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A Comparative Study of Select Ventures in E-waste Management: Exploring Scalability Related Problems

Kaushal Kothari[1], Lalit Lalwani[2] and Kirankumar Momaya[3]

Abstract

Electronic waste or E-waste is relatively a novel addition to the ever-growing hazardous waste stream. It includes discarded Electronic and Electrical Equipment (EEE). E-waste comprises of precious and hazardous materials which have a high impact on environment and to human health. The E-waste management has become a very critical issue in most parts of the world. This paper tries to compare the top technological venture related to E-waste, ERI (USA), with the rapidly rising Indian ventures namely Attero and E-Parisaara. The comparison is carried out based on background, technical capabilities, and the R&D prospects of the company. The secondary data is being used to draw the inferencesfor the ventures scalability. These comparisons are then being used to explore the areas where the ventures need to focus to deal with scalability and to overcome the barriers to venture competitiveness.

Keywords: Barriers to venture competitiveness, E-Waste management, Management of technology for flexibility, Techno Ventures from metro cities.

1. Introduction

Over the past 3 decades, especially in the 21st century, the amount and use of Electrical and Electronic Equipment (EEE) has increased exponentially.It can be partly attributed to rise in Information and Communication Technologies (ICT), the concomitant increase in versatility of most electronic devices and the downward trend in prices of the EEE. These reasons have attributed in reducing the lifespan of the EEE and thus converting them to Waste Electrical and Electronic Equipment (WEEE) or E-waste or End of life (EOL) equipment.

Electronics waste definition, categorization and compositions

E-waste term is used for electronic and electrical equipment, including all components, sub-assemblies, and consumables, deemed obsolete or unwanted by a user[1,2]. “Solving the E-waste Problem (StEP)” Initiative forecasts that the world will produce 33 percent more e-waste, or 72 million tons by 2017. As a leading producer, China produces about 12.2 million tons of e-waste, followed by the U.S. with about 11 million tons[4]. In 2015 India produced 15 million tons of E-waste and 90% of that was managed through informal recycling. Inescapably,

1. SRM University, Kattanakulathur Campus, Chennai - 603203
   Email: kaushalkothari22@gmail.com
2. Group on Competitiveness, SJM School of Management (SJMSOM)
   IIT Bombay, Powai, Mumbai - 400076
   Email: lalwani.lalit7@gmail.com
3. SJM School of Management (SJMSOM), IIT Bobmay, Powai, Mumbai - 400076
   Email: momaya@som.iitb.ac.in

the number of electrical appliances and communication technologies will continue to increase on a great scale, and usage of microprocessors and PCB's are increasing in daily objects. Today the Electronic market is one of the speedily expanding market. Fast -monetary growth, together with urbanization, decrease of cost of consumer products and a growing interest in consumer goods, has increased both the utilization and the manufacture of electrical and electronic equipment (EEE)[6].

The E-waste is categorized in 10 different categories as per the European WEEE directives 2002/96/EC and 2012/19/EU this categorization helps in recycling. This categorization is based on major household gadgets (Air conditioner, microwave oven, Refrigerator), minor household gadgets (DVD player, gaming console, television), IT and Communication equipment (mobile phones, modems, teleprinters), User gadgets (Radio, digital cameras), Illumination gadgets (LED, Halogens), Electrical and Electronic Equipment (wires, batteries, generators), Toys, Leisure and sports guide (batteries in cars, trains etc.), medical devices (medical thermometers, biomedical engineering instruments) and control instruments (microcontrollers relays etc.).

E-waste is constituting from a range of materials, from precious metals such as gold(Au), silver(Ag), copper(Cu) to plastics, glass and fibers. Generally, the constituents and compositions keep fluctuating according to the manufacturing product. A single electronic product could have 1000 different materials. These materials can fall under 'hazardous or 'non-hazardous' categories. Mainly E-waste comprises of about 50% ferrous metal, 21% plastics, 13% non-ferrous metal and the rest other constituents. Under non-ferrous metals, we have the precious metals (Au, Ag, Pt) and hazardous metals and compounds (Pb, As, Ce, Cr^{+6} etc.) There could be traces of radioactive metals as well.

E-waste in India

In 2016, a joint study by KPMG and The Associated Chambers of Commerce of India (ASSOCHAM), they reported India is the fifth largest E- waste producer. With 1 billion mobile phones in circulation, nearly 25% end up in waste annually. India has become world's second largest mobile market, after China, discarding roughly 1.85 million tons of electronic waste each year[3]. Figure 1 shows the top E-waste producing states in India. These states are responsible for more than 70% of E-waste in the country. Another recent study by Assocham-Frost & Sullivan shows that, the most E-waste are compounding from the urban cities to which Mumbai tops and followed by other major Indian cities. Table 1. Shows the amount of E-waste generated in the major metro cities of India. The percent composition of the waste can be seen by the pie chart in figure 1. Their study also shows that the E-waste is growing at a rate of 25%[5]. The rate of growth of E-waste in past 10 years and its future predictions is shown through figure 2[7].

Table 1: Amount of waste generated per annum in the major metro cities of India

Indian Cities	Amount of waste in 2016 (MT)
MUMBAI	120000
DELHI-NCR	98000
BANGLORE	92000
CHENNAI	67000
KOLKATA	55000
AHMEDABAD	36000
HYDERABAD	32000
PUNE	26000

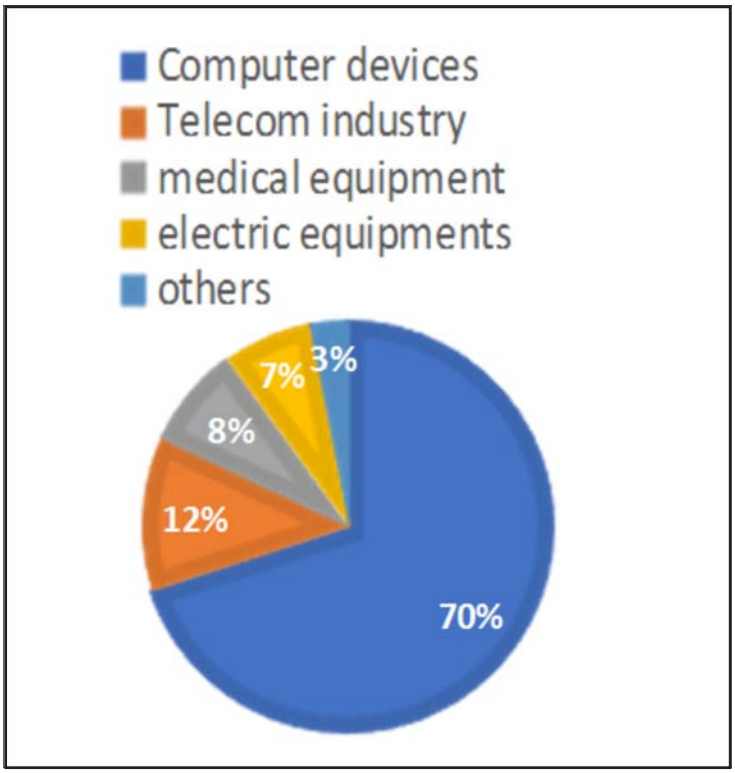

Figure 1: Percent representation of equipment's present in E-waste.

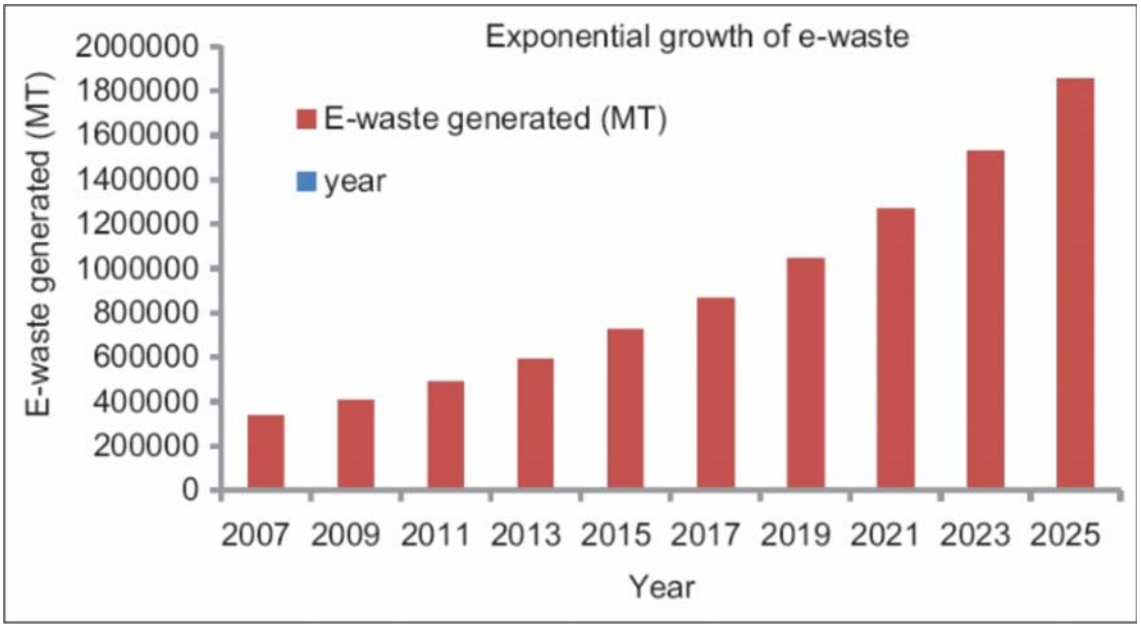

Figure 2: Exponential Growth of E-waste Over the 18 Years.

Figure 3: Top 10 major states of India responsible for more 70% of India's E-waste.

Health hazards due to informal recycling of E-waste

As the e-waste is combination of plastics, chemicals and metals improper handling of e-waste could be harmful to the environment and to humans. For the recycling of e-waste, India heavily depends on the unorganized sector or backyard recyclers as only a handful of an organized e-waste recycling facilities are available. Over 95% of the e-waste is treated and processed in most urban slums of the country, where untrained workers carry out the dangerous procedures without personal protective equipment, which are detrimental not only to their health but also to the environment[7]. Mainly in developing countries, the e-waste is dismantled manually and releasing the nondegradable plastics and persistent chemical to the environment thereby contaminating the quality of air, water and soil. The E-waste accounts for about 42% of the lead and 71% of heavy metals found in landfills. These pollutants lead to ground water and air pollution and soil acidification. High and prolonged exposure to these chemicals/ pollutants emitted during unsafe e-waste recycling leads to damage of nervous systems, blood systems, kidneys and brain development, respiratory disorders, skin disorders, bronchitis, lung cancer, heart, liver, and spleen damage[7].

Venture competitiveness and scale-up

Since India has often been very slow to diagnose and address such vexing problems such as E-Waste, technology-based and innovative ventures can play a catalytic role along with public bodies, firms and industries. Ventures have received major boost in India in last half a decade and numbers are growing rapidly. However, scalability of ventures is a major challenge (e.g. [32],[33]). Sometimes sustainability is also threatened, if relevant level of scale is not achieved. Hence, we also wish to focus on scalability dimension of ventures in our study.

2. Methodology

For exploratory phase of this study, we largely rely on analysis of secondary data. The study lays out the discussion based on the secondary data which was collected by the authors. The main discussion and the comparison were done on the inferences of these data. As the paper looks for the scalability of a venture in the current Indian scenario and a comparison with global successful companies (initially ventures). The authors chose the ventures based on their years of operation, achievements, milestones, awards and accolades earned till now and the growth of the company from initially a startup to a successful technological venture. Other aspects such as employee size, annual tons of recycling and location were also taken into consideration. As the Indian ventures had to be compared with a successful global venture, Electronics Recyclers International (ERI) was chosen for benchmarking. The Indian ventures which were eligible for our study were Attero Recycling and E-Parisaara. The data related to these companies and for our study were collected through the basic but detailed desk research and various interactive brainstorming among the authors. Experiences of authors of seeking efforts at E-Waste (very basic at IIT Bombay) and in advanced countries such as Japan and Singapore also helped. The following study is the foundation for the more depth studies in the determining the scalability for the upcoming technological ventures in E-waste industry.

3. Comparison between ERI, Attero Recycling and E-Parisaara

Background of the companies

Most of the E-waste recycling ventures came into existence only in 21st century. The comparison is carried out between the best of Indian ventures namely Attero Recycling and E-Parisaara and the global leader in E-waste recycling, Electronics Recyclers International (ERI). The table 2 gives an overview of the position of the top Indian ventures in compare to the global leader. Also, the scope for scalability to achieve the desired height for the Indian ventures. During the early years of Indian ventures, the main challenges they faced were to compete with their competitors mostly who were the informal recyclers, get the capital as during those days investment or funding were not as common as today, in India. The major challenge the Indian ventures had to counter was the development of the technology and to carry out the research work for providing green solutions in extraction of the reusable materials. The other common issues were the clearances of the possession for the land and approval from the state government and the environment and forest ministry for the setup of the plant. However, in developed countries these issues were not been faced by the international ventures.

Research and Development

Whether Indian technological venture or an international venture, to be successful and scalable, the venture must be very good at management of technology or innovation (MoT) and active in research and development. This can be proved by seeing the table 3, ERI invests around 10's of millions of USD in research of its technologies and thus has an advantage over all its peers and hence is a global leader in E-waste recycling. ERI have developed their own shredding, dust filtration and sorting equipment and have patents for these technologies. Other reasons that gives the ERI the advantage is the number of recycling plants and its presence in all the states of United states of America.

Indian ventures too understand the need to have the best technologies for better profits in future and for scaling up. Therefore, they are too investing in research and development and have developed some equipment's with better efficiency.

Table 2: A comparative table on the background of the ventures [13-31]

Name of venture (Country) -→	**Attero** (India)	**E-Parisaara** (India)	**ERI (**USA)
Criteria			
Year founded	2008	2005	2002
Founders	Nitin and Rohan Gupta	Dr P Parthasarathy	John Shegerian, EricRawn
Company size (employees)#1	250-300	180-200	600-800
Headquarters	Noida, Uttar Pradesh	Bangalore	Fresno, California
Recycle plant size	100,000 sq. feet	90,000 sq. feet	900,000 sq. feet
Plant location	Roorkee	Bangalore	Fresno, aurora, Colorado, auburn, flower mound, Plainfield, Badin, Holliston, saddle brook
No. of patents	7*	6 (patens applied)	4$
No. of cities	150*	100*	Whole united states
No. of recycling plants	1#	1#	8$
States	5*	5*	50
Clients	450+ (Samsung, amazon, Wipro, HCL*)	250+	2000+# (Samsung, HPAloca, Toshiba, LG, Panasonic)
Annual tons recycle	6,000	2,000	137,500+$
First round of funding	5 million USD	625,000 USD	No data available
Spent	2 million on land/building	325000 on land/ building	No data available
	2.5 million on machinery	250,000 on machinery	No data available
Fortune 500	No	No	Yes
CSR	No	Yes	Yes

Table 3: A comparison of the ventures in terms of Research and Development [13-31]

Name of venture (Country) -→	**Attero** (India)	**E-Parisaara** (India)	**ERI** (USA)
Criteria			
Exporting policy	Maybe	Yes, (Belgium, japan)	No
Technologically	Very good and competitive	Mediocre	World leader in terms of technology, highly efficient shredder
Technology environment friendly	Yes	Yes	Yes
Backed by	Un, world bank and other investors	E-waste agency, Karnataka state pollution Central board, EMPASwitzerland, GTZGermany	Us federal and local government, Aloca
In house R&D	Yes	Yes, but mostly out sourcing	Yes, highly focused
Research Funding	In thousands of USD	In millions of USD	In few thousands of USD

Technical Processes

The process of E-waste is the main core for any E-waste recycler as this is where the venture stands out in compare to other ventures in the market. The use of advance technology and efficient machinery will give the venture a benefit in operating and maintenance cost. The operation model is another important aspect for the venture, as the venture has plan to generate the revenue based on this model. Nowadays, the ventures are also taking extreme steps in collection and logistics of the E-waste from the consumer. Most of the E-waste ventures are providing complete transparency to the consumers in terms of recycling their product. They are assigning barcodes to the consumer products; this code is shared with the consumer to track the complete recycling and disposition of their product. They also assure the consumers of complete destruction of the data stored in the electronic devices through their data destruction and IT asset disposition technology. Attero was the first Indian venture to use these technologies in E-waste recycling.

Table 4: The comparison of ventures in terms of technical processes [13-31].

Name of venture (Country) -→	**Attero** (India)	**E-Parisaara** (India)	**ERI** (USA)
Criteria			
Operational model	Two bucket systems	One bucket system	Consumer used to pay
Shredding	Efficient	Mediocre	Very efficient (developed in house)
Glass cleaning system	Mediocre	Mediocre	Very efficient (developed in house)
Dust filtration system	Mediocre	Mediocre	Very efficient (developed in house)
Barcode tracking	Yes	No	Yes
Video verification and destruction	Maybe	No	Yes
Data destruction	Yes	Yes	Yes
It asset disposition	Yes	Yes	Yes
Direct pickup	Yes	Yes	Yes
Refurbishment	Yes	Yes	Yes

Certifications

The certifications listed shows the capability of the venture. ERI is the only venture which has been accredited by R2 and STEWARD certificate.

Table 5: The comparison in terms of certificates awarded to the ventures [13-31].

Name of venture (Country) -→	**Attero** (India)	**E-Parisaara** (India)	**ERI** (USA)
Criteria			
E-waste recycling authorization	Yes	Yes	Yes
STEWARD	No	No	Yes
R2	No	No	Yes
ISO 14001 - 2004	Yes	Yes	Yes
ISO 9001 - 2008	Yes	Yes	Yes
OHSAS 18001 - 2007	Yes	Yes	Yes

4. Discussion

To have environment friendly recycling of E-waste, skills and training of operationsis required. Expert personnel are prerequisite for recycling step as to screen the toxic and desirable substances from the complex e-waste and then different environment friendly recycling processes must adopted for toxic and desired substances separately. Also, to minimize the adverse environmental impacts on the recycling personnel, obsolete gadgets must provide by maintaining stringent environmental standards[8,9]. The focus of the paper is to determine the scalability for

Indian ventures and the challenges related to it in compare to global successful technological venture. The comparative table was drawn with the focus to check the possibility for scaling of the Indian ventures and for a depth of understanding of the challenges faced by the Indian ventures and the root cause for the vast gap between the Indian and global venture. The common challenges faced by the Indian ventures are competing with the backyard recyclers, governmental clearings, permissions and sanctions of projects, high capital demand for investment in R&D. The technological Indian ventures need to collaborate with the local municipal bodies for the more efficient collection of e-waste. For better logistical aspects the ventures can have branch collection points possibly in every major city and then the waste could be transported once the amount collected breaks even the operating, and transporting cost. With the current stage of ventures the technological support must be developed in the management of waste and in logistics. As, most of the ventures bleed a lot of revenue when mismanagement of waste happens. The Indian ventures have great scaling opportunities but a lot of reform in terms of laws and procurement of waste must be deal first.

5. Limitations and Further Areas of Research

As the study carried out basic desk research and just provides a glimpse over the scalability and challenges faced by the Indian ventures, a much more depth study is required on the ideas and the areas identified for scaling up. Intensive research as in interviews with the company officials, deep analysis of the company's financial condition and the actual management policies are missed. This paper is a starter for the future upcoming research work and for the other research groups as well. Here are just examples of high potential areas of further research.

- While concerns are being raised about failures of ventures, the holistic problem of 'low competitiveness of ventures in India' is less diagnosed systematically. Even a small step of problem structuring is likely to provide good learning.
- Low scalability of ventures in India has found to be a major problem. Research to identify drivers and enablers of 'venture competitiveness and scalability' is other fertile area of research.

6. Concluding remarks

E-waste is one of the rapid growing kind of waste. In the end of 20th century and in the beginning of 21st century it appeared in the developed countries. Nowadays, it has a been an important issue in most part of the world, including India. From past two decades a lot of new technologies have been developed to curb this issue. Apart from technological development, the government of India have also drafted a new set of rules for the recycling of e-waste.However, all these will be of limited help till concept of management of technology and innovation (MoT) that has relevance across levels-individuals, groups, ventures, firms, industries, states and country-is implemented with sincerity and flexibility. New technologies that we select and adapt should have significantly lower E-Waste or other waste and health problems. Concept of flexibility can provide better options to address such vexing problems and make ventures from India more competitive, scalable and sustainable.

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References

- Bhuie AK, Ogunseitan OA, Saphores J, Shapiro AA. Environmental and economic trade-offs in consumer electronic products recycling: a case study of cell phones and computers. In: Proceedings of the 2004 IEEE international symposium on electronics and the environment, IEEE;2004.
- CairnsCN.E-wasteandtheconsumer:improvingoptionstoreduce,reuseandrecycle.In:Proceedings of the 2005 IEEE international symposium on electronics and the environment, IEEE;2005.
- Chaturvedi A, Arora R.E-wasteassessmentinIndia:specificfocusonDelhi.Manufacturer'sassociation for information technology (MAIT) and Germantechnical cooperation organization (GTZ) New Delhi, India: BIRD.SocPolicySci2007;2007:127–43
- E-waste Rules 2011, Ministry of Environment and Forests,India.
- Heeks R, Subramanianab L, Jones C. Understanding e-waste management in developing countries: strategies, determinants, and policy implications in the indian ICT sector. InfTechnolDev2014:1–17
- http://ewasteindia.com
- http://ewasteindia.in
- http://fortune.com/2017/09/06/electronic-waste-recycling-cybersecurity/
- http://www.businesswire.com/news/home/20160720006306/en/Electronic-Recyclers-International-Solutions-California%E2%80%99s-e-waste-Problems
- http://www.recyclingtoday.com/article/electronics-recyclers-international-rebrands/
- http://www.recyclingtoday.com/article/electronics-recyclers-international-naid-certification/
- http://www.recyclingtoday.com/article/eri-electronics-recycling-alcoa-north-carolina/
- http://www.thehindu.com/sci-tech/energy-and-environment/India-fifth-largest-producer-of-e-waste-study/article14340415.ece http://m.deccanherald.com/articles.php?name=http%3A%2F%2Fwww.deccanherald.com%2Fcontent%2F541964%2Fmumbai-top-electronic-waste-generator.html
- https://eridirect.com
- https://nerc.org/advisory-members/member-spotlight/2015/03/electronic-recycling-international-(eri)
- https://patents.justia.com/assignee/electronic-recyclers-international-inc https://www.google.co.in/patents US9365227?dq=US20150123364+Inventors%09John+S.+Shegerian+ PATENTS & hl=en&sa=X&ved=0ahUKEwjvrrP31ZzXAhVKrI8KHakZAeMQ6AEIJDAA
- https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=24602867
- https://www.indiainfoline.com/article/news-sector-others/nitin-gupta-ceo-attero-recycling-message-for-world-environment-day-113110808489_1.html
- https://www.linkedin.com/company/333018/
- https://www.linkedin.com/company/81283/
- https://www.nextbigwhat.com/attero-funding-story-297/
- https://www.theverge.com/2016/6/22/11991440/eri-e-waste-electronics-recycling-nyc-gadget-trash
- https://yourstory.com/2012/10/nitin-gupta-of-attero-on-what-it-takes-to-build-a-global-clean-tech-business-from-india/
- Jayapradha Annamalai, Occupational health hazards related to informal recycling of E-waste in India: An overview, *Indian Journal of Occupational and Environmental Medicine*, Vol. 19, No. 1, January-April2015.
- Kasper AC, Gabriel AP, de Oliveira ELB, NCDF Juchneski, VeitHM. ElectronicWaste Recycling Techniques. Electronic waste. Switzerland: Springer InternationalPublishing; 2015. p. 87–127.
- Mehta N., Lalwani L., Momaya K. S. and Jain K., 2014, "Exploring the patterns of venture scale-up: Findings for IITB related ventures", in Challenges and Opportunities for IE in Emerging Economies, (pp. 301-307), Excel India Publishers, NewDelhi.

- Salian, S., Bali, A., Yugandhar, V., &Momaya, K. S. (2018). Analyzing the Role of Management of Technology in the Growth of Technology Ventures. In *Flexibility in Resource Management* (pp. 147-160). Springer,Singapore.
- Vijay Kumar, E-waste in India and developed countries: Management, recycling,businessand biotechnological initiatives, Renewable and Sustainable Energy Reviews 2016. CII. E-waste management, green business opportunities. Delhi: Confederationof Indian Industry; 2006. p.1.
- Vijay, E-waste in India and developed countries: Management, recycling, business and biotechnological initiatives, E-waste in India and developed countries: Management, recycling, business and biotechnological initiatives,2015.
- www.mait.com/assets/e-waste_management_by_e-parisaraa