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Feasibility of E-waste as a Business. A Case Study on Elxion Pvt

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It is aimed at aggregating and helping co-create knowledge and information on environmentally responsive behaviours and concurrently pursuing result-oriented social media campaigns to encourage people and specifically the youth, to take proactive actions in promoting sustainable lifestyle and creating a positive impact on the environmental ecosystem in their surroundings

By: _VO**IS Planet**

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Key takeaways

- E-Waste is currently the fastest growing waste stream in the world, with India being the third-largest producer of e-waste1. Increasing prosperity and government schemes such as Digital India are expected to increase the quantum of E-Waste in the coming years.
- A staggering amount, 95% of e-waste in India is disposed of or recycled in environmentally and socially irresponsible ways[2].
- Important changes to legislation in India are a move in the right direction but the sector faces many hurdles in implementation, a case in point is the highly touted EPR system.
- As large as this problem may be, there are ample opportunities to create circularity in the economy by the formalization of the e-waste recycling space. Although this has its drawbacks of being capital intensive and technically challenging.
- Elxion Pvt. has demonstrated that small-scale formal players can build economically viable and successful businesses in recycling. Small-scale commodity or metal recycling from e-waste is not yet a financially viable option without including the refurbishment of old electronics to supplement the business model.
- New areas of chemical extraction practices from e-waste are one potential revenue stream that companies such as Elxion can tap into to ensure financial viability.

E-waste is a growing problem

Technological advances in the modern world are heralded as triumphs of human ingenuity helping us to live better lives. This is the case, for the most part, and we have seen dramatic increases in human health and longevity in the past century. The range of improvement is from better access to healthcare or even our global reach in terms of communications. A by-product of these advances is the dramatic increase in Electrical and Electronic Equipment (EEE) both at the household level as well as in manufacturing. These EEE have become indispensable in modern societies and are enhancing living standards, but their production and usage can be very resource demanding. This as such also illustrates a counter to that very improvement in living standards. Higher levels of disposable incomes, growing urbanization and mobility, and further industrialization in some parts of the world are leading to growing amounts of EEE. This in turn has led to a dramatic increase in what is known as e-waste or Waste From Electrical or Electronic Equipment (WEEE).

Almost every household and business use products like basic kitchen appliances, toys, and tools such as mobile phones, laptops, and printers. Besides everyday household and business use, EEE is becoming increasingly used in transport, health, security systems, and in the generation of energy, such as photovoltaics in solar energy. Traditional products, such as clothes and furniture, are often equipped with electrical components, and consequently are increasingly contributing to the global e-waste generated. More and more EEE is also employed in the expanding sector of the Internet of Things (IoT), such as sensors or devices about the concept of the "smart home" or "smart cities".

Electronic equipment has become essential for industry and household consumers in the modern world. The exponential increase in electronic commodities has brought with it a new set of challenges. Electronic products have a limited life and get obsolete with technological innovations.

E-waste is the most rapidly growing waste problem in the world. We generate about 50 million tons of it every year1. This is equivalent to throwing out 1000 laptops every single second. India is one of the largest creators of e-waste, ranking third in the world[1].

According to the 'Solving the E-waste Problem' (StEP) Initiative, E-waste (Electronic and Electrical waste) is the waste thrown out without the intention of reuse. In other words, it comprises electronic products that have stopped working, unwanted or are nearing the end of their use. However, a growing number of e-waste include electronic products that still work perfectly well. This is because many consumers do not know how to correctly dispose of used electronics. Consumers are also not aware of the magnitude of the problem, something that needs to be addressed immediately with large-scale awareness building. In addition, technological advances continue at dizzying speeds making functional electronic devices that work, to be considered obsolete.

Despite the COVID-19 pandemic, the global electronic products market was valued at $1,191.2 billion in 20203. The market is expected to grow with a compounded annual growth rate of 6.8 % to reach 1,653.2 billion in 2025. [3]

The overall scenario is that the quantities and sources from which e-waste is being produced continue to increase. The capacity, financial incentives, and technology to recycle e-waste are not keeping up with the supply.

The Most Toxic Waste in The World

A large proportion of e-waste contains toxic or hazardous substances like CFCs, mercury, lead, cadmium, polybrominated flame retardants, barium, and lithium.[4] Unfortunately, the size and scale of toxic waste are staggering. For example, 50 tons of mercury were found in undocumented flows of e-waste annually, this directly impacts the environment and the health of the workers who deal with these materials.[1] Most e-waste is handled by the informal sector, for example, in India, it is estimated that about 95% of e-waste is processed by informal collectors and recyclers.[2] The informal sector refers to those actors who are finding business opportunities from recycling e-waste but operate outside most legal regulatory frameworks. In this space, it is common to see little or no environmental or health oversight or guidelines. There are health implications of handling toxic materials, both by direct exposure when recycling them as well as longer-term impacts from environmental contamination by toxic substances.

The enormity of the issue cannot be understated

In 2019 alone, globally we generated 53.6 million metric tons (Mt) of e-waste and less than 18% of this was officially collected and recycled[1]. Overall, the recycling or refurbishing capacity of e-waste is not keeping pace with the rate at which it is generated.

International and state bodies have made some progress in addressing these issues by enacting legislation, policy, or regulations that cover over 70% of the global population[1]. However, implementation of these has been a major hurdle across the globe.

For example, there is no record of what happened to more than 80% of the e-waste generated in 2019, leaving us with no knowledge of the environmental and health impacts of this improperly disposed waste[1]. High-income countries dispose of 8% of their waste in landfills and by incineration[1]. These mainly comprise small e-waste such as laptops and phones. These rates of disposal in landfills are going to be significantly higher in less developed countries. Developed countries continue to contribute most to the problem, but developing countries are rapidly catching up with the increase in globalization and urbanization across the world.

E-waste also throws up some inconvenient facts that show developed nations export their e-waste to less-developed nations. A recent report by the Basel Action Network and the Silicon Valley Toxics Coalition found that up to 80% of e-waste meant for recycling in the United States was exported to developing nations such as China, India, and Pakistan. Several countries surreptitiously export the waste to lower incomes states, many times under the guise of donations or recycling[1].

This insidious method facilitates the exportation of not just substandard goods but also the negative environmental and social impacts of e-waste. According to the global e-waste monitor 2020, the waste management infrastructure in middle- and low-income countries, is not yet fully developed or, in some cases, is completely absent. They argue that, therefore, electronic waste is mainly managed by the informal sector and often handled under substandard conditions. This results in serious health effects for workers as well as children who often live and play near sites dedicated to e-waste management activities.

According to the World Health Organization (WHO), health risks may result from direct contact with toxic materials that leach from e-waste. These include minerals such as lead, cadmium, chromium, brominated flame retardants, or polychlorinated biphenyls (PCBs). Danger can come from inhalation of toxic fumes, direct skin contact with hazardous materials as well as the accumulation of chemicals in soil, water, and food.

This puts not just people in danger but entire ecosystems including land and sea animals. The negative impacts of global e-waste have detrimental effects on the people that work with the e-waste but also the people that live around recycling and dumping sites. When E-waste gets buried at a landfill, it can dissolve in microscopic traces into the gross sludge that permeates the landfill. Eventually, these traces of toxic materials pool into the ground below the landfill. This is known as leaching, a well-documented phenomenon that leads to health and environmental hazards. The more E-waste and metals are at the landfill, the more of these trace toxic materials show up in the groundwater. The problem is that there is so much E-waste that the trace amounts have ballooned over the years. Toxic water under the landfill doesn't stop below the landfill. It continues to the groundwater and contaminates sources of all the freshwater in the surrounding area. Not only is this bad for anyone using a natural well, but it hurts the nearby wildlife. That, in turn, causes the wildlife to get sick from lead, arsenic, cadmium, and other metal poisonings due to the high concentration of these minerals. Such large-scale impacts and knock-on effects from the pollution of the environment are not confined to e-waste, however, the toxicity of much e-waste makes these issues far more dangerous than commonly perceived.

Circular economy - a potential way forward

Our current, linear way of producing and consuming products is ruining fragile ecosystems and causing the loss of valuable natural resources. The circular economy brings more sustainable solutions where products are in use longer and materials are reused to manufacture new products. In a circular economy, resources are handled more responsibly, and resources are reused as opposed to dumped or discarded. The goal is to extend product lifetime and recirculate all materials with minimal waste. This focus opens opportunities for new and innovative business models and concepts.

When it comes to e-waste the answer to this lies at the very heart of all Electrical and Electronic Equipment (EEE). These electronics can be made up of over 69 elements from the periodic table. Including what is known as Critical Raw Materials (CRM) such as cobalt, palladium, indium, germanium, bismuth, and antimony. CRMs have been classified by the European Union as those materials that are both economically and strategically important but have a high risk with their supply. This could be due to many factors for example most of the cobalt, up to 70 %, is mined in the Democratic Republic of Congo followed by a distinct second place in Russia at 6 %[5]. Both these areas are now at high risk of conflict. Making availability and price, of these resources a challenge.

To demonstrate the potential for circularity we only need to look at the overall value of certain raw materials contained in e-waste. The global e-waste monitor estimated that in 2019 the monetary value of these materials in e-waste such as iron, gold, and copper was approximately USD 57 billion. Most of this e-waste we are generating can be recycled. This is called urban mining, where resources are extracted from complex waste streams, and these can be economically viable compared to extracting metal ores from the earth[6]. If done right, this kind of urban mining can also be less energy-intensive than traditional mining.

For nations like India that are focusing on self-reliance as an important national goal, secondary mining of materials from e-waste can provide a solution.

The Indian Context

India is now the third biggest contributor to e-waste, after the USA and China. It is estimated that India produces 3.2 million tonnes of e-waste a year[1]. The Central Pollution Control Board in a 2020 report stated that India produced 1,014,961 tonnes of e-waste between 2019 and 2020. This is an increase of 32% from the previous financial year of 2018-2019. This report found that only 3.6% and 10% of the e-waste was collected in the country in 2018 and 2019, respectively. The report also highlighted that about 95% of e-waste collection and handling is in the control of the informal sector. At present we have a relatively low per person rate of e-waste production at 2 kilograms per person. This is currently only 25% of the global average and 11% of that of the developed world.

However, this is expected to change and grow significantly with the push for digitization and economic growth. The majority of the e-waste expected to contribute to our overall waste stream is expected to be from old mobile phones, small IT like laptops, and consumer electronics like shavers and toys.

Regularisation is a step in the right direction.

As an early adopter of e-waste regulation in comparison to other nations in Asia, India has had e-waste-specific laws since 2011. The latest in these laws is the E-waste (Management) Rules, 2016, and its amendment in 2018. The 2016 laws mandate targeted collection responsibilities for producers. This is reflected in the concept of extended producer responsibility (EPR). The EPR requires makers of electronics to take financial and physical responsibility for managing the disposal of their products when obsolete. To aid producers in this task the law allows for Producer Responsibility Organisations (PRO) to be established, these PROs would help in the collection, transport, and recycling of e-waste. In addition, buy-back schemes, deposit refunds, and exchange schemes were brought under the ambit of the EPR. In effect, the producer or the designated PRO must collect and meet set targets for recycling e-waste. The target under the EPR for 2023 requires 70% of e-waste to be collected from products manufactured in 2023. The introduction of a year-on-year collection scheme while a move in the right direction is also being viewed as unrealistic. Implementing stricter legislation and guidelines to manage e-waste needs to go hand in hand with direct action and support from the government to the e-waste recycling industry. Otherwise, compliance becomes a formality, and people find ways to bend the rules. For example, there are numerous allegations of PROs falsifying collection data just to meet targets. In other instances, they allegedly resort to sourcing their waste from the unorganized sector to meet these targets thereby defeating the purpose of the legislation and the push for formalization.

ELXION

Elxion founded in 2017 by Dr. Uttam Doraswami, Dr. Roshan S Pai and K Chandrasekar is a technology-oriented solution to E-Waste recycling and management. The company truly attempts to prioritize, process, sustainability, and compliance over profit. Elxion is located in Bangalore and is a small player in the e-waste recycling space with a capacity to recycle 360 metric tons of e-waste per annum.

They have a robust technical team of chemical engineers and chemical technologists who have over 30 years of experience in all aspects of the project value chain like chemical processing, synthesis, and effluent treatment.

They work from a pollution control board-licensed facility where they do the dismantling and storage of e-waste. They have all mandated pollution control measures and safety precautions in place, along with the necessary authorizations from concerned governing bodies. The company complies with environmental, and data destruction norms & safety regulations to ensure compliance with national and international standards.

What is noticeable is that Elxion has an ample amount of focus on safety; for example, all employees use a full range of PPE during de-manufacturing. This is a step that is largely missing from the informal sector of the e-waste industry where people come in direct contact with hazardous waste.

Elxion aligning with Government Focus Areas

While creating a viable business out of recycling and refurbishing e-waste, Elxion has been attempting to dovetail its efforts to align with state and central government objectives. This enables the company to showcase that its work is contributing to national goals. As of now, Elxion has been able to work towards a few of these larger national objectives and they aim to do more in the future. These alignments could potentially be a factor to help them to raise capital or justify the expansion of the business to other regions.

Water Conservation

A major source of water contamination from e-waste is the leaching of toxic materials into underground aquifers, rivers, and the ocean. Since its inception four years ago, Elxion has sequestered ten tons of mercury-containing lamps, CFL bulbs, and tube lights. This has helped safeguard 50 million liters of drinking water.

Their upcoming projects focus on mitigating pollution and will also stop irreversible damage to drinking water. This feature will align with the current focus on water conservation and protection as outlined in the Jal Jeevan mission of the Government of India (GoI).

Plastic and Air Pollution

Recycling plastics is an important step in reducing the burden of producing more plastic while also stopping plastic pollution. Recycling plastic reduces waste loads on existing solid waste management systems and prevents plastics from eventually contaminating water bodies. Elxion has recycled 50 tons of plastic, in four years.

Dr. Doraswami says,

> By recovering plastics, we ensure that plastics go back and have a second life. This enables extended use of plastic in industries such automobiles, footwear, and floor mats

The proposed expansion of Elxion has the potential to mitigate several more tons of plastic pollution annually. Plastic is currently a major pollutant clogging existing sewer networks and stormwater drains. An objective that aligns well with the Swachh Bharath mission.

Mitigation of air pollution caused by the open burning of E-Waste supports government efforts to improve the air quality index which is a major focus area of the Government of India under the National Clean Air Program (NCAP).

Digital India

One of the major aims and outcomes of Elxion's work is to ensure a framework for a circular economy within electronics. This objective is in line with the Digital India initiative of the government. Additionally, local production of commodity metals such as copper, silver, and gold, crucial to the manufacturing of almost all electronic printed circuit boards and solar cells, aligns well with the National Policy on Electronics 2019 (NPE 2019) under the Ministry of Electronics and Information Technology (MeitY) and the broader Make in India initiative.

Elxion's Revenue Streams

Elxion remains 100% bootstrapped and has no external funding, debt, or grants. The ongoing revenue sources include revenues from data sanitization services, revenues from segregation, testing, and sale to refurbishers of IT products, revenues from products of recycling (commodity metals and plastics), and revenues from environmental services concerning the treatment of hazardous E-Waste such as mercury-containing lamps and screens.

Elxion is now piloting the production of chemicals from the metals recovered during recycling operations. The installation of chemical lines will add sustained revenues from the sale of chemicals and derivatives to the revenue portfolio.

Dismantling of electronic items leads to the recovery of plastics and metals such as copper and iron. Table 1 shows that iron is the largest contributor to Elxion's revenue stream followed by recovered plastics. Those materials which are not recycled are sequestered (safely treated) and disposed of in government-approved landfills and incinerators. These landfills are PVC and cement coated to prevent toxic leaching. Sequestered waste is a small fraction, which is reflected in the table as "TSDF" and "Incinerables". Dr. Doraswami estimates that "Between 3 and 7 percent of what we process cannot be recycled.".

Elxion is showing year-on-year growth in tons of materials recycled as well as revenues and operating margins, despite headwinds from corona.

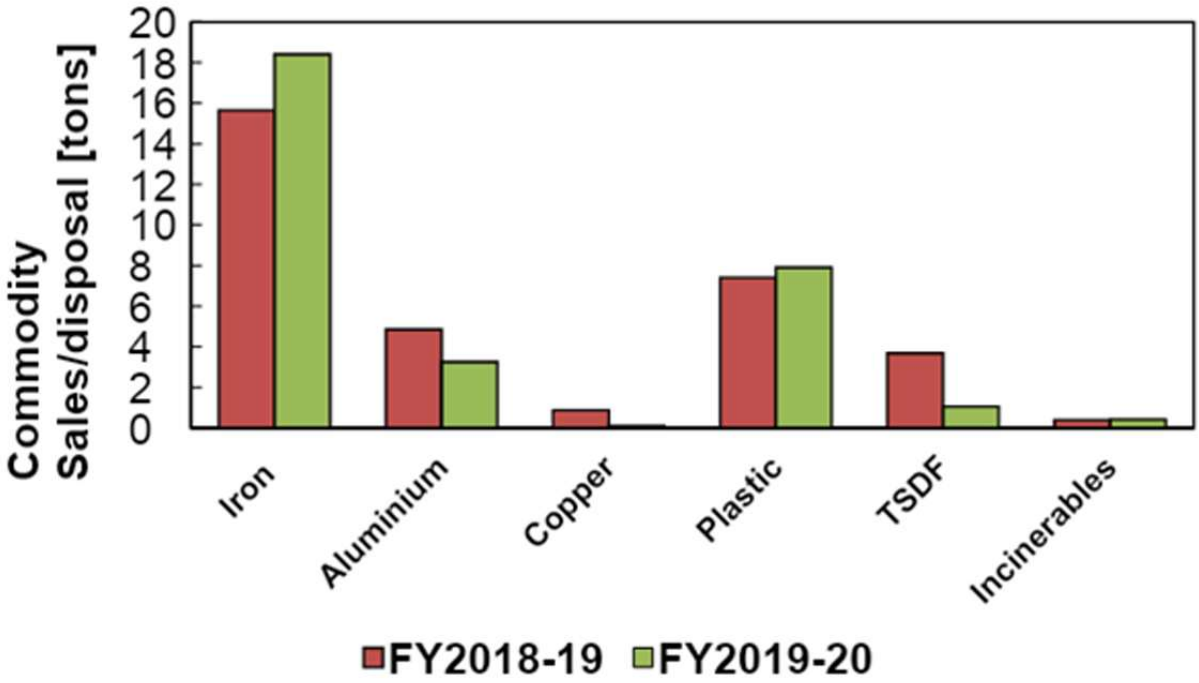

Table 1: Recovered or sequestered Materials from recycling operations for two financial years.

Elxion's Innovative Features

Elxion has managed to differentiate itself from all the players in the current market. Co-founder of Elxion, Dr. Uttam Doraswami says, "Existing and entering market players are predominantly from industries such as metal scrap, furniture scrap, or pure-play IT and Networking backgrounds. This leaves a deep hole in the market for players who have the requisite skill set to achieve material transformations sustainably. Elxion is a one-of-a-kind innovative company in this space". Dr. Doraswami further adds, "Our focus remains on core strengths such as material management however our combined corporate experience in R&D and process control confer us many advantages across the business spectrum".

Elxion focuses on a few priority areas, such as data sanitization, recycling of electronics, and the recovery of precious metals and chemicals.

Key aspects that make them stand out in the market from other players: -

1. **Data Sanitization**

   Data sanitization is the process by which data held on an electronic device is permanently wiped clean to ensure that no recovery is possible. This is an essential step to ensure private data is not misused once old electronic storage devices come for recycling or refurbishing.

Elxion adheres to global standards and security protocols, a service not easily available in India at the level of e-waste recyclers. Elxion can do this as they own and operate the required data sanitization tools and technologies. To this end, they also provide ISO standards in quality and documentation management.

2. **Recycling of end-of-life electronics**

   Elxion has developed proprietary predictive tools to enable the pricing of scrap based on global metal market dynamics. This helps them get better prices and place competitive bids for e-waste. They own trade secrets in the valuation and recovery potential from Printed Circuit Boards (PCB), an area of expertise within the e-waste sector. They have the technical expertise and the required equipment in managing hazardous chemicals present in E-Waste. Making them a socially and environment friendly option for customers to select.

3. **Recovery of precious metals and chemicals**

   Elxion has pilot-tested a novel aqueous electrochemical route to recover metals from scrap printed circuit boards based on technology developed at Imperial College London. This recovery technology offers significant advantages over the pyrometallurgical routes due to their footprint, capital cost, and modularity.

An example of Elxion's Solution through innovation

Problem:

India produced approximately 2 million metric tons (Mt) of E-Waste in 2017. Printed Circuit Boards (PCBs) represent approximately 5% (100,000 tons) by weight of the total annual E-Waste[1]. The majority of existing formal sector installed capacity has no facility for "recycling". PCBs for example are typically exported or leaked into the informal sector for processing by crude methods. PCBs contain both residual values (gold, copper) and toxic heavy metals such as lead and mercury. In India 85-95% of the value recovery from PCBs occurs illegally and informally by women and children, with devastating environmental and health safety impacts.[7]

Existing legal and environmentally viable solutions for value recovery from PCBs involve the use of pyrometallurgy to separate the valuable metals from the PCBs. Pyrometallurgy is a branch of extractive metallurgy. It consists of the thermal treatment of minerals and metallurgical ores at high temperatures[8]. It concentrates to bring about physical and chemical transformations in the materials to enable the recovery of valuable metals. However, in India, illegal practices are a blend of unscientific pyrometallurgy and acid or cyanide-based recovery.

The facilities to undertake pyrometallurgy are intrinsically expensive and require minimum size and scale while generating toxic fumes which require expensive downstream treatment8. Such treatment facilities do not exist in India and PCBs are exported to recover metals.

Solution:

The Elxion process involves an aqueous electrochemical route to achieve the required separation and recovery of target metals.

The absence of heat mitigates the complexity involved with flue gas processing and the use of an electrochemical technique renders the recovery process with the USP of it being modular and scalable while not involving the use of cyanide or other restricted chemicals.

Proposed technology at suitable scales can be deployed with appropriate management practices and technical oversight to replace existing processes without affecting economic viability. This allows the aqueous electrochemical process to compete for economic viability in the current market scenario.

This increases the accessibility of the process. A coupled analysis line ensures improved monitoring capabilities, and recovery efficiencies and minimizes the possibility of environmental impacts.

The aqueous electrochemical process has demonstrated recoveries above 90% at operating costs of approximately 1.0 kWh per kg of metal recovered[7]. These represent recovery costs of 1.75% of the product value in the case of copper, 0.0175% in the case of silver, and negligible in the case of precious metals.[7] This brings down both the capital expenditure per unit PCB treated as well as operating expenses per unit metal recovered.

Dr. Doraswami states "This novel electrochemical route to metal recovery allows deployment at batch sizes as low as 100 kg per day which provides economic viability in a highly capital sensitive market".

Impacts

The existing e-waste dismantling operation has led to direct employment opportunities for 10 people mostly from the Bottom of Pyramid (BoP). Efforts by Elxion have led to capacity building in the recycling industry, both among direct employees and the associated value chain. Dr. Doraswami states that "Over 350 individuals have been trained on e-waste recycling best practices and multiple corporates have been engaged through relevant trade bodies and facility management associations". Over the past four years, Elxion has recycled and safely treated over 120 tons of e-waste. They have served over 200 customers across India.

Training and capacity-building programs in residential neighbourhoods have resulted in volunteers dropping off e-waste they collect from friends and neighbours. The project has highlighted a local pathway to achieving sustainable circularity in the rapidly growing electronics consumption domain.

Dr. Doraswami states that "Enhanced and traceable metal recoveries are showing a positive impact on the growing metal needs of the manufacturing sectors with a potential reduction in import dependencies". He believes that local capacity to recycle metals is crucial for India, as it will reduce our dependency on imports.

Over the next few years, Elxion is looking to expand its business and increase its positive impact on the local environment. Their existing practice is to recycle PCBs and lithium-ion batteries in global copper smelters. The

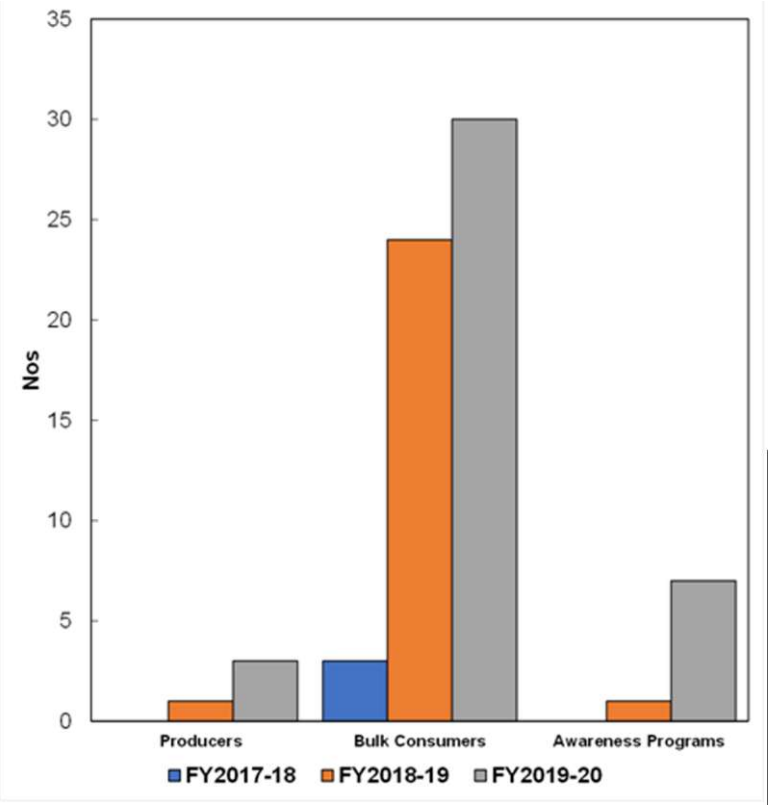

Table 2: A summary of Elxion's impacts.

impacts of mitigating pollutants from this are claimed by these global smelters. Elxion is planning to expand so that metal from low-value Printed Circuit Boards is done within India. This will mitigate the health and environmental effects of lead, mercury, cadmium, dioxins, and air pollution (all of which feature in the 10 chemicals of major public health concern by WHO) arising from illegal processing. The major positive impact will be on the prevention of contamination of drinking water used largely by BoP populations. It is estimated that BoP populations of mainly women and children are directly impacted by the hazards of illegal PCB processing, especially lead and mercury pollution. As Elxion proposes to contribute to more PCBs being safely processed, there should be a significant benefit to maternal and child health.

Table 2 shows a dramatic increase in Elxions supply from producers and bulk consumers in the second year of operation as compared to the first. This is expected with any new initiative. A few more years of operation data should reflect sustained impact and growth.

Elxion's continued Risks, Roadblocks, and Mitigation

There are a few major risks associated with most of the projects in the E-waste space. Elxion is no exception.

These are:

1. Supply risks

Supply-side risks are real since 95% of e-waste moves through the informal sector. Purchasing from the informal sector becomes financially unviable for formal establishments due to price mark-ups and volatility in supply. Elxion has been able to mitigate this by creating increased awareness in consumers and going directly to sources such as companies to stabilize raw material flows. They attend and procure from competitive bidding auctions held by companies looking to get rid of e-waste. Elxion has focused on creating awareness by holding programs in corporate offices, apartment complexes, and recycling association meetings. This has created a public interest in better management of e-waste and Elxion has regular "drop-offs" by the public. For example, apartment complexes regularly collect e-waste from residents and drop those off for recycling. Elxion has also launched a public campaign called "Naweeelu", a play on the Kannada word for peacock as well as the acronym EEE for e-waste. This campaign uses a life-sized peacock made from e-waste as an awareness-building tool.

2. Regulatory and environmental risks

Dr. Uttam Doraswami feels that the regulatory environment is largely supportive rather than a risk. However, he states that "you cannot give differential treatment to manufacturing and de-manufacturing. Almost all the focus is on the front end". He feels that there is a lack of incentives and subsidies and if they do exist, they are not proportional to what the recycling industry requires.

He further adds that "People should see that recycling is as important as the creation of the product". Fiscal and policy support is going into manufacturing, this can be seen by the announcement of various schemes like "Make in India". Manufacturing industries are given many incentives such as the creation of Special Economic Zones (SEZs), free or subsidized land, electricity, and water. A waiver on labour reforms such as Provident Fund payment is also a common incentive for manufacturing. None of these is available to the recycling industry, although they have to bear the cost of compliance.

3. Technology and Financial Risks

Dr. Doraswami feels that the "Development of local technologies to survive the current economic status quo is the real challenge". He believes that "Newer process designs need to be less capital intensive, smaller, cheaper, and more efficient". The capital costs of recycling units are high and the development of local technologies which can be deployed at a smaller scale might prove to be a viable economic model.

Growth and Potential to Scale.

As a developing market globally, the recovery of values and services business associated with electronics recycling is growing rapidly. Recent estimates by the Global E-waste Monitor 2020, suggest USD 10bn worth of metals are lost to landfills every year. Dr. Doraswami and his team estimate the following market size values for India.

1. **Recycled Iron, Aluminium & Plastics (E-Waste only): 0.5-1 billion USD**
2. **Recycled Copper & Precious Metals (E-Waste only): 4-5 billion USD**
3. **Recycled IT Products & Data Management: 20 billion USD**
4. **Chemicals and Catalysts (overall): 170 billion USD**

Elxion believes that much of this market associated with the E-Waste as a starting point is currently not being accessed by companies in the formal sector. Dr. Doraswami states that "whilst the chemicals and catalysts market is mature and formal, closing the loop to use E-Waste-derived sources as feed-stock to this industry remains a unique, scalable business opportunity". Dr. Doraswami believes that scalability will be driven in multiple ways: Expanded utilization of existing license capacity, new market penetration (e.g., chemicals and derivatives), and development in new geographies beyond their existing footprint.

With a diversified and rapidly expanding source market for raw materials (E-Waste CAGR 17%) and growing down-stream market for the products of recycling (Information Technology CAGR 14%, Metals 5.2%, Gold/Precious Metals CAGR 8%), Elxion has very good opportunities to scale their business model.

Way forward

With global economic development, the use of Electrical and Electronic Equipment (EEE) has increased. This has brought about enhanced standards of living while also creating large quantities of waste and resource depletion. Rapid urbanization, higher levels of disposable income, and industrialization has contributed to the growing e-waste sector.

What is amply clear is that e-waste is one of the fastest-growing streams of waste in the world today. India produces and processes vast quantities of e-waste, one of the leading countries to do so. While this is extremely challenging from an environmental and health standpoint, it also provides opportunities for employment as well as the opportunity to reduce impacts.

The recycling space (E-Waste, plastics, solid waste) remains a largely unorganized sector that is slowly migrating to the formal sphere. Population size and current consumption dynamics ensure that this is both a massive challenge and an opportunity for materials recovery, employment generation, and environmental protection on the upside. Globally, environmental, and social drivers have begun a push for a more circular economic framework across all market sectors. This transformation requires the development of new technologies as well as innovations in products, markets, and business models to ensure suitably efficient materials circularity.

Elxion Pvt is a small-sized company in the e-waste recycling space. They have been able to carve a niche for themself by addressing the complex technical aspects of sustainable e-waste disposal. Their strengths are in their ability to develop in-house techniques and technologies which are unique and competitive, while also following all mandated protocols. They struggle with challenges in raw material supply and sourcing, competition with the unorganized sector, and the price pressures from adhering to government compliance. What is also noticeable is that although Extended Producer Responsibility (EPR) was one of Elxion's objectives during the initial set up due to the lack of support infrastructure from the government, they have not ventured into this space.

Other major challenges include the lack of transparency, accountability, and incentives in the e-waste space. Pragmatic and realistic implementation of policy is crucial to address the challenge of e-waste. While it seems like collaborative approaches to bring together the formal and informal players in the e-waste sector is a solution, that might not be feasible.

It is unlikely that informal players will voluntarily choose compliance when the economics of non-compliance gives far greater profits. Regularisation of the informal sector is essential for any real change in the recycling sector to occur.

Using awareness and education regarding e-waste has proved to be an effective marketing tool for Elxion while also contributing to addressing the issues of e-waste in general. Large-scale awareness must be taken up in earnest by the government and producers, something which is not seen by the regular consumer on a day-to-day basis. In addition, innovation in finding financial and non-financial incentives for producers, consumers, and recyclers should be given a priority.

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