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Electronic Waste Management System In Bangalore – A Review

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Abstract

Electronic waste or e-waste consists of broken or unwanted electrical or electronic parts or equipment as a whole. The rapid obsolescence of electronics goods, compounded by dumping of electronic goods by the developed countries, has brought the e-waste problem in India into an acute crisis. Bangalore, the home of over 1,200 overseas and domestic technology firms, figures prominently in the danger list of cities that face e-waste hazard. E-waste including computers, refrigerators and televisions contain more than 1,000 different toxic materials and are non-biodegradable. Most of the e-waste in Bangalore is dumped in landfills or is incinerated, releasing harmful toxins into air and soil. Concerted efforts by various players in electronic product value chain, academic community and the government are required to evolve and implement a broad electronic waste management system in Bangalore. This paper discusses the current e-waste management system in Bangalore and proposes a new system.

Keywords: e-waste, Electronic waste management system, Recycling

Introduction

The increasing number of information technology firms is choking Bangalore, the Silicon Plateau of India, under heaps of e-waste. Improper disposal or contact with these materials can lead to contamination of the surrounding ecosystem and can be a major health hazard. A Greenpeace International Report (2005) study conducted found that toxic heavy metals and organic compounds can be released from e-waste, particularly as computers are broken down during the recycling and disposal

processes. Report (2004) says that over 1,000 toxic gases are released while burning the e-waste and the quantity of dioxins, copper and lead found in the soil is 20 times higher than the required level. As many as 1,000 tons of plastic, 300 tons of lead, 0.23 tons of mercury, 43 tons of nickel and 350 tons of copper are annually generated in Bangalore alone. An extensive study conducted by the authors involving survey of house hold users and the other major users of electronic goods; reveals that the annual e-waste generated in Bangalore is approximately 8000 tons and is showing an increasing trend.

Literature Review

A review of the literature regarding the e-waste management systems prevailing in other parts of the world brings out the key characteristic features of the systems, listed in Table-1. An Exploratory study was done by the authors reveals the status of e-waste management system prevailing in India, discussed in Table-1.

Table 1: Comparison of the four E- waste management systems.

Characteristics Features	**China** (C. Hicksa, et al. - 2005 and MOU Peng, et al. 2006)	**India**	**Switzerland** (e-waste guide 2009)	**South Africa** (Alan Finlay-2005)
Existing System	Mostly unorganized but semi organized in urban areas	Highly unorganized in all parts	SWICO system, highly organized	Partly organized
E-Waste specific	Semi organized sector not specific for e waste	Specific to e waste though unorganized	Not e waste specific	No program specific to e Waste
Legal restriction on E waste imports	Imports legally prohibited	Prohibited though not 100% implemented	Stringent Laws	Stringent laws though not properly enforced
Financial flow	Individuals collect e waste and are paid	No defined system	ARF-advanced recycling fee	Metal Scrap dealers pay for e Waste
Actors in the scene	Importers, Traders, consumers, scrap dealers, recyclers,	Importers, Traders, consumers, recyclers, disposers	Importers, Traders, consumers, authorized e-waste	Importers, Traders, consumers, authorized collectors,

	disposers		collectors, licensed dismantlers, refiners, disposers	sorting, formal &informal recyclers, disposers
Uniqueness of the system technology	Variety of refining & conditioning processes	Segregation into reusable and secondary raw materials	Limit on the disposal capacity of landfills	Screening & processing is unique during conditioning
Authorized e-waste collectors /pick up points	GTZ/EECZ & EMPA	Under pollution control board	SWICO & SENS	DESCO Electronic Recyclers, Universal recycling Company
Dumping Sites	Illegal dump sites or municipal landfills	Landfills	Landfills	Landfills in major centers
Technology at the disposal sites	Illegal dump sites- No proper methods;	No proper gas & water collecting systems	Meticulous & systematic procedure for gas & water	Present in permitted sites.

The following paragraphs summarize some important e-waste management systems worth emulating:

- L.-G. Scheidt, et al. (1995) reported that “CARE “VISION 2000” (Comprehensive Approach for the Recycling of Electronics) at Europe is to increase the value of recycling by driving down costs, reducing the amount of e-waste and hazardous material and thus the impact on the environment. Ultimately, the objective of CARE “VISION 2000” is to transform recycling into an industrial system.”
- Rickard Svensson, et al. (2005) reported that “Most of the Waste Electrical and Electronic Equipment (WEEE) in Sweden are collected at manned recycling centers, which play a key role for the downstream handling in order to ensure high collection rates of WEEE and a proper initial sorting. The Swedish concept for collection of WEEE is based on manual work which is quite risky for the employees”.
- Hilary Nixon, et al. (2007) reported that “In a recent survey of California households indicates that though most prefer curbside recycling, drop-off recycling at regional collection centers also has widespread support. Further the authors opines that the information on environmental attitudes and behaviors are important when estimating Willingness To Pay (WTP) for e-Waste recycling”.

Contemporary Electronic Waste Management System at Bangalore

The authors conducted a comprehensive study of the existing e-waste management system in Bangalore. The study provides insights into the existing e-waste practices of the various stakeholders in the system. Figure 1 illustrates the existing e-waste management system in Bangalore and the following paragraphs discuss the same.

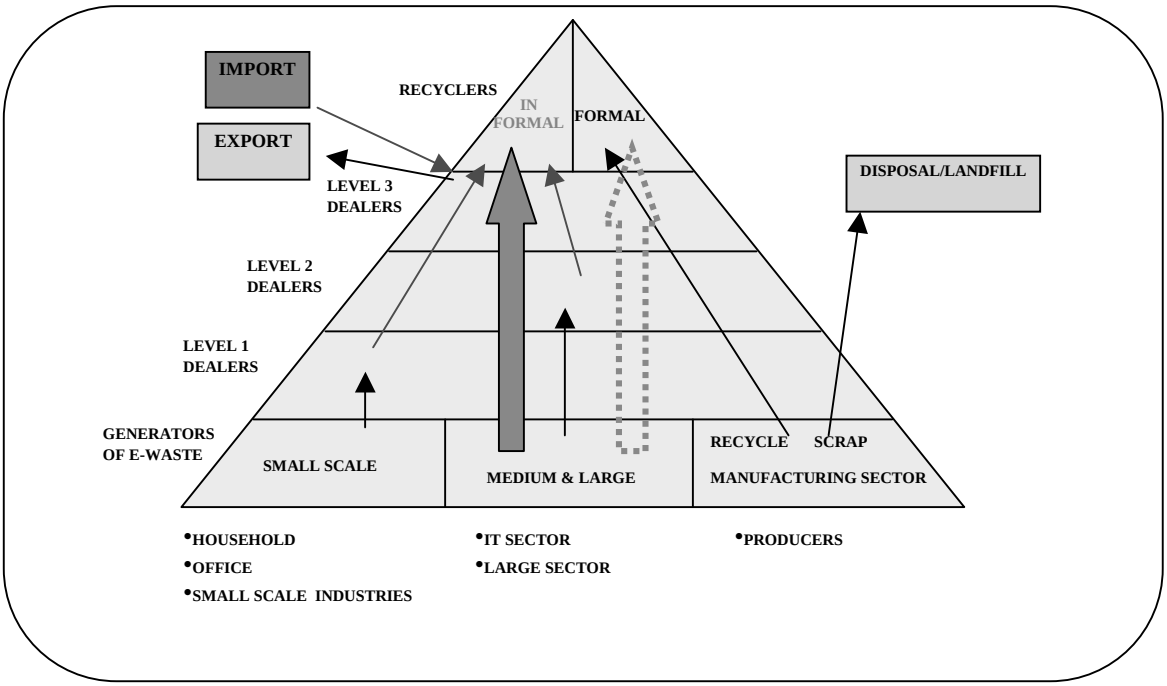


Figure 1: Electronic waste management system in Bangalore.

Informal Recyclers: The Hindu Report (2005) says that "The e-wastes produced in small and medium sectors mainly end up with the informal recyclers where recycling is done in a very crude and hazardous manner causing danger to not only to the environment but also to the people involved in the recycling activity". The e-Waste Guide reports that "The informal sector is handling and recycling over 95% of India's e-waste which is not only generated within India, but imported illegally as well. As 94% of Indian companies still do not have an e-waste disposal policy, this material has captured the attention of the large, existing network of the informal sector. It is estimated that around 25,000 people work in the informal e-waste sector and earn wholly or partly their living out of it, as per an e-waste case study Bangalore city. However e-waste has been kept away from the dump sites so far. But, its activity still generates a high environmental and social impact (use of toxic chemicals, poor working conditions, child labour, etc.)".

The study conducted by the authors, zooming in on the small scale generators of e-waste further reveals the channels that enable movement of e-wastes to the informal

recyclers include Kabadiwalas, Rag-Pickers and Auctions. Rag-picker picks discarded waste from local garbage dumps or open fields. Kabadiwala goes door-to-door and collects waste including papers, bottles, and medium sized electronic items from households in exchange for money. Various organizations dispose the waste including the e-waste through auctions. In the existing system the e-wastes collected by the Rag picker or the Kabadiwalas end up in the hands of informal recyclers through Local Waste Marts and the K R Market. Thus, new channels have to be developed and the existing channels should be tweaked to ensure that e-wastes end up with authorized formal recyclers.

Electronic Goods Supply Chain: In a pilot study conducted by the authors, 50 organizations in Bangalore were considered. The objective of the study was to understand the prevailing reverse logistics practices in the electronics goods manufacturing and selling organizations. The general response includes: 58% of the companies do not want to recycle or retreat the products since they feel that this activity involves additional cost, 32% of companies follow the strategy of purchase recyclable products and design products which are environment friendly and 6.9 % of the companies opt for pre-design, through which they focus on designing the product that can be completely recycled.

The systems of reverse logistics prevailing in various organizations; 47% of the manufacturing companies responded that those organizations do Remanufacturing/Refurbishing. Majority of the retailers and wholesalers sell the returned products to brokers who are part of informal channel resulting in disposing the returned product in an unscientific manner. Some companies (0.58 %) throw to land-fill which indicates the apathy towards environment. The barriers to initiate the scientific reverse logistics practices were listed; more than 30% of the companies feel that lack of financial resources, 52% attribute to the absence of a comprehensive system, 10% indicate management inattention and 30% of the companies have mentioned more than one barrier.

The primary goal of reverse logistics activities; 42 % of the companies responded that they are proactive i.e. their main focus is on satisfying the customer needs by involving them in the design stage. 33% are reactive and focus on complying with the existing laws and competing with others. 18% are value seeking and develop products that are completely recyclable and include the environmental aspects in to business strategies. The responses for why they initiate reverse logistics practices; 72% say protect margin, refurbishing the returned products or selling the components of the products. 47% opt for competitive reasons, 27.7% recapture of value in the returned products, 11.1% feared Legal disposal issues and 8.3% wanted to build clean channel image.

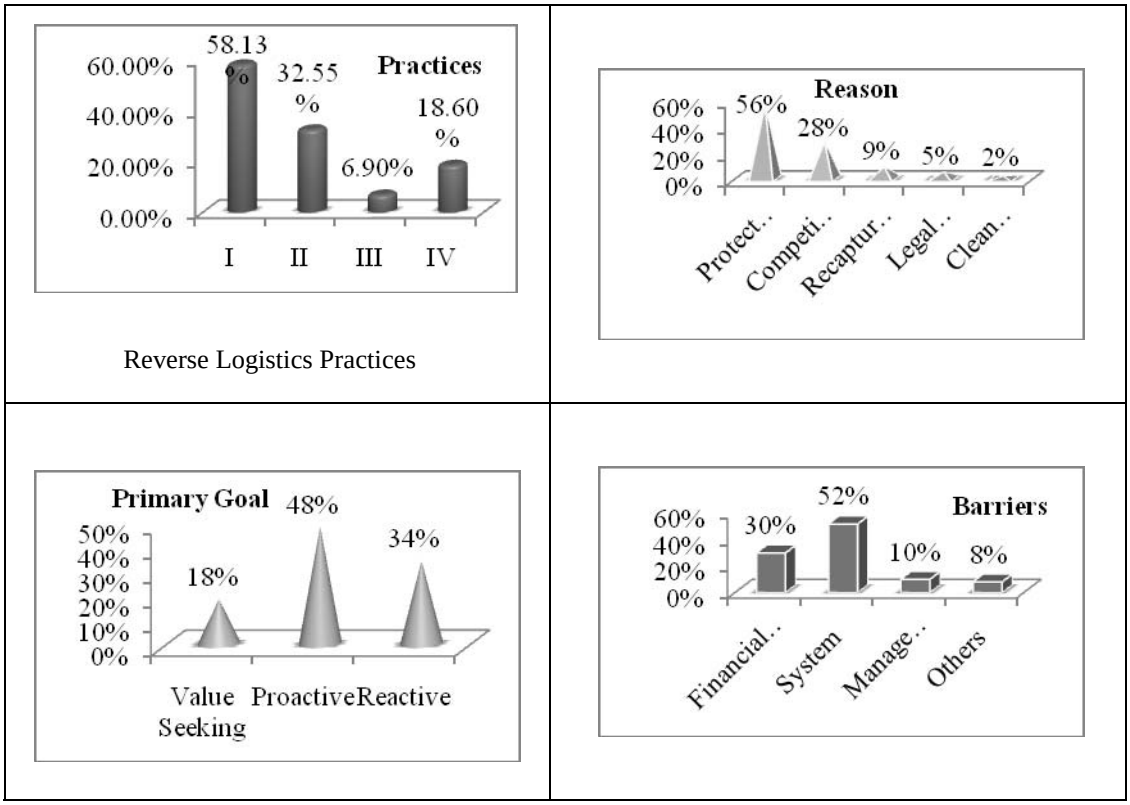
Domestic Users: The authors performed a survey of 250 household across Bangalore using random sampling. The focus of the survey was to study the buying and disposal pattern of the electronic products and to assess the e-waste awareness among the domestic users. The main residential areas in Bangalore were considered for the study. The survey threw light on the product usage, purchase and disposal behavior, awareness about e-waste, its hazards and recycling methods and the e-waste collection systems and convenience. The survey gave valuable inputs regarding

awareness of the toxic substances present in the e- waste and knowledge of the hazards to human health and the environment and the peoples' expected value from the products that were disposed and/or recycled. The analysis shows that most of the people are aware of the hazardous materials present in the electronics products but only a few actually knew the practices adopted to recycle this waste.

The type of collection center preferred by the people to dispose of these wastes was also obtained. Three feasible alternatives were listed for the people to dump their waste:

1. Door-to-door type of collection system, where a mobile vehicle would collect the e-waste right from the doorstep;
2. Stationary collection points and the people bring their wastes to the points. The stationary system was of three types: Temporary collection center, Permanent collection center, Non profit collection center;
3. Mobile collection system, where in a vehicle would come to the central part of an area on certain days and people have to take their e-waste to that point to dispose. These vehicles would operate either in milk runs or in specific location coverage;

The results reveal that a large percentage of the users preferred the mobile collection to the stationary and door-to-door collection. Outcome of the above two studies are illustrated in Figure 2.



Reverse Logistics Practices

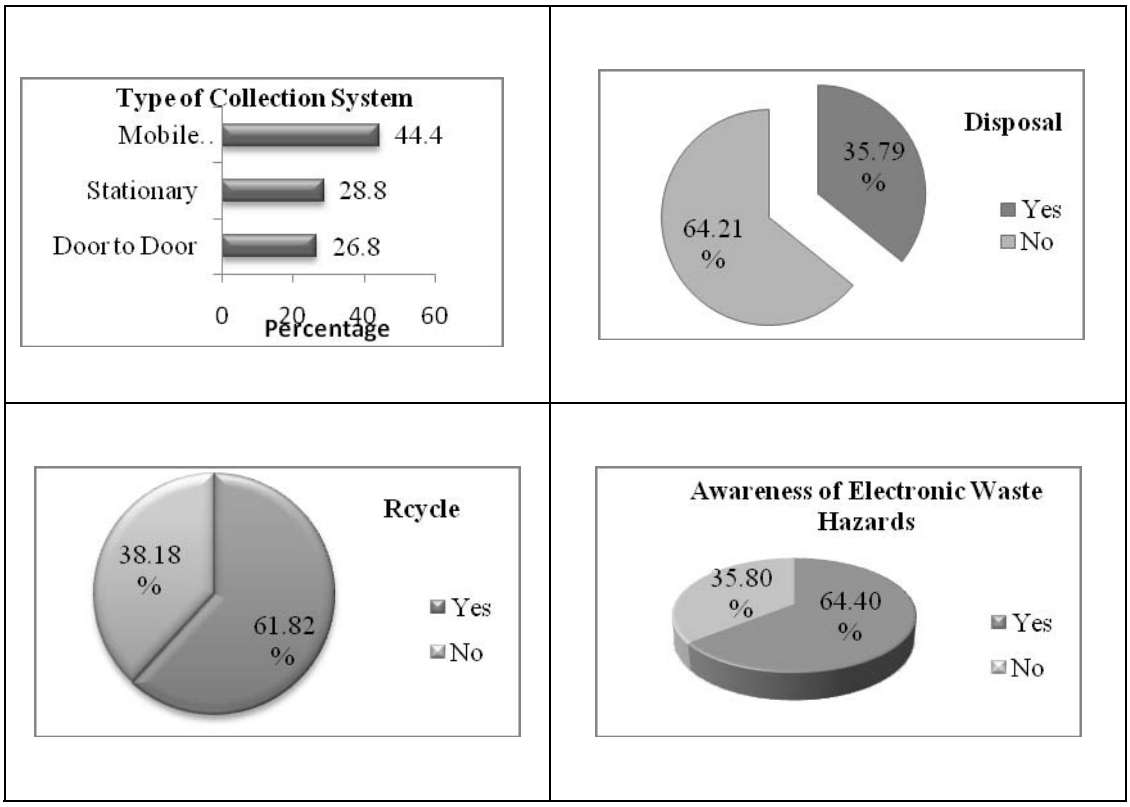


Figure 2: Illustration of reverse logistics practices and consumer preferences.

The Formal Recyclers: The report Published by Toxics Link on 16/10/2007 states that "There are eleven active recyclers in the country," the list can be accessed at the above reference. The e-waste guide lists the three Government authorized recyclers in India and operating in Bangalore. They partly handle the e-waste generated by medium and large organizations. Their activities are highlighted below and summarized in Table 2.

- Ash recyclers' aim is to use environmentally friendly ways and achieve 100% utilization and recovery from e-waste. They offer a free pick up of e-waste from anywhere in India and comply with WEEE norms.
- E-Parisaraa is an e-waste recycling unit situated in Dobaspet; Bangalore. It is the only authorized e-waste recycler by Government of Karnataka. The e-waste is collected from the companies using a pick up truck or the company drops off the waste at the plant. The plant is equipped with innovative indigenous machines to cut down costs. No incineration is done hence no toxic gases are let out in the open air. The computer wastes are either shredded or reused. The shredded wastes are ground to powder form from which metals are collected through the method of gravity separation. Only one percent of the waste coming into the company is sent to the land fills.

- Trishyiraya is the only e-waste recycling facility authorized by Tamilnadu Government. Located in Chennai, Trishyiraya works on PCs and printers. They differentiate PCBs among four categories on the basis of kinds of precious metals used. Then they are crushed and recycled. Trishyiraya uses a Finnish technology to dismantle the monitor and recover the mercury from the screen. The waste is obtained from the MNCs selling motherboards and chips in India. Currently, Trishyiraya manages wastes generated in five metropolitan cities namely- Chennai, Bangalore, Pune, Delhi, and Hyderabad. The powdered waste recovered is exported to European countries where it undergoes smelting process hence recovering precious metals at various temperatures.

Table 2: Comparison of the modus operandi of authorized Indian recyclers.

	Waste collection areas	**Methodology**	**Exports**
Trishyiraya	Major metros such as Chennai, Bangalore, Pune, Delhi & Mumbai	Shreds the e-waste	To smelters of developed nations
E-Parisaraa	Limited to Bangalore	Gravity separation	Not Applicable
Ash Recyclers	Anywhere in India	Sorting, dismantling, Segregation & Processing as per WEEE norms	Not Applicable

e-WaRDD is the fourth formal recycler in Bangalore which started the formal operations since May 2008. E-WaRDD has strongly been supported by EMPA, EWA, the Indo-German-Swiss e-waste initiative, GTZ. e-WaRDD will focus only on collection and dismantling of the, hazardous material which will be kept away from the informal sector.

Dr. A. Ravindra (2008), Reports that “SANKYA-A Collaborative Program to Promote Donation of used Computers and Reduce E-Waste”. Rotary, Bangalore South, helps IT Companies dispose of their discarded computer systems through donations to deserving schools and NGO's, at the same time help reduce generation of e-waste. SANKYA, a collaborative Project between Rotary Club, Bangalore South and a few major IT Companies (HP, Azim Premji Foundation, Microsoft, Microserv, Phoenix Login Solutions, Valtech and VXL Instruments) is a proactive effort having the following Methodology:

- Collection and deployment of used computers from the industry.
- Requirements and support through local Rotary clubs.

- Collaboration with other institutions for free/ low cost software, applications.
- Association with training institutes for training at various levels.
- Paid professional services for maintenance and support.

E-waste Guide Report (2009), summarizes the "ELCIA's concept of a 'Clean e-Waste Channel' to dispose e-waste responsibly at Electronic city, Bangalore". A Clean e-Waste Channel is;

- A convenient collection and disposal system for large and small consumers to return all their e-waste safely.
- A voluntary system for modern and concerned producers to care for their product beyond its useful life and
- A financially secure system that makes environmentally and socially responsible e-waste recycling viable.

The Government: The Karnataka Government has several initiatives through the following agencies: Electronic Waste Agency (EWA) formulates guidelines and oversees e-waste management in Bangalore. The partners are: Karnataka State Pollution Control Board (KSPCB); Gesellschaft Fur Technische Zusammenarbeit (GTZ); Swiss Federal Laboratories for Materials Testing and Research (EMPA). EWA deals with the crux of issues regarding e-waste. It consists of IT Associations, NGOs and major IT companies as its members. Dr Jurgen Porst (2006), reports that "The Hazardous Waste from Households (HAWA) project is an Indo-German-Swiss E-Waste Initiative with the objectives of: reduce the risks to the population and the pollution of the environment resulting from unsafe e-waste handling". It focuses on knowledge transfer to and skills up-gradation of all involved stakeholders through trainings and seminars. The target is mainly the existing informal recyclers allowing for their maximum but safe participation in future e-waste management by facilitating their evolution and integration in formal structures. The achievements from these activities are improved awareness, stakeholder engagement, recycling capacity and estimates of e-waste.

The existing e-waste management in Bangalore as discussed above will handle scientifically only 5 percent of the total e-waste generated in Bangalore. The first MAIT-GTZ study (2008) reveals that "Ninety-five percent of the e-waste is segregated, dismantled and recycled in the informal sector based in urban slums. It is fairly commonplace to find operations such as open burning of wires to extract re-saleable copper, soaking of circuit boards in open acid bath followed by manual scrapping to extract copper and precious materials next to open drains". Thus the systematic collection and scientific disposal remaining lion share of the total e-waste requires a comprehensive system involving the various stake holders of e-waste.

The Proposed System

A broad e-waste management system is an imminent necessity for Bangalore today. This system requires the involvement and concerted effort by the stakeholders of e-waste including; generators of e-waste (domestic users, offices, businesses, industries, Manufacturers and IT sector), channels of collection, the government, private agencies, general public and the like. The various issues in e-waste management

system hitherto viewed separately need to be addressed holistically. Figure-3 illustrates the issues and their relationships of the proposed broad e-waste management system for Bangalore City.

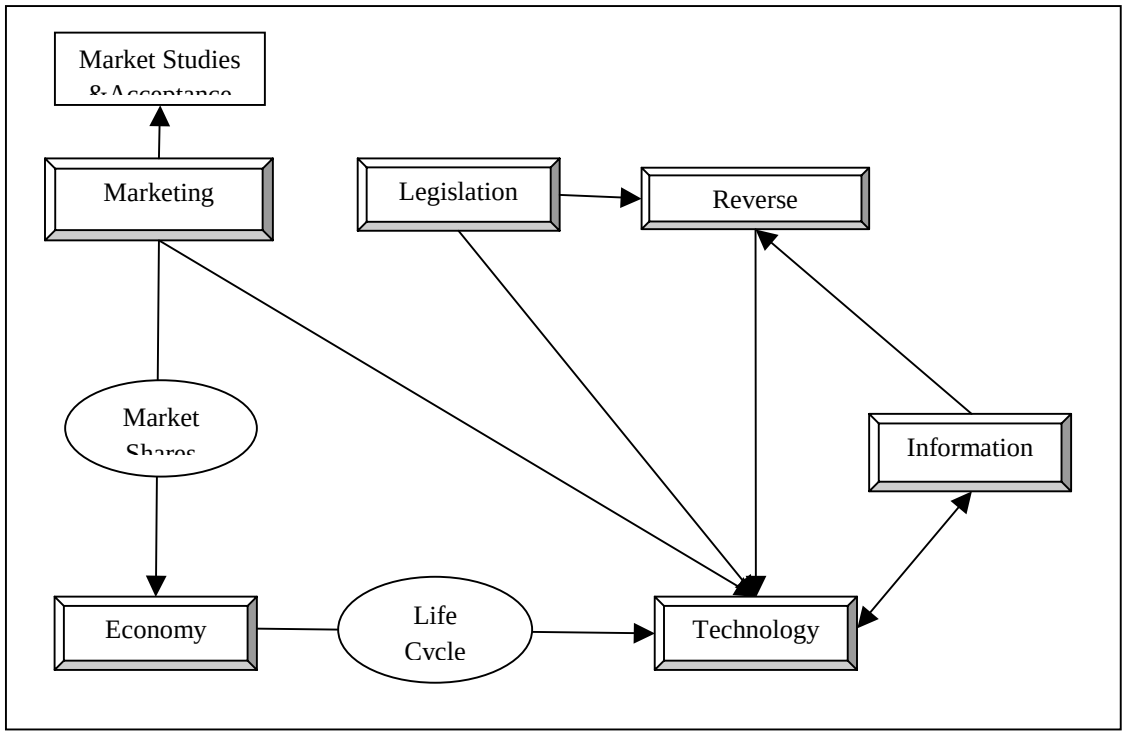


Figure 3: Various Issues and their Relationships of the Proposed Broad Electronic Waste Management System for Bangalore.

The **market issues** include: Investigation of the environmental demands of consumers and professional buyers in relation to other features such as prices, quality and service; Investigation of potential applications of recovered materials and modules and the market acceptance of new concepts of electronic products.

The major goals of the **technology** are to reduce the amount of mixed waste and to assure and prepare the reusability of material, components and modules of products. This can be assured through the following steps: the separation of material (recycling of material), the easy non-destructive disassembly of products (reuse of modules and components), and the estimation of the remaining life time of the modules and components and recertification.

The **economics issues** as reported by Hyunmyung Yoon, et al. (2006) include “the costs-benefits and environmental and social impacts of preventive and innovative approaches (e.g. cleaner product development); systems for end-of-life activities (collection and disposal) their financial viability and the socio-economic effects in comparison with the current situation”.

The proposed Reverse Logistics and Processing System of Electronic Waste for Bangalore is illustrated in Figure-4. Important excerpts from the proceedings of the ELCIA Seminar - (2006) identify the **reverse logistics issues** to be considered for the system;

- market study to assess manufacturer, dealer and consumer attitude towards take-back programs and collection systems,
- design of collection methods that best meet the targeted rate of return,
- evaluation of collection arid storage methods and safety procedures,
- research in the most effective sorting techniques,
- study of how transport can best be linked to the collection/sorting centers as well as of appropriate transportation modes taking into account variations in volume,
- location study to determine the geographical level of collection points and sorting centers, analysis of the current reselling, reconditioning, upgrading procedures and refurbishment resources".

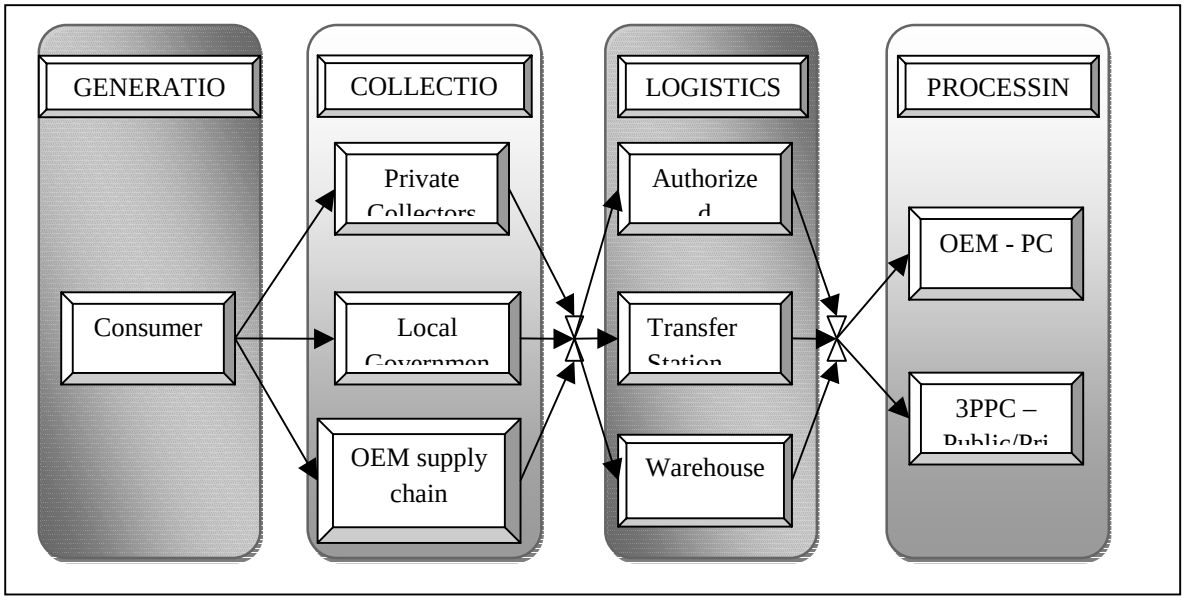


Figure 4: Proposed Reverse Logistics and Processing System of Electronic Waste for Bangalore.

The Draft Report on e-Waste Recycling in the Delhi Region-(2004) says that "despite a wide range of environmental **legislations** in India there are no specific laws or guidelines for e-waste or computer waste. Overall India has so far enacted around 14 laws for governing the country's environment, but none of these have any direct reference to e-waste or refer to its handling as hazardous in nature". Bangalore needs a **complete legislation** for tackling e-waste problem.

The issues discussed above need to be addressed and an all inclusive electronic waste management system involving the various stake holders need to be evolved and implemented. This system should take into account the best practices from the e-waste management systems prevailing elsewhere discussed under literature review. Some of the practices worth emulating include; Extended Producer responsibility at Europe and Willingness To Pay for e-Waste recycling at California. Such a system will bring down the ill-effects of unscientific disposal of e-waste on the environment and human health.

Conclusions

This paper discusses the status of e-waste practices prevailing at the various stake holders of the system in Bangalore and indicating absence of broad system. There existed half hearted efforts of Government and some organizations managing only a small percentage of the total e-waste generated. The various issues and their relationship in a comprehensive e-waste management system for Bangalore were discussed. The authors opine that concerted efforts by various players in electronic product value chain, academic community and the government are required to evolve and implement e-waste management system in Bangalore.

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Abbreviations

3 PPC – Third Party Processing Centers.
ARF – Advanced Recycling Fee.
ASEM – Advisory Services in Environmental Management
CARE – **C**omprehensive **A**pproach for the **R**ecycling of **E**lectronics.
EECZ – The Sino-German cooperation program, Environment-oriented Enterprise Consultancy Zhejiang.
ELCIA – Electronics City Industries' Association.
EMPA – Swiss Federal Laboratories for Materials Testing and Research.
EPR – Extended Producer Responsibility.
ERM – Environmental Resources Management.
EWA – E-waste Agency.
GmbH – Gesellschaft mit beschränkter Haftung.
GTZ – German Technical Cooperation.
HAWA – Hazardous Waste Management.
KSPCB – Karnataka State Pollution Control Board.
OEM – Original Equipment Manufacturers.
OEM PC – Original Equipment Manufacturers Processing Centers.
SENS – Waste Disposal Foundation Switzerland.
SWICO – Swiss Association for Information, Communication and Organisation Technology.
WEEE – Waste Electrical and Electronic Equipment.
WTP – Willingness To Pay for e-Waste recycling.