PLANNING & DEVELOPMENT BOARD

Government of The Punjab

Development of Standard Operating Procedures on E-waste Management

Draft Report

April 2023

Project Procurement International

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Project Procurement International and Otium Consultancy Services Pvt. Limited has prepared this document under a contract agreement signed with the Program Support Unit, PRIDE, Planning and Development Department, Government of Punjab.

The PRIDE Program Technical Report is an output of the development of standard operating procedures for E-waste Management. The final and validated output will be the SOPs on E-waste Management at the end of the assignment.

Executive Summary

Information and communications technology (ICT) is a combination of telecommunication and computers, with software, storage, and audio-visual, that enable users to access, store, transmit, understand, and manipulate information. The use of ICT is increasing worldwide, including in Pakistan.

Planning and Development Department (P&DD), Government of Punjab, is implementing the Punjab Resource Improvement and Digital Effectiveness (PRIDE) Program. PRIDE program aims to improve the accessibility of digital services for individuals and businesses in the Punjab province while increasing their own source revenue and the consistency of resource distribution.

The activities of the PRIDE Program will result in greater utilization of ICT equipment and products for the provision of certain public services by partner organizations. Once the program becomes operational, then there will be an increase in the purchase of new ICT devises; consequentially, e-waste will be generated due to the disposal of older or redundant ICT devices at the time of replacement and when these become redundant in future.

Electrical and electronic waste or e-waste is defined under the Basel Convention as "*Electrical or electronic equipment that is waste, including all components, sub-assemblies and consumables that are part of the equipment at the time the equipment becomes waste"*. There is a need for special treatment of e-waste to prevent wasting valuable materials and precious metals.

E-waste itself is inert. However, due to their non-biodegradability, the mishandling of openly discarded electronic items makes them harmful as toxins can be exposed to humans or released into soil, water, or air. E-waste develops health concerns for the involved personnel and nearby populations if it is dismantled, recycled, and disposed of under unsafe conditions. Therefore, there is a need for standard operating procedures (SOPs) to manage e-waste in an environmentally sound manner.

Germany is one of the prime examples of the best e-waste management practising countries. Developed countries mostly have e-waste regulations, regulatory authorities, and management systems. The developing countries do not have an efficient e-waste management and recycling system, due to which becomes a problem instead of an opportunity.

The objective of the study is to develop Standard Operating Procedures (SOPs) for the management of e-waste that public and private sector organizations in Punjab generate or will generate in future. There is a particular focus on the e-waste to be generated by the PRIDE Program since it would involve the digitization of manual workflows.

The SOPs of the e-waste management system will act as a road map to ensure that the stakeholders will comply with all environmental, occupational, health, and safety regulations.

A desk review of published literature on existing e-waste management in Pakistan was carried out. PRIDE Program documents, national, regional, and international e-waste management strategies, regulations, guidelines, and best practices were reviewed and analyzed for their relevance and effectiveness in the preparation of SOPs for e-waste management in Punjab.

An open-ended exploratory and stratified methodology for sample size was adopted for data collection from relevant stakeholders in eight divisional headquarters of Punjab. The questionnaires for key informant meetings (KII) with the relevant stakeholders were prepared. The consultative meetings and transect walks to e-waste management facilities were carried out.

The consultative meetings were held with relevant stakeholders consisting of importers, retailers, refurbishers, dismantlers, recyclers, waste management companies, academia and

regulatory authorities, private sector organisations and PRIDE partners. The consultative sessions were conducted in Northern, Central and Southern Punjab, i.e., Lahore, Rawalpindi, Gujranwala, D.G Khan, Multan, Sahiwal, Faisalabad, and Bahawalpur.

E-waste is generated in Punjab mostly from domestic use of new and used ICT devises. Once ICT devices like a laptop, computers, LCDs etc., become e-waste, then it is collected by scavengers and Kabarias from residential, commercial, private, and public sector organisations through direct sale or by participating in auctions.

The Kabarias segregate the e-waste into different categories. The first priority is to sell it to Refurbisher, who adds new or used parts in the devis to extend the life of the ICT devise or take out useful parts. The dismantler only purchases ICT equipment which cannot be further used even by adding new parts etc. The dismantler dismantles ICT equipment is different parts like motherboards, IC, metals, plastic etc., and sells them to their respective individual recyclers.

The e-waste extractor of precious metals from the motherboard, IC, and other ICT devices does use crude methods for the preparation of ingots by physical disassembly, open burning, acid baths, and blow torches. The e-waste extraction of precious metal is mainly being carried out without any regard to environmental, occupational health and safety measures, and waste is disposed of by open dumping in remote areas resulting in surface and ground water contamination and environmental degradation of the adjoining areas. There is no refinery for the extraction of gold, copper, or other precious material from the ingots in Pakistan; as such, ingots are exported to China for the extraction of precious metals.

The import of used computers, laptops, and printers has presently suffered mainly due to the massive devaluation of Pakistan's currency. Previously, the importer of used ICT devises was procured in large quantities in containers through Sea. Presently, all the used ICT devices are imported into Pakistan by air, so the importer does make sure that they are buying ICT devices which have a market in Pakistan. Therefore, the volume of import of used ICT equipment is decreasing mainly due to the ongoing economic crisis in Pakistan.

Presently, there are no regulations in Punjab that specifically deal with e-waste management. The federal EPA has prepared a draft of e-waste regulations which can be adopted by provinces as well. The current regulations, although they imply hazardous substances, no specific regulation addresses the concerns of e-waste management and, thus, no compliance obligations on any e-waste stakeholder.

There is no formal e-waste recycling facility in Punjab, and only partial recycling is done. There are no SOPs for E-waste collection, handling, transportation, recycling, or disposal in Punjab.

The private sector organisation does have established ICT hardware and software support facility with a stock of material; as such, they do provide instant ICT hardware and software support in their organisations.

There is a need that recycling of e-waste management in Punjab should be carried out in an environmentally friendly manner. The e-waste stakeholders should be registered with the Environmental Protection Department, Government of Punjab.

There is a need for all e-waste recycling facilities should comply with the occupational health, safety, and environmental regulations of Punjab.

Every effort should be made to bring the e-waste informal sector of e-waste management into formal by providing incentives.

The Section II of the report enlists the Standard Operating Procedures for PRIDE Partners, E-waste Refurbisher, Kabarias, dismantlers and recyclers.

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List of Abbreviations

ARF	Advanced Recycling Fee
BFR	Brominated flame retardants
BoR	Board of Revenue
CEA	Central Environmental Authority, Sri Lanka
CFCs	Chlorofluorocarbons
COP	Conference of Parties
CPCB	Central Pollution Control Board
EEE	Electrical and electronic equipment
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
EPD	Environmental Protection Department
ESM	Environmentally Sound Management
ESSA	Environmental and Social Systems Assessment
ET&NCD	Excise, Taxation & Narcotics Control Department
FD	Finance Department
FOEN	Swiss Federal Office for the Environment
FR	Flame Retardant
GDP	Gross Domestic Product
GoPb	Government of Punjab
HWM	Hazardous Waste Management
IBRD	International Bank for Reconstruction and Development
ICT	Information and Communication Technology
KIIs	Key informant Interviews
LGCD	Local Government and Community Development Department
MPPI	Mobile Phone Partnership Initiative
Mt	Million Metric Tonnes
NEP	National Environmental Policy
NHWMP	National Hazardous Waste Management Policy
OCS	OTIUM Consulting Services Pvt
ODS	Ozone Depleting Substances
OECD	Organisation for Economic Co-operation and Development
ORDEE	Ordinance on the Return, the Taking Back and the Disposal of Electric Equipment
P&DD	Planning and Development Department
PEPA	Pakistan Environmental Protection Act

PEQs	Punjab Environmental Quality Standards
PFMU	Public Financial Management Unit
PIC	Prior Informed Consent
PITB	Punjab Information Technology Board
PLGA	Punjab Local Government Act
POPs	Persistent Organic Pollutants
PPI	Project Procurement International
PPRA	Punjab Procurement Regulatory Authority
PRA	Punjab Revenue Authority
PRIDE	Punjab Resource Improvement and Digital Effectiveness
PSU	Program Support Unit
RoHS	Restriction of Hazardous Substances in Electrical and Electronic Equipment
SEA	Sexual Exploitation and Abuse
SH	Sexual Harassment
S-LCA	Social Life Cycle Assessment
SOP	Standard Operating Procedures
SPCBs	State Pollution Control Boards
TORs	Terms of Reference
UNEP	United Nations Environment Programme
WEEE	Waste Electrical and Electronic Equipment
WHO	World Health Organization
WMC	Waste Management Company
WSR	Waste Shipment Regulation
WTO	World Trade Organization
WWF	World Wildlife Fund

Glossary

Condemned ICT equipment	Condemned ICT equipment refers to computer hardware or electronic devices that are no longer functional due to various reasons like outdated technology, damage or malfunction. Some parts may contain hazardous materials, which require specialized handling and disposal.
Dismantler	A dismantler is a person/entity that disassembles discarded materials regarded as waste. The term dismantler in this document refers to a person/entity who buys and disassembles ICT equipment that has become e-waste.
E-waste	E-waste is any abandoned electrical or electronic equipment. This applies to both functional and damaged things that are discarded or donated. E-waste in this document refers to ICT equipment that is no longer in-use or usable by PRIDE partners and thus is auctioned/discarded.
ICT equipment	ICT equipment is Information and Communication Technology equipment used, including desktop computers, laptops, servers, monitors, printers, audio-visual (AV) equipment, software and network equipment. ICT equipment in this document refers to all types of Information and Communication Technology equipment in-use or to be used under the PRIDE Program by the PRIDE partners.
Kabaria	A kabaria is a person who collects waste and discarded materials that have value and can thus be sold off to a refurbisher, dismantler or recycler. The term kabaria in this document refers to a person/entity who collects e-waste from various sources and then segregates it on the basis of its material and useability.
Refurbisher	Refurbisher is any person who processes any type of equipment or component for reuse. The term refurbisher in this document refers to a person/entity who refreshes and reuses components of ICT equipment and thus refurbishes equipment using components from various devices.
Recycler	A person or company collects and sorts waste and treats it in order to produce useful materials that can be used again. The term recycler in this document refers to a person/entity who collects and recycles e-waste and converts it into other useful material.
SOPS	SOPs are policies, procedures and standards that define the methods of carrying out tasks in accordance with relevant legislation or own guidelines. SOPS in this document refer to a set of procedural guidelines defined for PRIDE partners to handle their e-waste generated by the PRIDE Program.

SECTION 1

1 Introduction

1.1 Background

Electrical and electronic waste or E-waste is defined under the Basel Convention as *Electrical or electronic equipment that is waste, including all components, sub-assemblies and consumables that are part of the equipment at the time the equipment becomes waste*("Overview" n.d.).

The US EPA describes E-waste as *used electronics that are nearing the end of their useful life and are discarded, donated, or given to a recycler* (US-EPA 2014). According to OECD, *Any appliance employing an electric power source that has reached its end-of-life is considered E-waste*.

Information and communications technology (ICT) is a combination of telecommunications and computers, with software, storage and audio-visual, that enable users to access, store, transmit, understand, and manipulate information. The use of ICT is increasing worldwide, including in Pakistan.

ICT technology is evolving rapidly through artificial intelligence, geo-targeting, automation, and other advancements. Rapidly occurring technological advancements often reduce the effective lifespan of ICT equipment and products. Increased usage of ICT equipment and products is anticipated to be generated at the beginning of the program (when redundant ICT equipment and products are replaced) and during the use (for example, a printer needs new or re-filled ink cartage after a limited usage) and at end-of-life of the purchased equipment.

Planning and Development Department (P&DD), Government of Punjab is implementing the Punjab Resource Improvement and Digital Effectiveness (PRIDE) Program, which supports the Public Financial Management Reforms Strategy and Public Finance Management and Governance Pillars (Pillars D and E) of Responsive Investment for Social Protection and Economic Stimulus (RISE) Punjab (subsets of Punjab Growth Strategy) in the following areas:

- Strengthened Budget Formulation and Fiscal Risk Management,
- Increased Use of Digital Technology for Delivery of Selected Public Services, and
- Improved Collection of Own Source Revenues.

PRIDE program aims to improve the accessibility of digital services for individuals and businesses in the Punjab province while increasing their own source revenue and the consistency of resource distribution.

The activities of the PRIDE Program will result in greater utilization of ICT equipment and products for the provision of certain public services by partner organizations. Since the program will become functional, it will increase the purchase of ICT equipment.

As the PRIDE project involves the digitization of public service departments, e-waste generation is quite expected. Waste is projected to be generated both at the start of the program when redundant ICT equipment will be replaced and throughout the end-of-life maintenance of the acquired equipment, electronic waste, which will occur from the usage of ICT equipment.

Just like any other waste, e-waste has to be disposed of under a defined mechanism based on its category and level of toxicity. Disposal of e-waste from the point of origin to the location of its disassembly and recycling mechanisms need to be separate and well-organized in order to avoid its negative impacts.

E-waste disposal, disassembly, and recycling greatly impact the environment and human health. E-waste develops health concerns for the involved personnel and nearby populations if it is dismantled, recycled, and disposed of under insufficient dismantling, extraction, and

disposal procedures. The release of heavy metals into the environment impacts environmental and human health.

There will be considerable procurement of new personal electronic devices, monitors and laptops, cell phones, audio/video equipment, display screens, scanners and copiers, cameras, mouse, and keyboards under the PRIDE project, whereas a large number of existing equipment and products will become e-waste. Hence, there is a need for SOPs to manage E-waste in an environmentally sound manner.

Figure 1.1: Types of E-waste generated under the PRIDE Project

According to the UN, in 2021, each person on the planet produced, on average, 7.6 kg of e-waste, meaning that a massive 57.4 million tons were generated worldwide. Only 17.4% of this electronic waste, containing harmful substances and precious materials, was recorded as properly collected, treated, and recycled. Many initiatives are to be undertaken to tackle this growing concern, but none of them can be fully effective without the active role and correct edification of the consumers of ICT equipment and products (GEN n.d.).

With the invention of new ICT products, previous or older products are often considered outdated and replaced with new ones. The problem is compounded by falling prices of older ICT product equipment and their redundancy, resulting in a fast-growing surplus of electronic waste around the globe. Although technical solutions are available, in most cases, a legal framework for storage, recycling and disposal systems or a framework for e-waste is needed before a technical solution can be applied.

The significant environmental and human health impacts of improperly handling e-waste have become challenging for many developing countries, including Pakistan. There is a need to develop standard operating procedures (SOPs) for E-waste management to reduce environmental and health impacts in the Punjab province and the country as an aftermath.

1.2 Objectives of the study

This study aims to develop Standard Operating Procedures (SOPs) for the management of e-waste that public and private sector organizations in Punjab generate or will generate in future. There is a particular focus on the e-waste to be generated by the PRIDE Program since it would involve the digitization of manual workflows. Since it is much-needed digitization in public sector organizations, thus, it will produce a noticeably large amount of e-waste. The study's anticipated results will include a road map for regulating the production of e-waste in a way that is both sustainable and safer for the environment.

The SOPs of the e-waste management system and a tracking system will be part of an action plan to make sure that the stakeholder of e-waste complies with all environmental, occupational, health, and safety regulations.

1.3 Methodology

The formal and informal sectors are involved in e-waste management in Punjab. The formal sector comprises importers of ICT equipment and products, local generators of ICT equipment and products' e-waste, and waste management companies/municipal corporations/municipal committees in urban and rural areas of Punjab. The informal sector comprises scavengers, Kabarias, refurbishes, dismantlers, recyclers of e-waste, and metal extractors for the production of metal ingots.

Literature Review: A literature review of existing e-waste management in Pakistan, published by international development organizations, academia, and public and private sector organizations, was carried out. PRIDE Program documents, including Environmental and Social Systems Assessment (ESSA), were examined to better understand the program's objective and activities.

National, regional, and international e-waste management strategies, regulations, guidelines and best practices were reviewed and analyzed for their relevance and effectiveness in the preparation of SOPs for e-waste management in Punjab.

Information about e-waste management in Punjab, including the collection, storage, disposal, treatment, recycling, and import of E-waste, was sought through a literature review.

Waste Amount Characterization Survey reports prepared by Waste Management Companies and other organizations in Pakistan were reviewed to better understand the e-waste generation rate, including quantities of e-waste in the waste streams.

Data Collection Tools: The environmental impacts of e-waste management in Punjab were studied through a literature review, stakeholders' consultation and transact walk to e-waste storage, handling and disposal facilities.

The qualitative and quantitative information/data collected from importers of e-waste (ICT equipment and products), local manufacturers, dismantlers, refurbishers, and metal extractors located in Punjab were obtained through secondary data collection, stakeholder consultations and Key Informant Interviews.

Questionnaires for e-waste importers, Kabarias, Refurbishers, Dismantlers, Recyclers, Public Sector Organizations/PRIDE partners, Waste Management Companies, Environmental Protection Department and Academia were prepared.

The sample size for data collection and stakeholders' consultation: There is no coherent data on e-waste generation, consumption, recycling, and disposal in Punjab, so an open-ended exploratory and stratified methodology for sample size was adopted for data collection and stakeholders' consultation.

The sample size consisted of manufacturers, recyclers, and retailers in Northern, Central and Southern Punjab selected for stakeholders' consultation in ten divisional headquarters of

Punjab, namely Lahore, Rawalpindi, Gujranwala, Gujrat, Faisalabad, Dera Ghazi Khan, Multan, Bahawalpur Sargodha, and Sahiwal.

At least 70 potential stakeholders and large-scale waste generators within Punjab were contacted. A list of persons to be interviewed was prepared beforehand and shared with PRIDE Punjab. After taking input from PRIDE, the list was finalized, and field visits were carried out.

Field visits were carried out in all the ten divisional headquarters of Punjab. Since Punjab's E-waste management is not well documented, a convenience-based sample size was adopted for data collection and interviews.

Table 1.1: Geographical Locations and Sample Size for KIIs

Northern Zone	Central Zone	South Zone
Rawalpindi, Gujrat,	Gujranwala, Faisalabad, Sargodha and Lahore	Sahiwal, Dera Ghazi Khan, Multan, Bahawalpur
E-waste generators, public and private sector municipal and E-waste management companies	E-waste generators, public and private sector municipal and E-waste management companies	E-waste generators, public and private sector municipal and E-waste management companies
ICT vendors/suppliers.	ICT vendors/suppliers.	ICT vendors/suppliers.
Kabarias (Informal Sector)	Kabarias (Informal Sector)	Kabarias (Informal Sector)
Importers	Importers	Importers

Stakeholders' consultation: Based on the literature review of secondary data, questionnaires for Key Informant Interviews were prepared to collect information on the existing e-waste management practices and suggestions for developing SOPs.

The key stakeholders included importers, Kabarias, refurbishers, dismantlers, recyclers, waste management companies, and PRIDE partners (contributing to e-waste).

The KII were conducted with stakeholders, and their suggestions on the development of SOPs for e-waste management in Punjab were noted.

The e-waste handling facilities were visited as part of the stakeholder's consultation, and compliance with Health, Safety and Environment (HSE) aspects was noted.

Case studies of e-waste generators and Recyclers**:** Three case studies on how e-waste is disposed of or recycled by public and private sector organizations, namely by P&DB, and AQ Metals, have been presented in the report.

Dissemination of Study Findings in a Workshop: The draft study findings and the developed SOPs will be shared with the stakeholders in two workshops. Feedback on the development of SOPs for e-waste management in Punjab will be sought, and their comments will be incorporated into the final version.

Capacity Development Plan and Training of E-waste Management Stakeholders: After submitting the Draft Report and obtaining feedback on the SOPs and draft study, the Communication Specialist/Sociologist will prepare a capacity development plan. The capacity development plan will include the level of capacity to be achieved at each level. Similarly, the training manuals will be prepared for each aspect of E-waste management, e.g., collection, transportation, handling, treatment, and disposal. The SOPs and health and safety measures will be listed for every stage.

Form for Maintaining Records of E-waste: The design of this form will enable the user to collect all the relevant details with regard to E-waste items generated by individual branches/departments of an organization.

1.4 Limitations of the Study

The limitation found during the preparation of the SOPs for e-waste management is as follows:

- The baseline data on e-waste generation, recycling and disposal in Punjab is lacking, which is a pre-requisite for evidence-based SOPs for e-waste management in Punjab.
- There is a general fear among the Kabarias, dismantlers, and furnace owners who prepare metal ingots from e-waste that if they provide information, then their business will be closed, or income taxes will be imposed. Therefore, they do not want to share their business details or allow the visit to their premises.

2 E-Waste and its environmental Impacts

2.1 Introduction

Electrical and electronic equipment (EEE) usage is closely related to worldwide economic growth. EEE has emerged as a necessity in contemporary cultures and is a result of rising living standards. EEE is increasing because of rising incomes, increased urbanization, mobility, and continued industrialization in the world.

The role of the internet and other associated digital technologies in both our personal and professional lives has grown significantly during the past ten years. Cloud storage has become the new standard, where our emails, papers, social media accounts, and other files are kept on remote servers and instantly accessed from a PC, laptop, or mobile device from practically anywhere on Earth. In addition, many of our financial transactions are now digital. By the end of 2022, it was predicted that 60% of the world's GDP would be digital, and 70% of the new value produced in the economy during the next ten years will be based on platforms with digital capabilities (Digital Development-World Bank, n.d.).

The turmoil surrounding COVID-19 has hastened the digital transformation's accelerative progress. The creation of vaccinations, risk modelling, and contact tracking were only a few examples of the digital technologies that helped us be resilient to COVID-19. Web conferencing has become common in work, school, and keeping in touch with family and friends. Many enterprises and educational institutions have now transitioned to an online format.

Considering the quick timelines for their technological execution, the digital advancements produced are astounding but come with a price since the manufacturing of the gear and the electricity required to power this internet growth both have significant environmental impacts. When equipment is damaged or broken after usage and can no longer be repaired, it has to be disposed of; thus, at this stage, it is termed e-waste. Thus, e-waste is any electrical or electronic equipment used by the domestic, institutional, or commercial sectors.

E-waste, or electrical/electronic waste, refers to a variety of electrical and electronic devices that are outdated, no longer valuable to their users, or have reached the end of their useful lives. E-waste is made up of a complicated collection of substances, some of which are dangerous. If the abandoned gadgets are not treated appropriately, these could have serious negative effects on the environment and human health. Modern electronics also contain rare and valuable resources that, with proper waste management, can be recycled and utilised again.

One of the waste source consequences of the fastest global growth is WEEE. EEE becomes a waste of electrical and electronic equipment, or WEEE, when it is no longer functional and needs to be disposed of. Additionally, it is one of the hardest to control safely. Our electronic equipment often only lasts a few years, which is a relatively limited lifespan. The constraints in the appropriate collection and, in the best situation, recycling continue to be tremendous.

The currently adopted practices for e-waste collection, reuse, recycling, and disposal are not sustainable. The extensive resource consumption, greenhouse gas emissions, and the release of harmful compounds during informal recycling are some of the environmental impacts which arise due to the sluggish adoption of e-waste collection and recycling practices.

A record 53.6 million metric tonnes (Mt) of e-waste was generated in 2019 (Adrian et al. 2020), making e-waste the fastest-growing waste stream in the world. Increased electrical and electronic equipment consumption, short product life cycles, and limited repair alternatives primarily drive its growth. Less than 20% of electronic waste is officially recycled, leaving the other 80% to either wind up in landfills or be sporadically recycled. In accordance with the records, just 17.4% of e-waste was collected and recycled globally in 2018 (Forti and Peter Baldé, 2020).

2.2 Types of E-waste

When electrical and electronic items become waste, they can be classified into two broad categories, i.e., hazardous waste and non-hazardous e-waste. They can be described as follows:

Hazardous e-waste: E-waste becomes hazardous when improperly handled, and its toxic substances leak into the environment. Substances such as lead, mercury and cadmium are used in electronic items that are harmful and can cause toxicity even in lesser quantities. Since such substances can cause harm to the environment and the well-being of living organisms, it is termed hazardous e-waste.

The presence of elements like lead, mercury, arsenic, cadmium, selenium, hexavalent chromium and flame retardants beyond threshold quantities of e-waste classifies them as hazardous waste.

Non-hazardous e-waste: Non-hazardous e-waste does not directly threaten human health or the environment, but it still cannot be dumped into a waste receptacle or a sewer line because of the risks it could pose. Most of the waste produced is plastics, glass, metals, etc., non-hazardous waste because it is not toxic by nature.

Some e-waste components, such as antimony and palladium, are usually precious and beneficial even after the item is disposed of. Such components are categorized as non-hazardous e-waste. Non-hazardous e-waste is typically separated at first when e-waste is disassembled and may then be recycled or disposed of. It is always very important to correctly distinguish between hazardous and non-hazardous e-waste.

Handling and disposal methods are the main prospects that discriminate between hazardous and non-hazardous waste. E-waste itself is inert. Mishandling of discarded electronic items makes them harmful as toxins can be exposed to hums or released into soil, water, or air.

2.3 Sources of E-waste

US-EPA has divided the overall general e-waste into different sorts for categories that also represent major sources of different types of e-waste. The categories are as below:

- Domestic freezing and cooling appliances
- Small domestic appliances
- Luminaries
- Tools
- Information Technology devices
- Medical equipment
- Leisure tools and toys
- Consumer appliances
- Automatic vendor machines
- Monitoring devices
- Photovoltaic panels

These categories have numerous amounts of devices that have an average life of no more than 3-5 years and then become a waste.

2.4 ICT e-waste

Information and communications technology (ICT) is a combination of telecommunications and computers, with software, storage and audio-visual, that enable users to access, store,

transmit, understand and manipulate information. The use of ICT is increasing worldwide, including in Pakistan.

ICT technology is evolving rapidly through artificial intelligence, geo-targeting, automation, and other advancements. Rapidly occurring technological advancements often reduce the effective lifespan of ICT equipment and products. With the invention of new ICT products, previous or older products are often considered outdated and replaced with new ones.

The issue is made worse by the declining costs of older ICT equipment and its redundancy, which has led to a rapidly expanding glut of electronic waste globally. Although there are technological solutions available, in most situations, a framework for e-waste or a regulatory framework for storing recycling and disposal methods is required before a technical solution can be implemented.

Information and Communication Technology (ICT) equipment is becoming a major source of e-waste, particularly from public and private sector organizations and commercial sectors activities. The sources of ICT e-waste from these sectors are as follows:

- Centralized Data Processing: Various types of Computers, Laptop, Notebook Computers and accessories, Notepads
- Printers, including components.
- Telephones, Cordless Telephones and Cellular Telephones
- Copying Equipment
- User terminals and systems
- Mobile phones
- Scanners

2.5 Hazardous components in ICT e-waste

The valuable heavy metals are extracted from e-waste using a variety of techniques. Different amounts of heavy metals are present in e-waste.

Table 2.1: **Hazardous material present in ICT e-waste components.**

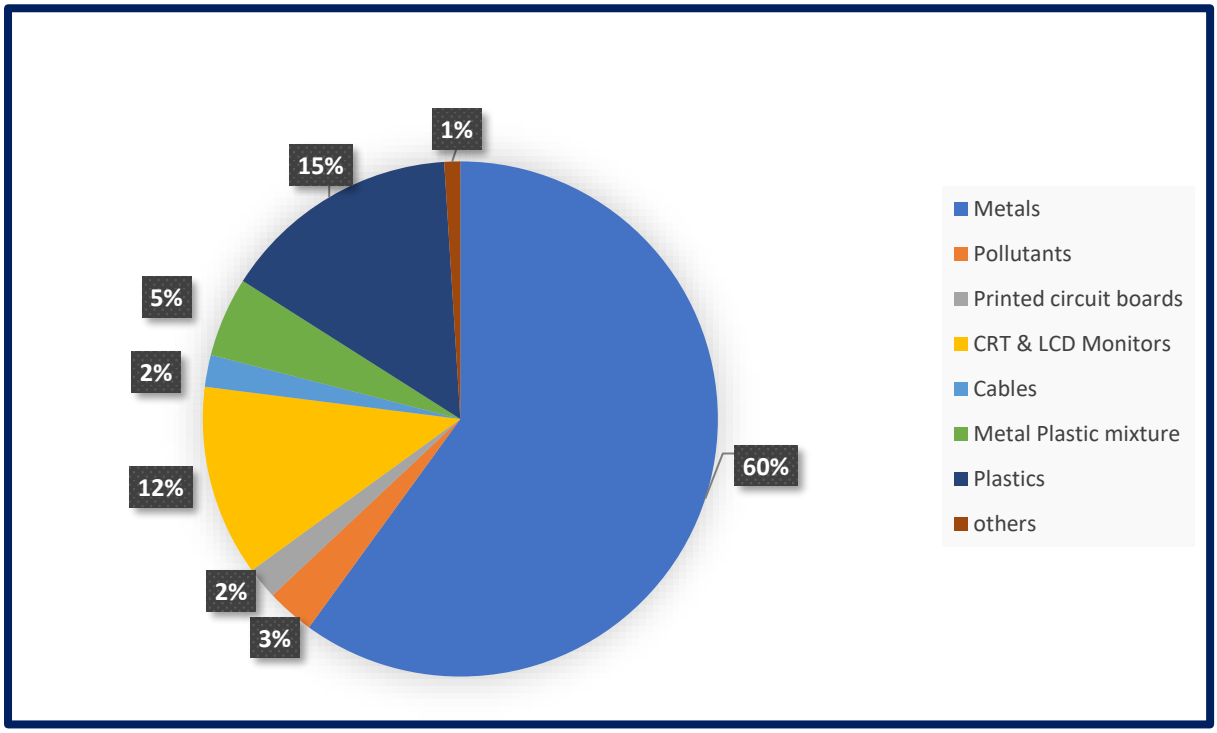
Component of E-waste	Possible Hazardous Contents
Wiring	Brominated flame retardants (BFR), Phthalate plasticize, Lead
Displays (LCD)	Mercury
Circuit Board	BFR, Antimony, Beryllium and Lead
Batteries	Lithium, Lead, Mercury, Cadmium
Thermostat	Mercury
External electrical cables/wires	Plasticizers, BFR
Cathode Ray Tubes	Antimony, Lead, Mercury, Phosphorus
Electrolyte Capacitors	Glycol
Rubber	BFR, Phthalate plasticizer

1.1 Composition of E-waste

Typically, e-waste comprises 40% inorganics, 30% organics and 30% ceramics materials. The organic portion of e-waste usually comprises polymers, flame retardants and glass fibre. Whereas the inorganic portion remains to be, in most cases, noble metals (e.g., gold, palladium and silver), base metals (e.g., iron, copper, tin and aluminium), heavy metals (e.g.,

beryllium, zinc, mercury, cadmium, nickel, chromium and lead) and rare earth metals (e.g., platinum, tantalum and gallium). (Li et al. 2008).

Figure 2.1: Generalized composition of e-waste



Source: (Li et al. 2008)

There is a need for special treatment of e-waste to prevent wasting valuable materials and rare elements. Materials such as gold and palladium can be mined more effectively from E-waste than ore mining. There are more valuable metals in scraps from ICT equipment and products than from home appliances(Chancerel et al. 2009).

A cell phone contains more than 40 elements, base metals such as copper (Cu) and tin (Sn); special metals such as lithium (Li), cobalt (Co), indium (In), and antimony (Sb); and precious metals such as silver (Ag), gold (Au), and palladium (Pd)(Li et al. 2008).

2.6 Global Pattern of E-waste Generation

The major problem associated with e-waste management is its ever-increasing quantum. However, the e-waste quantities represent a small percentage of the overall municipal solid waste. The data on e-waste generation may vary between areas of a country because of the definitions of waste arising, technological equipment used, the consumption patterns of the consumers, and changes in the living standards across the globe(Maciej Serda et al. 2013).

According to a United Nations report 2019, the global electrical and electronic waste (E-waste) generation reached 53.6 million metric tons in 2019 and is projected to expand to 120 million metric tons annually by 2050 (World economic forum, 2019, Rautela et al., 2021).

Recycling processes, such as hydro, pyro, and bio-metallurgy, are employed to recycle and recover valuable materials from E-waste in developed countries such as Germany, Belgium, and South Korea (Wang et al., 2013), whereas some developed countries like Japan, USA and Europe have used entirely automated, cost-effective e-waste recycling technologies (Abalansa et al., 2021).

Globally, millions of tons of e-waste are produced annually, and only a very small portion of this waste is recycled. Literature suggests that 17.4% of E-waste is properly recycled after collection, and the remaining 82.6% ends up in dumps and landfills(Baldé et al., n.d.).

On average, the global E-waste generation rate per capita is 7.3 kg/annum, whereas, in Europe, it was 16.2 kg. The region-wise production of E-waste is provided in **Table 2.2**.

Table 2.2: Global E-waste generation pattern

S. no	Region	E-waste generated (Mt)	E-waste formally collected (Mt)	E-waste collection rate %
1	Africa	2.94	0.03	0.9
2	Asia	24.9	2.9	11.7
3	Europe	12	5.1	42.5
4	America	13.1	1.2	9.4
5	Oceania	0.7	0.06	8.8
6	Global	53.6	9.3	17.4

Source: United Nations University, 2020

E-waste generated from diverse sources is normally collected as a unit or sub-unit of functional equipment. In many instances across the globe, whole units of e-waste have been categorized as e-waste. In developing and transition countries, little consideration is given to the quantification of the e-waste collected or disposed of.

The reason is that in the pre-reprocessing stages, the collection of e-waste is mostly undertaken by the unorganized sector of Kabarias/traders or peddlers. As a result, this information is invisible to the statistics collection system, which makes the waste generation information of e-waste very difficult to acquire in Punjab, Pakistan, like other developing countries(Troschinetz and Mihelcic 2009).

There is no compliance with SOPs for the storage, recycling, and disposal of e-waste in an environmentally sound manner in Pakistan. Due to the complexity of e-waste composition, its treatment and management remain challenging and threaten the environment and humans. Hazardous materials that are also toxic in nature, such as hexavalent chromium, nickel, cadmium, lead, mercury, and brominated flame retardants (BFRs), are the major hurdle in the way of e-waste treatment and management.

E-Waste generally includes items that are very valuable but contain toxins as well. E-waste frequently includes useful and possibly hazardous elements. The kind of equipment's components, model, the company, the date of manufacturing, and the age of the remaining components all significantly impact the composition of e-waste. There are more valuable metals in scrap from IT and communications systems than in scrap from home appliances(Chancerel et al. 2009).

A case in point can be a mobile phone for comparison. It has more than 40 different elements in it, including basic metals like tin (Sn) and copper (Cu), special metals like cobalt (Co), lithium (Li), antimony (Sb), indium (In), and as well as valuable metals like palladium (Pd), gold (Au) and silver (Ag) (Li et al. 2008).

Due to the complexity of e-waste composition, its management remains a challenge, and its presence poses a threat. The presence of toxic materials are also hazardous in nature, such as hexavalent chromium, nickel, cadmium, lead, mercury, and brominated flame retardants (BFRs), pose many health effects to humans, which have been discussed in **Table 2.3**.

Table 2.3: Sources of e-waste and associated health risks

E-waste sources	Constituents	Health effects
Computer displays have gaskets, glass panels, and printed circuit boards soldered in.	Lead (Pb)	• Kidney disease, blood system injury, and central and peripheral nervous system damage • Negative effects on children's cognitive development; damages the kidney and circulatory system
Semiconductors and chip resistors	Cadmium (Cd)	• Damages the nervous system. • Has toxic, permanent consequences on human health. • Builds up in the kidney and liver
Switches, relays, and printed circuit boards	Mercury (Hg)	• Skin and respiratory conditions brought on by bioaccumulation in fish. • Brain injury that is ongoing.
Steel housing with galvanized steel plates and a decorator or hardener	Chromium (Cr)	• May cause bronchitis
housing for cables and computers	PVCs & Plastics	• Dioxin, a by-product of burning, is harmful to both growth and reproduction.
Circuit boards and electronic devices	Brominated flame-retardants	• Impair the endocrine system's operations
CRT front panels	Heavy metals, Phosphorus (P), and Barium (Ba)	• Weaken the muscles and harm the heart, spleen, and liver
Printed circuit board tracks and copper wires	Copper (Cu)	• Wilson's disease, nausea, liver damage, and stomach discomfort
Rechargeable nickel-cadmium batteries	Nickel (Ni)	• Dermatitis is the consequence of skin allergy to nickel, whereas asthma is the outcome of lung allergy to nickel.
Lithium-ion battery	Lithium (Li)	• Lithium can infiltrate breast milk and harm a breastfeeding infant. • It can also induce pulmonary oedema when inhaled.
Motherboard	Beryllium (Be)	• Lung cancer • Chronic beryllium illness is brought on by inhaling dust and fumes from motherboards.

2.7 Impacts of E-waste on Environment, Social and Human Health

As components of e-waste are non-biodegradable, therefore it is toxic to the environment. Polychlorinated biphenyls, polyaromatic hydrocarbons, and heavy metals such as mercury and cadmium. E-waste accounts for 70% of the harmful waste in landfills, and some landfills actually forbid the disposal of any electronic waste(US-EPA 2014).

Impacts on human health: Recovery of precious elements from electronic components using acid baths are often carried out domestically using crude methods. With 12.9 million women employed in the unregulated waste industry, both they and their new born babies may be in danger of exposure to hazardous e-waste. Workers dealing with toxic materials are also exposed to high levels of contaminants, including polychlorinated biphenyls (PCBs),

brominated flame retardants (BFRs), lead, mercury, beryllium, thallium, cadmium, and arsenic.

The harmful compounds of e-waste endanger human health by coming into direct contact with people and contaminating the soil and water. Such contaminants can cause cancer, miscarriages, neurological damage, and lowered IQs, among other irreversible health effects. This tremendously influences society and the environment since it mostly affects the poorest citizens of the least developed nations(“Soaring E-Waste Affects the Health of Millions of Children, WHO Warns”, n.d.).

Children's health will suffer tremendously as a result of increasing e-waste, and the health system will be heavily taxed in the years to come if they do nothing. According to Marie-Noel Brune Drisse, the primary WHO author of the “Children and Digital Dumpsites”, "A youngster who eats just one chicken egg from Agbogbloshie, a waste site in Ghana, will absorb 220 times the European Food Safety Authority daily limit for ingestion of chlorinated dioxins".

The Unprecedented DNA Damage Associated with E-waste

A study was conducted in 2011 at an e-waste recycling facility in South-east China. The objective was to determine health impacts of e-waste on handlers. One experiment group of 48 individuals and one control group consisting of 56 individuals were part of the study. The study reported increased micronuclei frequencies associated with high lead levels in blood of individuals tested from the recycling facility. Using a cytokinesis-block micronucleus test, the frequencies of lymphocytic micro nucleated binucleated cells (MNBNCs) were calculated.

The exposed group's blood lead levels were found to be considerably higher than those of the control group (median: 11.449 g/dL, 1st/3rd quartiles: 9.351-14.410 g/dL vs. 9.104 g/dL, 1st/3rd quartiles: 7.275-11.389 g/dL), according to the study's findings. In comparison to the controls (median: 1.0 per thousand, 1st/3rd quartiles: 0.0-2.0 per thousand), the exposed group saw higher MNBNCs frequencies (median: 4.0 per thousand, 1st/3rd quartiles: 2.0-7.0 per thousand).

The e-waste substances have sources have adverse impacts on human health.

Table 2.4: Effects of e-waste components on human health

Substance	E-waste source	Human Health Impacts
Mercury	Lamps, batteries, and switches	Affect the central nervous system and kidney
Lithium	Batteries	Distress the nervous system and intestinal system
Arsenic	Printed circuit boards, diodes and cathode ray tubes, screens	Causes a variety of cancers and skin conditions, damages the cardiovascular and respiratory systems and harms the reproductive system
Nickel	Batteries and cathode ray tubes	Responsible for different cancers and lung and skin disease
Brominated flame retardant	Flame retardant for electronic equipment	Difficulties with the thyroid, liver and endocrine systems, including weakened neurological systems
Cadmium	Chips, switches, the printed circuit board in semiconductors	Extremely carcinogenic, it affects bones, kidneys, and the respiratory system
Copper	Printed circuit boards	Causes diarrhoea and liver disorders
Chromium	Batteries, disks, cathode ray tubes and computer body	Responsible for causing brain, neurovascular, respiratory and kidney damage
Polyaromatic hydrocarbons (PAH)	Discharged as a combustion by-product	Different cancers may be caused by chronic exposure. Adverse impacts on developmental and reproductive health
Polychlorinated dibenzodioxins (PCDDs)	Combustion by-products	Different cancers and disruptions with nervous systems

2.8 Impacts on the Environment

Since e-waste is not biodegradable and builds up in the environment, it may be harmful. When techniques like open-air burning and acid baths are used to recover precious elements from electronic components, toxic chemicals are discharged into the environment. The effects of inappropriate e-waste disposal on the ecosystem threaten and endanger the wide-ranging environment.

Soil, air, and water components of the ecosystem are affected by the improper disposal of these pollutants. The major culprit of such problems is improper e-waste management. Many nations have not yet recognised this growing problem as a health hazard. The major impacts of e-waste on the environmental components are as below:

Air quality: Air pollution is generated when electronic equipment is shredded, melted, or burned in burn pits or other illegal e-waste disposal methods. The pollutants emitted may spread over long distances into the atmosphere, inflicting long-term illness as well as respiratory ailments. Burning electronic waste can cause emissions of hydrocarbons into the environment, thereby polluting the air.

The informal sector's crude and unsophisticated e-waste processing techniques have considerably contributed to the high air particulate matter levels, notably the levels of heavy metals, in an illegal e-waste burning region. Chronic exposure to air pollution brought on by the processing of e-waste led to alarming levels of toxic heavy metal exposure in the

community, which in turn was linked to a high prevalence of cardiovascular illness, specifically hypertension(Gangwar et al. 2019).

Soil: E-waste toxins may contaminate the soil directly or indirectly by contact with contaminated water, such as during irrigation. E-waste dumps on the surface and subterranean e-waste both alter the soil's chemical makeup. In the subsoil, where it affects the soil's structure and texture, ash from burning electronics and fine particles from shredding are also found.

The first proof of human and environmental Flame Retardant (FR) exposure in Karachi City was reported in 2017. The two main e-waste recycling regions, i-e., Shershah and Lyari, were both found to be extremely FR-contaminated, pointing to informal e-waste recycling as a significant source of FR emissions in the Karachi City environment. The main exposure route for e-waste toxins was determined to be ingestion by soil and inhalation by air (Iqbal et al. 2017).

Toxic heavy metals are released as e-waste degrades. These heavy metals include cadmium, lead, and arsenic. These toxins have an impact on plants and trees when they enter the soil. As a result, these chemicals may find their way into the food supply for people, which may result in a variety of health issues, including birth deformities.

Water: Air, soil nutrients, and water are the three important elements that plants require. When precipitation disintegrates hazardous substances such as heavy metal complexes of barium, lead, and mercury, it contaminates surface water, which then flows into ponds, rivers, and lakes.

As a result, when minerals, metals, and chemicals contaminate the air, soil, and water; in this way, they seep into crops, which has an impact on all forms of agriculture since it impacts our livestock and food supply.

Although placing electronic debris in landfills can seem like a sensible way to dispose of it, doing so also pollutes the groundwater. Groundwater is one of the most valuable resources on Earth, and without it, a bulk of us would have to resort to drastic means to survive dry conditions and droughts(Adrian et al., 2020).

2.9 Impact on Climate Change

It is important to consider how technological products affect climate change. Every piece of equipment ever built leaves a carbon footprint and contributes to the global warming caused by humans. A metric tonne of laptops may produce up to 10 metric tonnes of CO_2 emissions. The carbon dioxide released across a device's lifespan occurs primarily during manufacture, prior to customers purchasing a product.

The reduced carbon production techniques and inputs—such as the utilization of recycled raw materials—and product lifespans—are key factors in determining the total environmental effect. According to research, 2.9 metric tonnes of carbon were discharged for every ton of CRT display items produced. Large volumes of CO_2 are also released during the production of electronics. Only 10% of greenhouse gas emissions are generated during appropriate recycling (GEN n.d.).

Researchers from the University of California, Irvine found that between 2014 and 2020, greenhouse gas emissions from electronic gadgets and the trash they produce grew by 53%, including 580 metric tonnes of carbon dioxide in only one year.

It is predicted that by 2030, e-waste sources will be responsible for the yearly emission of around 852 million metric tonnes of CO2 compounds if there is no legislation or legal framework to extend the usable life of information and communication technology equipment (WEEE n.d.).

2.10 Impact on the social structure

A major loss of rare and important raw materials, including precious metals like neodymium essential for motor magnets, indium, and cobalt, is caused by the faulty management of e-waste (for batteries). Rare earth minerals are mined in a harmful manner. Thus, hardly any are retrieved through informal recycling. However, it is challenging to extract metals from e-waste; for instance, overall cobalt recovery rates are just 30% despite the existence of technology that could recycle 95% of it.

Nevertheless, this material has become highly sought after for batteries in electric cars, smartphones, and laptops. Additionally, repurposed metals require 2–10 times less energy to melt than metals made from virgin ore. In addition, extracting gold from discarded electronics emits 80% less carbon dioxide per unit of gold than mining it from the ground. In underdeveloped nations, a large portion of the recycling and dismantling labour is carried out manually using outdated techniques.

Burning of the outer rubber covering off wiring removes the wiring, and valuable metals are removed from computer chips by dipping them in acid baths. Long hours, dangerous working conditions, and little compensation are common for employees, including child labourers. The long-term impacts of toxins like lead are a concern for these employees, but they also run the danger of being hurt or killed by falling machinery and carelessly disposed of gadgets (ILO 2012).

1.2 E-waste management techniques

Understanding e-waste management procedures are crucial for both individuals and companies. There are several e-waste disposal methods. Therefore, it's important to grasp the regulations and the repercussions of each before using them. A fresh approach is required to produce and use electronic and electrical products. It is simple to portray e-waste as a post-consumer concern, yet the problem spans the whole lifespan of the gadgets that we all use.

It takes a team effort from designers, manufacturers, investors, traders, miners, producers of raw materials, consumers, policymakers, and others to reduce waste, maintain system value, increase a product’s economic and physical life, and increase its capacity for repair, recycling, and reuse. Properly.

Different methods have traditionally been used to get rid of e-waste, but each has its own set of environmental problems. Common e-waste disposal methods used around the globe have been discussed below:

Landfilling: excavating a sizable portion of the earth, dumping waste into it, and then covering the hole. Even though the pits are lined with clay or plastic and equipped with a leachate basin to stop hazardous waste from seeping into the environment, certain contaminants, such as cadmium, lead, and mercury, invariably make their way into the soil and groundwater.

Acid Bath: Metals are separated from the electronic pathways by immersing electronic circuits in potent sulfuric, hydrochloric, or nitric acid solutions. After that, the metals can be recycled and used to make new goods. However, the highly dangerous acid waste must be disposed of with extreme caution to prevent it from getting into nearby water sources, thereby creating a new trash disposal issue.

Incineration: This highly primitive e-waste disposal technique includes burning the material at a very high temperature. This offers the dual advantages of dramatically lowering the volume of waste and producing energy that may be used for other purposes.

Unfortunately, a significant number of harmful pollutants, including cadmium and mercury, are discharged into the atmosphere during the burning of electronic waste components.

Recycling: Many e-waste gadgets can be taken apart, and their individual parts can be used to create new products. Using e-waste recycling procedures, valuable metals from circuit

boards can be recovered and melted down to create new products like jewellery or new devices.

Reuse: Reusing gadgets is by far the most environmentally beneficial method of disposing of electronic waste. Many organizations are working to collect used electronics that can be repaired and given to those in less fortunate communities.

3 Existing E-Waste Management in Punjab

3.1 Existing e-waste situation in Pakistan

E-waste is physically and chemically distinct from municipal and industrial waste. It contains valuable metals like copper and gold, while hazardous substances such as flame retardants, lead, mercury, arsenic, etc., are also present. This makes it necessary to handle or recycle e-waste carefully to reduce environmental contamination and potential negative effects on human health.

In Pakistan, like other developing nations, there are higher exposures to harmful compounds due to a combination of factors, including shorter appliance lifespans, increasing consumption, low recycling rates, and illicit transboundary transfer of e-waste from developed to developing countries(Tong and Wang 2013).

Due to high labour costs, stringent environmental restrictions, and a lack of facilities for recycling e-waste, developed countries are more likely to export some of their e-waste to underdeveloped countries. E-waste is frequently handled and recycled in underdeveloped and emerging nations at the expense of the environment and public health(Iqbal et al. 2017).

Asia recorded the highest e-waste generation rate increase as compared to other regions from 2016 to 2019. (Forti et al., 2020). This indicates the need to upgrade our e-waste management techniques.

Table 3.1: Amount of e-waste generation by region

#	Region	Quantity 2016 MT Per Annum	E-waste per capita	Quantity 2021 MT	Quantity 2030 MT Projected	Recycling %
1	Asia	18.2	4.2	24.9	-	11.7
2	Europe	12.3	16.6	12.0	16.2	42.5
3	America	11.3	11.6	13.1	-	9.4
4	Africa	2.2	1.9	2.9	2.5	0.9
5	Oceania	0.7	-	0.7	16.1	8.8
6	**Global**	**(2019) 53.6**	**(2019) 7.3**	**57.4**	**74.0**	**9.3**

Source: Global E-waste Monitor, 2020

E-waste generation from homes, businesses, organizations, and the public sector has increased significantly because of the quickly rising sales and domestic technological breakthroughs. In Pakistan, managing solid waste is already a great concern because of the absence of a proper waste management system and the illegal dumping of all types of waste.

Despite previous accords like the Basel Convention dealing with the management of transboundary movements of hazardous wastes and their disposal, the flow of e-waste from the US, Canada, Australia, EU, Japan, and Korea to Asian nations like China, India, and Pakistan continues to be diffident.

According to a study on social life cycle assessment (S-LCA) conducted in Pakistan, the management and disposal of e-waste in Pakistan adds toxins to the environment and adversely impacts human and environmental health. The necessity for an evaluation of the e-waste inventory and a thorough investigation of Pakistan's black-market recycling is thus very important(Umair, Anderberg, and Potting 2016).

Direct imports of computer junk into Pakistan also contribute to the development of e-waste. The examination of the data gathered indicates that Pakistan has a sizable and desirable

market for refurbished and used goods. As a result, Pakistan imports used or second-hand goods that are considered e-waste by developed nations.

A survey also revealed that both documented and undocumented imports of computer equipment occur. All of the regularly occurring legal imports of computer equipment by brand dealers and local assemblers, who most often do so through seaports, are documented imports.

Additionally, it has been learned that Pakistan imports this equipment as a gift for public universities and schools as well. E-waste is also supposedly smuggled into Pakistan from the US, EU, Australia, Saudi Arabia, Kuwait, Singapore, and the United Arab Emirates, among many other nations(Iqbal et al. 2017).

E-waste from the EU and the US is allegedly also pre-distributed through Dubai in the United Arab Emirates and Singapore to South Asian nations, with India and Pakistan being the main destinations (Schmidt, Krauth, and Wagner 2017).

A comparison of e-waste generated by China, India and Pakistan throughout the years. The e-waste generation rates increased from 210 metric kilotons in 2005 to 433 kilotons in 2019. This increase can be attributed mostly to digitization through the years and the import of e-waste from developed countries.

Table 3.2: Comparison of e-waste generated in major Asian countries.

Country	E-waste generated per capita per annum (kg) (2012)	E-waste generated total in metric kilotons (kt)			
		2005	2012	2015	2019*
Global	-	35,000	48,894	-	-
China	5.36	3300	7253	7317	10129
India	2.25	1600	2751	2803	3230
Pakistan	1.68	210	300	315	433

Source: Global E-waste Monitor 2020

Pakistan recorded its highest retail and purchase in 2013, which also translates into more people using technology. The number of mobile phone subscribers in the country reached an all-time high of 137.68 million in April 2014. This shows that mobile phone usage is immense and will eventually lead to a rise in the production of e-waste.

A 12% yearly growth rate in the purchase of television screens and monitors is also anticipated due to the quick replacement of old technology with new one. Because of rising demand from consumers, businesses, and the government sector, the industry is still growing. Sales of computers climbed by 5.8% annually from 409 million dollars in 2014 to 432 million dollars in 2015, while sales of cell phones increased by 9.1% annually(Gill et al. 2022).

Due to its location as a seaport, Karachi receives containers of e-waste from all over the world. This refuse is transported to warehouses once it has been cleared by the port, where Kabarias purchase the materials at a per-ton rate. The e-waste is either disassembled and reused, burnt, or disposed of, depending on its content. Many labourers, often teenagers, make a living by disassembling and removing precious material from the waste.

The recycling and disassembly of electronic waste are seen as serious health risks in 15 nations, including Pakistan, due to malpractices. India, Pakistan, and Bangladesh, the three major South Asian countries, are among the most severely impacted by e-waste. In 2019, Pakistan generated 433 kilotons of electronic waste. An estimated 12.46 kilotons of used computers were brought into Karachi from several developed countries in 2014(Iqbal et al. 2017).

3.2 Existing e-waste situation in Punjab

Waste Characterization Surveys provide insight into the characteristics of waste being generated in a typical city. **Table 3.3** shows the e-waste being generated in 6 major cities of Punjab. The analysis shows that around **2.35 tons/day** of e-waste is generated in these cities, which includes household, commercial as well as institutional e-waste.

Table 3.3: Daily e-waste generation rate in 6 major cities of Punjab

S. No	City	Waste collection authority	The population of the city (2022)	Average waste generation rate (tons/day	E-waste component in collected waste %	Average e-waste collection per day
1	Lahore	Lahore Waste Management Company	13,979,000	5000	0.02	1 ton/day
2	Rawalpindi	Rawalpindi Waste Management Company	1,001,000	1000	0.05	0.5 tons/day
3	Sargodha	Sargodha Municipal Corporation	926,336	347	0.07	0.24 tons/day
4	Bahawalpur	Bahawalpur Waste Management Company	881,458	483	0.08	0.38 tons/day
5	Rahim Yar Khan	Rahim Yar Khan Municipal Corporation	504,561	255	0.06	0.15 tons/day
6	Dera Ghazi Khan	Dera Ghazi Khan Waste Management Company	540,393	222	0.04	0.08 tons/day
					Total	**2.35 tons/day**

E-waste is produced in Punjab mostly from domestic consumption and import. The first collection point of e-waste is the repair shops where customers bring their non-working e-waste. Kabarias and scavengers gather e-waste that is discarded from these sources. The vendors occasionally segregate the waste into components, which are then sold to dismantlers and recyclers.

Dismantlers and material extractors take precious and valuable materials from e-waste components using ecologically harmful technology. The residual waste is frequently dumped in dumpsites or aquatic bodies. Diverse components of old equipment are occasionally put back together for sale by Kabarias, refurbishers and dismantlers. Workers that participate in recycling tasks may not be entirely mindful of the possible negative effects of recycling or disassembling electronics, subjecting them to highly toxic substances.

To remove rich metals, crude recycling methods are used, such as physical disassembly, open burning, acid baths, and the use of blow torches. In Pakistan, informal recycling is expanding as small and medium businesses across the country and is developing day by day. Most of the informal recycling of e-waste is carried out in small factories built in homes where the process is carried out using crude methods, thus decreasing the recycling efficiency of precious material.

E-waste is imported under the description of "used equipment". Only a very small portion of the imported materials are recycled. The majority of the e-waste is transported to the recycling

sector once the useable component has been removed. The recycling and disassembly of e-waste are done on a limited scale, although major recycling firms are located in Lahore, Faisalabad, Gujranwala, and Rawalpindi.

Waste Generators:

Waste generators comprising domestic, commercial, and institutional holdings generate e-waste per their usage of electrical and electronic equipment. E-waste is primarily composed of household items such as refrigerators, televisions, air conditioners, washing machines, electrical motors, and ICT equipment such as Personal Computers, laptops, printers, screens, fax machines, communication devices, keyboards and others.

Electrical or electronic equipment becomes waste when it is deemed irreparable. This usually happens at the workshop or places where the customers take the item to get it repaired. From here, the e-waste is mostly sold to scavengers who come with carts and buy the e-waste, which is preferred by the seller rather than discarding this e-waste into dustbins; hence, negligible quantities of e-waste are found in collected municipal waste.

E-waste from the commercial sector is dealt with in various ways. Depending on the scale of the commercial entity, e-waste is either sold to Kabarias, handed over to a waste management company or auctioned. Most of the commercial sector sells its discard able e-waste to waste scavengers that come door to door and buy the equipment at reasonable charges.

E-waste at the institutional level is mostly auctioned. Since institutions have a high rate of electronic purchases, the e-waste generation rates are also seemingly high. The PRIDE partners have been considered as the e-waste generators here, as the program will result in waste generation from these entities. It is important to note that a hard drive that contains sensitive data is only wiped and cleaned through software, whereas no physical alteration is neither available nor utilised to ensure the complete destruction of any data available in the desktop/laptop.

PRIDE partners

Board of Revenue (BoR), Government of Punjab: The West Pakistan Board of Revenue Act of 1957 superseded the West Pakistan Board of Revenue Ordinance, which established the board in 1956. In 1970, when the Province of West Pakistan was dissolved, it was given the name Board of Revenue Punjab. Involved in determining land valuation, collecting land taxes, and keeping track of land rights in the province of Punjab.

Finance Department (FD), Government of Punjab: The Finance Department also manages public debt, prepares the vicinal budget, and supervises and controls provincial finances. All issues that directly or indirectly impact the province's finances must be discussed with the finance department by the administrative departments. The Secretariat handles all crucial tasks related to the Finance Department, including budgeting.

Excise, Taxation & Narcotics Control Department (ET&NCD), Government of Punjab: The Excise, Taxes and Narcotics Control Department offer services for the efficient and successful collection of various taxes and charges.

It also makes recommendations for greater resource mobilization in the province. The formation of a taxpaying culture and giving the public access to facilities for tax payment are the primary priorities, in addition to boosting taxpayer confidence.

Punjab Revenue Authority (PRA), Lahore: The Punjab Revenue Authority is responsible for sales tax collection from all over Punjab. It collects and manages general sales tax from individuals as well as businesses.

Punjab Procurement Regulatory Authority (PPRA), Lahore: The Authority is responsible for enhancing public procurement quality, management, and accountability. It also develops performance indicators for the Procuring Agencies' procurement performance, monitors

compliance with these indicators through independent third-party review, and provides suggestions for enhancing the Procuring Agencies' procurement performance.

Punjab Information Technology Board (PITB), Government of Punjab: The basis for Punjab's innovation economy is laid by the Punjab Information Technology Board, an independent organization established by the Punjab government. The Board's objectives include, among many other things, improving citizens' digital literacy as well as updating governing practices through ways that encourage openness. The PITB is devoted to providing the government and national and international companies with effective and efficient IT services and infrastructure.

Local Government & Community Development Department: The LGCD Department has a supervisory duty to guarantee that local governments carry out their duties within the provincial framework and respect federal and provincial legislation. LGCD was established to address the unique requirements for the good administration of Punjab's megacities and mostly urban areas. LGCD aims to support and direct local governments in developing a climate that fosters independent and responsible decision-making.

The present E-Waste Management System is as follows in the seven PRIDE Partners:

1) Stage I – Generation of E-Waste

Each program partner has an internal procedure for the declaration of an item as e-waste. Basically, if ICT items are not working, all efforts are first carried out by the internal maintenance department (or individuals hired to repair it) to start the work. This is carried out regardless the ICT equipment has passed its useful life or not.

Once the ICT item is declared not non-repairable, it becomes E-waste. A formal inspection is carried out by the Head of Administrative Affairs, and in that inspection, it is declared as a “condemned item”. Once the ICT equipment becomes e-waste, useful individual parts of the e-waste are cannibalised on other items. For example, once a desktop’s motherboard becomes non-repairable, its individual working items, such as RAM, hard drive, wifi card etc., are used to bolster other items. If there is no use of the e-waste, move to the second stage, i.e. storage.

2) Stage II – Transportation of E-waste

E-waste is transported from the point of generation to the storage area without any specified transportation equipment/machinery. In all PRIDE partner organizations, there is no specific handling device used for the transportation of e-waste. Most of the equipment is transported by hand with the help of staff. For transportation of larger equipment such as printers, trollies are used. Hence, none of the PRIDE partners has a standardized method of transportation.

3) Stage III – Storage of E-waste

Of the seven program partners, none have any dedicated place for the storage of e-waste. All the e-waste is stored with other discarded items such as chairs, tables and any other miscellaneous items. The storage is mostly done in basements of the offices or any available vacant room. The items are stored haphazardly with no consideration for the occupational health and safety of the office. There are no tags, signboards, or segregated places (partitions) between different items. Upon consultation with the program partners, it has been revealed that the items remain in these storage conditions for 2 – 4 years till the time the temporary storage room cannot further contain any item. At this point, the next stage of the e-waste management system comes, i.e., the Discard of E-Waste.

4) Stage IV – Discard of E-Waste

The program partners discard the e-waste through an open auction. First, vendors are contacted to set an initial base price for the e-waste. Once set, the vendors are invited to the auction, where through competitive bidding, the e-waste is sold.

It is worth pointing out that none of the organizations (PRIDE partners) have any buyback agreement with the procurement vendor. It is also worth noting that none of the organizations has any contract agreement with any waste management company for the disposal of e-waste management.

Waste management companies

There are different waste management companies and municipal corporations to handle the waste of their own cities. Some private businesses contract with their area's waste management company to handle and dispose of their e-waste. Waste management companies often bulldoze the packed electrical and electronic waste especially hard drives to mitigate there are no privacy concerns or the risk of data leakage.

It was reported during consultation sessions with the representatives of the waste management companies from areas under study that e-waste is mostly not a part of municipal solid waste due to its monetary value, and scavengers can sell these items to Kabarias and Refurbisher for a fair price.

Importers

Importers of e-waste are those who import electrical and electronic items discarded or refused by developed countries. These importers participate in auctions where tons of e-waste are bid by importers from many countries. A typical importer imports 10-12 containers of e-waste in a period of 6 months.

E-waste is imported to Pakistan via air transportation now, which is why the importers now buy only refurbish able items. These importers then sell these in lots to local companies, wholesalers and retailers. E-waste import has now come to a practical halt due to the ongoing economic crisis in Pakistan, the ban on opening of LCs and the extensive cost of imports that ranges from Rs. 4500-6000 per device.

Transporter

E-waste is transported for repairing purposes inside and outside the department without any specific transportation method. If E-waste is taken to the department's store, it is done either by hand lifting, using a trolley, or using a vehicle from the department. E-waste is transported to repairing shops/vendors mostly by the repairer/vendor themselves. After auctions, e-waste transport is the responsibility of the auctioneer.

Refurbisher/repairer

Electrical items that are damaged are taken to a refurbisher first. The repairer decides if the item has become a waste or is still usable. Sometimes these shops buy unrepairable devices at minimal rates and then reuse the intact components in other devices. Some of the damaged parts are then kept at shops until a scavenger comes to the shop and buys it.

Most of the importers in Pakistan have shifted to being only computer repairers due to LC issues and a decline in the profit rates of the business.

Kabarias

The scrap collectors and scavengers either sell the e-waste collected from homes, shops and waste bins to Kabarias at different rates per kg of e-waste, depending upon the device and its reuse, or they segregate that waste themselves and sell it to recyclers as separate components. The Kabarias stock up on e-waste components for 6-12 months and then are forwarded to recyclers in bulk.

Some Kabarias collect e-waste at their workshops, where it is disassembled and segregated based on the material they are made up of, such as plastic and metal from CPUs, printers, fax

machines etc. These segregated components are then sold to different recyclers with small industrial setups, such as in Faisalabad, Gujranwala, Lahore and Rawalpindi.

Dismantlers

Mostly, Kabarias and dismantlers are the same people who buy scrap from scavengers. They collect and segregate e-waste according to the buyer's requirements. These dismantlers sell metallic parts to metal furnaces located in Lahore, Sharaqpur and Gujranwala by the informal sector. Circuit breakers and motherboards of computers and laptops fetch the highest prices.

Recyclers

The process of extracting valuable materials is known as e-waste recycling. After the e-waste is broken down into minuscule bits that can be used in a new electronic device. Recyclers extract copper, silver, and gold from e-waste.

In Punjab, the process of recycling is not fully executed; rather, only partial recycling is done here, where only the melting and formation of metal ingots are done. Once the ingots are produced, these are exported to China for the refining and segregation of each metal. Therefore, most of the valuable portion of e-waste generated in Pakistan finds its way to China. Some Chinese nationals also collect e-waste from shops or in bulk from Kabarias, which is sent to China from Pakistan.

Currently, neither Pakistan nor the province of Punjab has any municipal e-waste collection system, a framework enabling producer and retailer takebacks, nor any official e-waste recycling facilities that have been accredited or regulated. Thus, there is uncontrollable hazardous handling of e-waste across the country. Since Punjab is the most populous province, it has the most e-waste generation out of all the provinces.

Human health and the environment are sacrificed at the expense of processing and recycling e-waste in underdeveloped and developing nations. With 24.9 Mt of e-waste generation, Asia leads other continents in the world. Pakistan produced 433 kilotons of e-waste in Asia in 2019(Forti and Peter Baldé, 2020). Pakistan's national environmental policy covers air, water, ozone, climate change, agriculture, and the import/export of hazardous chemicals or waste products.

When electronic waste is disassembled, plastic parts are burned, metals are recovered via chemical procedures, and discarded pieces are disposed of in an unsafe manner on land and in water, resulting in the discharge of hazardous compounds. The populations living nearby E-waste recycling operations and those participating in those activities are at risk due to improper recycling techniques.

The scrappers dealing with e-waste do not really wear any safety equipment. They use their bare hands to handle very toxic waste. Individuals who crush devices face the possibility of breathing in dust containing phosphorus, lead, and barium oxide. There is nearly no awareness regarding using Personal Protective Equipment whilst dealing with such hazardous waste.

The National Hazardous Waste Management Policy, which addresses e-waste trading, generation, and dumping, and discusses the transboundary flow of hazardous wastes, was authorised by Pakistan's federal cabinet on June 28, 2022. Regrettably, no policy implementations have been seen on either the private or public level. Notably, the NHWMP does not expound on the nation's e-waste management (NHWMP, 2022).

4 Review of National Regulations and Multilateral Agreements on E-Waste Management

4.1 Introduction

One of the objectives of the legislation is to guarantee that waste is managed in an environment-friendly way. Laws related to e-waste or addressing e-waste establish criteria for safeguarding public health and the environment from possible risks of e-waste disposal.

Any electrical or electronic product that is discarded would be considered e-waste. Electronics that are unwanted, broken, or nearing the end of their useful lives are referred to as "e-waste." Due to the toxic synthetic chemicals that typically leak from the metals within when buried, e-waste is particularly dangerous.

E-waste recycling and dismantling are deemed to be a substantial concern in 15 countries across the globe, including Pakistan. Unorganized treatment of e-waste can harm animals, human health, and the environment. India, Pakistan, and Bangladesh are among the Asian nations mostly affected by e-waste.

4.1 National Regulations Relevant to e-waste management

4.1.1 Pakistan Environmental Protection Act (PEPA) 1997

Pakistan Environmental Protection Act 1997 is a fundamental piece of legislation that gives the government the power to formulate rules for environmental protection. It is a comprehensive piece of legislation that offers the fundamental legal basis for preserving, enhancing, and protecting the environment. The legislation covers a wide variety of concerns, including the treatment of hazardous wastes, air, water, soil, marine, and noise pollution.

Sections 13 and 14 of the Act concern environmental pollution control related to hazardous waste. No individual is allowed to transport hazardous waste into Pakistan, its territorial seas, its Exclusive Economic Zone, or its historic waterways, according to Section 13 of the Constitution, which forbids such importation.

No person is allowed to create, collect, consign, transport, treat, dispose of, store, handle, or import hazardous waste without first obtaining a licence from the Federal Agency and following any applicable regulations or in accordance with the terms of any other law or any provisions of any international treaty, convention, protocol, code, standard, agreement, or other instruments to which Pakistan is a party. This is stated in Section 14, "Handling Hazardous Substances."

4.1.2 Hazardous Substance Rules 2003

The import and transportation of hazardous substances from a Federal or Provincial agency will be subject to licensing requirements under the Hazardous Substance Regulations 2003. The EIA report and safety plan will also be submitted with the licence application for any industrial operation involving the production, collection, consignment, transit, treatment, disposal, storage, handling, or import of hazardous chemicals. The licensee will report each significant accident happening at a licenced facility to provincial and federal authorities. There will be requirements for packaging and labelling as well as worker and workplace safety measures that must be adhered to. The provincial or federal employees may inspect the licenced establishment.

4.1.3 National Environmental Policy 2005

The National Environment Policy 2005 offers a framework for resolving Pakistan's environmental problems, particularly the ineffective waste management that can have a negative impact on the environment. It suggests using legislative initiatives to ensure the

limiting, recycling, and control of harmful emissions from waste. It promotes the establishment of a licensing system for businesses involved in waste management.

A comprehensive framework for addressing Pakistan's environmental problems, including deforestation, biodiversity loss, desertification, air pollution, contamination of freshwater and coastal waters, improper waste management, natural disasters, and climate change, is provided by the National Environmental Policy. Moreover, it provides guidelines for tackling cross-sectoral problems, the root causes of environmental deterioration, and upholding international duties.

4.1.4 Punjab Environmental Protection Act, 2012

Sections 13 and 14 of the Punjab Environmental Protection Act 2012 cover environmental pollution control related to hazardous waste. No one is allowed to bring hazardous waste into the territory of Punjab, as stated in Section 13 of the law. It is against the law to produce, collect, consign, transport, treat, dispose of, store, handle, or import hazardous waste unless authorised by a licence or in accordance with the terms of another law or an international treaty, convention, protocol, code, standard, agreement, or another instrument to which Pakistan is a party, according to Section 14 of the law on handling hazardous substances.

Suppose the provincial agency determines that the discharge or emission of any effluent, waste, air pollutant, noise, disposal of waste, handling of a hazardous substance, or any other act or omission is likely to occur, is occurring, or has occurred in violation of any provision of this act, rules, or regulations, or of the condition of the licence, or is likely to cause, is causing, or has caused an adverse environment. In that case, the agency may issue an environmental protection order. After providing the individual responsible for the discharge, emission, handling, conduct, or omission a chance to be heard, the provincial agency may direct that person to take whatever actions it deems necessary by issuing an order.

4.1.5 Punjab Hazardous Substances Rules, 2018

To govern hazardous compounds in the province for their collection, generation, handling, consignment, transit, treatment, disposal, production, and storage, the Punjab Environmental Protection Act 2012 established these regulations.

Schedules 1, 2, 3, and 4 include a list of the substances and the threshold amounts that fall under these regulations. Once a year, the relevant industrial activity must be inspected by the responsible authorities, who must also report to the EPA on the occupants' compliance with the requirements. Whenever a serious accident occurs while producing, loading, unloading, supplying, storing, selling, or transporting hazardous materials on the premises of the licensee or off the premises, the occupier must immediately inform the appropriate authority. This notification period is 48 hours.

After submitting a Hazardous Substance Report, the occupier of the subject industrial activity will need to get a licence from the relevant authorities, namely the EPA, to operate the facility. 90 days before to starting the industrial activity, the occupier must also submit a safety report to the relevant authorities. Every year, this safety report will be updated.

The rules outline requirements for the safety plan and waste management plan, as well as general and specific safety precautions to be taken at the facility and for the workers. They also provide guidelines to the occupier regarding the packaging and labelling of hazardous materials and conditions to be maintained for premises where hazardous substances are generated, collected, consigned, treated, disposed of, stored, or handled.

4.1.6 The Punjab Occupational Safety and Health Act 2019

The employer would be tasked with ensuring the workers' health and safety at work under the terms of this act. According to the law, employers, site managers, and employees are all required to guarantee that certain health and safety standards are met. The Chief Inspector

and the inspectors designated under the act are accountable for enforcing the legislation's health and safety regulations. If the conditions are not met, penalties will be applied. The act gives information regarding employers' obligations towards their employees' health and safety.

4.1.7 Pakistan Penal Code

The Pakistan Criminal Code describes offences that result from the purposeful or unintentional wrongdoing of a person or group of persons and impact public or private property as well as human life. Penalties for infractions involving air, water, and land pollution are laid forth in the Code.

4.1.8 National Hazardous Waste Management Policy, 2022

The policy to facilitate the implementation of international treaties & Conventions on a national level to improve the definition & implementation of Hazardous Waste Management (HWM) for better environmental management, clarify institutional responsibilities related to HWM, and strengthen the management of hazardous & other wastes. Whereas matters mentioned above are pivotal for reducing environmental pollution, The Policy on HWM has the following objectives:

- To facilitate the implementation of the relevant provisions of the Basel Convention, the Stockholm Convention, and the Minamata Convention at the national level.
- To prevent, minimize and control hazardous waste being generated in the country.
- To control the transboundary movements of hazardous waste.
- To create an enforcement mechanism through an effective regulatory framework and monitoring, inspection & verification system.
- To build the capacity of all relevant stakeholders for Environmentally Sound Management of hazardous waste in Pakistan.

The management of discarded electrical and electronic equipment (E-waste or WEEE) is a critical issue in the solid waste management industry because of the interlinks between developed, developing, and transitional nations on a worldwide scale. Due to its potential for environmental and human health harm, this waste stream requires specific handling and control measures.

4.2 Multilateral Agreements Relevant to e-waste Management

4.2.1 Basel Convention on Movement of Transboundary Movement of Hazardous Waste and their Disposal

The international trade in hazardous wastes is regulated under the “Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal”. The 1989-adopted Convention, which became effective in 1992, established a "notice and consent" framework, also known as prior informed consent (PIC), for the transfer of hazardous waste and some other types of waste to importing nations. The Articles of the Convention typically prohibit commerce in such wastes:

- Without the prior approval of the importing nation.
- If the exporting nation has cause to suspect that the specific wastes won't be treated in an ecologically responsible way.

A multi-national agreement known as the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was devised to stop the trade in hazardous waste that is harmful to the environment and society. Due to its composition, e-waste frequently includes dangerous components.

Basically, Basel Convention is an international treaty that was designed to reduce the movements of hazardous waste between nations and specifically to prevent the transfer of hazardous waste from developed to less developed countries (LDCs). The Convention is also intended to minimize the amount and toxicity of wastes generated, to ensure their environmentally sound management as closely as possible to the source of generation, and to assist LDCs in the environmentally sound management of the hazardous and other wastes they generate.

The Convention, therefore, states that to safeguard human health and the environment, hazardous waste should not be exchanged freely like other commercial items. As a result, it provides written notices and a permission process for all cross-border transfers of hazardous wastes.

However, the Basel Convention's exemption from regulatory requirements for equipment intended for reuse is fully consistent with its primary environmental goal of preventing waste generation because reuse extends the lifespan of electronic equipment and, as a result, reduces the production of hazardous waste.

The reuse of electronic equipment encourages the conservation of natural resources and, at the very least, temporarily eliminates the need for recycling or disposal by extending the useful life of electronics. However, the Basel Convention has long debated whether something is waste and, consequently, meant for reuse.

4.2.2 Conference of Parties (COP)

The Convention's top decision-making body is the Conference of Parties. At the COP, which reviews the implementation of the Convention and any other legal instruments that the COP adopts, all States that are Parties to the Convention are represented. The COP also makes decisions regarding institutional and administrative arrangements that are necessary to support the Convention's effective implementation.

Since The Mobile Phone Partnership Initiative (MPPI) was endorsed by the Conference of the Parties to the Basel Convention's sixth meeting in 2002, the Basel Convention has begun to address e-waste concerns.

At the Conference of the Parties' eighth meeting in 2006, the “Nairobi Declaration on the Environmentally Sound Management (ESM) of Electrical and Electronic Waste” was adopted. In this declaration, parties to the Convention vowed to work together, among other things, to develop policies and strategies, improve the environmentally responsible collection, separation from household waste, repair, recycling, and final disposal of e-waste, and stop the illegal trafficking of e-waste.

The Conference of the Parties (COP9) approved Decision IX/6, giving the Secretariat the authority to carry out a technical assistance work plan to improve the ecologically sound management of e-waste in developing nations and those with economies in transition. Since then, the Convention Parties' major area for technical cooperation has been providing help to improve the environmentally sound management of e-waste.

The mandate of the Follow-up Partnership to PACE was expanded at COP-27 in 2022 to cover not just computers and mobile phones but also televisions, video and audio equipment, refrigerators, and cooling and heating electronic equipment. The alliance was renamed "Partnership for Action on Challenges Relating to E-waste", or PACE II, to reflect the expanded scope.

The Parties amended the Basel Convention's Annexes II, VIII, and IX at the same conference in 2022 to include both hazardous and non-hazardous e-waste. Hazardous e-wastes are included in Annex VIII under a new number: A1181, whereas non-hazardous e-wastes are listed in Annex II with the code Y49. A1180, which the new code A1181 will replace, was eliminated together with entries B1110 and B4030. The changes will take effect on January

1st, 2025. After this date, the Basel Convention's Prior Informed Consent Procedure (PIC) will apply to transboundary flows of both hazardous and non-hazardous e-waste.

4.2.3 Stockholm Convention on Persistent Organic Pollutants (POPs)

A global agreement called the Stockholm Convention became operative on May 17, 2004. The most recent meeting of the Stockholm Convention took place in November 2022. The convention strives to safeguard both human health and the environment against the impacts of persistent organic pollutants (POPs). Parties must adopt various control measures under the Stockholm Convention, which presently governs 29 POPs items, to decrease and, where possible, eliminate POPs emissions.

Parties shall forbid or restrict the manufacture and use of POPs that are purposefully created, with some exceptions like the ongoing use of DDT. It establishes a framework for dealing with other compounds that have been determined to be too dangerous. In the end, the Convention pledges to reduce our economy's reliance on hazardous chemicals and indicates the way to a future free of harmful POPs.

The Stockholm Convention mandates that nations create national action plans to deal with emissions of inadvertently created POPs and implement "Best Available Techniques" for regulating them. The Stockholm Convention also seeks to guarantee responsible management of POP-containing wastes and stocks. Parties must also abide by the Stockholm Convention's restrictions on trading certain chemicals.

By limiting and ultimately eradicating the manufacture, use, sale, release, and storage of highly hazardous, long-lasting chemicals, the Stockholm Convention on Persistent Organic Pollutants, which was established in 2001, aims to preserve human health and the environment. The Stockholm Convention's Parties are required by Article 6, Paragraph 2 to work closely with the relevant Basel Convention bodies on relevant shared concerns.

Twelve POPs, which may be divided into three groups, have been identified as having harmful impacts on both people and the environment. Examples of pesticides include Aldrin, DDT, chlordane, endrin, heptachlor, dieldrin, toxaphene, and hexachlorobenzene. Industrial chemicals include hexachlorobenzene and PCBs. By-products include PCDD/PCDF, hexachlorobenzene and PCBs.

4.2.4 Rotterdam Convention on Prior Informed Consent for Certain Hazardous Chemicals

The Rotterdam Convention was enforced in 2004. It encourages worldwide attempts to protect the environment and human health and gives nations the option to determine whether or not to import pesticides and hazardous chemicals that are included in the Convention. The convention has been adopted by 155 parties all around the globe, while 72 countries are signatories. Parties have a first line of defence against dangerous chemicals according to the Rotterdam Convention on the “Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade”.

In order to avoid possible harm to human health and the environment, the convention strives to encourage shared responsibility and collaboration among Parties in addressing the international trade of some hazardous substances. A previous informed consent process is established under the agreement for the entry of dangerous substances.

The convention has a list of protected substances and mandates that anybody attempting to export a chemical from that list must first prove that the target importing nation has given its authorization. It further stipulates that a state wishing to export a chemical that is not specified under the Convention but is subject to a ban or strong restrictions on its own soil must notify the importing nation of the intended shipment.

The Rotterdam Convention is applicable to commercial pesticides and chemicals that fulfil the requirements for inclusion on the Convention's list, typically due to being outlawed, severely restricted, or containing pesticide compounds which pose a high risk of harm. The PIC method must be followed if a chemical is included in Annex III of the Rotterdam Convention.

Prior informed consent (PIC) is a method established by the Rotterdam Convention to prevent the transfer of banned hazardous chemicals to nations that do not want them. The PIC mechanism is put into action by parties through substantial information sharing, preferential consideration of state importing decisions, as well as commitments regarding export control requirements. No chemicals are prohibited or restricted by the PIC method, and no nation is required to automatically forbid their importation.

4.2.5 Vienna Convention and Montreal Protocol on Ozone Depleting Substances (ODS)

The Vienna Convention (1985) and the Montreal Protocol (1989) were two international agreements to protect the ozone layer that was signed under the auspices of the United Nations Environment Programme (UNEP) after the mechanism by which chlorofluorocarbons (CFCs) destroy ozone was demonstrated in the 1970s, and the ozone layer's depletion was observed in 1987. This convention includes chlorofluorocarbons, halons, trichloroethane, bromides, halons, bromodichloromethane, HFCs and HCFCs.

The Vienna Convention, which entered into force in 1988 and was ratified by all nations in 2009, was the first convention of any sort to be signed by all parties. The Convention aims to encourage international collaboration by exchanging data on how human activity affects the ozone layer. By doing this, the Convention's founders believed that decision-makers would take action to stop the behaviours that cause ozone depletion. Thus, it demonstrates the severity of ozone depletion at the time and the readiness of nations to cooperate to find a solution.

The 1985 Vienna Convention's main goals are safeguarding human health and shielding the ecosystem from any negative repercussions of stratospheric ozone loss. The 1987 Montreal Protocol's main goal is to restore the ozone layer through international regulation, decrease, and ultimately cessation of ozone-depleting substance production and use. The Kigali Amendment, the Montreal Protocol's most recent addition from 2016, covers hydrofluorocarbons as well.

The Convention is constantly evolving. After every three years, all participating nations gather to discuss as well as decide on significant concerns, such as research and document analysis, in addition to monetary and organizational issues. The Parties must foster and facilitate the interchange of information related to this Convention in the fields of science, technology, socioeconomics, business, and law.

They shall work together to promote the advancement and transfer of technology and knowledge, either directly or through reputable international organizations, in accordance with their national laws, regulations, and practices and with consideration for the needs of developing nations. The Parties agree to work together, either directly or via relevant international organizations, to ensure the timely and frequent gathering, validation, and transmission of research and observational data through the proper global data centres.

4.2.6 WEEE Directive (2012/19/EU)

Regarding EU legislation, waste electrical and electronic equipment disposal is governed by Directive 2012/19/EU of the European Parliament and the Council of the European Union (WEEE). A European Community Directive with the number 2012/19/EU, the Waste Electrical and Electronic Equipment Directive (WEEE Directive) addresses waste electrical and electronic equipment (WEEE). Since its commencement in 2002, this directive has undergone a slew of minor updates.

Under August 13, 2004, the twenty-five EU member states were required by the WEEE Directive to implement their obligations into domestic legislation. Cyprus only reached this deadline. Except for the UK, all member states had transferred at least framework legislation by August 13, 2005, a year after the deadline. The WEEE Directive was implemented into UK law in 2006 and became effective in 2007.

According to the principle of the directive, a producer is the one responsible for the waste generated by the manufactured electrical and electronic equipment. It covers all the electrical and electronic waste generated by domestic as well as commercial consumers. The directive states steps required by the producers to manage the produced electronic waste.

Member states must ensure the following:

- The handling, as well as recuperation for collected and returned WEEE, is guaranteed by electrical and electronic equipment manufacturers.
- When producers release new equipment onto the market, they promise to finance its ecologically responsible disposal.
- Under some circumstances, distributors will take WEEE from residences.
- The stipulated goals under the directive for collection, recycling, and recovery have been attained.

The guideline mandates that WEEE shall be handled separately. WEEE returns from private customers must be free of charge. It is necessary to develop collecting methods appropriate for the population's density. Member nations are required to reach the mandatory collection target. Producers must adhere to unique marking requirements in order to meet this goal. For instance, all electrical and electronic devices covered by the regulation must display the wheeled bin symbol with a cross through it.

4.2.7 Waste Shipment Regulation (WSR)

The Commission approved a proposal to create new legislation for trash shipments on November 17, 2021. the proposal seeks to prevent the transfer of EU's waste problems to other nations and to encourage a cleaner and circular economy. It carries out the Basel Convention's (1989) requirements regarding the management of transborder flows of waste products, including its storage. Regulations for cross-border garbage transportation are part of EU legislation.

The regulations were developed with the following objectives:

- Ensuring that the Basel Convention's and the OECD Decision's requirements are incorporated into EU law.
- Enabling the WSR to be applied consistently across all Member States
- Keeping waste shipment systems and processes in accordance with technological advancement
- Preventing the shipment of toxic waste to non-OECD nations. Decisions will help ensure that waste shipped beyond the EU does not have a negative impact on the environment or public health in the countries of destination.
- In accordance with the applicable EU waste legislation, including the principles of proximity and self-sufficiency and giving priority to recovery, to ensure that waste transported among EU Member States would be handled in an environmentally sound manner and shipment and transportation to a suitable destination for treatment.

Regarding compliance, Waste Shipment Regulation mandates that members set up inspections of enterprises, businesses, and dealers as well as of shipments along with the associated collection and disposal procedures. The absence of specific regulations that

guarantee the waste is managed sustainably in the destination countries often resulted in lax enforcement, creating environmental and public health issues.

It may harm both human health and the environment when waste transported across borders is not adequately controlled and sustainably treated in the destination nations. E-waste is also shipped by many developed nations to developing nations to dispose of them or for treatment. This waste transportation needs to be carefully handled to make this process beneficial rather than harmful. The EU imported about 16 million tons of waste in 2020 and exported approximately 33 million tonnes to non-EU nations.

4.2.8 Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS)

The rise in the usage of electrical and electronic products consequentially gives rise to waste production of electrical and electronic waste. E-waste may release some hazardous substances during its life cycle, particularly if it is mishandled. Some of the hazardous substances that are released by electronic waste are lead, cadmium and mercury. To cater for this problem and to restrict the usage of such hazardous substances, the European Union came up with the RoHS directive.

The directive for restricting the usage of hazardous substances in electrical and electronic equipment came into effect on 1st July 2006, and now the latest RoHS 3 directive came into force in July 2019. Initially, the directive restricted 6 hazardous substances, but after the amendment, the number has risen to 10.

The directive prohibits the usage of some hazardous substances in electrical and electronic equipment. The directive applies to all objects that have any electrical component. The main objective of this directive is the disciplined management of e-waste and preventing damage to the environment and human health. The directive makes that happen by restricting and suggesting alternatives to hazardous substances.

The hazardous substances that come under this directive, with some exceptions, are polybrominated diphenyl ethers, butyl benzyl phthalate, bis phthalate, dibutyl phthalate, polybrominated biphenyls, dibutyl phthalate and di-isobutyl phthalate, hexavalent chromium, lead, cadmium, and mercury. Almost all these substances are found in electronic equipment; thus, this directive deals directly with E-waste.

5 International and Regional E-Waste Management Practices

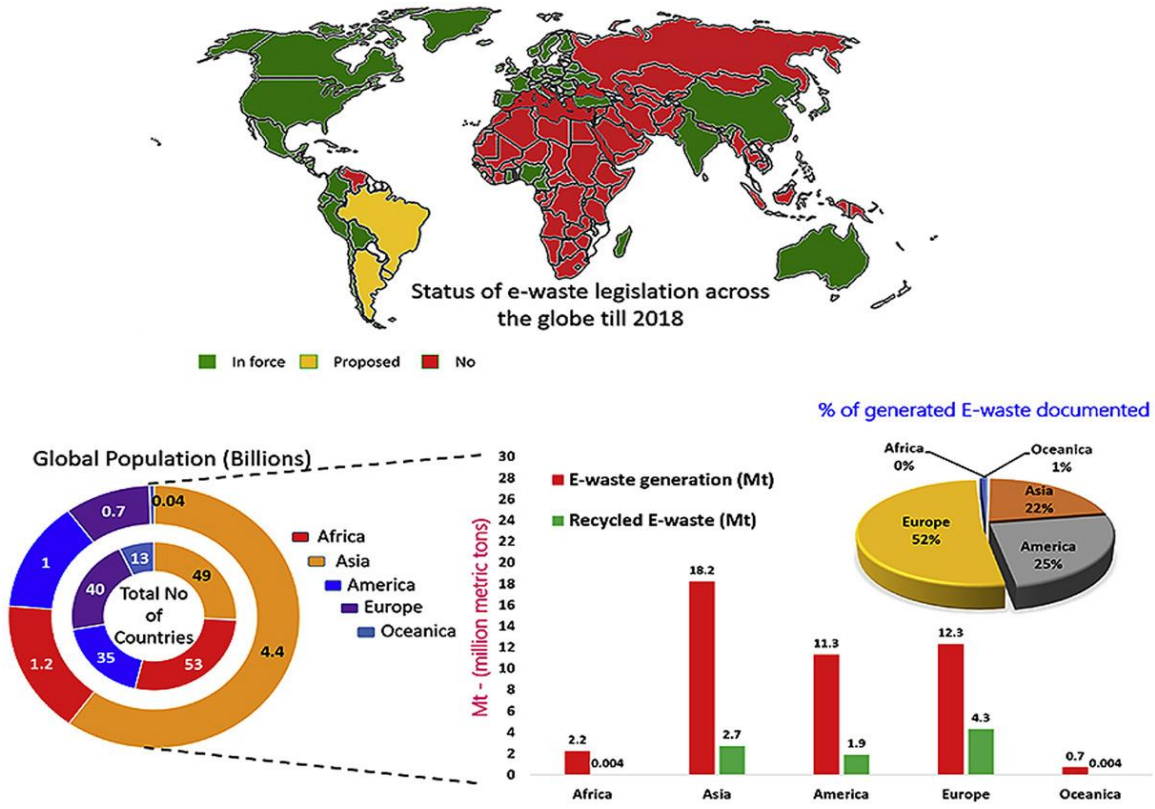
5.1 Introduction

Around the globe, over 50 million metric tons of e-waste was produced in 2018, of which 18.2 metric tons were produced by Asia, presenting an almost 12% increase in waste production as compared to the previous year. The production of e-waste has continued to increase as the ICT and EEE industries continue to grow at a rapid pace, particularly in developing countries due to expanding economies.

The US EPA reports that only 15 - 20% of this waste gets recycled and tracked while the rest ends up in landfills and open dumps, often in developing countries as the developed countries export their waste to the poorer countries for foraging of various materials(Gollakota, Gautam, and Shu 2020). The developed countries that export this waste and the developing countries that import this waste both often have little to no checks and balances for waste that actually gets recycled or the emissions that are produced; as a result, various environmental and human health concerns are raised.

Despite the concerns and initiatives regarding the e-waste issue, only 41 countries have proper management strategies to deal with e-waste. The figure presents the status of e-waste legislation proposed or in force across the globe, along with the figures regarding population and waste generation and recycling statistics.

Figure 5.1: Status of e-waste legislation proposed or in force across the globe.



1.1 E-waste Management in Developed Countries

Germany is one of the prime examples of the best E-waste management practising countries. The Electrical and Electronic Equipment Act (ElektroG) in Germany lays out specific requirements for managing e-waste for all relevant parties, including producers, retailers, municipalities, owners, and recyclers. Prioritizing waste prevention instead of recycling is what sets the German e-waste handling mechanism apart from others.

The public waste management authority (PuWaMA), the E-equipment producer and Elektro-Altgeräte Register (EAR). The country has legalized Extended Producer Responsibility; hence the producers have to take back or recycle whatever they have introduced into the market. Before introducing any EEE onto the market, the producers are obliged to register with the EAR.

PuWaMA is responsible for waste collection in containers provided by producers, and then producers take back that e-waste not only from PuWaMA but also from distributors and retailers. According to their extant market share, producers are responsible for addressing historic e-waste as well. This entire electronic waste management system of Germany is very efficient and ensures compliance and accountability of all key stakeholders.

5.2 E-waste Management of the European Union

The European Union has one of the best e-waste recycling and management practices and strategies in place.

E-waste Management by Switzerland: Switzerland holds the place of a pioneer in legislation regarding the management and regulation of e-waste, as it introduced its first law regarding e-waste management in 1998.

The Swiss Federal Office for the Environment (FOEN) issued the “Ordinance on the Return, the Taking Back and the Disposal of Electric Equipment (ORDEE)”. However, a formal collection and management system for electronic waste was already in practice before the legislation was enforced(Sinha-Khetriwal, Kraeuchi, and Schwaninger 2005).

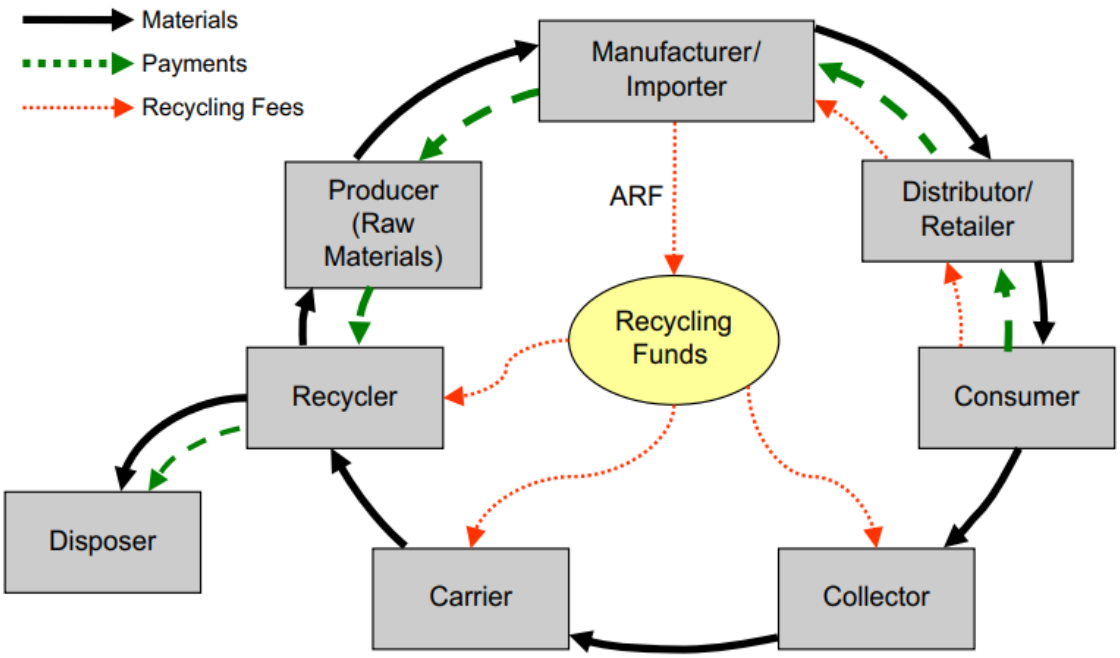
As Switzerland imports most of its electronic goods, it prevents free riders who might avoid these e-waste management strategies by maintaining an Advanced Recycling Fee (ARF) for every electronic appliance that is imported at the customs level.

The PROs are responsible for operations, audits, and deciding a fee for recycling. The Swiss federal government oversees and frames the guidelines, while the cantoning authority controls and monitors the recycling licenses. The retailers are responsible for clearly mentioning the recycling fee in a consumer invoice, making the consumers responsible by law to return the discarded appliances to the designated collectors instead of throwing them in the trash.

The recyclers then acquire the discarded appliances from the collection points and recycle them while adhering to emissions and employee health and safety standards. The recycling facilities sort the e-waste and extract precious metals like gold, copper, iron, aluminium, plastics, and glass from the waste, which is sent to refineries for smelting and material recovery. This concrete system ensures that the e-waste that ends up in landfills is just 2% of the total e-waste produced in Switzerland.

In addition to the solid recycling and management policy, Switzerland is also leading in the field of innovation by refusing to export its waste to be dumped in underdeveloped countries like Ghana, where it is more likely to end up in a dump and cause not just environmental but human health risks as well(Adrian et al. 2020).

Figure 5.2: Flow of finances and materials in the e-waste management system of Switzerland



1.2 E-waste Management in Developing Countries

Electronic waste contains a variety of toxic materials that call for special management. Conventions, guidelines, and laws founded on extended producer responsibility (EPR) govern disposal in developed countries. Manufacturers return goods gathered by retailers and municipal authorities for secure material recovery or disposal. However, it can be challenging to ensure compliance because it frequently conflicts with financial rewards. Large quantities of e-waste are exported to China, India, Pakistan, Nigeria, and other developing countries due to the high cost of appropriate disposal.

Shipments frequently go through intermediaries and are subject to tariff classifications that make it challenging to estimate quantities. There, most e-waste is handled as general waste or is crudely processed, frequently by burning or acid baths, with the recovery of only a few materials of economic value, in spite of national regulations and hazardous waste laws. It is inevitable that the release of dioxins, furans, and heavy metals will harm the environment, workers, and local people.

The developing countries are producing more e-waste than the developed countries, which indicates the ongoing growth of an informal sector due to a cheap labour force and non-compliance to environmental and social safeguards. 2017 research in the Environmental Science and Technology journal estimated that developed countries annually export 23% of their electronic waste to developing nations. This figure is anticipated to increase in the future due to the West's rising demand for electronics.

Waste management in developing countries is most often overlooked due to economic constraints. Proper waste management is considered to be poor, especially in medium and small cities, due to a lack of funding and non-payment of service delivery chargers by the community. Hence, improper waste collection and management pose serious health risks in developing countries. E-waste is also among the ignored waste category that requires safe and technically advanced management practices to avoid its side effects.

5.3 South Asian Countries

In comparison to the rest of Asia, the e-waste scenario in South Asia is becoming quite worse than before. When compared to all of Asia, e-waste generation in South Asia was 13% in 2015, and with yearly increases of 1%, it reached about 16% in 2019. These data show that South Asia generates a significant amount of electronic waste compared to the rest of Asia. In South Asia, India led the pack in terms of e-waste production in 2019.

India ranks as the fifth-largest producer of e-waste in the world because it has one of the world's largest electronic marketplaces (especially in the IT and telecommunication sectors). Following Bangladesh (4.9%) and Sri Lanka (3.4%) in terms of the region's e-waste producers, Pakistan now generates 10.6% of it, with the remaining 1.5% coming from other nations.

Hundreds of labourers, including teenagers, are working for a very low wage in e-waste warehouses in Rawalpindi, Pakistan. Due to the lack of safety precautions like safety glows, goggles, and protective clothing, the workers are exposed to hazardous chemicals and are experiencing various health problems. **Table 5.1** shows the amount of e-waste generated in South-Asian countries during 2015-2019(Priyashantha, Pratheesh, and Pretheeba 2022).

Table 5.1: Amount of e-waste generated in South-Asian countries_ 2015-2019

Sr. No.	Country	GEG Gross e-waste generated (kt)			EGPC E-waste generated per capita (kg/capita)		
		2017	2018	2019	2017	2018	2019
1	Pakistan	389	410	433	2	2	2.1
2	India	2529	2863	3230	1.9	2.1	2.4
3	Bangladesh	165	182	199	1	1.1	1.2
4	Afghanistan	20	21	23	0.5	0.6	0.6
5	Nepal	24	26	28	0.8	0.9	0.9
6	Bhutan	3	3	3	3.6	3.8	4

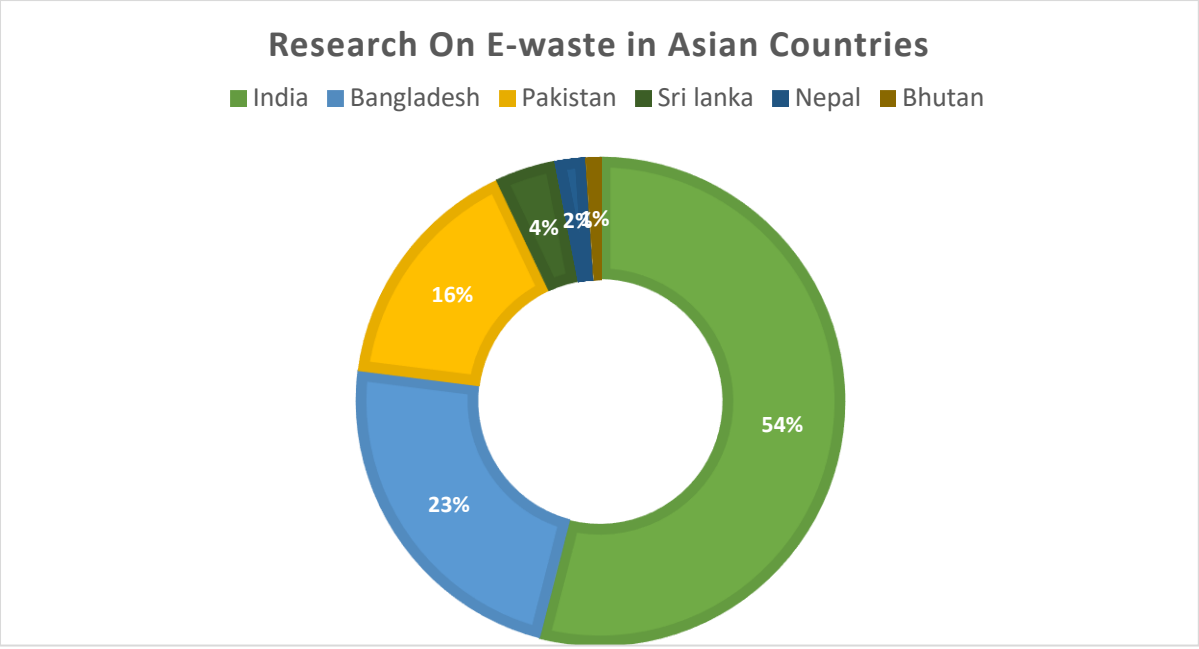
Source: (Priyashantha, Pratheesh, and Pretheeba 2022).

5.3.1 Current trends and gaps in South Asia:

Despite the fact that e-waste is growing alarmingly quickly, few studies are being carried out in South Asian nations. Only 106 studies in South Asia were carried out over the course of the literature surveys conducted in 20 years, the bulk of which were in the year 2020.

Figure 5.3 presents the overall proportion of e-waste-based research carried out in different South Asian countries. Approximately 85% of investigations were also carried out after 2013. India (54% of the studies) has been the site of the majority of research, with Bangladesh (23%), Pakistan (16%), Sri Lanka (4%), Nepal (2%), and Bhutan (1%), following. Afghanistan and the Maldives, regrettably, have not been the subject of any research.

Figure 5.3: Proportion of e-waste-based research carried out in different South Asian countries.



5.4 India

Current Condition: The availability of cheap skilled and unskilled labour and exploitation of the unemployed educated class has led to many companies building their manufacturing industry in India, giving further rise to the problem of e-waste (Maciej Serda et al. 2013). According to the 2018 report of India's Central Pollution Control Board (CPCB), India produces over 800,000 tonnes of e-waste per annum with an annual growth rate of 10%.

Dealing Authority: The dealing authority for e-waste and its recycling and management is the Central Pollution Control Board (CPCB), which works as the Ministry of Environment, Forest, and Climate Change organization. The CPCB manages and overlooks all states' State Pollution Control Boards (SPCBs).

Legal Background of E-Waste Management (Laws, Regulations and Policies):

- Hazardous wastes (Management and Handling) amendment rules: 2003
- Guidelines for Environmentally Sound Management of E-waste: 2008
- E-waste (Management and Handling) Rules: 2011
- E-waste (Management) Rules: 2016

According to the rules set by Indian legislation, e-waste includes all components and spare parts of the EEE, which make it operational, including fluorescent or other mercury-containing lamps. The rules are applicable to all producers, collection centres, refurbishers, retailers, bulk consumers, and consumers of EEE products.

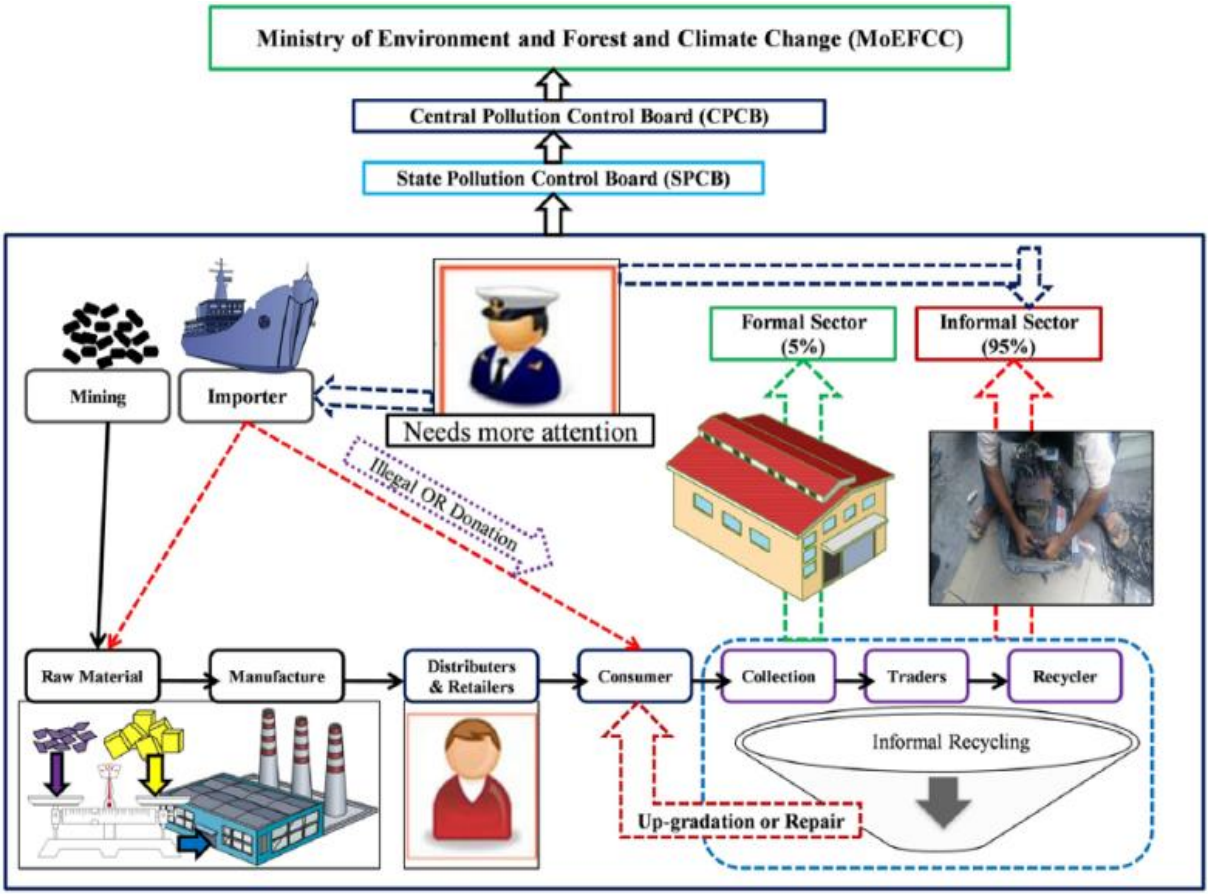
Management and Standard Operating Procedures: The majority of the e-waste is processed by the informal sector, with only 5% reaching the formal recycling sector, as the rise in metal prices has made foraging for metals by the informal sector a source of livelihood.

The collected waste is first sent to family-owned dismantling workshops, usually through an informal sector worker, where it is sorted for reselling parts or informal recycling. The informal sector then extracts the metals or reusable plastics from the e-waste using conventional methods, which are often unsafe for employee health. The unusable residues are dumped in landfills. There are 178 formal e-waste recycling facilities in India registered with the CPCB,

of which only 27 have a capacity of more than 5000 tons per annum(Awasthi, Zeng, and Li 2016).

For the formal sector, the responsibility for recycling the e-waste generated at the non-consumers end, i.e., industries etc., lies with the producing company**.**

Figure 5.4: E-waste management framework in India



Limitations: The informal sector manages most of the waste, meaning that the recycling process is inefficient due to manual labour.

There is also a lot of exploitation of workers in the informal sector as they work in poor and unsafe working conditions with little to no PPEs available, and salaries are often below the minimum wage.

Many free riders avoid the regulations regarding e-waste management, thereby contributing to the amount of e-waste that ends up in landfills.

5.5 Sri Lanka

Current Condition: Sri Lanka imports almost 95% of all electronics in its market, including second-hand goods. In 2015 alone, Sri Lanka produced more than 26,756 metric tons of e-waste from air conditioners, refrigerators, photocopiers, washing machines, computers, electronic ovens, mobile phones, televisions, and toys.

According to a 2017 report published by the Central Environmental Authority (CEA), Sri Lanka had a 22-fold increase in the number of EEEs in the market between 2007 and 2015(Kavirathna, Dassanayake, and Lanka 2022).

Dealing Authority: Central Environmental Authority is the main authority dealing with e-waste in Sri Lanka, which was established under the National Environmental Act, No. 47, 1980. It issues licenses regarding the generation, disposal and recycling/treatment of E-waste and permissions regarding the export of e-waste.

After the CEA, the Department of Performance and Environment Audit Division is responsible for controlling the imports of electronic equipment (New or Second-hand) according to the country's Import and export control act.

Sri Lanka Standards Institution ensures that the imported or manufactured electronic equipment meets the standard specified by the country. The Telecommunication Regulatory Commission of Sri Lanka deals specifically with the import of mobile phones. It is also responsible for granting permission for the import of mobile phones.

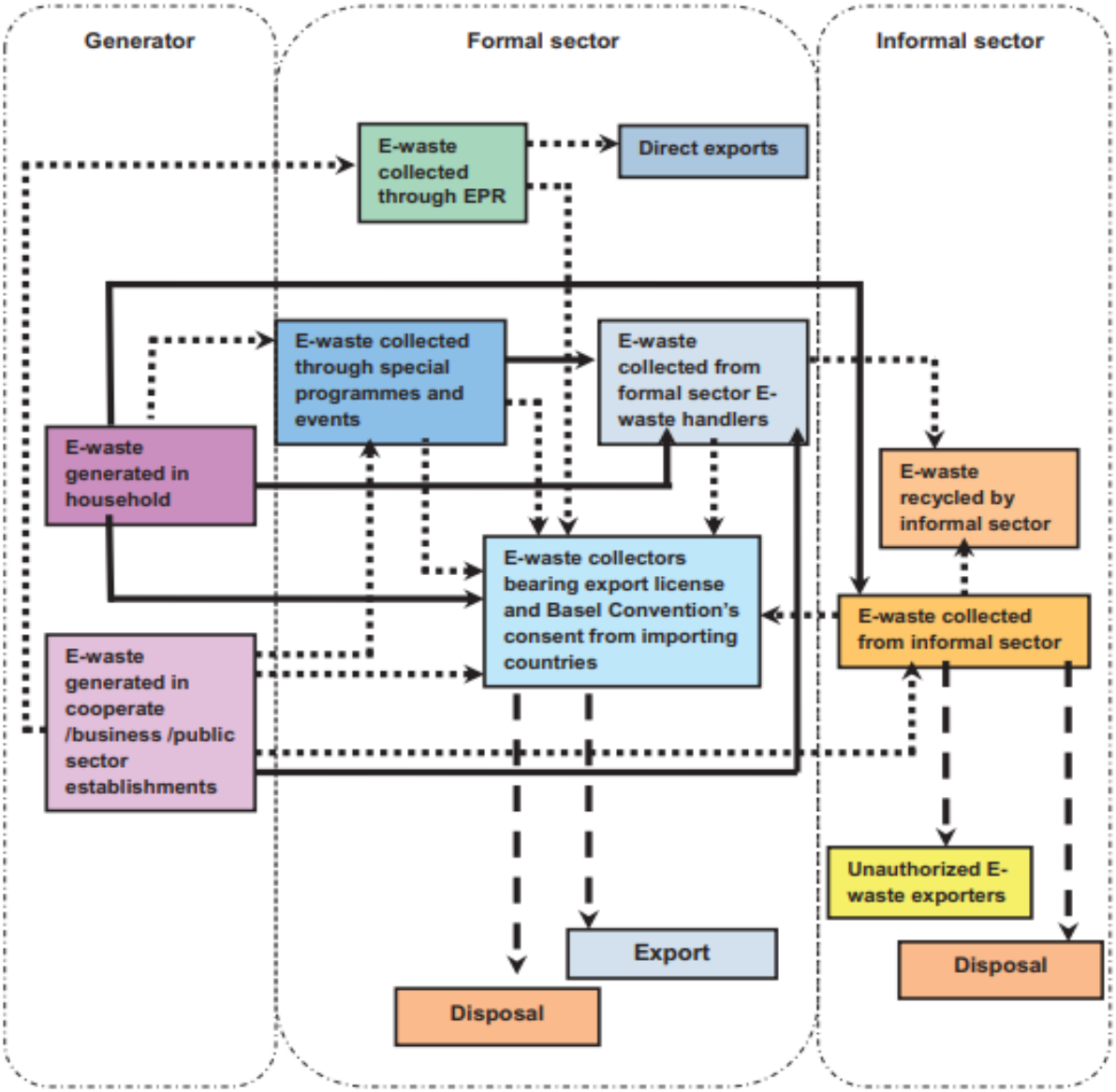
Legal Background of E-Waste Management (Laws, Regulations and Policies): Sri Lanka's national policy on the management of e-waste was drafted in 2008 by CEA in which electrical and electronic waste was mentioned as Scheduled waste. Rules were developed for the management of this hazardous scheduled waste under the National Environmental Act of 2008 in compliance with the Basel Convention.

The management policy and rules aimed to minimize the harmful impacts of the irresponsible disposal of electronic waste, either on environmental or human health. This policy also focused on the life cycle assessment of electronic equipment, its reusability, lifespan etc. The treatment and recovery of valuable materials from waste electronics by using proper methods to avoid health hazards and pollution was also regulated in this policy.

Management and Standard Operating Procedures: After 2010, the formal sector collectors had an agreement with the corporate sector, and the CEA signed an MoU with a telecommunications company to collect e-waste. All shops, franchises, etc., were converted to collection points through this scheme. However, this was not very successful.

In 2011, CEA launched National Corporate E-Waste Management Program and signed an MoU with 14 organizations. The program focused not just on the collection of e-waste but also focused on creating awareness among citizens regarding the importance of e-waste management (Kavirathna, Dassanayake, and Lanka 2022). Telecommunication companies, vendors, E-waste management companies, and software companies were involved as stakeholders in the program at a national level.

Figure 5.5: E-waste management framework in Sri Lanka



A Scheduled Waste Management License is a requirement for the public sector and businesses; this has helped in promoting Extended Producer Responsibility (EPR), which requires them to hand over their obsolete EEEs, changing the informal sector into an organized formal e-waste management sector.

The recyclable plastic and metals are sold to vendors, while the usable or recyclable circuit boards are exported. A significant part of the e-waste management system in Sri Lanka is the incorporation of informal collectors into a community-based operation(Weerasundara 2014).

Limitations: The management plan and SOPs do not specify the responsibility of manufacturers towards the disposal of E-waste. Instead, the main focus is directed towards the businesses and vendors etc.

The e-waste management policy only considers a specific portion of the total e-waste in its SOPs.

The generator is held responsible for the management of its generated e-waste, but it is not practically feasible because it is difficult to identify the generator to manage the e-waste.

The issue of transboundary pollution due to the export of e-waste is not addressed.

5.6 Bangladesh

Current Condition: A deal was signed World Trade Organization (WTO) Vision 2021 of digital Bangladesh, which removed tariffs from over 201 electronic items (WTO 2014). A report by the National Board of Revenue (NBR) of Bangladesh shows that more than 63 million phones were introduced in the Bangladeshi market between 2012 and 2015, with a maximum life of 2.5 years (Rahman and Mahboob 2015). This is expected to overflow the e-waste stream, as electronics have a limited life.

The amount of e-waste generated in Bangladesh is growing at an alarming per-annum rate of 10% (Shamim, Mursheda, and Rafiq 2015). In the last 21 years, Bangladesh has produced more than 10,504 metric tons of toxic e-waste from mobile phones alone.

Bangladesh produced 2.81 million metric tons of e-waste annually, according to research in 2016, contributing to nearly 14% of the total global e-waste production; this figure continues to grow, yet still, only 20 – 30% of e-waste gets reused or recycled in Bangladesh, while the rest ends up in landfills, open soil, open land, or in open water bodies (Awasthi, Zeng, and Li 2016).

Dealing Authority: Due to the lack of e-waste control regulations, there is no specialized body for the maintenance or dealing of e-waste in Bangladesh, and it is overlooked by the Ministry of Environment, Forest, and Climate Change.

Legal Background of E-Waste Management (Laws, Regulations and Policies): Bangladesh signed the UN's Basel Convention on the Control of Transboundary Movements of Hazardous Solid Wastes Between Nations in April 1993. Under this treaty, Bangladesh's Import Policy 2015 – 2018 prohibited the import of used electronics (Ministry of Commerce: Government of the People's Republic of Bangladesh 2015).

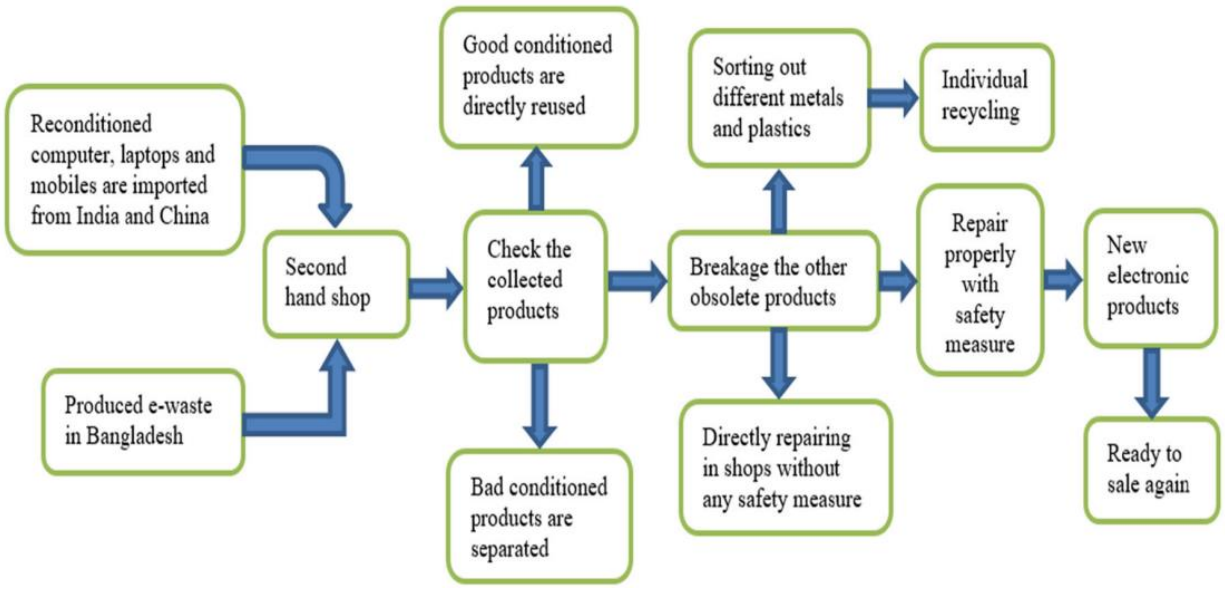
In 2003, the restriction of certain hazardous substances in e-waste became law under the RoHS directive (SGS 2015). In 2014, Extended Producer Responsibility was implemented in compliance with the WEEE directive, which required producers to provide the collection and processing cost of their product's e-waste (EXPRA 2016).

Apart from signing these international treaties, there are no specific laws for controlling e-waste in Bangladesh.

Management and Standard Operating Procedures: The government formulates no proper e-waste management system, and most of the e-waste is processed by the informal sector (Masud et al., 2018).

The main trades linked with e-waste in Bangladesh are dismantling and repairing discarded electronics which is becoming a rising trade, particularly in the informal sector. Almost 20 – 35% of the total e-waste produced in Bangladesh is recycled, almost entirely by the informal sector, except a very small percentage which is recycled by the formal private sector. Of the total e-waste generation of Bangladesh, 15% is recycled in Dhaka city alone. The remaining 65 – 80% of e-waste ends up in dumps, landfills, open spaces, and water bodies. Like other developing countries, there is also a trend of repairing and scavenging materials from e-waste for resale or to manufacture local-level products (Masud et al. 2018).

Figure 5.6: E-waste management framework in Bangladesh



Limitations: There is a lack of regulatory bodies or authority for e-waste.

No local or regional level laws or regulations are available for the management of e-waste, specifically in the context of Bangladesh.

Almost all recycling is done by the informal sector, which lacks the provision of PPEs and poses a risk to human health.

A huge proportion of e-waste ends up in landfills or other open spaces and water bodies.

There is a lack of formal recycling facilities in the public sector.

5.7 Conclusion and Recommendations

- Developing countries generate a lot of e-waste primarily associated with illegal transboundary dumping from developed countries, along with the procurement of second-hand products that become e-waste more quickly.
- Developing countries do sign treaties and multilateral agreements but lack implementation.
- Proper records of e-waste generation in developing countries are not present.
- There is a lack of e-waste management sector in developing countries.
- Most of the e-waste in developing countries is processed by the informal sector.
- A specialized body should be enforced to cater for the issues of e-waste management.
- Crude methods of recycling should be discouraged.
- E-waste should be treated separately from other waste, such as plastic or metal, because of its body material and the hazardous materials present inside.
- Since most of the e-waste is managed by the informal sector, it should be incorporated into the formal sector through collaborations and sponsorships.

5.8 Recommendations for Pakistan

From the review of the current best waste management practices opted out by the developed countries and the current situation of e-waste management in developing countries following recommendations for Pakistan have been drawn:

- E-waste should be redefined for Pakistan (as well as all developing countries) as the term is, although universally used, its literal meanings vary depending on the economic situation of the country, as evident from the fact that most of the laptops/desktops imported into Pakistan are ones discarded by the first world countries.
- The ownership and enforcement of SOPs should rest on Environmental Protection Department, Government of Punjab. Moreover, the tweaking needed in the Punjab Environmental Protection (Amended) Act, 2012.
- Data regarding the total imports and exports of e-waste should be recorded and updated, thus helping in research and evaluation of better management practices.
- E-waste regulation or policy should be introduced, and implementation shall be strictly monitored.
- The Environmental Protection Department, Government of Punjab, is the regulatory body to cater for the issues of e-waste management.
- The informal sector of the e-waste management sector should be uplifted and upgraded with help from capacity development initiatives.
- The E-waste management system should be formulated after a comparative analysis of different waste management techniques with the help of social, economic and life cycle assessments.
- Formal e-waste recycling should be promoted by all government bodies, including regulatory authorities, customs departments as well as taxation departments, in terms of subsidies, compensations, and credit scores.

6 Key Findings and Recommendations of Stakeholder Consultations and Key Informant Interviews

6.1 Introduction

Key Informant Interviews with stakeholders were conducted through one-to-one meetings about the existing status of e-waste management and to seek their suggestions for the development of SOPs which are described hereunder.

6.2 Stakeholders Consultations and Key Informant Interviews

The key Informant Interviews were conducted with relevant stakeholders to understand the current e-waste management system in six divisional headquarters in Punjab. The public and private sector organisations were consulted from six divisional headquarters in Punjab, namely Lahore, Rawalpindi, Gujranwala, Dera Ghazi Khan, Multan, and Bahawalpur, as follows:

- PRIDE Partners
- Regulatory Agency (Punjab Environmental Protection Agency)
- Federal EPA
- Private companies
- Academic Institutions
- Waste Management Companies
- E-waste Importers
- E-waste Refurbisher
- E-waste Dismantlers
- E-waste Recyclers

6.2.1 PRIDE Partners

Key Informant Interviews were conducted with all PRIDE partners, namely the Board of Revenue (BoR); Finance Department (FD); Excise, Taxation & Narcotics Control Department (ET&NCD); Punjab Revenue Authority (PRA); Punjab Procurement Regulatory Authority (PPRA); Punjab Information Technology Board (PITB); and Local Government & Community Development Department (LG&CDD).

- The majority of laptops/desktops are old, and their economic life has already expired. However, ICT equipment is used to the extent possible. The economic life of a laptop is 4 years, as per PC 1, whereas its physical life is considered to be 5 years. However, older versions of computers are still in use. There is a need for an updated inventory of ICT equipment wherein data about older laptops/computers should be collected while planning for the procurement of new laptops, desktops, printers etc.
- Cartridges for printers are generally refilled; damaged batteries and other hardware is replaced.
- Oftentimes older generation laptop and desktops are used that needs regular hardware and software upgradation. There should be a regular mechanism with specific replacements and maintenance, thus limiting the generation of large amounts of e-waste, such as batteries and cartridges.
- All PRIDE partners procure their ICT equipment through tenders.
- The frequently replaced parts of ICT equipment are the mouse and keyboards.

- The economic life of ICT equipment varies from product to product; in the case of desktops and laptops, according to PC-1, its economic life is 5 years. However, ICT equipment is used as long as it is repairable or its parts can be replaced. Once the ICT equipment is no longer repairable, then a relevant staff member checks it and declares it as “non-usable” or “Redundant”.

  Once there are a good number of “non-usable” ICT equipment, then these are auctioned. An Auction Committee is formed, which cross-checks all the non-usable ICT equipment, and its minimum auction price is fixed. A tender for the auction of ICT equipment is floated, and the bidder quoting a higher price is awarded the contract. The whole auction process takes around 2 to 3 years. During this period, the overall condition of ICT equipment further deteriorates, and the equipment is sold at a comparatively lesser price than anticipated.
- There should be an annual phase-out of e-waste generated by all the public sector departments with a simplified procedure for auction.
- There is no designated e-waste storage space in any of the partner organizations. The e-waste is stored along with other waste in storage rooms. There is the possibility of rusting equipment during storage.
- None of the PRIDE partners has prepared any SOPs for e-waste management.
- All the PRIDE partners agreed that there is a need for an e-waste management regulation and clearly defined SOPs to manage e-waste at various levels.
- All the ICT equipment is an “Asset”. So, disposal of e-waste is comparatively cumbersome as everyone wants to avoid “audit para” if they dispose of it without following the auction procedure.
- PPRA stated that their procurement regulations are only for the procurement of new equipment as per their mandate. Therefore, there is no regulation by the PPRA on the disposal of old equipment.
- Recycler of e-waste must be registered, and Extended Producers' Responsibility (EPR) in ICT equipment may be enforced.
- There should be some flexibility in the procurement of ICT equipment, and priority should be given to state-of-the-Art equipment with the required warranty. The economic and useful life should be redefined, which can be enforceable.
- The normal warranty for a laptop/desktop is one to two years. However, there is a need for a service-level agreement with the supplier of ICT equipment for 3 years.
- ICT equipment procured 2-3 years ago must be refurbished with an increase in RAM or upgraded to newer generations.

According to the ICT equipment data collected from seven out of eight PRIDE partners show that there are 3,113 desktops/laptops, 671 LCDs, 437 scanners and printers, 73 routers and servers and 48 other pieces of equipment. The majority of this ICT equipment is old and will be replaced with new equipment; therefore, it is anticipated that the PRIDE project is going to generate significant quantities of e-waste when procurement of ICT equipment for the PRIDE program takes place.

Table 6.1: ICT equipment currently present in PRIDE partner organizations

PRIDE Partner	Desktop Computers	Laptop Computers	LCD	Printers + Scanners	Routers/ Servers	Others	Remarks
P&DB	170	60	170		3	23*	* Wireless controllers
ET&NCD	478	50		78			
BoR	140	19		60			
LG&CDD							
PPRA	10	10	4	11*			3 photocopier + 8 printers
FD	221	40	221	198 + 15		22 + 3*	Scanner +Fax Machine
PITB	1700		150	200			
PRA	215		126	75	70		

6.2.2 Waste Management Companies

Key Informant Interviews were conducted with Lahore Waste Management Company (LWMC), Faisalabad Waste Management Company (FWMC), Rawalpindi Waste Management Company (RWMC), Gujranwala Waste Management Company (GWMC), Multan Waste Management Company (MWMC), Dera Ghazi Khan Waste Management Company (DGKWMC) and Bahawalpur Waste Management Company (BWMC). Sahiwal, Sargodha and Gujrat do not have dedicated solid waste management companies. The collection and disposal of MSW is carried out by Municipal Corporations.

- Waste management companies do not have separate e-waste collection or disposal systems.
- E-waste is collected by scavengers from residential and commercial areas, and we cannot find it in municipal waste.
- Waste management companies do collect municipal solid waste from 200 tons to 5,000 of municipal solid waste per day, depending upon the population of the city.
- Rawalpindi Waste Management Company do dispose of e-waste generated by a private company. The e-waste, mostly comprised of laptops/computers, is first spread over an area. Then the e-waste is crushed by a bulldozer. The crushed e-waste is then dumped in a specially lined pit, and finally, it is filled with concrete. This is done to eliminate the risk of any data retrieval.
- To improve the e-waste management system, the first step should be to develop a clear policy and subsequent laws and regulations. The second step should be the development of guidelines and SOPs so that implementation can be effectively carried out.
- There should be e-waste management regulations, SOPs, and registration of e-waste recyclers.
- The improper e-waste management by recyclers is a hazard, and a well-defined e-waste management mechanism is needed.
- E-waste is an asset of its own. There is a need that e-waste recycling should be carried out in Pakistan in an environmentally friendly manner. There is a need to promote a circular economy in e-waste management.
- The development of SOPs and their implementation will enhance will be sufficient for

satisfactory e-waste management, while 60% suggested that SOPs should be based on a regulation; only then will its implementation be effective.

- 100% of representatives of the waste management companies agreed that e-waste handlers should be registered and compliance with EHS safeguards by e-waste handlers shall be ensured.

6.2.3 Punjab Environmental Protection Agency

A consultation meeting was conducted with the Director General of Punjab EPD on the development of SOPs for e-waste management. Similarly, during field visits, consultation with district environment officers also took place.

- It is a very positive development that SOPs are being prepared for e-waste. We are aware that e-waste is the next emerging issue if it is not properly disposed of.
- The development of draft e-waste management rules by the Pakistan Environmental Protection Agency is very good. Once notified, it will be a good guiding principle for all provincial environment protection agencies.
- If we look into the Punjab Environmental Protection Act 1997 (amended 2012), in our opinion, e-waste is included in the definition of “solid waste”.
- E-waste is dismantled and recycled by the informal sector in congested commercial areas near computer markets. The informal sector does not follow Punjab Environmental Protection Act, 1997 (amended 2017) and Punjab Occupational Health and Safety Regulations 2019, resulting in adverse environmental impacts on workers and on the local environment.
- The community do complain to District Environment Officer about noise and burning of waste which are recorded, and appropriate actions are taken as per prevailing environmental regulations.
- All of the District Environment Officers did agree that after plastic waste, e-waste is going to become a new environmental hazard. They appreciated that it is encouraging to note that SOPs are being prepared for e-waste management.

  There are illegal metal recovery furnaces which are being operated illegally as they have not obtained any environmental approval from the Environmental Protection Department, and they are using crude methods for the extraction of metal. During the stakeholder’s consultation, only one Metal recovery plant was visited, which was duly approved by the Environmental Protection Department.
- The majority of the district environmental officer do agree that SOPs will be sufficient for satisfactory e-waste management, while some of them suggest that preparation of regulation for e-waste management is the right approach. There is a need to involve all the stakeholders in drafting the SOPs for e-waste management.
- There are now more shops dealing with the refurbishment of used computers and laptops as the cost of new ICT equipment skyrocketed due to the massive devaluation of the Pakistani currency.
- There is a need for plastic and e-waste recyclers must be registered with the Environmental Protection Department, Government of Punjab.

6.2.4 Federal EPA – Ms Farzana Altaf Shah, Director General

- E-waste is a hazard that poses adverse health risks for human beings and the environment.
- A limited quantity of E-waste is collected in municipal solid waste because it is valuable and not discarded by households but rather sold to scavengers.

There is no formal recycling facility located in Islamabad Capital Territory that handles E-waste. Informally, e-waste is recycled in Islamabad Capital Territory. There are retailers and refurbishers who collect e-waste from scavengers in the Blue Area of Islamabad. The e-waste is manually dismantled, and plastic or metal parts are melted to extract metals through blowtorches and other rudimentary techniques.

- It is very difficult to monitor these informal recycling activities, as these happen on a small scale, and we only come to know and act when we receive complaints from the community.
- Recently, Pakistan Environmental Protection Agency has drafted its regulations on e-waste Management. These draft regulations have been drafted keeping in view the entire value chain of e-waste. However, it is suggested that all provincial Environmental Protection Agencies can learn from our experience. Moreover, these draft regulations can be used as a guiding document. The e-waste management regulations will only be effective if these are adopted by all Environmental Protection Agencies in Pakistan.

6.2.5 Private Companies / Environmental Awareness Group

Key Informant Interviews were carried out with national and international organisations, namely Attock Oil Refinery Limited, Rawalpindi; Nestle Pakistan, Lahore; World Wildlife Fund, Pakistan, Lahore; and National Cleaner Production Center, Rawalpindi.

- Large national and international private sector organisations have established ICT equipment workshops at their premises, providing software and hardware support on a demand basis. The workshop has all the necessary tools and spare parts, along with hardware and software engineers, to attend to any call for maintenance during office hours.
- The economic life of a laptop/computer is considered 4 years. Nestle Pakistan has a policy to give back a laptop to a user as an incentive to the staff after four years of usage.
- The upgrading of the laptop/desktop within the whole organisation is carried out at regular intervals.
- The non-usable and redundant ICT equipment is stored and then auctioned on a yearly basis.
- All the ICT equipment is first cleaned from all the data. Once hardware ware and software engineers confirm that now it is safe to dispose of, then ICT equipment is disposed of through auction.
- Redundant electrical and electronic waste equipment is stored in designated storage rooms that are the responsibility of the IT department of the respective company.
- Programmable chips for printers are preferably bought, so it is easy for them to programme it as per demand. The purchase of new toner and drums is expensive. So, cartages are refilled 3-4 times; after that, new cartage is procured.
- The e-waste generated by Nestle Pakistan is disposed of by their Environmental, Occupational Health & Safety Department as per duly defined e-waste disposal protocols.
- E-waste is a potential hazard in any environment; therefore, it should be disposed of in an environmentally sound manner. There is a need for e-waste recyclers duly registered with Environmental Protection Department.
- There is continuous upgradation of ICT equipment, and comparatively new equipment is energy efficient and maintenance-friendly. There is a need to purchase toner and drum, which are separate rather than combined. There is a need to check the maintenance aspect of any ICT equipment at the time of purchase.

- There is a need for a circular economy approach to e-waste management.

6.2.6 Academic Institutions

Key Informant Interviews were conducted with academia, namely Allama Iqbal Open University, Islamabad; Information Technology University, Lahore; Government College University, Lahore and University of Engineering and Technology, Lahore.

- The procurement of ICT equipment is made through tendering procedures for large quantities, whereas a three quotations procedure is adopted for small quantities for an amount less than Rs 500,000/-.
- Framework contract with vendors for toners and cartages for printers is made.
- The average life of ICT equipment, specifically desktops and laptops, is 5 years, while frequently used items such as printers, telephones, fax machines etc., are used for 3 years on average.
- Presently, there are no SOPs for the disposal of non-usable or redundant ICT equipment.
- IT equipment and products are “assets” which cannot be disposed of without following the auction procedure.
- There is a need for old-generation laptops/desktops with older versions of Windows, or generation should be provided to the staff at a nominal price.
- There is a need for regulation on Extended Producer Responsibility for e-waste management. The producers must be forced to take back old/worn-off/ redundant equipment as extended producer responsibility.
- There should be an annual phase-out of e-waste generated by all the departments of academic institutions.
- Organizations that have a considerable amount of ICT equipment should have their internal hardware and software department for maintenance. Waste should not become a part of the environment. Rather reused, recycled or disposed of properly.
- Open burning of any type of waste, specifically e-waste, shall be strictly prohibited as e-waste consists of highly toxic substances that can cause air pollution and damage nearby flora and fauna.
- Public-private partnerships shall be encouraged to promote a circular economy approach through upcycling and recycling of redundant ICT equipment.
- The academic institutions agreed that e-waste handlers should be registered, and regulatory agencies shall ensure compliance with EHS safeguards by e-waste recyclers.

6.2.7 E-waste Importers

To establish the current condition of e-waste import in Pakistan, e-waste importers from Rawalpindi, Bahawalpur, Gujranwala, Multan, Lahore, and D.G Khan were consulted.

- This e-waste comprising used laptops and computers is graded according to their specifications and potential sale price. There are only 5-10% of junk items are sold to Kabarias for extraction of material. However, now the import of e-waste has largely suffered due to the devaluation of the Pakistani currency. The import of used laptops and computers is no longer economical. Now, all the import of e-waste is coming by air. Therefore, the importer does check each piece carefully.
- Now there is a market for used computers within UAE, and many importers from Pakistan have shifted to UAE because of the ease of business in UAE.

- The old computers are sold in lots, but now, due higher exchange rate of dollars, only limited stock is procured.

6.2.8 E-waste Refurbisher/Repairer

E-waste refurbishers/repairers are the ones that do the repair work on damaged ICT equipment. Consultative sessions and transect walks were arranged in Rawalpindi, Lahore, Faisalabad, Gujranwala, D.G Khan, Bahawalpur, and Multan at Hafeez Center, Lahore; Computer market, 6th Road, Rawalpindi; Bank Road, Saddar, Rawalpindi; Rex Market, Faisalabad; Khan Plaza, Multan Cantonment; Manka Road, D.G Khan; Girls' College Road, Anwar colony, Bahawalpur; Al Qadir market, Bahawalpur; and Hospital Road, Gujranwala.

- The majority of used equipment (computers, laptops and Printers) can be refurbished with software and hardware upgradation.
- When a laptop or computer cannot be further used, then its components, like ICs, capacitors, fans, cables, etc., are extracted. The rest of the waste materials are sold to Kabarias.
- The least valuable components are keyboards and mouse. As these items are made of black plastic, wires, mouse, and keyboards are less valuable.
- Li-ion batteries are not reusable once they are dead; the only part that can be extracted and reused is the battery management system.
- Dead batteries are sold to Kabarias and battery-repairing entities at the rate of Rs. 200-250 per piece.
- A panel Bonding Machine is a state-of-the-art machine used to repair LCDs. This machine is available only in Rawalpindi, Faisalabad, Gujranwala and Lahore. This machine allows refurbishers to repair LCD and LED.
- Li-ion batteries are buried in grounds to avoid explosions and the release of toxic substances in the air, which can damage the well-being of humans and the environment.

6.2.9 E-waste Kabarias

Kabarias buy e-waste from domestic, commercial, and organizational bodies. E-waste Kabarias from Rawalpindi, Bahawalpur, Gujranwala, Lahore, D.G Khan and Multan were consulted at Band Road, Lahore, Hall Road, Lahore; Misri Shah, Lahore; Commercial area, Multan; Satellite town, Rawalpindi; Karachi Morr, Bahawalpur; and Manka Road, D.G Khan.

- The quantity of electronic waste is now increasing at a significant rate.
- E-waste is a resource, as evident from the fact that discarded e-waste can be resold, and there is a whole market of totally discarded e-waste.
- Kabarias buy scrap that cannot be put to other good use.
- The majority of Kabarias have 4-5 scavengers who roam around to collect the scrap from homes, shops, and offices, while others have contracts/ mutual agreements with computer refurbishing shops.
- Mostly iron cases/ metallic items are sold, and repair shops often reuse motherboards, RAM, and processors.
- CPU is the most useful item as a resold product as it is resold to dismantlers and recyclers at the rate of Rs. 1,100-2500 per unit.

6.2.10 E-waste Dismantlers

Kabarias buy e-waste from domestic, commercial, and organizational bodies. E-waste Kabarias from Rawalpindi, Bahawalpur, Gujranwala, Lahore, D.G Khan and Multan were consulted at Misri Shah, Lahore; Hall Road, Lahore; Garden gate, Lahore; Lahori gate, Lahore; Hanno ka Chaja, Multan; Satellite town, Rawalpindi; Karachi Morr, Bahawalpur; Manka Road, D.G Khan; and Sheikhupura Road, Gujranwala.

- The older versions of computers have more recyclable items, including precious metal content, than the newer ones.
- The latest generation models of laptops and computers have an inbuilt mechanism for identifying and sorting out software and hardware issues.
- The recovery of precious metals from e-waste is the most profitable business. However, there is no facility in Pakistan to refine ingots to extract the precious metal. Therefore, all the ingots produced in Pakistan are sent to China.
- The circuit breakers are purchased at Rs 300/kg, whereas the motherboard is at Rs 1,000/kg. After dismantling of laptop/desktop, different material is sold separately, i.e., Copper Rs 1,600/Kg, Screen/glass Rs 650/piece, Circuit breaker Rs 3,000/kg, and motherboard Rs 1,000/kg.
- The motherboards are sold in lots to metal recovery furnaces in Lahore, Sharaqpur and Gujranwala. The motherboard and IC are first crushed and then shifted to the furnace, and an ingot is produced, which is exported to China for extraction of precious metal.
- Plastic is recycled into plastic shoes and the soles of rubber shoes.
- Metal from e-waste is bought by steelwork companies in Pakistan that recycle it.

6.2.11 E-waste Recyclers

The e-waste recycling market in Pakistan is not well established. Only a few informal recycling units are present across the country, some being in Punjab province.

- Items like circuit boards, RAM, and IC chips are recycled by extracting material from them; thus, only a fraction of the recycling process is performed in Pakistan.
- There is no local refinery to extract materials from e-waste in Pakistan, so the e-waste has to be exported to China for the extraction of valuable material.
- The average capacity of furnaces is 20-25 tons/day of melted material.
- The employees at the recycling facility are provided with a mask, gloves, hi-vis jackets, glasses, and helmets and comply with occupational health and safety protocols.
- Skilled workers are required to segregate, dispose of, and recycle e-waste.

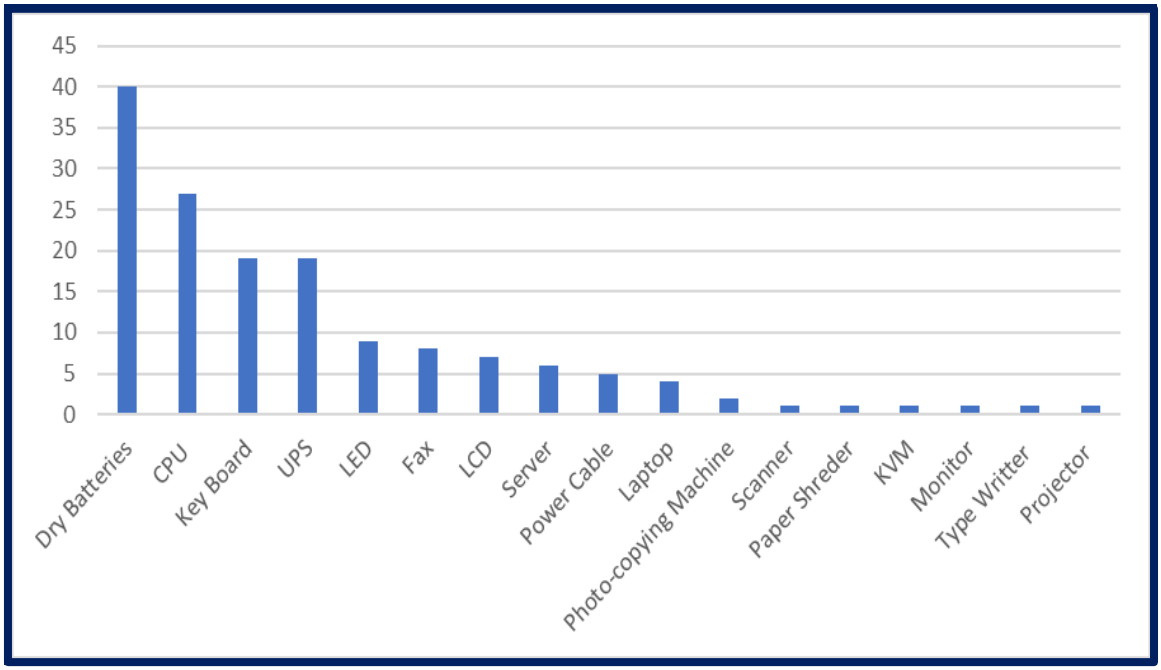
6.3 Case Studies

Case Study 1:

A recent ICT auction comprising 152 products was auctioned at a price of 0.7 m by the P&DB. The auction material mainly consisted of dry Batteries, CPUs, Keyboards, UPS, Fax, LCD, Servers, Power cables, Laptops, and Photocopying machines. The process of the auction took almost two years.

The case study shows that dry batteries, CPU, Key Board and Ups are the main ICT equipment which needs to be replaced frequently and in large quantities.

Figure 6.1: ICT equipment auctioned by Planning & Development Board during 2022



Case Study 2:

Mr. Amjid has four shops at Misri Shah, Lahore. He employed 10 scavengers who roam around the city to buy e-waste, i.e., laptops, desktops, keyboards etc. Moreover, he has engaged four workers to manage the segregation and dismantling of laptops and desktops at his shop.

They collect and segregate e-waste according to buyer's requirement, circuit breakers and motherboards and laptops as these fetch the highest prices. He is one of the biggest e-waste dealers, collecting roughly 1.5 to 3.0 tons of e-waste in one month.

The circuit breakers are purchased at Rs 300/kg, whereas the motherboard on Rs 900/kg. After dismantling of laptop/desktop, different material is sold separately, i.e., Copper Rs 1,600/Kg, Screen/glass Rs 650/kg, Circuit breaker Rs 3,000/kg, and motherboard Rs 1,000/kg. He sells it with a profit margin of 8-10%. He sells all e-waste in lots to metal furnaces located in Lahore, Sharaqpur and Gujranwala.

Copper, silver, and gold are extracted from e-waste in crude methods. As metal extraction is being done in makeshift plants, the extraction efficiency is low. Therefore, now there are furnaces where ingots are produced from melting crushed motherboards and ICs.

Mr Amjid has limited knowledge of the occupational, environmental health and safety regulation of Punjab. His staff is well aware of health hazards associated with e-waste as they occasionally use gloves while dismantling desktops/laptops. He is willing to train his staff for proper dismantling and segregation of e-waste to protect the health and safety of his workers. His staff occasionally use gloves and masks.

Exhibit 1: Disassembled circuit boards stored in bulk

Exhibit 2: Motherboards stocked at a dismantler shop

Exhibit 3: Scavenged e-waste at a scrap yard

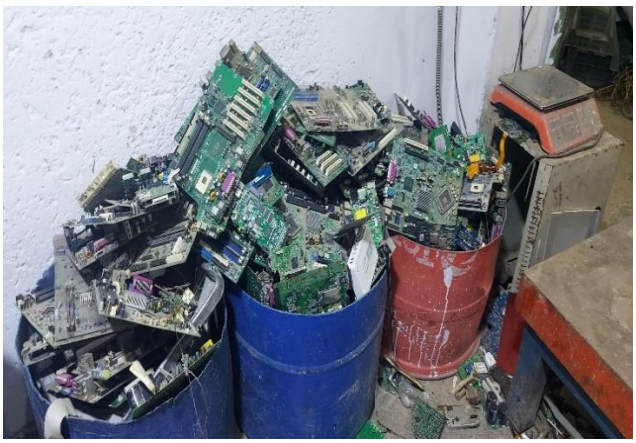


Exhibit 4: Motherboards are stocked for sale.

Case Study 3:

AQ Metals is located on a four-kanal plot in Gujranwala. He melts 20-25 tons of e-waste per month. He imports e-waste as well as procure it locally. He collects all e-waste items like motherboards and other items which contain copper. There is no refinery locally, so he only makes ingots. He uses coal as fuel. He has got a melting capacity of 15-20 tons/day; as such, the furnace is used only once or twice a month. The furnace is fitted with zig-zag technology air pollution control devices to reduce the exhaust emissions emanating from the furnace.

The employees are provided with a mask, gloves, hi-vis jackets, glasses, and helmets and comply with occupational health and safety protocols. There are no women workers in the factory. He needs skilled workers to segregate, dispose of, and recycle e-waste. His facility has obtained environmental approval from Punjab Environmental Protection Department.

Exhibit 1: Metal melting furnace of AQ metals

Exhibit 2: The outer look of the furnace where ingots are formed

Exhibit 3: Metal ingots kept after taking out from the furnace

Exhibit 4: Workers at AQ Metals abiding by OHS principals

Section-2

Standard Operating Procedures (SOPS)

SOPs offer technical instructions for all e-waste handlers who actively deal with and manage condemned ICT equipment in the PRIDE partner organizations.

This document outlines the processes for the collection, segregation, off-site transportation, secure handling, and disposal of e-waste throughout all PRIDE partner offices situated in Punjab.

SOP-01: Establishment of ICT inventory

Purpose

The purpose of this SOP is to define procedures for establishing an inventory for any ICT (Information and Communication Technology) equipment procured or present in

_____ Office.

Scope

This procedure is applicable to each office/department of _____

Reference

Basel Convention; Pakistan Environmental Protection Act 1997; Punjab Environmental Protection Act 1997; Punjab Hazardous Substance Rule, 2018

Assigned Roles & Responsibilities

	Designation	Assigned Role	Assigned Responsibility
1	*Head of Administrative/IT Department*	Inventory Authorizer	Authorize and verify the current inventory of ICT equipment on a *quarterly* basis.
2	*Section Officer*	Establish ICT inventory	Establish and maintain inventory of newly procured, existing as well as redundant ICT equipment of the relevant office/department.
3	*IT Incharge*	Collect data regarding ICT equipment procured, in use, stored and disposed	Collect data regarding ICT equipment procured, in use, stored and disposed of in the relevant office/department

Procedure

- Inventory for ICT equipment, including servers, desktops, laptops, printers, scanners, fax machines, routers, tablets, and mobile phones, shall be maintained.
- ICT equipment from a vendor along with Delivery Challan (DC) shall be received by authorized personnel. Material received shall be compared with Purchase Order and DC to ensure completeness and appropriateness of ICT with respect to specifications /quantities ordered.

- If the ICT are according to the specifications, a copy of the DC shall be acknowledged and returned to the vendor. IT Group will create a Good Receipt note (GRN), and inventory will be updated. A sample of GRN is attached as **Annexure – B**.
- The distribution of GRN shall be as follows:
  - Original GRN along with original Delivery Challan to Accounts Payable department for payment.
  - Copy for record retention (Inventory Management team)
  - Copy for record retention (IT Group)
- The ICT equipment is to be divided into three categories, i-e, Category A, Category B, and Category C.
  - Category 'A' (CAPEX Item) will include large ICT equipment, including Servers, LCDs, Monitors, CPUs, Laptops, Printers, Fax machines and Scanners.
  - Category 'B' will include medium to small ICT equipment, including Surveillance equipment, Mobile phones, Tablets and Routers
  - Category 'C' will include components of ICT equipment that are frequently replaced, including Power cables, networking cables (for surveillance and servers), Wi-Fi dongles, RAMs, and Hard Drives (both SSD and HDD).

Category 'A' Inventory

Category 'A' equipment; large ICT equipment including Servers, LCDs, Monitors, CPUs, Laptops, Printers, Fax machines and Scanners to be inventoried in Form 1 (Inventory form for Record Maintenance of 'Category A' ICT equipment).

Information regarding Category 'A' ICT equipment procured, in-use, stored, as well as ICT equipment sold off by auctions or other means shall be recorded in **Form 1**.

Inventory records shall be maintained for at least 3 years on the same register.

Category 'B' Inventory

Category 'B' equipment; medium to small ICT equipment, including Surveillance equipment, Mobile phones, Tablets and Routers to be inventoried in Form 2 (Inventory form for Record Maintenance of 'Category B' ICT equipment).

Information regarding Category 'B' ICT equipment procured, in-use, stored, as well as ICT equipment sold off by auctions or other means shall be recorded in **Form 2**.

Inventory records shall be maintained for at least 3 years on the same register.

Category 'C' Inventory

Category 'C' equipment; ICT equipment that is frequently replaced, including Power cables, Batteries, Networking cables (for surveillance equipment and servers), Wi-Fi dongles, RAMs, and Hard Drives (both SSD and HDD) to be inventoried in Form 3 (Inventory form for Record Maintenance of 'Category C' ICT equipment).

Information regarding the Category 'C' ICT equipment procured, in use, and stored, as well as ICT equipment sold off by auctions or other means, shall be recorded in **Form 3**.

Inventory records shall be maintained for at least 3 years on the same register.

Each item of ICT (Category A and Category B) shall be assigned a unique material code in the system/Ledger for cyclic inventory count.

The inventory audit/review system shall be in place for all inventory items.

Storage of ICT material

i. The ICT material received shall be stored at their specified locations under IT group control. The storage area shall be demarcated into the following sub-areas:
   a. Receiving and inspection area.
   b. Project-related material.
   c. Stock items.
   d. Tools/instruments and equipment.
   e. Rejected items.
ii. Materials shall be stored in an accessible area to facilitate further issuance to the requisitioning department. The Material Requestion Form is attached as **Annexure-C**.
iii. Access to the storage area shall be restricted to authorized personnel only.
iv. Each storage location shall be identified on bin cards / Ledger / System with a unique location ID.
v. Measures shall be taken to protect inventory against physical deterioration and adequately insure its value against loss.

Labelling of ICT material

i. Labels must be legible and prominently displayed.
ii. Personnel shall not remove or deface existing labels on containers.
iii. Department managers and supervisors shall ensure that labels or other forms of warnings are legible (in the English language if applicable) and prominently displayed.

The information on the labels and the importance of proper labelling and following the label direction will be transmitted to all department personnel, and proper handling procedures will be shared in the safety training program.

EHS Requirements:

Poor lifting and carrying techniques can result in discomfort and increase the risk of injury. In extreme cases, these injuries can have permanent effects. These risks can be reduced by adopting the following precautions:

- ► Ensure that safe working practices for the activity are complied with;
- ► Make full and proper use of lifting and carrying aids and access equipment;
- ► Store heavy items between shoulder and hip height; where possible, store only small or light items above shoulder or below knee height;
- ► Use the legs and knees to bend and lift; avoid bending the back;
- ► Avoid tasks which involve stretching or twisting;
- ► Ensure that regular rest breaks are taken to prevent the onset of fatigue and to where manual handling activities are repetitive;
- ► Ensure the load has no sharp, hot or cold edges, which could cause injury;
- ► Ensure that walkways are free from obstructions;
- ► Make full and proper use of PPE;

- ► Report any problems or concerns associated with manual handling to a responsible person without delay.

Note: Tracking of equipment in inventory is to be done with the help of material codes assigned to each ICT equipment at the time of procurement.

Issuance of ICT material

I. On receipt of approved Material Requisition with instruction for either full delivery or partial delivery, a Goods Issuance Note (GIN) shall be generated and issuance record to be logged in Ledger/system after proper counting and physical measuring. GIN is attached as **Annexure-C**.

II. 3 copies of GIN shall be made for the following distribution:

   a. Receiver copy
   b. Accounts copy
   c. IT Group copy.

III. The acknowledgement shall be obtained from the person receiving the ICT material.

IV. If materials are to be transferred outside the storage area, a Gate Pass shall also be prepared and approved by the authorised personnel.

V. 4 copies of DN shall be made for the following distribution:

   a. Receiver copy
   b. Accounts copy
   c. IT Group copy
   d. Gate / Security copy.

Physical count of ICT materials

1.13.1Periodic counting and weighing

All ICT items/materials shall be physically counted/weighed on pre-defined material count dates by the Internal Audit Department (IAD) and the IT Group.

Management reporting

Following management reports shall be prepared:

S.No.	Report	Reviewed by	Purpose	Frequency
1.	Stock Position Report	Manager Inventory ITG.	It sets out the stock positions at various stores at each month's end or up to any date if required.	As and when required
2.	Ageing Analysis	Manager Inventory ITG.	It is used to analyse the materials by their age for obsolete and slow-moving items.	As and when required
3.	ABC Analysis	Manager Inventory ITG.	It is used to analyse the materials by their value for the identification of high-value items and their access controls.	As and when required
4.	Slow-moving or obsolete stock	Manager Inventory ITG.	Identifies slow-moving or obsolete items in the inventory.	Quarterly
5	Stock count discrepancies report	Manager Inventory ITG / Internal Audit.	To investigate and resolve differences between physical and recorded inventory.	As and when required

Form 1: Inventory of Category 'A' ICT equipment

	ICT equipment Category A (Insert material code number)									Status of device (Mention date of acquired status)				
Sr. No	**Servers**	**LCDs**	**Monitors**	**CPUs**	**Laptops**	**Printers**	**Fax Machines**	**Scanners**	**Others**	**Date of Procurement**	**In-Use**	**In-Store**	**Disposed**	**Remarks**
1														
2														
3														
4														
5														

Form 2: Inventory of Category 'B' ICT equipment

ICT equipment Category B (Insert Material code number)						Status of device (Mention date of acquired status)				
Sr. No	**Surveillance equipment**	**Mobile phones**	**Tablets**	**Routers**	**Others**	**Date of Procurement**	**In-Use**	**In-Store**	**Disposed**	**Remarks**
1										
2										
3										
4										
5										

Form 3: Inventory of Category 'C' ICT equipment

ICT equipment Category C (Insert Material code number)								Status of device (Mention date of acquired status)				
Sr. No	**Toner Cartridges**	**Networking cables (for surveillance equipment and**	**Wi-Fi dongles**	**Batteries (phones, laptops etc.)**	**RAMs**	**Hard Drives (Both SSD and HDD)**	**Others**	**Date of Procurement**	**In-Use**	**In-Store**	**Disposed**	**Remarks**
1												
2												
3												
4												
5												

SOP-02: Maintenance of ICT equipment

Purpose

The purpose of this SOP is to define procedures for the maintenance of ICT (Information and Communication Technology) equipment present in the office.

Scope

This procedure is applicable to each office/department/sub-department of _____ Office.

Reference

Basel Convention; Pakistan Environmental Protection Act 1997; Punjab Environmental Protection Act 1997; Punjab Hazardous Substance Rule, 2018; The Punjab Occupational Safety and Health Act, 2019

Assigned Roles & Responsibilities

	Designation	Assigned Role	Assigned Responsibility
1	*IT Administrator*	*ICT Administrator*	Authorize and verify the maintenance schedules. Finalize whether malfunctioning equipment requires a visit to a repairer.
2	*System Engineer/ IT Technician*	Maintenance Inspector	Carry out inspections of newly procured and in-use ICT equipment of the relevant office/department. Decide if any equipment needs maintenance from outsourcing.
3	*IT Support Staff*	ICT technician	Ensure maintenance of ICT equipment on a monthly basis besides or when required.

Procedure

- ICT equipment in use by the employees as well as newly procured ICT equipment to be properly maintained to ensure longer useful life.
- Employees shall file a request through *phone calls or in writing* to call for an IT technician if the equipment is malfunctioning.
- ICT technicians shall reach out in person to check the malfunctioning equipment and perform any maintenance procedure required.
- If the equipment needs extra maintenance or the ICT technician is unable to resolve the issue, the equipment shall be transferred to the IT department of the office if it is easily portable.
- Such equipment needs to be checked by the maintenance inspector.
- If the device is not portable, e.g., surveillance cameras, large printers or servers, a maintenance inspector is required to visit the site of equipment.

- If the equipment needs replacement of a component, e-g., RAM or Hard Drive, this shall be done by the maintenance inspector and also update the data in Form 3.
- If the equipment needs advanced maintenance, e.g., by a repairer, the maintenance inspector shall inform the ICT administrator.
- Any ICT equipment or component posing a spill or fire hazard shall not be used again and thus be replaced by a new component.
- The ICT administrator shall ensure maintenance Form 4 is filled for any maintenance required outside of the office premises.
- Maintenance requests shall be put up by the user in the given Form 4.
- If any component replacement has been done by the repairer, the data shall also be added to Form 3.
- The ICT administrator is to do necessary communication with the department, the equipment user, and the outsourcer (repairer) regarding the time and amount required for maintenance by an outsource.
- The ICT equipment shall be transported in a careful manner from the office to the repairer's workshop.

Form 4: Maintenance Request form for ICT equipment

Form No:		**Request Form for Maintenance work on ICT equipment**		**Organization Name:**
Requestor's Name:	Date:	Department/Sub-Department:	Room No. (if applicable)	Issue Faced by user:
Work Required:				Contractor/Repairer:
Approved	Disapproved	Authorizer's Signature:	Date:	Additional Remarks:
To be used only by ICT Administrator after ICT equipment returns after maintenance				
Description of issues resolved: (as per the attached maintenance receipt provided by the repairer)				
Issues Resolved:	Repairer's contact information:	Amount paid: (*Receipt Attached*)	Final Remarks:	
Yes ☐				
No ☐				

SOP-03: Declaration of Condemned ICT Equipment

Purpose

The purpose of this SOP is to define procedures for the declaration of Condemned Information and Communication Technology equipment present in _____ office.

Scope

This procedure is applicable to each office/department/sub-department of _____ Office.

Reference

Basel Convention; Punjab Environmental Protection Act 1997 (Amended 2012); Punjab Hazardous Substance Rule, 2018; The Punjab Occupational Safety and Health Act, 2019

Assigned Roles & Responsibilities

	Designation	Assigned Role	Assigned Responsibility
1	*IT Administrator*	*ICT Administrator*	Decide if the equipment has become redundant after carrying out a final inspection. Declare the equipment as a "Condemned item." Forward request for replacement of the condemned item with a new one and storage of the condemned item.
2	*Repairer/ICT vendor*	Repair/ Declare redundancy	Inspect the ICT equipment for issues, and if it is non-repairable able, declare the equipment redundant.
3	*IT Technicians*	Maintenance Inspector	Carry out inspections of ICT equipment that has potentially become redundant. Decide if any equipment needs component replacement or it has become totally non-useable. Follow the procedure for the replacement and storage of condemned items.

Procedure

ICT equipment that is no longer repairable either by the IT department of the office or by the ICT vendor/repairer shall be declared as a "Condemned item".

- For declaration, a final inspection by the ICT administrator shall be carried out.
- If the equipment is no longer repairable or reusable, the ICT equipment shall be declared as a "condemned item" by the ICT Administrator.
- *IT technicians* shall test the parts that could be reused from the damaged equipment and could be applied to fix other broken gadgets.
- The condemned items that are no longer usable will be classified as e-waste.

- The condemned item shall be replaced by a new one on an immediate basis after the declaration.
- The inventory of the new ICT equipment shall be updated as per the requirement in Forms 1, 2 or 3.
- Arrangements for the storage of condemned items are to be made by the *IT support staff* in coordination with the *manager* of the storage room.
- Details of e-waste generated by the department/office and further handling shall be filled in Form 5.

Form 5: Form for Maintaining e-waste Generation & Handling Record

FORM FOR MAINTAINING E-WASTE RECORD	
E-waste generator/handler Name and Address:	
Date of EPD NOC/Approval issuance & Expiry: Approval Date**:** Expiry Date**:**	**EPD NOC approval no./Registration no**.
Category & Quantity of E-waste generated or handled:	
Category	Quantity
Description of e-waste handling methodology:	
Description of E-waste items:	

SOP-04: Interdepartmental Transportation of Condemned ICT Equipment (e-waste)

Purpose

The purpose of this SOP is to define procedures for interdepartmental transportation of Condemned Information and Communication Technology equipment present in _____ office. (The SOP is applicable to PRIDE partners that have multiple branches/sub-departments across the city/province)

Scope

This procedure is applicable to each office/department/sub-department of _____ office.

Reference

Basel Convention; Punjab Environmental Protection Act 1997 (amended 2012); Punjab Hazardous Substance Rule, 2018; The Punjab Occupational Safety and Health Act, 2019

Assigned Roles & Responsibilities

	Designation	Assigned Role	Assigned Responsibility
1	*Store Manager (Main Branch)*	*Transport Head*	Ensure the transportation process is carried out following the necessary protocols. Ensure proper storage of transported e-waste in the designated storage area.
2	*Store Supervisors*	Transportation supervisors	Carry out necessary communication between the sub-departments/branches for the transport of e-waste. Organize adequate transportation vehicles for transportation.
3	*Store staff*	*Assist Transportation*	Assist in carrying out e-waste to/from transport vehicles.

Procedure

- ICT equipment that has been declared as a “condemned item” and thus has become e-waste in sub-departments of the _____ office/department shall be transported to the main branch of the department before the auction.
- The departments shall coordinate an adequate transportation plan prior to the transport.
- The selected vehicle shall be covered and impermeable in order to avoid any hazard.
- The selected vehicle shall be equipped with a first aid kit placed in the front, and a spill kit shall be available for any spill/leakage of hazardous substances.
- The transport vehicle selected shall be used only up to 80% of its capacity.
- Category ‘C’ ICT equipment shall be transported in specific containers consisting of plastic.

- Any e-waste item having a risk of leakage or explosion, such as batteries, shall be transported with extreme caution.
- Batteries and any such e-waste item consisting of terminals shall be transported in plastic or cardboard boxes.
- The batteries, such as laptop batteries without recessed terminals and mobile phone batteries, shall be wrapped up with electrical tapes to avoid electrical conductivity in case of contact with other charged equipment.
- If the battery has recessed terminals, they can simply be packed with clear tape or a wrapping sheet depending upon the size of the batteries.
- Record regarding e-waste transported for storage shall be maintained in Form 5.
- In case transport is outsourced, a selected member of the relevant office department shall accompany the e-waste transporter to ensure safe transport to the *main branch*.

Form 6: Transportation Request form for e-waste

Form No.	**Request Form for Interdepartmental Transportation of e-waste**	**Organization Name:**
E-waste origin office/department:	Requestor's Name & Designation:	Date of transportation of e-waste:

Details of transported e-waste:

ICT Equipment	**Quantity**	**Material Code No.**	**Designated storage section/room no.**	**ICT Equipment**	**Quantity**	**Material Code No.**	**Designated storage section/room no.**

Further Details, if any:	Date & Time of receiving:	Receiver's Signature & Remarks:

To be used only by *Store Manager*

Storage area section/ room no.:	Information about storage method (if specific):	
	Final Remarks:	*Store Manager's* Signature & data of receiving:

SOP-05: Storage of Condemned ICT equipment

Purpose

The purpose of this SOP is to define procedures for the storage of Condemned Information and Communication Technology equipment present in _____ office.

Scope

This procedure is applicable to each office/department/sub-department of _____ Office.

Reference

Basel Convention; Punjab Environmental Protection Act 1997 (amended 2012); Punjab Hazardous Substance Rule, 2018; The Punjab Occupational Safety and Health Act, 2019

Assigned Roles & Responsibilities

	Designation	Assigned Role	Assigned Responsibility
1	*Store Manager*	*ICT equipment Storage Manager*	Designate storage areas for redundant ICT equipment. Inspect the storage area on a weekly basis.
2	*Store Supervisor*	Supervision of storage procedure	Supervise the storage procedures followed by the *store staff.* Inspect the storage area on a daily basis.
3	*Store staff*	Store ICT equipment as per procedures described in SOPs	Assist IT Department in the transfer of condemned items to the storage area. Follow protocols of equipment storage as per SOPs. Maintain and inspect storage area on a daily basis.

Procedure

- Segregate e-waste as per defined categories.
- Before storage of condemned items, it shall be made sure that the data storage devices have been formatted and all data has been erased.
- Each category of e-waste is to be stored in a specific designated *area/room.*
- The storage area shall be far from any heat-generating area or a fire hazard such as kitchens, smoking areas etc.
- The area shall be accessible to authorized personnel only.
- Baseline knowledge and understanding of e-waste handling and storage are to be given to the store staff.
- Category ‘C’ e-waste is to be stored in separate boxes for each component, e.g., RAM, Hard drives, Wires, Power Cables, Batteries and any other such component.

- Wooden, plastic or cardboard boxes/compartments to be used for storage of Category 'C' ICT equipment. Metal compartments for storage of Category 'C' ICT equipment shall be avoided.
- Any reusable item that has to be stored before usage shall be stored separately in boxes separate from condemned items.
- It is the responsibility of the store management to ensure that the stored items are not damaged due to haphazard placements.
- First aid training is to be given to all employees or a significant proportion.
- Any item that has any suspicion of leakage or explosion, such as batteries, shall not be stored but rather disposed of with the help of an ICT refurbisher, Kabaria, dismantler or recycler.

The storage area must adhere to the following rules for a safe and accident-free storage period of e-waste.

- The storage area must be a covered area with more than one entrance to ensure escape in case of any emergency.
- The areas shall be kept free of any fire hazard, such as malfunctioning electronics or circuit boards.
- Any uninsulated or barbed wiring shall be immediately removed from the storage area.
- The storage area shall be free of short-circuiting risks.
- The storage area must be well-ventilated.
- Proper signage to indicate storage area storing flammable material.
- Highly flammable materials will be kept in an area separate from oxidizing agents (material susceptible to spontaneous heating, explosives etc.).
- The storage area for flammables will be supplied with firefighting equipment, either automatic or manual. There will be "flammable material" signs posted in and around the storage area.
- Oxidizers will not be stored close to liquids of low flash points.
- Acids and acid fume-sensitive materials will be stored in a cool, dry, well-ventilated area, preferably wooden.
- Materials which are toxic as stored or which can decompose into toxic components from contact with heat, moisture, acids or acid fumes will be stored in a cool, well-ventilated place out of the direct rays of the sun. Incompatible toxic materials will be isolated from each other.
- Corrosive materials will be stored in a cool, well-ventilated area (above their freeze point). The containers will be inspected at regular intervals to ensure they are labelled and kept closed. Corrosives will be isolated from other materials.
- The storage area shall have a fire and emergency response system, such as fire extinguishers.
- In case of spills of hazardous waste from the store equipment, dry sand shall be present at the site.
- Request for declaration and storage of condemned items shall be made as per Form 7.

Form 7: Storage Request form for ICT equipment

<table>
<tr><th>Form No.</th><th colspan="2">Request Form for Storage of ICT Equipment</th><th>Organization Name</th></tr>
<tr><td>Maintenance Form No.</td><td colspan="2">Requestor’s Name & Designation:</td><td>Date of Declaration of Condemned Item:</td></tr>
<tr><td colspan="2">Further details, if any:</td><td colspan="2">Category and material code no. of condemned item:</td></tr>
<tr><td colspan="2">Details of reusable components, if any:</td><td>Date:</td><td>Additional Remarks:</td></tr>
<tr><td colspan="4">To be used only by Store Manager</td></tr>
<tr><td>Storeroom no.</td><td colspan="3">Information about storage method:</td></tr>
<tr><td>Equipment dismantled (for taking out reusable components)</td><td colspan="2" rowspan="3">Final Remarks</td><td rowspan="3">Store Manager’s Signature:</td></tr>
<tr><td>Yes ☐</td></tr>
<tr><td>No ☐</td></tr>
</table>

SOP-06: Departmental Auction of E-waste

Purpose

The purpose of this SOP is to define procedures for the Auctions of the stored Information and Communication Technology e-waste present in _____ office.

Scope

This procedure is applicable to _____ PRIDE partner organizations.

Reference

Basel Convention; Punjab Environmental Protection Act 1997 (amended 2012); Punjab Hazardous Substance Rule, 2018; The Punjab Occupational Safety and Health Act, 2019

Assigned Roles & Responsibilities

	Designation	Assigned Role	Assigned Responsibility
1	*Auction Committee*	Conduct & Execute the Auction process, Decide the winning bid	Execute the auction process timely and decide the winning bid Carry out necessary steps to complete the process as per the department's protocols
2	*Administrative Head of Department*	Administrate auction process	Administrate the auction process Prepare tender documents Coordinate with store manager & obtain listings of e-waste
3	*E-waste store manager*	Listing of e-waste equipment to be auctioned	Collect and share data on each category of e-waste present in the storage room. List all the available e-waste items to be auctioned by the department.
4	*IT Incharge*	Update Inventory of the discarded ICT equipment	Collect data regarding ICT equipment disposed of in the relevant office/department and update the existing inventory after the auction.

Procedure

- The auction process shall be carried out as per the respective department's auction procedures.
- The auction process shall be carried out on a yearly basis.
- The auction shall be carried out two months prior to the closing of the financial year.
- Only bidders complying with environmental and health regulations set by the Government of Punjab shall be allowed to participate in the auction.
- The auctioneers shall comply with Pakistan Environmental Protection Act 1997, Punjab Environmental Protection Act 1997, and Punjab Hazardous Substance Rule 2018 for e-waste handling due to the presence of hazardous substances.

- Auction documents shall come with a BOQ (Bill of Quantity) of the available e-waste being auctioned and TORs to be complied with by the bidders for e-waste handling.
- Before the commencement of the auction process, a meeting with local registered e-waste handlers, e-g, refurbishers, kabarias and dismantlers shall be held to fix a minimum price for each ICT equipment depending on its refurbishing and recycling capacity.
- E-waste management and handling capacity, technique and compliance with local e-waste handling laws shall be taken into account before deciding the bid winner.
- The transport of the auctioned material to the winner's location shall be carried out as per the following guidelines:
  - The relevant department shall make sure an adequate transportation vehicle has been selected for transportation for off-site transport.
  - In order to avoid any hazard, covered and impermeable vehicles shall be selected.
  - The transport vehicle selected shall be used only up to 80% of its capacity.
  - The selected vehicle shall be equipped with a first aid kit placed in the front, and a spill kit shall be available for any spill/leakage of hazardous substances.
  - Category 'C' ICT equipment shall be transported in specific containers consisting of wood or plastic.
  - Any e-waste item having a risk of leakage or explosion, such as batteries, shall be transported with extreme caution.
  - Batteries and any such e-waste item consisting of terminals shall be transported in plastic or cardboard boxes.
  - The batteries, such as laptop batteries without recessed terminals and mobile phone batteries, shall be wrapped up with electrical tapes to avoid electrical conductivity in case of contact with other charged equipment.
  - If the battery has recessed terminals, they can simply be packed with clear tape or a wrapping sheet depending upon the size of the batteries.
  - Record regarding e-waste transported for storage shall be maintained in Form 1 as well as the department's auction forms already in use for auctions.

SOP-07: SOPS for E-waste Refurbishers

Purpose

The purpose of this SOP is to define guidelines to be followed by e-waste refurbishers while carrying out the refurbishment/repair work on e-waste.

Scope

These are general guidelines for e-waste refurbishers operating in Punjab & specifically applicable to ones dealing with the e-waste of PRIDE partners.

Reference

Basel Convention; Punjab Environmental Protection Act 1997 (amended 2012); Punjab Hazardous Substance Rule, 2018; The Punjab Occupational Safety and Health Act, 2019

Procedure

- E-waste refurbishers shall make sure to get registered with Environmental Protection Department, Punjab.
- The refurbisher shall make sure any leaking equipment is not stored at his workplace, including the workshop & storage area.
- When a defective product is obtained from the customer, the type of complaint shall be evaluated.
- An estimate of charges for the repair service shall be disseminated to the concerned department.
- Rectification of malfunctioning ICT equipment shall be done by a skilled technician.
- Provision of adequate PPEs to be ensured during repair work.
- Baseline knowledge and understanding of preferred practices and work methods to be imparted to the employees.
- Check the equipment for 24 to 48 hours for confirmation of fault removal.
- The equipment shall be sent back/taken back to the office after repair.
- Receipt of the repair done, a replacement made, and service charges shall be provided.
- Components in the ICT equipment replaced shall be of good quality.
- Any component replaced shall be sent back/purchased as per the agreed terms.
- In case of procurement of ICT equipment in auction, the refurbisher shall make sure to reuse 100% of reusable components.
- Any non-usable component shall be sold to a registered/certified kabaria/recycler.
- The transport of the e-waste by the refurbisher (if his responsibility) shall be carried out as per the following guidelines:
  - The relevant department shall make sure an adequate transportation vehicle has been selected for transportation for off-site transport.
  - In order to avoid any hazard, covered and impermeable vehicles shall be selected.
  - The transport vehicle selected shall be used only up to 80% of its capacity.

- ▷ The selected vehicle shall be equipped with a first aid kit placed in the front, and a spill kit shall be available for any spill/leakage of hazardous substances.
- ▷ Category 'C' ICT equipment shall be transported in specific containers consisting of wood or plastic.
- ▷ Any e-waste item having a risk of leakage or explosion, such as batteries, shall be transported with extreme caution.
- ▷ Batteries and any such e-waste item consisting of terminals shall be transported in plastic or cardboard boxes.

► The e-waste storage area must adhere to the following rules for a safe and accident-free storage period of e-waste.

- ▷ The storage area must be a covered area with more than one entrance to ensure escape in case of any emergency.
- ▷ The areas shall be kept free of any fire hazard, such as malfunctioning electronics or circuit boards.
- ▷ Any uninsulated or barbed wiring shall be immediately removed from the storage area.
- ▷ The storage area shall be free of short-circuiting risks.
- ▷ Highly flammable materials will be kept in an area separate from oxidizing agents (material susceptible to spontaneous heating, explosives etc.).
- ▷ The storage area for flammables will be supplied with firefighting equipment, either automatic or manual. There will be "flammable material" signs posted in and around the storage area.
- ▷ Oxidizers will not be stored close to liquids of low flash points.
- ▷ Acids and acid fume-sensitive materials will be stored in a cool, dry, well-ventilated area, preferably wooden.
- ▷ Materials which are toxic as stored or which can decompose into toxic components from contact with heat, moisture, acids or acid fumes will be stored in a cool, well-ventilated place out of the direct rays of the sun. Incompatible toxic materials will be isolated from each other.
- ▷ Corrosive materials will be stored in a cool, well-ventilated area (above their freeze point). The containers will be inspected at regular intervals to ensure they are labelled and kept closed. Corrosives will be isolated from other materials.
- ▷ The storage area shall have a fire and emergency response system, such as fire extinguishers.
- ▷ The storage area must be well-ventilated.
- ▷ Proper signage to indicate storage area storing flammable material.
- ▷ In case of spills of hazardous waste from the store equipment, dry sand shall be present at the site.

SOP-08: SOPS E-waste Kabarias (Waste Collectors)

Purpose

The purpose of this SOP is to define guidelines to be followed by e-waste kabarias (collectors) while carrying out e-waste collection.

Scope

These are general guidelines for e-waste Kabarias operating in Punjab.

Reference

Basel Convention; Punjab Environmental Protection Act 1997 (amended 2012); Punjab Hazardous Substance Rule, 2018; The Punjab Occupational Safety and Health Act, 2019

Procedure

- E-waste Kabaria shall make sure to get registered with Environmental Protection Department, Punjab.
- The Kabaria shall make sure any leaking equipment is not stored at his workplace, including the workshop & storage area.
- E-waste procured to be collected & transported as per general health and safety rules.
- Provision of adequate PPEs to be ensured during the handling of the collected e-waste.
- Components containing hazardous substances are to be stored under optimum conditions not exceeding 50°C.
- E-waste shall not be stored with any flammable material, such as gasoline.
- Segregation/dismantling of e-waste is to be carried out using suitable tools and methods as per international practices.
- Baseline knowledge and understanding of preferred practices and work methods to be imparted to the employees.
- The transport of the e-waste by the Kabaria (if his responsibility) shall be carried out as per the following guidelines:
  - In order to avoid any hazard, covered and impermeable vehicles shall be selected.
  - The transport vehicle selected shall be used only up to 80% of its capacity.
  - The selected vehicle shall be equipped with a first aid kit placed in the front, and a spill kit shall be available for any spill/leakage of hazardous substances.
  - Category ‘C’ ICT equipment shall be transported in specific containers consisting of wood or plastic.
  - Any e-waste item having a risk of leakage or explosion, such as batteries, shall be transported with extreme caution.
  - Batteries and any such e-waste item consisting of terminals shall be transported in plastic or cardboard boxes.
- The e-waste storage area must adhere to the following rules for a safe and accident-free storage period of e-waste.

- The storage area must be a covered area with more than one entrance to ensure escape in case of any emergency.
- Any uninsulated or barbed wiring shall be immediately removed from the storage area.
- The storage area shall be free of short-circuiting risks.
- The storage area must be well-ventilated.
- Proper signage to indicate storage area storing flammable material.
- The areas shall be kept free of any fire hazard, such as malfunctioning electronics or circuit boards.
- Highly flammable materials will be kept in an area separate from oxidizing agents (material susceptible to spontaneous heating, explosives etc.).
- The storage area for flammables will be supplied with firefighting equipment, either automatic or manual. There will be "flammable material" signs posted in and around the storage area.
- Oxidizers will not be stored close to liquids of low flash points.
- Acids and acid fume-sensitive materials will be stored in a cool, dry, well-ventilated area, preferably wooden.
- Materials which are toxic as stored or which can decompose into toxic components from contact with heat, moisture, acids or acid fumes will be stored in a cool, well-ventilated place out of the direct rays of the sun. Incompatible toxic materials will be isolated from each other.
- Corrosive materials will be stored in a cool, well-ventilated area (above their freeze point). The containers will be inspected at regular intervals to ensure they are labelled and kept closed. Corrosives will be isolated from other materials.
- The storage area shall have a fire and emergency response system, such as fire extinguishers.
- In case of spills of hazardous waste from the store equipment, dry sand shall be present at the site.

SOP-09: SOPs for E-waste Dismantlers

Purpose

The purpose of this SOP is to define guidelines to be followed by e-waste dismantlers while dismantling e-waste components in the jurisdiction of Punjab.

Scope

These are general guidelines for e-waste refurbishers operating in Punjab & specifically applicable to ones dealing with the e-waste of PRIDE partners.

Reference

Basel Convention; Punjab Environmental Protection Act 1997 (amended 2012); Punjab Hazardous Substance Rule, 2018; The Punjab Occupational Safety and Health Act, 2019

Procedure

- Dismantler shall make sure to get registered with Environmental Protection Department Punjab.
- E-waste procured to be dismantled as per general health and safety rules.
- Provision of adequate PPEs to be ensured during the dismantling of the ICT equipment.
- Components containing hazardous substances are to be dismantled with extreme caution. Any type of external force, such as hammering, crushing etc., is to be avoided to prevent leakage and explosion hazards.
- Dismantled e-waste components shall be segregated from other types of waste.
- Reusable and recyclable components shall be sold to a registered/certified refurbisher/recycler.
- Non-usable and non-hazardous ICT equipment, such as plastic body to be sold off to kabarias/recyclers or disposed of in a waste management company's designated disposal site.
- Suitable tools and methods as per international practices shall be utilized for dismantling e-waste.
- Baseline knowledge and understanding of preferred practices and work methods to be imparted to the employees.
- Emergency services such as 1122 are to be contacted in case of emergency/ accident.
- Clear directions regarding emergency procedures, evacuation plans & contact numbers are to be displayed in the vicinity of the workplace.
- The transport of the e-waste by the Dismantler (if his responsibility) shall be carried out as per the following guidelines:
  - In order to avoid any hazard, covered and impermeable vehicles shall be selected.
  - The transport vehicle selected shall be used only up to 80% of its capacity.
  - The selected vehicle shall be equipped with a first aid kit placed in the front, and a spill kit shall be available for any spill/leakage of hazardous substances.

- ▷ Category 'C' ICT equipment shall be transported in specific containers consisting of wood or plastic.
- ▷ Any e-waste item having a risk of leakage or explosion, such as batteries, shall be transported with extreme caution.
- ▷ Batteries and any such e-waste item consisting of terminals shall be transported in plastic or cardboard boxes.

► The e-waste storage area must adhere to the following rules for a safe and accident-free storage period of e-waste.

- ▷ The storage area must be a covered area with more than one entrance to ensure escape in case of any emergency.
- ▷ The storage area must be well-ventilated.
- ▷ Proper signage to indicate storage area storing flammable material.
- ▷ The areas shall be kept free of any fire hazard, such as malfunctioning electronics or circuit boards.
- ▷ Any uninsulated or barbed wiring shall be immediately removed from the storage area.
- ▷ The storage area shall be free of short-circuiting risks.
- ▷ Highly flammable materials will be kept in an area separate from oxidizing agents (material susceptible to spontaneous heating, explosives etc.).
- ▷ The storage area for flammables will be supplied with firefighting equipment, either automatic or manual. There will be "flammable material" signs posted in and around the storage area.
- ▷ Oxidizers will not be stored close to liquids of low flash points.
- ▷ Acids and acid fume-sensitive materials will be stored in a cool, dry, well-ventilated area, preferably wooden.
- ▷ Materials which are toxic as stored or which can decompose into toxic components from contact with heat, moisture, acids or acid fumes will be stored in a cool, well-ventilated place out of the direct rays of the sun. Incompatible toxic materials will be isolated from each other.
- ▷ Corrosive materials will be stored in a cool, well-ventilated area (above their freeze point). The containers will be inspected at regular intervals to ensure they are labelled and kept closed. Corrosives will be isolated from other materials.
- ▷ The storage area shall have a fire and emergency response system, such as fire extinguishers.
- ▷ In case of spills of hazardous waste from the store equipment, dry sand shall be present at the site.

SOP-10: SOPs for E-waste Recyclers

Purpose

The purpose of this SOP is to define guidelines to be followed by e-waste recyclers operating in the jurisdiction of Punjab.

Scope

These are general guidelines for e-waste recyclers operating in Punjab & specifically applicable to ones dealing with the e-waste of PRIDE partners.

Reference

Basel Convention; Pakistan Environmental Protection Act 1997; Punjab Environmental Protection Act 1997; Punjab Hazardous Substance Rule, 2018; The Punjab Occupational Safety and Health Act, 2019

Procedure

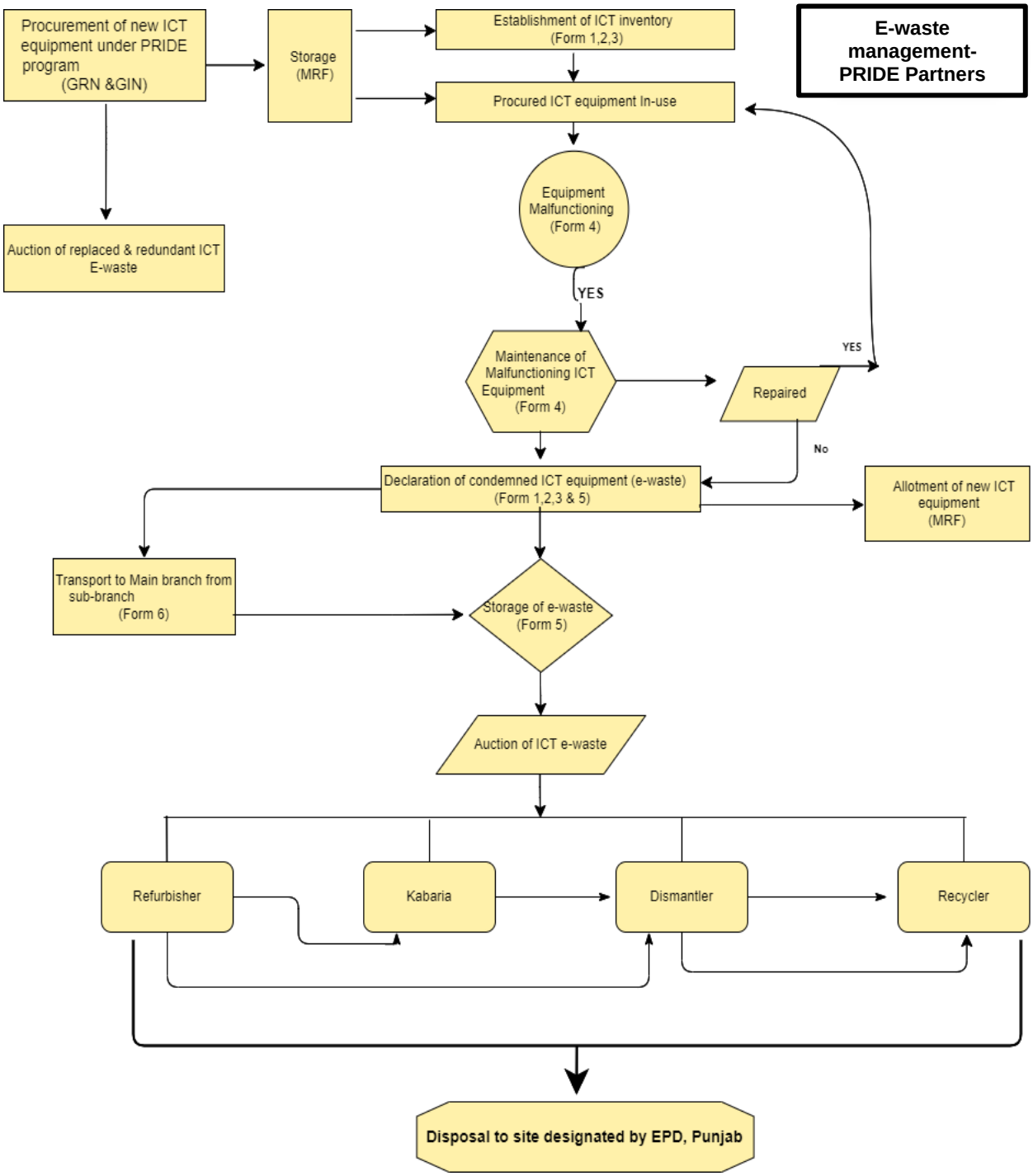
- The recycler shall make sure to obtain registration/certification from Environmental Protection Department, Punjab, before commencing operations.
- Methods and procedures for recycling are to be clearly disseminated to concerned regulatory authorities.
- E-waste recycling facility shall be equipped with pollution control devices such as scrubbers and filters.
- A health and safety officer shall be appointed who supervises the facility during working hours.
- The workers shall be given induction training, first aid training, emergency response training, firefighting training and any other relevant training as declared necessary by the regulatory authority or the health and safety officer.
- Baseline knowledge and understanding of preferred practices and work methods to be imparted to the employees.
- An emergency response plan highlighting emergency exits to be prepared and displayed in suitable locations.
- Air & water quality monitoring devices shall be installed and regularly monitored.
- E-waste procured to be recycled as per ‘Hazardous Waste Management Rules, 2018’ and general health and safety rules.
- Provision of adequate PPEs such as eye, hand and foot protecting PPE to be ensured for workers working in the vicinity of the e-waste recycling unit.
- Child labour, particularly in the vicinity of the recycling plants, shall be strictly prohibited.
- Components containing hazardous substances are to be recycled with extreme caution.
- No crude method of recycling shall be encouraged/used during the whole recycling process.
- Emergency services such as 1122 are to be contacted in case of emergency/ accident.

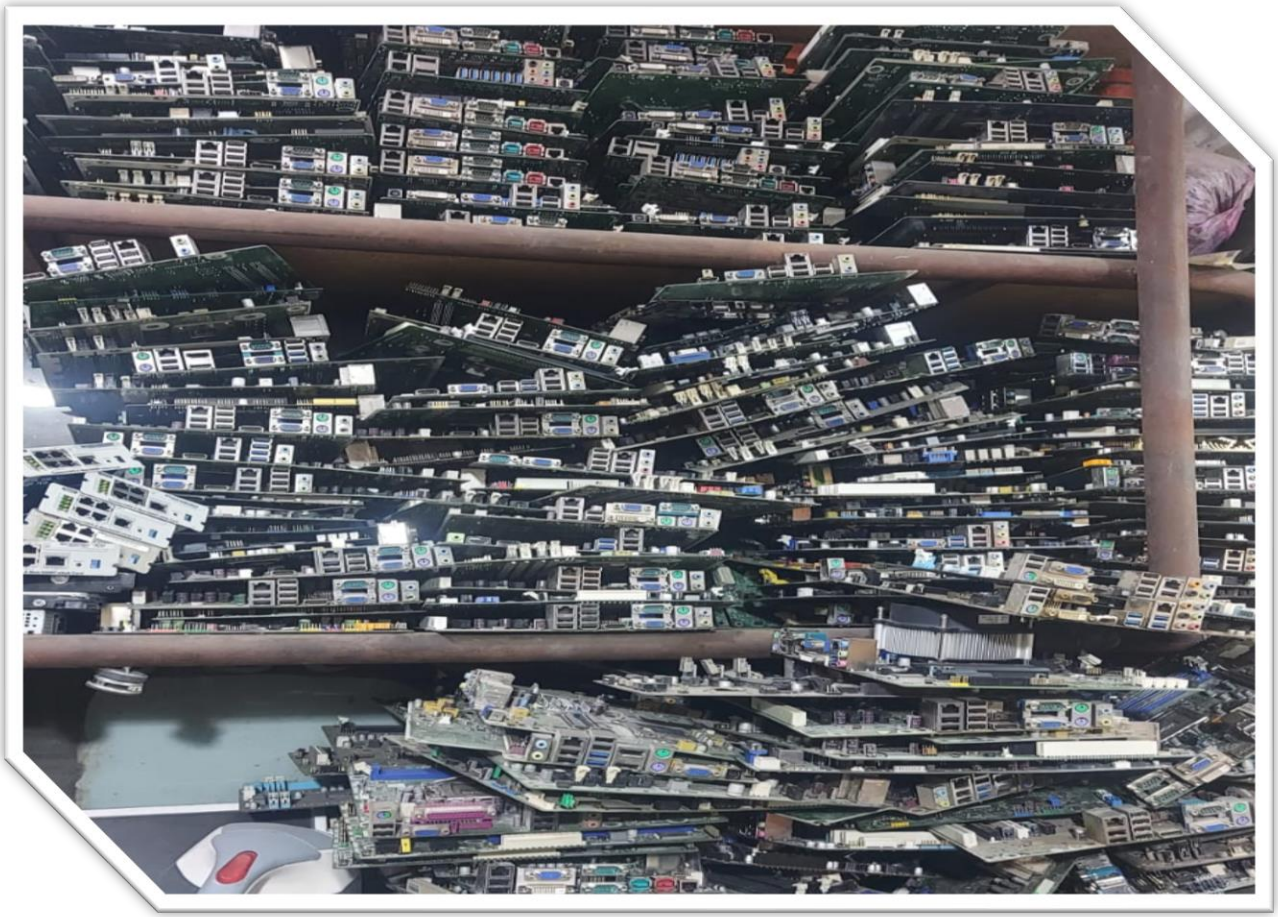
- Clear directions regarding emergency procedures, evacuation plans & contact numbers are to be displayed in the vicinity of the workplace.
- In case of any accident e-g, injuries, fatalities, leakages or explosion, emergency departments and the district environmental office should be immediately contacted.
- The transport of the e-waste by the Recyclers (if his responsibility) shall be carried out as per the following guidelines:
  - In order to avoid any hazard, covered and impermeable vehicles shall be selected.
  - The transport vehicle selected shall be used only up to 80% of its capacity.
  - The selected vehicle shall be equipped with a first aid kit placed in the front, and a spill kit shall be available for any spill/leakage of hazardous substances.
  - Any e-waste item having a risk of leakage or explosion, such as batteries, shall be transported with extreme caution.
  - Batteries and any such e-waste item consisting of terminals shall be transported in plastic or cardboard boxes.
- The e-waste storage area must adhere to the following rules for a safe and accident-free storage period of e-waste.
  - The storage area must be a covered area with more than one entrance to ensure escape in case of any emergency.
  - The areas shall be kept free of any fire hazard, such as malfunctioning electronics or circuit boards.
  - The storage area must be well-ventilated.
  - Any uninsulated or barbed wiring shall be immediately removed from the storage area.
  - The storage area must be free of short-circuiting risks.
  - Proper signage to indicate storage area storing flammable material.
  - Highly flammable materials will be kept in an area separate from oxidizing agents (material susceptible to spontaneous heating, explosives etc.).
  - The storage area for flammables will be supplied with firefighting equipment, either automatic or manual. There will be "flammable material" signs posted in and around the storage area.
  - Oxidizers will not be stored close to liquids of low flash points.
  - Acids and acid fume-sensitive materials will be stored in a cool, dry, well-ventilated area, preferably wooden.
  - Materials which are toxic as stored or which can decompose into toxic components from contact with heat, moisture, acids or acid fumes will be stored in a cool, well-ventilated place out of the direct rays of the sun. Incompatible toxic materials will be isolated from each other.
  - Corrosive materials will be stored in a cool, well-ventilated area (above their freeze point). The containers will be inspected at regular intervals to ensure they are labelled and kept closed. Corrosives will be isolated from other materials.

- ▷ The storage area shall have a fire and emergency response system, such as fire extinguishers.
- ▷ In case of spills of hazardous waste from the store equipment, dry sand shall be present at the site.

Process Flow Chart

Strategic Plan for E-waste Management in PRIDE Partner Organizations





Section-3

7 Conclusions and Strategic Action Plan

7.1 Conclusions

- E-waste in Punjab is not generally found in municipal waste; rather, it is mostly collected by scavengers engaged by Kabarias or through auctions conducted by public and private sector organisations.
- The average useful lifespan of ICT equipment depends upon its usage; for example, a laptop can have an economic life of four years, depending on the frequency of its usage.
- The average time of storage of ICT equipment before auctioning in public sector organizations is three years.
- No formal recycling facility is currently operating in Punjab, and all E-waste in Punjab is informally recycled.
- The e-waste comprising of used ICT equipment from developed countries and is mainly handled by the informal sector, i.e., Refurbisher, dismantler and recycler. The processing of metal is carried out by the production of ingots which are exported to China for the extraction of precious metals.
- The dismantling and extraction of metals from e-waste are done by crude methods resulting in efficiency in the recovery of precious metals and a large quantity of waste. Moreover, there is no compliance with Occupational Health and Safety protocols by the informal sector resulting in environmental degradation and risks to workers' health.
- There are no SOPs for E-waste collection, handling, transportation, recycling, or disposal in Punjab.

7.2 Strategic Action Plan

Develop Standard Operating Procedures (SOPs): The objectives of the SOPs on E-waste Management are to establish: the guidelines under SOPs shall enable the recovery and/or reuse of useful material from E-waste, thereby reducing the hazardous wastes destined for disposal; to ensure that recycling is carried e environmental sound management of all types of ICT E-waste, and address the safe and eco-friendly handling, transporting, storing, and recycling of E-waste.

The SOPs will create awareness of E-waste collection methodologies, provide training and disseminate information on E-waste collection and disposal; to ensure proper disposal of E-waste generated from damaged ICT equipment's parts, electronic parts, plastics, printed circuit boards, motherboards, cables etc.; to maintain a pollution and hazard-free environment.

Establish E-Waste Management Unit at Environmental Protection Department, Government of Punjab: There is a need to establish an E-Waste Management Unit at the Environmental Protection Department, Government of Punjab, with consultation with PRIDE Partner Organizations and relevant stakeholders. The roles and responsibilities of the E-waste Management Unit will be developed.

Establish an Inventory of ICT equipment: Every PRIDE partner shall make an inventory of the existing ICT equipment and the anticipated timing and quantities of E-waste generation. This ICT inventory will assist in making informed decisions for the new procurement of ICT equipment under the PRIDE Program. In some cases, during the implementation of the project, the existing or new ICT equipment would become part of the E-waste, ensuring that the inventory is updated periodically to incorporate any changes with respect to allocation, movement, auction etc.

This type of E-waste shall also be included in the inventory with the remarks “non-useable” or “redundant.” This inventory shall be useful in identifying the quantum of the E-waste collected or when to be disposed of.

Storage of the E-waste: All the discarded ICTs or the E-waste shall be stored or handed over to the administration department. The administration department shall receive the E-waste, record it in its E-waste inventory, and place it in the specified storage facilities based on E-waste volume and recycling purposes.

Registration of the E-waste stakeholders: The stakeholders involved are producers, importers, collectors, refurbishers, dismantlers, and recyclers for final disposal need to be registered.

Visit of the Licensed E-waste Recycling Facility: After the EPD acts on E-waste management and certifies the E-waste recyclers, the E-waste Management Unit’s designated staff shall visit the certified collection, dismantling, and recycling facilities to sure that the facilities are complying with the EPD’s SOPs on e-waste management. After the visit, E-waste Management Unit designated staff should record whether the recycling facility does comply with the SOP or not. If not, then a penalty shall be imposed as per the existing Environmental Protection Act, 1997, amended in 2017.

Continuous Liaison with the E-waste Management Unit at EPD: The PRIDE Partners and other government departments shall not hand over E-waste to any recycler or the scrap collector because of the risks that the E-waste may be handled improperly in the absence of a licensed recycler/facility in the Punjab province.

SOPs for Collectors, Transporters, Dismantlers and Recyclers:

Collectors: The SOPs for the collector shall be simply related to the safe storage of the E-waste. The workers should be equipped with proper PPEs while handling the waste. The segregation of E-waste should be according to its usage and components.

Transporters: The transport of E-waste should be safe so that it cannot break/damage the E-waste to avoid the release of hazardous material. The surface of the transport vehicle should be impervious and equipped with containment arrangements and spill kits to manage releases in case of an accident.

Dismantlers: The SOPs for the dismantlers should mainly focus on manually dismantling different parts of the E-waste without using any chemicals or burning process. The labour involved in the dismantling should be equipped with proper PPEs while handling the waste. Decontamination/ Dismantling is done manually. It includes the following steps:

- Removal of parts containing hazardous/dangerous substances
- Removal of easily accessible parts containing valuable substances (cable containing copper, steel, iron, precious metal-containing parts, e.g., contacts)
- Segregation of hazardous/dangerous substances and removal of easily accessible parts

Recyclers: The guidelines for the recyclers shall be specific for the type and nature of the recycling process to be adopted by the recyclers. However, whatever process is adopted, it should be safe for the environment, workers, and community health.

The major E-waste recycling technique is disassembly or repair followed by shredding of different fractions. E-waste fractions emitted after shredding go for metal recovery. The remaining E-waste fractions are disposed of in landfills. Following unit operations are involved at recycling facilities:

Segregation of ferrous metal, non-ferrous metal, and plastic: This separation is generally carried out after shredding and followed by a mechanical and magnetic separation process.

Recycling/recovering valuable materials: E-waste fractions of ferrous and non-ferrous metals after segregation are further treated. Ferrous metals are smelted in electric arc furnaces, and non-ferrous metals and precious metals are smelted in smelting plants.

Treatment/disposal of dangerous materials and waste: Shredder light fraction is disposed of in the landfill site. CFCs are treated thermally, Poly Chlorinated Biphenyl (PCB) is disposed of in underground storages, and Mercury (Hg) is often recycled or disposed of in underground landfill sites.

Health Hazards of E-waste Management: E-waste contains toxic components that are dangerous to human health, such as mercury, lead, cadmium, polybrominated flame retardants, barium, and lithium. The negative health effects of these toxins on humans include brain, heart, liver, kidney, and skeletal system damage. E-waste is a health hazard, and proper disposal techniques shall be introduced.

The informal sector of E-waste recycling shall be upgraded to include new technologies.

- E-waste in public sector organizations shall be properly managed.
- Auctions shall be held on a frequent basis to reduce E-waste storage over longer periods.
- E-waste recycling facilities shall be introduced and encouraged to carry out the entire recycling process of E-waste within Punjab.

After the acceptance of the draft report, SOPs will be developed that will enable waste generators, collectors, transporters, dismantlers, and recyclers to carry out E-waste management in a safe and sustainable manner.

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Section-4

Annexure-A: Names and Details of the Consulted Stakeholders

S. No	Name	Position	Company
1.	Mr. Shahid Latif	Deputy Secretary	Local Government & Community Development (LG&CD)
2.	Mr. Ihsan Gujjar	Section Officer	Planning & Development Board (P&DB)
3.	Mr. Saleem	System Analyst	Excise & Taxation & Narcotics Department (ET&NCD)
4.	Mr. Asad Khalid	Head of Resource & Administration	Public Finance Management Unit (PFMU), Finance Department
5.	Mr. Kamran Khan	Section Officer	Public Finance Management Unit (PFMU), Finance Department
6.	Ms. Maryam Daud	Data Administrator	Punjab Procurement Regularity Authority (PPRA)
7.	Mr. Ashfaq Tiwana	Senior Program Manager	Punjab Information Technology Board (PITB)
8.	Mr. Kamran Khan	Section Officer	Finance Department (FD)
9.	Mr. Shabaz	Assistant	Finance Department (FD)
10.	Mr. Shehzad Hussain	Assistant S. General	Board of Revenue (BOR)
11.	Mr. Khalid Rasool	Caretaker	Board of Revenue (BOR)
12.	Ms Farzana Altaf Shah	Director General	PAK-EPA, H-8, Islamabad
13.	Miss Nadia Saqib	Director General	EPD, Near Qaddafi Stadium, Lahore
14.	Naeem Shahzad	Assistant Manager (HR)	Attock Refinery Limited, Rawalpindi
15.	Mr Zulfiqar Ali	EHS Officer	Nestle Pakistan
16.	Mr. Mohammad Irshad Ramay	Coordinator	National Cleaner Production Center
17.	Mr Mustafa Sajid Trimzi	Manager IT	Information Technology University
18.	Mr. Saqib Anwar	Manager IT	Information Technology University
19.	Mr Awais Fayyaz	System Administrator	Information Technology University
20.	Miss. Sofia Khalid	Lecturer	Allama Iqbal Open University

S. No	Name	Position	Company
21.	Dr Atif Ishaq	Lecturer, Computer Department	Government College University, Lahore
22.	Dr Yasir Gill	Assistant Professor, Department of Polymer and Process Engineering	University of Engineering and Technology, Lahore
23.	Mr. M. Aftab	Project Engineer	Lahore Waste Management Company
24.	Mr. Ali Niazi	Project Engineer	Lahore Waste Management Company
25.	Amir Mushtaq	Senior Manager Operation	Gujranwala Waste Management Company
26.	Mr. Shakeel Ahmed	Managing Director	Multan Waste Management Company
27.	Muhammad Asif Shabbir	P&C Manager	Multan Waste Management Company
28.	Mr. M. Abbas	Company Secretary	D.G Khan Waste Management Company
29.	Mr. M. Ijaz	Project Manager	Faisalabad Waste Management Company
30.	Mr. Naeem Akhtar	Managing Director	Bahawalpur Waste Management Company
31.	Mr. Hamid Iqbal	Senior Manager Planning, Operation and Procurement	Rawalpindi Waste Management Company
32.	Mr. Asif Sarwar	Member	Polymer Waste Importers and Recyclers Association, Suite No. 2, First Floor Abdullah Plaza, 5 K, Commercial Area, Model Town, Lahore
33.	Muhammad Rafiq	District Environmental Officer	Rawalpindi
34.	Mr. Ali Aijaz	District Environmental Officer	Lahore
35.	Mr. Imtiaz Ahmad	District Environmental Officer	Gujranwala
36.	Mr. Parvez Ilahi	District Environmental Officer	Faisalabad
37.	Mr. Maqsood Butt	District Environmental Officer	Sahiwal
38.	Mr. Javed Akbar	Importer & Refurbisher	New Bismillah Traders, Hafeez Centre, Lahore
39.	Mr. M. Umar	Refurbisher	Morr Wala chowk, Sahiwal
40.	Mr. Atif	Refurbisher	Morr Wala Chowk,Sahiwal
41.	Shamshad Ali	Importer & Refurbisher	Hassan Computer, Hafeez Centre, Lahore

S. No	Name	Position	Company
42.	Hassan	Refurbisher	Computer Valley, Khan Plaza, Multan Cantonment
43.	M. Arif	Refurbisher	Al-Ahmed Computers, near Khan Plaza, Multan Cantonment
44.	Ali Raza Hashmi	Refurbisher	Hashmi Computers, Khan Plaza, Multan Cantonment
45.	Mr. Jabir Sajid	Refurbisher	Computers Solutions,Manka road, Khayaban e Sarwar, D.G Khan
46.	Mr. Muhammad Riaz	Refurbisher	Prime Computers,Manka road, Khayaban e Sarwar, D.G Khan
47.	Muhammad Latif	Refurbisher	Computer 4U, Gujranwala
48.	Imran Saleem	Refurbisher	Girls College Rd, Riaz Colony Anwar Colony, Bahawalpur
49.	M. Adeel	Importer & Refurbisher	MAC Laptops, Umair Plaza, Block A, Satellite Town Rawalpindi
50.	Ubaid Ullah Shah	Printer Refurbisher	COMTECH Business Center, Faisal Plaza, Bank Road, Saddar Rawalpindi
51.	M. Ali	Battery refurbisher	Awan Batteries, Faisal Plaza, Bank Road, Saddar Rawalpindi
52.	Umair Shehzad	Laptop refurbisher	Hospital Road, Gujranwala
53.	Mr. Ghaffar	Kabaria	Sahiwal
54.	Mr. Homayoun Akram	Kabaria	Gujranwala
55.	Mr. M. Ali	Kabaria	RS Traders, Bund Road, Lahore
56.	Amjad Ali	Kabaria	Misri Shah, Lahore
57.	Ali	Kabaria	Misri Shah, Lahore
58.	Abdul Qadir	Kabaria	Commercial Area, Multan
59.	Mr. Akram	Kabaria	Sajid Traders,Manka road, D.G Khan
60.	Sher Alam	Kabaria	Karachi Morr, Bahawalpur
61.	Shahid Ali	Kabaria	Noor Shah Road, Faisalabad
62.	Ghulam Murtaza	Kabaria	Noor Shah Road, Faisalabad
63.	M. Nawaz	Kabaria	Noor Shah Road, Faisalabad
64.	Mr. Bajwa	Kabaria & Dismantler	Taj Mahal Plaza, Block, satellite town Rawalpindi
65.	Mr. Athar	Dismantler	Lahore Garden Gate, Lahore
66.	Mr. Atif Mehmood	Dismantler	Hanno Ka Chaja, Multan
67.	Mr. Asif Iqbal	Recycler	AQ Metals, Umer Colony, Sheikhupura Road, Kohlo Wala, Gujranwala

Annexure-B: Goods Receipt Note

Goods Receipt into Blocked Stock For Inspection

Posting Date: Material Doc:

Receiving Date: Delivery Note:

Vendor No.: Plant :

Vendor Name:

PO Number:

Remarks: Page ___ of ___

S.No	Item Code Description	Storage Location / A/C Assignment	Units	Quantity

Inspection
Remarks: _____

Movement Type: Created by:

Reason: Goods Recipient:

Receiving Section	Quality Inspector / User depth.	Acceptor (stores/user)
Date:		

Annexure-C: Material Requisition Form

MATERIAL REQUISITION (FRONT)

Form (1)	Date (2)	Due Date of Requirement (3)	Site/office M.R No (4)	Date: **15**	No: **16**
Job Order No (14)	Site / Office (5)				

					17	21	23	25		
BOQ No (6)	S. No (7)	Description (8)	Unit (9)	Quantity (10)	Availability in Store	Purchasing Required	P.O.No	Material Received by Store/Site		
								D1	D2	D3

Site Office						Store Purchase				Purchase	
Initiator			Authorisation				Authorisation				
Prepared by	11.a		Technical(12)		Commercial (13)		Store(22)		Purchase(24)		Purchase (26)	
Signature	11.b		Signature		Signature		Signature		Signature		Signature	
Approved by	11.c											
Signature	11.d		Date		Date		Date		Date		Date	

MATERIAL REQUISITION (BACK)

BOQ No (06)	S. No (7)	Material Delivered to Store/ Site (18)			Dispatch Doc. Ref. (19)		
		D1	D2	D3	D1	D2	D3

Store (20)
Signature
Date

To be filled by the Initiator (instructions 1-14 & 24)

To be filled by the Store department (instructions 15-22)
To be filled by the purchase department (instructions 23 & 25-26)

PURPOSE

To fill this document completely & correctly

INSTRUCTIONS

a) There should be no alterations / amendments or over writing in the document. However in case of clerical error, it should be properly supported by the same authorized signatories.

b) Each column of both sides of Material & Office Supplies requisition should be completely filled in order to make it understandable for all concerned users.

c) The instruction for filling this form is explained here. Each column are properly numbered and are explained below.

1. Name of the Business Unit or section that prepares this requisition.
2. Date of requisition.
3. Date when materials is required.
4. Serial No of the material requisition (generate own at site).
5. Name of the office / site.
6. BOQ #
7. Serial No of the item.
8. Description of the item.
9. Measurement unit of the item.
10. Quantity required.

11.a Name of the person who prepares the requisition.

11.b Signature of the person who prepares the requisition.

11.c Name of the person approving the requisition.

11.d Signature of the person approving the requisition.

12. Authorization from the initiator's head of department or any responsible person.
13. Authorization from commercial.
14. Job order No (number allotted by the BA as per order numbering system).
15. Date when the requisition is received by the store.
16. Machine code to be assigned by the store.
17. Status of availability in store.
18. Quantity and Date when the material is delivered to store / site (D1, D2 & D3 are for partial deliveries)
19. Numbers of dispatch document reference.
20. Signature of issuing authority from store.
21. To be filled by the store if the item / material is not available in store.
22. To be filled by the store personnel stating the date when the document is forwarded to purchase department.
23. No. of purchase order.
24. Authorization for purchase to be signed by the BU Manager/Sr. Manager.
25. Quantities and Date when the material is received by the store after purchasing (D1, D2 & D3 are for partial deliveries).
26. Document received by the purchase department for procurement.

Annexure-D: Goods Issuance Note

Posting Date: _____ Material Doc.: _____

Current Date: _____ Material Slip: _____

Assignment: _____ Plant: _____

Remarks: *Header Text* Page ___ of ___

S.No	Item Code Description	Storage Loc./ Storage Bin	Units	Quantity

Movement Type: Created by:

Reason: Goods Recipient:

Unloading Point:

Issued By:	Received By:	Authorized Signature:
Date:	Date:	Date:

Contacts:

Project Support Unit, Punjab Resource Improvement and Digital Effectiveness Program, Planning and Development Department, Government of Punjab
11-A, Upper Mall Scheme, Mian Mir Road, Lahore

Consortium of
Project Procurement International and OTIUM Consulting Services Pvt Ltd