collect WEEE from different retailer chain and then the EEE manufacturers sell them to the recyclers at higher price which makes business of the recycling units more challenging and affects the business sustainability.

In Switzerland, the whole thing is under the control of SWICO and S.EN.S. The most interesting thing in the Swiss system is the blend of EPR and ARF. Based on Life Cycle Analysis, the advanced recycling fee is included in the product price when it is purchased. However, ARF in small appliances like electric kettle, iron, hair dryer etc are not included and are recovered by the ARF of bigger appliances like Fridge, T.V. etc. This cross-subsidy may be a future issue for Switzerland. Another important thing is that by virtue of EPR everybody must take everybody's e-waste and the recycling fee is provided by the PROs, which are taken from the consumers while they purchase the items.

After critically reviewing the WEEE management system of these three countries it the following are suggested –

- i) India can make their SCN effective by learning from the UK supply chain management system.
- ii) Both the UK and India can bring the whole WEEE management system under one governing body like PROs existed in Switzerland which may help to make the whole system effective.
- iii) The UK may implement the ARF policy (excluding the cross-subsidy thing in Swiss system) to get rid of the loopholes of EPR.
- iv) India may implement ARF also, only after making some governing body like PRO, to eliminate the economic issue regarding recycling as the consumer pays for the waste generated.

It is also proposed that, both India and the UK may make laws where every EEE manufacturing company must have their own recycling plant which should be approved by CPCB and AATF respectively, just like any chemical industry has their own effluent treatment plant. This will not only enhance EPR, but also open a door for reuse, recycle and refurbishment of the products or parts of the product.

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