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# AWARENESS ON E-WASTE MANAGEMENT AMONG COLLEGE STUDENTS IN TIRUNELVELI DISTRICT

**Project Funded by**

**The Council of the I.C.M. Educational Institutions**

**Investigators**

**Rev. Dr. L. Vasanthi Medona ICM**

**Dr. M. Maria Saroja**

**Mrs. E. Michael Jeya Priya**

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New Delhi

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# THEORETICAL AND CONCEPTUAL FRAMEWORK

## 1.1.INTRODUCTION

***'The world has enough for everyone's need, but not enough for everyone's greed." -Mahatma Gandhi.***

Today's technology has taken a revolutionary step and helped humans develop and save me. However, despite the benefits of technology, it has created a massive waste of electronics and gadgets, adversely affecting the environment and people's lives. It has always been a double-edged sword that, if not correctly handled, causes more trouble than benefits. The pace at which the trend change in electronic products has been at an increasingly reduced time frame (Rastogi,2020). The smartphone segment products in India, almost all new models of mobile phones are being introduced in the market by the competitors. When we take the laptop segment of consumers, there has been a recent increase in the upgrades of existing technology in the market place. These upgrades insist that customers change their existing products, which are outdated due to technological changes in electronic products. India contributes 8 million tonnes of the Global electronic waste produced by various countries. The electronic products that stopped functioning or reached their determined end period are considered E-waste. Primarily, the sectors that perform the e-waste recycling process are working as an unauthorized category (Dzombak et al.,2019).

Electrical and electronic waste (e-waste) is one of the ever-growing waste streams. The increasing market penetration in developing and underdeveloped countries, faster replacement in developed countries, and heavy obsolescence rate make e-waste one of the fastest increasing waste flows. Environmental issues and trade associated with e-waste at local, transboundary, and international levels have driven many agencies and nations to introduce control measures. Rapid development, combined with rapid EEE, EOL, and obsolete electronics, is now the fastest-growing waste stream in the developing world. Industrialized sectors worldwide are starting to address e-waste as it is cumulatively mixed into the solid waste

stream. The growing waste inventory from electronic and allied industries, known as e-waste, is beginning to reach immeasurable quantities. Solid waste management, which is already an unsettled job in India, has become more confusing because of the massive stockpiling of e-waste, particularly computer and ICT waste, in India from other parts of the world (Shibulal,2014).

Toxic e-waste creates various types of diseases among human beings. It can be prevented by providing awareness of e-waste and how to manage an extensive collection of e-waste (Ahmed & Rukhsar,2017). The progress of a nation in diverse fields ultimately depends upon the quality of the environment and good civic which, in turn, depends upon how well aware the youngsters are about their surrounding environment, and it can be provided by the quality of good education, teachers, and parents. Electronic waste is termed discarded computers, office electronic equipment, entertainment electronic devices, mobile phones, television sets, and refrigerators that are wholly damaged (Chiang, 2001). As specific components of some electronic products contain hazardous materials, depending on their condition and density, e-waste is considered dangerous. The hazardous content of these materials also threatens human health and the environment (Hischier et al., 2005). Improper disposal of discarded computers, televisions, VCRs, stereos, copiers, fax machines, electric lamps, cell phones, audio equipment, and batteries can lead and other substances into soil and groundwater. Electrical and electronic equipment (EEE) contains valuable and health-hazardous materials; if such materials are not disposed of scientifically, they may cause severe threats to the environment and public health. The presence of heavy metals like arsenic, cadmium, barium, lead, lithium, mercury, nickel, and zinc sulphide and other toxic substances like PCB (Polychlorinated biphenyls) may cause extreme harm if they are not disposed of in an eco-friendly manner.

Our country aims to build a digital infrastructure linking its billion-plus population. However, ensuring the process does not choke its environment is necessary. In this 21$^{st}$ century, we talk of digitalization, big data, Internet of Things (IoT), connectivity, instant access and convenience.

This rapid rate of advancement in technology and the resultant proliferation of electronic equipment and gadgetry are constantly facilitating our daily lives immensely. However, it has also been simultaneously creating a highly dangerous impact on the environment and, thus, the sustenance of life itself. Obsolete equipment or electronic waste is, today, one of the fastest-growing and most complex waste forms globally. The hazards of e-waste and the challenges in e-waste management are manifold. This brings us to consider ways to overcome these challenges and arrive at optimal solutions to conserve resources. It is crucial for the government and other stakeholders of electronic waste to educate the consumer about the proper disposal of e-waste and to develop mechanisms to recycle electronic waste to cause less environmental hazard (Ravindra & Mor, 2019). That has been a positive sign regarding e-waste management due to the establishment of a refurbished goods market through online shopping websites. It has increased the reuse of electronic goods and provides attractive discounts for customers willing to exchange old electronic goods for new ones. It has been found that the accumulation of E-waste has increased every year, which is a significant threat to the environment.

Every electronic item has a life, and at the end of the same, it becomes e-waste. Electronic appliances, including refrigerators, televisions, cell phones, and ovens also became e-waste after a specific duration. In the past ten years, several e-appliances have been used worldwide (Shah et al.,2019). This also leads to the invention of new equipment and the obsolescence of old ones, due to which e-waste is the fastest-growing solid waste (Shaikh et al., 2020). Poisonous chemicals and materials, including the lead polybrominated diphenyl and biphenyl, are also emitted from these appliances, which then cause severe impacts and health issues to humans and the surroundings. It must be treated with the proper precaution to avoid such dangerous effects (Srivastava et al., 2019).

Solid waste reduction should be the primary strategy for future sustenance. Reduction involves reusing, remanufacturing, recycling, burning, and landfilling. Recycling involves taking pieces of electronic equipment and recovering the resources. This also reduces the pollution and exhaustion of natural resources and secures energy savings. Recycling

practice is considered one of the chief techniques that could be utilized to lessen pollution and prevent natural resources by improving energy-saving approaches (Cui & Zhang,2008). From the economic and social viewpoint, the Recycling technique provides a way to implement and enhance green-based technologies, and it also increases the economic commotion and job opportunities due to the expansion of the recycling business industry (Huisman,2019). To attain the stage of successful e-waste management, inspiring and evolving recycling behaviors are required. With deadly chemicals and toxic compounds in electronic gadgets, clearance of e-waste is becoming an ecological and health nightmare. E-waste is now one of the best ever-growing waste streams. Every year, hundreds of thousands of old computers, mobile phones, television sets, and radio tools are redundant, ending up in landfills or unauthorized remanufacturing yards. This has led to a quest to enact e-waste management laws as a vital part of contemporary ecological jurisprudence.

### 1.1.2.E-WASTE-A GLOBAL CHALLENGE

Electronic and Electrical waste, popularly known as e-waste products, do not decompose or rot away (Pandve,2007). Daily, our lives depend on these electronic devices, providing us with a more comfortable life. However, the same technology is the most upcoming threat to our society. Students should be aware of this e-waste management, which will reduce the environmental burden since there is no proper segregation and disposal of domestically used electronics. India has only recently implemented regulations directly addressing this issue through the Ministry of Environment and Forests (Shah & Anuj, 2012). The younger generation who are in the public health department, should smartly handle this upcoming threat. E-waste includes discarded electronic devices such as cellular calculators, phones and printers, scanners, audio and video devices, washing machines, microwave ovens, refrigerators, air conditioners and recording devices (Subhaprada,2017). E-waste is the cause of significant health and environmental concern due to its hazardous nature compared to municipal waste. Electronic gadgets contain components made of toxic chemicals and

metals such as lead, cadmium, chromium, mercury, beryllium, antimony, and polyvinyl chlorides (Priyadharshini,2018). Proper disposal of e-waste management is the only key. Frequent exposure of e-waste will damage the nervous, reproductive and endocrine systems. E-waste carries harmful substances (lead, mercury, flame retardants, and arsenic) and valuable metals (silver, copper, and gold) that need special recycling techniques to protect environment and human health.

E-waste is composed of 30% organic material (flame retardants, polymers, and glass fibre), 40% inorganic materials (non-ferrous and ferrous) and 30% ceramics material (Rautela et al., 2021). Inorganic metals contain base metals (tin, aluminum, copper and iron), valuable metals (palladium, gold and silver), heavy metals (cadmium, nickel, zinc, chromium, mercury, lead and beryllium), and earth metals (tantalum, gallium and platinum groups) (Kaya and Martin, 2016). Heavy metals contaminate environment with low concentration by bio magnification in animals and plants or chemical concentration in food cycle. Plants absorb heavy metals through soil and water, whereas humans and animal's intake heavy metals via air, water and food ingestion. E-waste possess many hazardous substances like brominated flame retardants, cadmium, polychlorinated biphenyls, lead and mercury that pollutes environment and jeopardize human health without direct exposure to environment (Wong et al., 2007). The processing of e-waste retrieves precious metals (copper, gold and silver) by using simple techniques like open burning, acid leaching, melting, and incineration. These processes release a vast range of poisonous gases and heavy substances into the environment which pollutes atmosphere, terrestrial and aquatic ecosystem (Grant et al.,2013). Moreover, improper disposal and crude processing of e-waste are proven to be chronic and lethal for human health. Furthermore, human health issues are for both workers involved in unrefined processes of e-waste and general population surrounded by polluted environment (Caravanos et al.,2011). The competitive electronic market and the growing consumer buying behaviour are leading to the rapid obsolescence of electronic devices. Over a period, when these devices are replaced or discarded for various reasons, the

end-of-life management of electronic waste (e-waste) becomes a complex challenge. Unlike other solid wastes, e-waste cannot be treated easily as it contains several components including metals, non-metals, chemical compounds, plastics, and other hazardous substances. Hence, the treatment or recycling of electronic waste is extremely challenging (Shevchenko et al., 2019).

Electronic waste or e-waste is one of the fastest-growing types of waste. Used electronics that are destined for reuse, resale, salvage, recycling, or disposal are also considered e-waste (Subhaprada & Kalyani ,2016). Today technology has taken a revolutionary change and it has helped human beings in developing and saving money and time. But despite the benefits of technology it has created a huge waste of electronics and gadgets which is adversely affecting the environment and the lives of people. Toxic e-waste creates various types of diseases among human beings. It can be prevented by providing awareness of e-waste and how to manage a large collection of e-waste (Ahmed & Rukshar, 2018). Electronics waste, commonly known as e-scrap or e-waste, is the trash generated from surplus, broken, and obsolete electronic devices. Electronic and electrical products that are discarded or reaching their end of life are called e-waste or electronic waste (Sukkur & Channa, 2022). With the booming Indian economy and changing technology at a faster pace, product life cycles have become shorter. Due to the presence of toxic materials in these products, recycling them or disposing of them in a safe and environmentally friendly manner becomes essential (Iyer, 2014). Electronics contain various toxic and hazardous chemicals and materials that are released into the environment due to improper disposal of the materials. E-waste or Electronics recycling is the process of recovering material from old devices to use in new products. With such a very short constructive life, electronics transition into e-waste at a rapid pace (Ramanujam & Nepoleon, 2020). E-waste contains toxic substances like Lead, Mercury, Cadmium, and Polycyclic Aromatic Hydrocarbons (PAH) that hurt human health and the environment if not handled properly (Forssberg ,2003). E-waste may be described as waste electrical and electronic equipment (WEEE), in whole or

in part from their manufacturing and repair process, which are intended for disposal. E-waste is more hazardous than any other municipal waste and it contains many hazardous chemicals like polyvinyl chloride (PVC plastics), Non phenol, Polybrominated diphenyl ethers, polychlorinated biphenyls copper, triphenyl phosphate, chromium, barium, beryllium, phosphor and additives lead, mercury, arsenic, cadmium, manganese, cobalt, gold, and iron. These chemicals create water pollution, land pollution, and air pollution and are hazardous to human health (Sivathanu, 2016). Electronic products nearing the end of their useful life are also called e-waste (Govil, 2009). With increasing market penetration, replacement market, and increase in affordability of new products, it is easy to purchase rather than repair outdated equipment (Arora, 2008).

### 1.2.1.E-WASTE TYPES

E waste can be classified into four different categories.

- Telecommunication Waste: Telecommunication waste involves smartphones, personal computers, television and the Wi-Fi equipment's, connecting cable involved in the telecommunication network.
- Electrical Waste: Electrical waste includes switches, relays and connectors related materials which are considered as scrap.
- Electronic Waste: Electronic waste includes printed circuit boards, socket assemblies, equipment and machinery and integrated chips.
- Cable waste: Cable waste includes poly vinyl chloride wires and assemblies, pre-insulated coils of aluminium and copper.

### 1.2.2. ELEMENTS OF E-WASTE

E-waste is mainly used old, end of life discarded electrical & electronics appliances. Sources of E-waste can be categorized into following types:

- Domestic E-waste
- Government Sector E-waste
- Industry E-waste
- Hospital E-waste

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E-waste broadly covers various electronic products such as, computers, printers, hard disk, mobile phones, digital music recorders/players, televisions Television, fan, Fax, Xerox machine, Fluorescent bulbs, electrical and electronic laboratory instrument. Some of them containing toxic substances/chemical like lead, zinc, barium, cadmium, mercury, beryllium, polyvinyl chloride and phosphor compounds that release in the atmosphere can have an adverse impact on human health and the environment if not handled properly. Serious repercussions may arise for those in proximity to places where E-waste is recycled or burnt due to improper recycling and disposal procedure.

***Table.1.1. Elements and their effects on environment***

| Element | Effect on Environment |
|---|---|
| Lead | Damage to central nervous system, blood system and kidney damage. |
| Chromium | Asthmatic bronchitis |
| Cadmium | Toxic irreversible effects on human on health. |
| Mercury | Chronic damage to the brain |
| Plastics including PVC | Burning produces dioxin. It causes reproductive and developmental problems, Immune system damage and Inference with regulatory hormones. |

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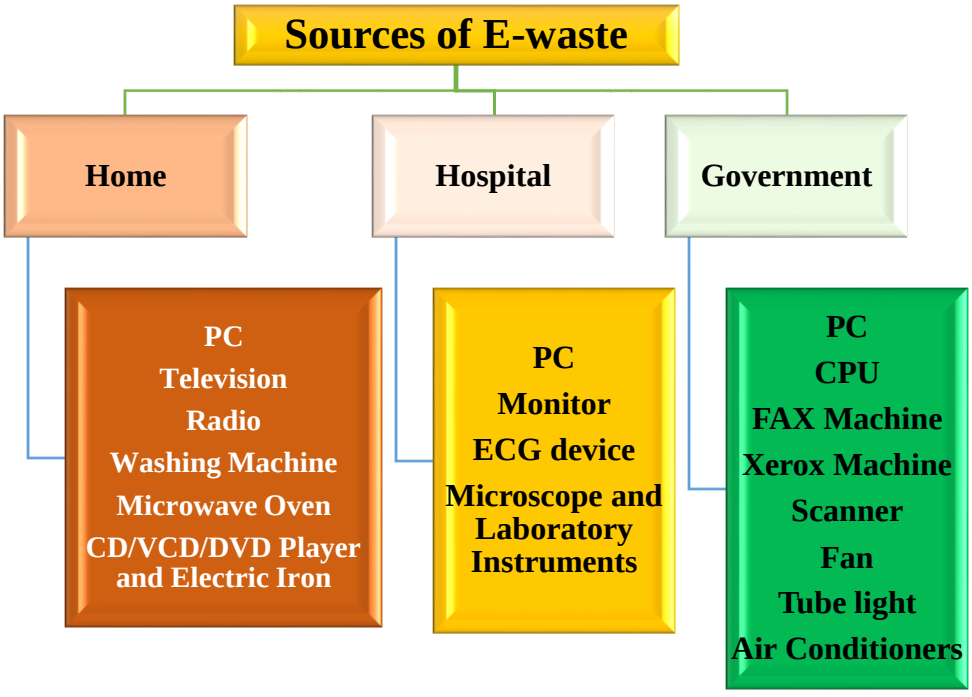
*Fig.1.Sources of E-Waste*




## 1.3. SOURCE OF INFORMAL AND FORMAL E-WASTE

Formal Sector

- Producer/Manufacturers
- Retailers (businesses, government, others)
- Consumers (Individual households, businesses, government)
- Importers
- Traders
- Scrap dealers

Informal Sector

- Dissemblers/ dismantlers
- Smelters
- Recyclers.

Reasons how electronic items become E-waste

- Advancement in technology is first and main reason for e-waste.

- ❖ Change in Style, Fashion and Status is another important reason.
- ❖ The end of their useful life at reaching the product.
- ❖ To handle them properly precautions are not taken.

### 1.4.1. REASONS FOR E-WASTE GENERATION

Other developing countries dispose their e-waste in India and developed countries like US. In India the cost is only 2 US dollars as cost of recycling computers in USA and Europe is 20 US dollars. India has become dumping ground of e-waste for many developed countries. In India from different developed nation's e-waste is imported. US contribute maximum share of 42% from these countries, 30% China around and 18% Europe around and remaining is imported from other countries as South Korea, Taiwan, and Japan

### 1.4.2.E-WASTE RECYCLING AND METAL RECOVERY

Currently, the most appropriate physical processes used as pre-treatment techniques according to the technological aspect are

- ➢ Pyrometallurgy
- ➢ Hydrometallurgy
- ➢ Bio hydrometallurgy
- ➢ Pyrolysis.

Non-chemical approaches are becoming the most feasible before recycling or treating E-waste. The pyro metallurgical methods involve magnetic separation, eddy currents, air currents, and vacuum metallurgical separation. Hydrometallurgy uses chemicals, whereas bio-hydrometallurgical uses "Green Technology", in which microorganisms are used for metal abstraction. Using microorganisms to regain noble metals is a relatively economic and environmental approach regarding several other resources. The thermal cracking (pyrolysis) or thermal conversion of E-waste is quite a beneficial and emerging technology. However, it cannot be implemented at a larger scale due to thermogenesis, initiation energy, and yield restrictions. These sophisticated adopted technologies are indispensable for

better recycling and environmental sustainability. They are on hand to help restore natural resources while also reducing the hazardous and economic burden. The recovery scheme involves mechanical separators to sort, crush, and separate electronic parts, followed by pyro metallurgical treatment that deals with nonferrous metals, separation of metallic and noble elements, and separation of metallic and noble elements. For metallic item recovery, electrometallurgical therapies are carried out, followed by a treatment with liquid in which the acidic wastewater is neutralized and treated before discharge

Electronic and electrical products that are discarded or have reached their end of life are called e-waste or electronic waste. With the booming Indian economy and faster technology changes, product life cycles have become shorter. Due to the toxic materials in these products, recycling or disposing of them in a safe and environmentally friendly manner is essential. The lack of organized segregation processes has created more harm to the people involved. The Constitution of India says that everyone has the right to live pollution-free lives. Public awareness and cooperation among manufacturers are essential for advancing the e-waste management system. Also, the government's responsible for allocating sufficient grants and protecting the internationally agreed environmental legislation within their borders. Licensing certifications like stewardship may ensure security to prevent illegal smugglers and handlers of e-waste. As e-waste is a known primary source of heavy metals, hazardous chemicals, and carcinogens, diseases related to skin, respiratory, intestinal, immune, endocrine, and nervous systems, including cancers, can be prevented by proper management.

Most of the waste is inherently dangerous. It will degrade to provide leachate, which can contaminate water and make lowland gas explosive. Additionally, owing to the risks related to lowland sites, there needs to be more relaxed needs for developing, operating, and medical care. Most design authorities want a figured-out quarry for landscaping instead of a lowland website that nobody wants in their backyard. The Indian Government’s ability to safeguard the country’s environment depends on

policies and education systems. The disposal of e-waste is one of the significant challenges facing the world today. Hence, humans are asked to reduce, reuse, and recycle their waste.

## 1.5.CONCEPT OF E-WASTE

E-waste, an abbreviation for electronic waste, is inspired by e-as in e-mail, e-commerce, and e-learning. It differs from these examples. Even this prefix relates to electronic in its basic sense, using electricity and electrical parts, instead of denoting the idea expressed in the Macmillan Online Dictionary as on or using the Internet. The prefix and its association with electronic data began in the early eighties in the word e-mail, quickly assuming productive use on various expressions relating to emerging technologies. With English as the lingua franca of know-how, e- soon became used cross-linguistically, favoured as an abbreviation for electronic regardless of how this translates into other languages. E-waste is an accepted, informal name for electronic goods nearing the end of their 'useful life' or electronic goods at end-of-life. It is different from used electronic goods. Because used electronic or electrical goods may be older and have been used for some time, but end-of-life goods are e-waste only. Computers, televisions, VCRs, stereos, copiers, and fax machines are common electronic goods. Many of these goods can be reused, refurbished, or recycled.

E-waste is a difficult issue to deal with as it contains various diverse resources and many extremely perilous compounds. In India, importers import used goods because they are profitable, and for authorities, it is almost impossible to distinguish used goods from end-of-life waste goods. Faulty clearance of electronic items can result in several perilous chemicals entering our environment in the course of water systems and air pollution. Importers import end-of-life goods for recycling and to separate precious metals from e-waste. Technical know-how is in a rudimentary stage in India. This results in pollution, which endangers workers' lives in the recycling industry. E-waste is a term used to cover almost all types of electrical and electronic Equipment (EEE) that has or could enter the waste tributary. Even if e-waste is a general term, it can be considered to cover TVs, computers,

mobile phones, white goods (refrigerators, washing machines, and dryers) and home entertainment, stereo systems, toys, toasters, kettles, or almost any household or industry item with circuitry or electrical elements with power or battery supply. E-waste or electronic waste is loosely discarded, left-over, out-of-date, broken, electrical, or electronic devices. It includes mobile phones and charging adapters; computers and their accessories such as monitors, printers, keyboards, and central processing units namely remotes, headphones, batteries, LCD, air conditioners, refrigerators and other household appliances. E-waste has many harmful metals/elements present They require immediate treatment or can harm human health and the environment. Globally, only 40 percent of e-waste is collected for recycling; the rest is in landfills. Therefore, there is an urgent international call for action against e-waste. The soaring international demands for electrical and electronic products are fuelling a global rise in e-waste

## 1.6. COMPOSITION OF E-WASTE

E-waste consists of all electronic and electrical equipment waste that has reached its end-of-life period or is no longer fit for its original intended use and is ordained for resurgence, remanufacturing, or clearance. It includes computers and their accessories, monitors, printers, keyboards, central processing units, typewriters, mobile phones and chargers, remotes, compact discs, headphones, batteries, LCD/Plasma TVs, air-conditioners, refrigerators, and other household equipment. The composition of e-waste is diverse and cascades under perilous and non-perilous categories. It comprises ferrous and non-ferrous metals, plastics, glass, wood and plywood, printed circuit boards, concrete, ceramics, rubber, and other items. Iron and steel constitute 50 percent of the waste, followed by plastics (21 percent), non-ferrous metals (13 percent), and other constituents. Non-ferrous metals consist of metals similar to copper and aluminium and expensive metals similar to silver, gold, platinum, palladium, and so on. The presence of elements identical to lead, mercury, arsenic, cadmium, selenium, hexavalent chromium, and flame retardants beyond threshold quantities make e-waste perilous. It contains over 1000 diverse compounds, several noxious, and creates stern pollution upon clearance.

## 1.7.E-WASTE PRODUCTION IN INDIA

All over the globe, the extent of electrical and electronic waste produced each year, predominantly computers and televisions, has assumed frightening proportions. In 2006, the International Association of Electronics Recyclers (IAER) projected that 10 billion electronic and electrical equipment would become WEEE or E-waste by 2015. That would be indistinguishable from an average annual waste generation rate of 800 million units until 2015. Globally, 20- 50 MT (million tonnes) of e-waste is disposed of yearly, accounting for 5 percent of all municipal solid waste. For Instance, according to the Comptroller and Auditor General's (CAG) report, over 7.2 MT of industrial perilous waste, 4 million tonnes of electronic waste, 1.5 MT of plastic waste, 1.7 MT of medical waste, 48 MT of municipal waste are generated in India annually. In 2005, the Central Pollution Control Board (CPCB) projected India's e-waste at 0.573 MT daily. A study released by the Electronics Industry Association of India (ELCINA) at the electronics industry expo -Componex Nepcon 2009 had projected the total waste generation in India at a whopping 4.34 million tonnes by end of 2009.

The CPCB has projected that it will exceed the 8 million tonnes mark by 2012. There are ten States that contribute to 70 percent of the total e-waste produced in India, while 65 cities produce extra than 60 percent of the total E-waste in India. Among the top 10 e-waste-producing States, Maharashtra ranks first, followed by Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh, and Punjab. Mumbai ranks first among the top ten cities generating e-waste, followed by Delhi, Bengaluru, Chennai, Kolkata, Ahmadabad, Hyderabad, Pune, Surat, and Nagpur. The leading sources of electronic waste in India are the government, public, and private (industrial) sectors, which account for almost 70 percent of total waste generation. The contribution of individual households is relatively small at about 15 percent; manufacturers contribute the rest. Even individual households are not hefty contributors to waste generated by computers. They consume hefty quantities of end-user durables and are, consequently, impending creators of waste. An Indian

Market Research Bureau (IMRB) survey of E-waste generation at Source in 2009 found that out of the total waste volume in India, televisions and desktops together with servers comprised 68 percent and 27 percent, respectively. Total imports and mobile phones consist of 2 percent and 1 percent respectively. The Attero Remanufacturing Plant in Roorkee opened in January 2010 as a hefty-extent prearranged E-waste remanufacturing facility. Despite 23 units currently registered with the Government of India, Ministry of Environment and Forests/Central Pollution Control Board, as E-waste remanufacturers/reprocesses, having ecologically effective management services. The entire remanufacturing method still exists in the unorganized segment. The Cobalt-60 radiation tragedy at Mayapuri in Delhi, in which one person lost his life and six persons were admitted to hospital, served as a wakeup call depicting attention to the escalating extent of perilous waste together with e-waste in India while revealing systemic problems on the issue of waste clearance. The Ministry of Environment and Forests (MoEF) has notified the Hazardous Wastes (Management, Handling, and Transboundary Movement) Rules, 2008, for effective management of perilous wastes and E-waste in India. However, these rules do not apply to radioactive wastes such as Cobalt 60, covered under the Atomic Energy Act of 1962.

## 1.8.E-WASTE MANAGEMENT

Electronic waste is a common, informal name for electronic products approaching the end of their useful life (Preethi & Karnan, 2020). E-waste is considered dangerous, as certain components of some electronic products contain hazardous materials, depending on their condition and density. The hazardous content of these materials poses a threat to human health and the environment. Waste of electrical and electronic apparatuses generated in huge amounts surrounds the earth today and has become a global environmental issue. The environmental pollution caused by e-waste is irreversible and is yet to be realized by the masses, particularly in developing countries. There is no unique or ideal model for e-waste

management in developing countries, each of which has its own specific environmental, social, technological, economic and cultural conditions.

Environmentally sound management of Waste of Electrical and Electronic Equipment (WEEE) recognizes three R's namely Reduce, Reuse and Recycle. The aim is to reduce the generation of e-waste through intelligent manufacturing and maintenance, reuse electronic equipment by someone else, and recycle those components that cannot be repaired. So, e-waste is a wide problem in our country and causes people's suffocation from e-waste's hazardous problem. Increased use of electrical and electronic equipment coupled with a huge population and changing consumption patterns is generating waste at an alarming rate in India. This is due to the advancement or development in technology. These spectacular developments in modern times have undoubtedly enhanced the quality of our lives. At the same time, these have led to manifold problems including the problem of the massive amount of hazardous waste and other wastes generated from electric products (Kumar & Sharma, 2015).

Electronic waste or e-waste is the collective name for discarded electronic devices that enter the waste stream from various sources. The used and spoiled electronic appliances which have been disposed of by their original users, come in the category of E-waste. The electronic goods are classified under three major heads:

- White goods: Household appliances.
- Brown goods: TVs, camcorders, Cameras
- Grey Goods: Computers, printers, fax machines, Scanners, etc.

When electronic appliances become useless, they become part of the category of e-waste. The grey goods' waste is more toxic than white and brown goods. This kind of waste poses a severe challenge in the disposal and recycling of waste in both developed and developing countries. Apart from these, computers, printers, and other equipment contain a sophisticated blend of plastics. These toxic materials are complex and difficult to recycle in an environmentally sound manner, even in developed countries, so these materials generated from the dismantling of computers are dumped in nearby soil and water. Landfilling of this waste results in significant soil and

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groundwater contamination, while incineration of waste leads to the release of toxic gases like dioxins and furans.

Mobile phones and Personnel Computer screens regularly contain perilous materials. Because of these substances' nearness, reusing and transferring e-waste becomes a vital issue. Many people are unconscious of the potential contrary effect of the quickly expanding utilization of PCs, mobiles, and TVs. At one point, these items are put in landfills and buried or burned; they pose dangers to well-being because of the dangerous materials they contain. The dishonourable transfer of electronic items prompts the likelihood of harming the earth. As more e-waste is set in landfills, introducing ecological poisons will prevent it, bringing about lifted dangers of disease and formative and neurological issues.

Most e-waste recycling and dumping operations by backyard recyclers are manual disassembling, open burning of plastics, exposure to toxic soldiers, and river dumping of acids, which are highly polluting and damaging to the environment. Backyard recycling adopts very crude recycling activities, mainly aimed at material recovery. In this method, e-scrap undergoes open sky incineration, cyanide leaching, and smelting operations to recover primarily copper, gold, and silver with comparatively low yields. Wires are collected and burned in open piles to recover re-saleable copper. Circuit boards are treated in an open acid bath to recover copper and precious metals. These crude methods result in resources and energy wastage and cause environmental pollution. Most workers involved in such activities are unaware of the ecological and health risks and need to learn practices.

In addition, heavy metals not emitted into the atmosphere are transferred to slag and exhaust gas residues and can re-enter the environment upon disposal. Therefore, e-waste incineration will increase these emissions unless reduction measures like removing heavy metals from waste are taken care of. The retrieval of copper or aluminium is done by open burning of wires in narrow lanes without any protective gear. This process is hazardous as the burning of PVC results in the emission of carcinogenic dioxins and furans. Dismantling and breaking monitors and hard disks are done with screwdrivers and hammers. The recovery of gold from gold-coated plug-ins

is done through the hazardous acid treatment process. The most worrying factor is that the plug-ins containing the gold are treated along with the plastic casings, which might emit toxic fumes, endangering the workers' lives.

## 1.9.E-WASTE DISPOSAL METHODS

- Incineration: Thermal treatment in special incinerators involves exposing electronic wastes to high temperatures to turn the wastes into gas, steam, or ash. The original waste to at least 20% reduces its size and applied treatment method. With incineration as dioxins and furans, the drawback associated with the environment is the release of gaseous toxins, which may have serious environmental consequences. Because of the hazards related to improper methods of electronic waste disposal, this method is considered harmful and is the most common method employed in other developing countries.

- Landfills: Several years by natural means, they may discharge to the environment after, and batteries discharge acids and heavy metals, mercury. There is a possibility of leakage of wastes, such as electronic circuits that contain lead, cadmium, zinc, copper, and mercury. Land water, such as rivers and streams, may get mixed and reach animals and humans through other freshwater sources. In Asia and Africa, nearly half of the e-waste of the US and Australia is dumped in landfills while the rest is exported.

- Acid baths: To dissolve Copper, the acid bath technique is used and also used to extract Copper; for 12 hours, the circuit board is submerged in sulphuric acid for about the solution is boiled, and the rest of the solution is added with scraped particles, and the copper which is received and sulphate is taken and, subsequently copper stains are removed. Gold and silver were also extracted to dissolve the lead acid baths.

- Safe E-Waste Disposal Methods: 4 R's, Reduce, Reuse, Recycle and Recovery The standard methods of e-waste disposal are, which are used to dispose of other waste too.

- Recycling: Recycling is a feasible and safe solution for e-waste disposal. By dismantling new products, collecting different materials, and sorting, this method comprises processing electronic wastes into and in later productions before they are used. For environmental degradation ref, furbished materials are sold, and unrecovered materials are left as second-hand goods. Automated machines or manual can be done either with the dismantling of equipment. Some drawbacks are related to the manual method of dismantling the waste substance of constituents: Workers may be bare to the risks of during the work. For future use, e-waste recovers metals and preserves natural resources. Recycling has been defined to the rising e-waste issues as the finest remedy when these metals are reused. It also reduces the amount of greenhouse gas produced by manufacturing new product releases. Some remarkable benefits of e-waste recycling include helping to protect the environment.
- Recycling decreases the amount of waste deposited in Recycling or burned in incinerator plants.
- Recycling Helping in conserving limited resources: For a steady supply of raw materials, apple, and cell phone manufacturers like Dell and Computer have recognized that to recycle materials, the requirement from used products most are active in buyback programs.
- Recycling provides energy efficiency: From fresh raw material to reduced costs, recycling is a better new option than producing something that leads and is more efficient in energy consumption.
- Recycling helps build a strong economy: Cost reduction, energy efficiency, conservation of material, and job generation are benefits of recycling

- Recycling leading jobs available: Segregating raw materials to dismantle, getting recovery for making new products, electronic items, and or dispose of other useless parts requires a considerable number of workers. Landfilling and incinerating waste is ultimately creating more jobs than ever before.
- Recycling can be financially rewarding: To start a home-based business, recycling is profitable. It is easy and relatively inexpensive, too.
- Recovery, Reduce, and Reuse Methods: Recovery and reuse are the best methods for economic growth. In business, both methods provide benefits and are environmentally sound. Electronic waste offers monetary support to firms from the recovery of precious metals. The circuit board contains some valuable materials such as silver, gold, platinum and base materials such as iron, Copper, and aluminium. For new products the same way, the social and environmental benefits of reusing electronics consist of diminished demand. Preventing health problems by properly disposing of or reusing electronics reduces greenhouse gas emissions and creates jobs. On generation of e-waste, reducing the purchases of electronic items can be controlled; by donating also, electronic items can be reused. The life of products by repairing electronic items can increase, and those products can be reused.

## 1.10.POLICIES REGARDING E-WASTE MANAGEMENT IN INDIA

In 2003, the Hazardous of Management and Handling Amendment Rules Including all components of e-waste is defined as waste electrical and electronic equipment that is WEEE, except falling under section 3 rules the subassemblies and batteries their fraction. In 2008, Guidelines for Environmentally Sound E-waste Management by the Ministry of Environment, the government of India approved the initiative Forest, and the guidelines were according to the central pollution control board's various components. It classified the electronic waste and the management compositions and mainly emphasized treatment practices of e-waste as

extended producer responsibility, which is the guideline that combines concepts.

In 2011, the Management and Handling Rules of E-Waste Addressed the issues related to e-waste, a very recent initiative by India. According to this regulation, electronic electronics and electrical equipment depend on electric currents or electromagnetics. Which fields are fully functional electronic waste? This means whole or in part a waste of electrical and electronic equipment or every consumer rejects from their manufacturing and repair process intended to be discarded. These rules are expected to be applied to bulk consumers and producers, including in the Manufacturing, Sale, Purchase, and recyclers of electronic waste processing EEE, collection centres, and dismantlers. These rules define and incorporate duties for producers, collection centres, consumers, dismantlers, and recyclers.

## 1.11.PROBLEMS IN E-WASTE MANAGEMENT

- There is a need for people to be aware of e-waste generation. Now and then, new devices with new advanced features have come into the market, so people switch to new devices without managing old ones, which have become e-waste. This causes e-waste generation. Unnecessary purchases of electronic devices lead to a contribution towards e-waste generation.
- E-waste is entering in India about 95 percent of the informal sector through waste management company, which reach the poor houses in material recovery and extraction of components where families are engaged and physically like the boards are initially heated on a gas stove or loosen the lead soldering through blowtorch using basic and risky processes.
- The rise in e-waste generation is expected, and a significant challenge is managing the country's growing e-waste generation.
- There is a lack of awareness in the public regarding the disposal of e-waste, and in India, e-waste enhances the problem. Inadequate policies are needed to handle the related issues, with effective

management of inadequate laws by the local and central government.

### 1.11.1. ISSUES RELATED TO THE FORMAL SECTOR IN E-WASTE DISPOSAL

An infrastructure problem is mainly related to E-waste collection. There are very few collection centres authorized by state pollution control boards in every state. They cannot cater entirely-inflexible formalities for seeking authorization for collection centres result in several entrepreneurs in this area. People who wish to get returns for their e-waste prefer selling it at waste management company. Even companies that extend producer Responsibility (EPR) put responsibility problems in collection facilities. The high cost of transportation of e-waste in unsystematic locations of processing units without caring for collection centre locations contributes to the transition from collection centres to processing units. Thus, significant challenges faced by the formal recycling system in India are collection and the high cost of transportation. To understand the Existing System and to find the problems related to e-waste in public regarding awareness of e-waste. Some information has been collected through primary and secondary data. Primary data has been used to check whether people are aware of those systems, about proper methods of e-waste management and government policies, and to find the problems that provide feasible solutions to the problem. Secondary data has been used to check the current system of e-waste, the safe management method to check e-waste, to check the procedures for proper disposal, and to find the rules and regulations of the Indian government to manage e-waste properly.

### 1.11.2. ENVIRONMENTAL DEGRADATION

When e-waste is disposed of or recycled without any control, there are negative impacts on the environment and human health. Presently, the informal e-waste processing in India is not monitored for compliance with environmental regulations. As a result, the crude methods used to reclaim materials may cause pollution, creating severe problems for ecological and

human health. E-waste contains more than 1,000 toxic substances, such as lead, mercury, arsenic, cadmium, selenium, hexavalent chromium, and BFR. The rudimentary recovery process has limited material efficiency, resulting in the loss of significant amounts of sensitive metals and the disposal of residues of toxic materials into water bodies and soil, creating severe water and soil pollution issues. There are also cross-contamination issues with materials, as plastics containing BFR are recycled and mixed with virgin materials and other plastics to manufacture new plastic products. The other important aspect is the wide dispersal of toxic chemicals and elements into the environment due to the highly dispersed recycling units across the country, resulting in various health problems. Emissions of dioxins and heavy metals like lead, cadmium, and mercury in the air cause Blood flow restriction (BFR). Indiscriminate dumping of spent fluids/chemicals contaminates soils. Groundwater contamination through leachate and landfilling of non-recyclables causes health issues in humans.

### 1.11.3. IMPACT OF PUBLIC HEALTH ISSUES

In the informal sector, there is little regulation to safeguard the health of those who handle e-waste. Most people involved in informal recycling are the urban poor with low literacy levels and, hence, need more awareness regarding the hazards of e-waste and the recycling processes. A sizeable number of women and children engaged in these activities might be more vulnerable to the dangers of this waste. Many of these workers get eye irritation, breathing problems, and constant headaches. Environmental laws are defined in the way that this law science of province and conscience. This means that making laws on this subject depends upon the contribution of scientific research detailing when elements in the natural environment will harm the human body. The social and economic environments are influenced by society's values and judgment. So, to protect the natural environment, the social and economic environment should be regulated, and thereby, value judgment must be considered to have adequate laws relating to the environment. For example, the dumping of e-waste affects the country's economic strength. If financial stability or the infrastructure allows

only then the waste of e-waste can be dumped after treatment without treatment, the e-waste may hamper the sub ternary water, polluting the sub ternary water and there by violating the principle of the public trust doctrine. E-waste pollution should also be evaluated, considering the three principles of environmental regulations: Public Trust Doctrine, Precautionary principle, and Polluter Pay principle. They are directly responsible for sustainable development, and the rights of the unborn show any pollution issue should pay greater attention to three principles.

In the case of E-waste, the issue pertains to slow poisoning of individual seals because of the polluted natural environment. So, it is mentioned in Section 2 (a) of the Environment Protection Act, 1986. Section Cleary says and uses the word inter-relationship between any of the environment's components. Environment (Protection) Act, 1986 is the first statute in the history of environmental law to define the term "environment." section 2(a) Environment (Protection) Act provides the environment includes water, air, and land, and the inter-relationship that exists among and between water, air and land and human beings, other living creatures, plants, microorganism, and property. The disposal of e-waste should be such that it does not break or impair the environment. The inter-relationship between and among the components of the environment should be maintained.

### 1.11.4. EFFECT ON ENVIRONMENT AND HUMAN HEALTH

Disposal of e-waste is a particular problem faced in many regions across the globe. Computer wastes that are landfilled produce contaminated leachates, which eventually pollute the groundwater. Acids and sludge obtained from melting computer chips, if disposed of on the ground, cause soil acidification. Illegal e-waste recycling is facing acute water shortages due to the contamination of water resources. This is due to the disposal of recycled wastes, such as acids, sludge, in rivers. Now water is being transported from faraway towns to cater to the demands of the population. Incineration of e-waste can emit toxic fumes and gases, thereby polluting the surrounding air. Improperly monitored landfills can cause environmental hazards. Mercury will leach when specific electronic

devices, such as circuit breakers, are destroyed. The same is true for polychlorinated biphenyls (PCBs) from condensers. When poly-bromine flame-retardant ethers (PBDE) cadmium-containing leach into the soil and groundwater when brominated flame-retardant plastic or cadmium containing plastics are landfilled. It has been found that significant amounts of lead ions are dissolved from broken lead-containing glass, such as the cone glass of cathode ray tubes, get mixed with acid waters and are a common occurrence in landfills. When exposed to fire, metals and other chemical substances, such as the highly toxic dioxins and furans tetrachloride dibenzo-dioxin, polychlorinated dibenzodioxins (PCDD), polybrominated dibenzo-dioxin (PBDD) and polychlorinated dibenzofurans (PCDF) from halogenated flame retardant products and PCB containing condensers can be emitted. The most dangerous form of burning e-waste is the open-air burning of plastics to recover copper and other metals.

***Table.1.2. Summarizes the Health Effects of Certain Constituents in E-wastes.***

| SOURCE OF E-WASTES | CONSTITUENT | HEALTH EFFECTS |
|---|---|---|
| Solder in printed circuit boards, glass panels and gaskets in computer monitors | **Lead (PB)** | ❖ Damage to central and peripheral nervous systems, blood systems and kidney damage.<br>❖ Affects brain development of children. |
| Chip resistors and semiconductors | **Cadmium (CD)** | ❖ Toxic irreversible effects on human health.<br>❖ Accumulates in kidney and liver.<br>❖ Causes neural damage.<br>❖ Teratogenic. |
| Relays and switches, printed circuit boards | **Mercury (Hg)** | ❖ Chronic damage to the brain.<br>❖ Respiratory and skin disorders due to bioaccumulation in fishes. |

| | | |
|---|---|---|
| Corrosion protection of untreated and galvanized steel plates, decorator or hardener for steel housings | **Hexavalent chromium (Cr) VI** | ❖ Asthmatic bronchitis.<br>❖ DNA damage. |
| Cabling and computer housing | **Plastics including PVC** | ❖ After Burning, it produces dioxin. It causes<br>❖ Reproductive and developmental problems;<br>❖ Immune system damage;<br>❖ Interfere with regulatory hormones |
| Plastic housing of electronic equipment and circuit boards. | **Brominated flame retardants (BFR)** | ❖ Disrupts endocrine system functions |
| Front panel of CRTs | **Barium (Ba)** | Short term exposure causes:<br>❖ Muscle weakness;<br>❖ Damage to heart, liver and spleen. |
| Motherboard | **Beryllium (Be)** | ❖ Carcinogenic (lung cancer)<br>❖ Inhalation of fumes and dust. Causes chronic beryllium disease or beryllicosis.<br>❖ Skin diseases such as warts. |

### 1.11.5. STEPS TO MAKE INDIA GREENER

Most people are contributing to the generation of e-waste, but they still have questions about what e-waste is and how it is generated, as there is a lack of awareness. First, there is a need to understand what e-waste is and how it is generated. When a mobile phone is launched in the market with new advanced features and technology, most of us purchase the phone without thinking about what to do with the old one. Even if it is in good condition, one still buys a new phone. That old phone becomes E-waste, not only mobile phones but also Television and other electronic items. Initially, CRT TVs were there, then LCD and LED came with new features, and we started switching to new products. People rapidly change their devices as per new

technologies, and our old devices become e-waste, generating e-waste. India is the fourth largest country in terms of the generation of e-waste. There should be control over the generation of e-waste, one should control purchases of new devices, and ultimately, e-waste generation can be reduced.

## 1.12.E-WASTE LEGISLATION IN INDIA

Because of the ill effects of hazardous wastes on the environment and health, several countries exhorted the need for a global agreement to address the problems and challenges of hazardous waste. However, the policy-level initiatives regarding E-waste in India could be more extensive and need immediate attention. The following are some of India's policy-level initiatives regarding e-waste. The Hazardous Wastes (Management and Handling) Amendment Rules, 2003 Under Schedule 3, E-waste is defined as "Waste Electrical and Electronic Equipment including all components, sub-assemblies and their fractions except batteries falling under these rules." The definition provided here is similar to that of the Basal Convention. E-waste is only briefly included in the rules and needs a detailed description. Guidelines for Environmentally Sound Management of E-waste, 2008. This guideline was a Government of India initiative approved by the Ministry of Environment and Forest and Central Pollution Control Board. It classifies e-waste according to its various components and compositions and emphasizes the management and treatment practices of e-waste. The guideline incorporated concepts such as "Extended Producer Responsibility".

The e-waste (Management and Handling) Rules, 2011. This is a very recent initiative and the only attempt in India meant solely to address the issues related to e-waste. These rules still need to be implemented in India and will only come into practice from 1st May 2012. According to this regulation, 'electrical and electronic equipment' means equipment that is dependent on electric currents or electro-magnetic fields to be fully functional, and 'e-waste' means waste of electrical and electronic equipment, whole or in part or rejected from their manufacturing and repair process, which are intended to be discarded. These rules are meant to be applied to

every producer, consumer, or bulk consumer involved in manufacturing, selling, purchasing, and processing electrical and electronic equipment, collection centres, dismantlers, and e-waste recyclers. Responsibilities of producers, collection centres, consumers, dismantlers, recyclers, are defined and incorporated in these rules. Implementing E-waste (Management and Handling) Rules, 2011 needs to be improved. The company comprehensively revised e-waste rules in 2011 and notified the E-waste (Management) Rules in March 2016 for effective and environmentally sound e-waste management. Electronic waste generation in India Actual and reliable data on the generation, both domestic and import of E-waste, is currently out of stock in India. Various agencies have conducted several studies to devise an inventory of E-waste in the country. According to the Comptroller and Auditor-General's (CAG) report, over 7.2 MT of industrial hazardous waste, 4 lakh tonnes of electronic waste, 1.5 MT of plastic waste, 1.7 MT of medical waste, and 48 MT of municipal waste are generated annually.

In 2005, the Central Pollution Control Board (CPCB) estimated India's e-waste to be 1.47 lakh tonnes or 0.573 MT per day. A study released by the Electronics Industry Association of India (ELCINA) at the electronics industry expo "Componex Nepcon 2009" estimated the total e-waste generation in India at a whopping 4.34 lakh tonnes by the end of 2009. The CPCB has estimated it will exceed 8 lakh tonnes or 0.8 MT by 2012. It is worth mentioning here that, according to the UN Report, India is the world's fifth biggest Producer of E-waste. Maharashtra, Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh, Madhya Pradesh, and Punjab, with a total generation of 1,09,577 MT, generated 70% of the total e-waste in the country during the year 2005. A compliant national database on e-waste generation in the country is not maintained annually.

The e-waste problem is of global concern because of the nature of production and clearance of waste in a globalized world. Even if it is challenging to quantify worldwide e-waste amounts, we know that hefty amounts are ending up where processing occurs at a very rudimentary phase. This raises concerns regarding resource efficiency and immediate concerns

about the dangers to humans and the global environment. There is a long and often complicated chain of events in the e-waste problem. Beginning from an idea, someone has asked for the latest artefact and then its production, ending in its purchase and eventual clearance by the end-user. By engaging with various stakeholders and relevant scientific wisdom inside this chain of events, we are on the way to add more to the existing E-waste Problem.

## 1.13. SIGNIFICANCE OF THE STUDY

In the technical era, companies are finding new electronic items and satisfying consumer needs every day. Consumers also express their interest in buying electronic goods immediately after the electronic goods are introduced in the market. Due to the innovation in electrical and electronic companies, consumers frequently replace their existing equipment with new ones. It has a significant impact on society in the name of e-waste. The consequences of E-waste are shocking.

The usage of electronic devices is increasing day by day. Developed and developing countries are both equally responsible for generating E-waste. Technology has a short span of life. It has no shelf life. Change in technology takes place quite often; therefore, the older one becomes redundant and wasted when a new version of technology emerges. This leads to the generation of E-Waste on a massive scale. The existing management practices related to e-waste in India need to be better managed, and they potentially risk human health and the environment. Moreover, the policy-level initiatives are not being implemented in an appropriate way. The extreme amount of lead in electronics alone causes damage to the central and peripheral nervous systems, the blood, and the kidneys. E-waste related to computers ends up in landfills. Only about two percent of PCs find their way to a second user. About 60 million cell phones are replaced worldwide a month, and only 10 percent are recycled. Flat panel computer monitors and notebooks often contain small amounts of mercury in the bulbs used to light them. Cathode ray tubes in older TVs. All these toxic elements are harmful to human health and the environment.

In recent years, the extent to which electronic goods are used has become a significant environmental issue around the globe. The dumping of electronic waste and improper remanufacturing of e-waste are the foremost causes of the growing junk of e-waste. As a result of this, life-threatening diseases similar to cancer and other infectious diseases have become prevalent in every society. It is also widely believed that e-waste is not the foremost pollutant compared to different elements. This misconception has aggravated the problem substantially. Improper remanufacturing and improper metal extraction methods are widely extended without safety precautions. Due to this, contamination of detrimental metals in water and air has become a natural phenomenon. Inappropriate and inefficient e-waste management laws are liable for this emerging and extended ecological problem.

Nevertheless, e-waste is a source of money because it contains expensive metals similar to gold, copper, and silver. The remanufacturing industry is earning huge profits from e-waste, and after extracting expensive metals, they dump detrimental e-waste in the soil or contaminate the water. Cases of life-threatening diseases are prevalent, and eventually, medical science is incapable of discovering the cause of illness. Indirectly, they blamed water, air, and soil. We all know that various laws and regulations are enacted in India to curb environmental pollution. It is widely believed that ecological pollution is mainly caused by industrial waste, domestic waste, and automobile effluents. But now, waste's foremost contribution to industrial waste has been made. The legislature has done its duty by enacting hazardous waste management rules in India in 2003 and 2008, which need to be more comprehensive and not exhaustive on the issue of e-waste. The government and industry cannot control and curb the e-waste problem. The services and remanufacturing system are in a shocking state of affairs, and the cases of pollution caused by e-waste are rapidly increasing in India. The laws governing them seem insignificant and ineffective, creating no deterrence.

The environmental pollution caused by e-waste is irreversible and is yet to be realized by the masses, particularly in developing countries. Larger organizations may dispose of their e-waste directly through scrap dealers and recyclers, whereas specific Government departments use auctions as a medium of sale. The government has implemented nationwide programs, conferences, and policies regarding protecting the environment and the e-waste problem. There are laws, articles, and acts made by the government to solve the problem of e-waste, which is prevalent in our country. Still, more than this action is needed as most people are unaware of government activities that keep the environment healthy. Improper recycling and disposal methods can be dangerous, causing ill effects on human health. Crude recycling techniques like dissolving the parts containing metals in acid or burning them cause widespread environmental contamination (Priyadarshini et al., 2011). Some potential ecological contaminants in e-waste are lead, cadmium, mercury, and nickel, though they also contain valuable metals like Cu, Platinum, and Gold.

E-waste is highly complex to handle due to its composition. It comprises multiple components, some containing toxic substances that adversely impact human health and the environment if not handled properly. Often, these problems arise out of improper recycling and disposal methods. Technical solutions are available, but in most cases, a legal framework, a collection system, logistics, and other services must be implemented before a technical solution can be applied. It is felt that they are unaware of the harmful effects of e-waste accumulation. However, more is needed, as most people are unaware of the government's activities in keeping the environment healthy. People must be aware of the potential negative impact of the rapidly increasing use of computers, monitors, and televisions. When these products are placed in landfills or incinerated, they pose health risks and contain hazardous materials.

The study was conducted because a healthy environment is a part of our lives. The problem can be solved only by instilling awareness in people about e-waste and the management of electronics. In many cities in the

country, the e-waste problem is caused by the fact that most people use electronic gadgets, but they need proper knowledge of their management and disposal. Students are the future consumers and future citizens. The use of technology should not be in a selfish manner. It is felt that old generations are not technologically friendly. It is the present and our future generations that need to change their attitude. Younger generation indulge in a tech-savvy life for social approval and status but do not take responsibility for their actions.

Hence, the teacher must create awareness among the young generation about e-waste and its harmful effects. The teacher should provide knowledge of the proper disposal methods of discarded electronic materials and their management. According to Borthakur and Sinha (2013), In India, the volume of e-waste generated was 146,000 tonnes per year. In the present life, technology has taken revolutionary growth due to human efforts to get more benefits, but apart from this revolution's benefit, the problem of disposing of e-waste reigns, as humans know how to use the gadgets but not to dispose of them. The study investigates the awareness of electronic waste management among college students. So, the reason for selecting college students as the target group is to raise awareness about the environment and electronic waste management problems. So, the present study focuses on "**Awareness on E-waste Management among College Students in Tirunelveli District.**"

## 1.14.TITLE OF THE STUDY

Environmental pollution is one of the most significant problems that the world is facing today. Seventy-five percent of e-waste that gets disposed of can be recycled or trashed into landfills or incinerators. For cell phones, EPA (2011) estimates that roughly twenty percent of mobile phones are kept in storage after usage instead of being recycled or thrown away. Out of all the metals used in electronics, cadmium and lead are the most toxic. Mercury is used in electronics as a lighting device to help illuminate flat screens. If released into the environment, mercury can be converted into methyl mercury, which can interfere with and damage the development of

foetuses. Knowledge, skills, and values form the basis for higher levels of understanding. Therefore, the current study aims to investigate ***"Awareness on E-waste Management among College Students in Tirunelveli District."***

## 1.15. OPERATIONAL DEFINITIONS OF IMPORTANT KEY TERMS

E-waste

Electronic waste or E-waste is any broken or unwanted electrical or electronic appliance. E-waste includes computers, entertainment electronics, mobile phones and other items that have been discarded by their original users (Puckett et al.2002). It includes a broad and growing range of electronic devices from large household appliances such as refrigerators, air conditioners, hand-held cellular phones, personal stereos, consumer electronics and computers. E-waste is hazardous, and it is generated rapidly due to the extreme rate of obsolescence. E-waste contains over 1,000 different substances, many of which are toxic, and creates serious pollution upon disposal. These toxic substances include lead, cadmium, mercury, plastics and so on (Gaulon et al.2005).

Awareness

Awareness at this moment refers to the generalization of divergent views or different concepts that are growing in the mind of an average person in any particular field. The idea may have a positive or negative response.

Management

Management is a set of activities including planning and decision-making, organizing, leading, and controlling directed at an organization's resources (human, financial, physical, and information) to achieve organizational goals efficiently and effectively (Griffin 2002).

## 1.16.OBJECTIVES OF THE STUDY

The present study aims to know about the awareness on e-waste management among college students in Tirunelveli District.

1. To find out the level of awareness on e-waste management among college students with respect to background variables such as gender, locality of residence, type of family, stream of study, type of college, type of management, father's education qualification, mother's education qualification, father's occupation, and mother's occupation.
2. To find out the significant difference between male and female college students in their awareness on e-waste management.
3. To find out the significant difference between rural and urban college students in their awareness on e-waste management.
4. To find out the significant difference between nuclear and joint family college students in their awareness on e-waste management.
5. To find out the significant difference between arts and science stream college students in their awareness on e-waste management.
6. To find out the significant difference between girls and coeducation college students in their awareness on e-waste management.
7. To find out the significant difference between autonomous and non-autonomous college students in their awareness on e-waste management.
8. To find out the significant association between father's education qualification of college students and their awareness on e-waste management.
9. To find out the significant association between mother's education qualification of college students and their awareness on e-waste management.
10. To find out the significant association between father's occupation of college students and their awareness on e-waste management.
11. To find out the significant association between mother's occupation of college students and their awareness on e-waste management.

## 1.17. HYPOTHESES OF THE STUDY

1) The level of awareness on e-waste management among college students is moderate.

2) There is no significant difference between male and female college students in their awareness on e-waste management.
3) There is no significant difference between rural and urban college students in their awareness on e-waste management.
4) There is no significant difference between nuclear and joint family college students in their awareness on e-waste management.
5) There is no significant difference between arts and science stream college students in their awareness on e-waste management.
6) There is no significant difference between girls and coeducation college students in their awareness on e-waste management.
7) There is no significant difference between autonomous and non-autonomous college students in their awareness on e-waste management.
8) There is no significant association between father's education qualification of college students and their awareness on e-waste management.
9) There is no significant association between mother's education qualification of college students and their awareness on e-waste management.
10) There is no significant association between father's occupation of college students and their awareness on e-waste management.
11) There is no significant association between mother's occupation of college students and their awareness on e-waste management.

## 1.18. LIMITATIONS

Limitations are conditions beyond the research's control that may restrict the study's conclusions or application to other situations. As far as the study is concerned, the investigators find the following limitations. The investigators have limited to test a 5% level of significance. They expect a sampling error, the truthfulness of the responses by the respondents, and the respondents' mood, whim, and interest while answering.

## 1.19. DELIMITATIONS

"Delimitations are the boundaries of the study." Owing to the constraint of time, the investigators have following boundaries for their study

- The present study has been delimited to following demographic variables namely gender, locality of residence, type of family, stream of study, type of college, type of management, father's education qualification, mother's education qualification, father's occupation, and mother's occupation.
- The investigators have taken samples only from Tirunelveli District.
- The investigators have confined their study only to the students studying in arts and science college students
- The college students in the rural and urban areas were alone involved in the study.
- The investigators have selected only 500 students as samples for this research.

## 1.20. CHAPTERISATION

Chapter I of this study contains a brief Introduction, the concept of e-waste, the composition of e-waste, e-waste production in India, e-waste management, environmental degradation, impact of public health issues, effect on environment and human health and e-waste - A global challenge and a note about the need and significance of the study, objectives, hypotheses, limitations, and delimitations.

Chapter II reviews the studies related to the present investigation, done in India and other countries related to e-waste Management.

Chapter III talks about the Methodology. The method used to collect the data, variables, tools employed, sample, and statistical techniques for the analysis are discussed in this chapter.

Chapter IV contains the analysis and interpretation of the data.
Chapter V summarizes the procedure, significant findings, and educational implications. It also includes recommendations and suggestions for future research.

## 1.21. CONCLUSION

Waste management is a severe concern wherever there is human existence. E-waste is one of the most complex and heavily accumulated forms of waste we are living with. Every day, newer and technologically improved electrical and electronic devices are introduced. In modern lifestyles, devices like mobile phones, computers, television sets, air conditioners, refrigerators, mixer grinders, etc., are essential. Today, the consumer is fashion or style-conscious and adopts the latest offering in the market even when the existing products may be functional. This tendency contributes to increasing quantities of e-waste across the world. Illegal dumping and transboundary movement of e-waste in under-developed and developing countries are massive economic and environmental challenges. Mining natural raw materials for the electronic industry leads to the acute depletion of resources. People must be aware of the potential negative impact of the rapidly increasing use of computers, monitors, and televisions. When these products are placed in landfills or incinerated, they pose health risks and hazardous materials. At the same time, e-waste management is a phenomenal business opportunity. The complexity of e-waste management involves various components with harmful and dangerous toxins. Improper handling of e-waste can lead to health and environmental challenges.

# CHAPTER-II
# REVIEW OF RELATED LITERATURE

## 2.1. INTRODUCTION

Familiarity with the literature in any problem area helps the students to discover what is already known, what others have attempted to find out, what methods of attack have been promising and disappointing, and what problems remain to be solved. According to Aggarwal, J.C. is correct in stating that The study of related literature implies locating, reading, and evaluating research reports and reports of observation and opinion related to the individual's planned research project. W. Best says all human knowledge can be found in books and libraries. Unlike other animals that must start a new generation, man builds upon the accumulated and recorded knowledge of the past. His constant addition to the vast store of knowledge makes progress in all areas of human endeavour possible.

The phrase 'Review of Related Literature' comprises two words: Review and Literature. The term 'Review' means to "Re-Look" or to look again or to collect the knowledge of the particular area of research systematically, to involve a collection of knowledge to show that the study would be an addition of knowledge to the field. The term "Literature" refers to the knowledge of a particular field of study of a stream, which includes theory, practical, and research or literature as the mirror that reflects the past view and presents the future perspective. Review of related literature means locating, reading, and evaluating the past and current literature of the research concerned with the planned investigation. Such literature provides the researcher with the footprints of earlier travellers who have gone ahead on the same route. The time spent on a survey of related literature is invariably a wise investment. It is a crucial step that minimizes the risk of dead ends, wasted efforts, rejected topics, and, even more importantly, errorless findings based on a faulty research design. A literature review also makes a researcher aware of the nature, kind, and magnitude of the work done in the field and indicates the direction of further studies on the subject. Sometimes, the probable and possible research topics may also emerge from

such reviews of the relevant literature. The investigator must review related literature to conceptualize the research problem explicitly and meaningfully. Keeping in mind the stated arguments, the researcher has reviewed the relevant literature, followed by a systematic analysis of different researchers' studies, ideas, concepts, and views. These are presented here: Studies done abroad and Studies in India.

## 2.2. OBJECTIVES OF REVIEW OF LITERATURE

1. To provide theories, ideas, explanations, or hypotheses which may be helpful in the formation of a new problem
2. To indicate whether the evidence already available solves the problem adequately without requiring further investigation. It avoids the replication.
3. To provide the sources for hypotheses. The researcher can formulate research hypotheses based on available studies.
4. To suggest methods, procedures, sources of data, and Statistical techniques appropriate to the problem's solution.
5. Locate comparative data and findings that are useful in interpreting and discussing results. The conclusions drawn in the related studies may be significantly compared and used as the subject for the study's findings.
6. To help develop the expertise and general scholarship of the investigator in the area investigated.
7. Contributing to the accurate knowledge of the evidence or literature in one's area of activity is a promising avenue towards making oneself. Whether employed in an institution of higher learning or a research organization, this knowledge is an asset.
8. To provide some insight regarding solid points and limitations of the previous studies.

## 2.3. NEED OF REVIEW OF LITERATURE

A summary of the writings of recognized authorities and previous research provides evidence that the researcher is familiar with what is already known and what is still unknown and untested. Since effective research is based

upon past knowledge, reviewing related literature helps eliminate the duplication of what has been done and provides valuable suggestions for significant investigation. This helps in understanding the nature and design of the research investigation

### 2.3.1. IMPORTANCE OF THE RELATED LITERATURE

The study of related literature helps acquire information about the studies done in the field, protects against unnecessary duplication, guides the carrying out of the investigation successfully, and makes the investigators familiar with the steps. A survey of related literature serves the following purposes.

1. It gains background knowledge of the research topic.
2. It provides valuable ideas, theories, explanations, or hypotheses for formulating the problem.
3. It identifies the concepts relating to their potential relationships and formulating researchable hypotheses.
4. It defines appropriate methodology, research design, methods of measuring concepts, and analysis techniques.
5. It locates comparative data applicable to the interpretation.
6. It identifies other researchers' data sources and learns how others structured the reports.

### 2.3.2. PURPOSE OF THE STUDY

Besides allowing the researcher to acquaint himself with current knowledge in the field or area in which he will conduct his research, a review of the related literature serves the following.

1. The review of related literature enables the researcher to define the limits of his field. It helps the researcher to delimit and define his problems. The knowledge of related literature brings the researcher up-to-date on the work that others have done and thus states the objectives clearly and concisely.
2. The researcher can avoid unfruitful and useless problem areas by reviewing the related literature. He can select those areas in which

positive findings are likely to result, and his endeavours are likely to add to the knowledge meaningfully.

3. By reviewing related literature, the researcher can avoid duplication of well-established findings. It is no use to replicate a study when the stability and validity of its results have been established.
4. The review of related literature gives the researcher an understanding of the research methodology, which refers to how the study will be conducted. It helps the researcher know about the tools and instruments that proved valuable and promising in previous studies. The advantage of the related literature is that it also provides insight into the statistical methods through which the validity of results is to be established.
5. The final and crucial specific reason for reviewing the related literature is to know about the recommendations of previous researchers listed in their studies for further research.

### 2.3.3.TWO PHASES OF REVIEW OF LITERATURE

- Identification and Reading - It includes identifying all the relevant published material in the problem area and reading that part with which we are not thoroughly familiar. One develops the foundation of ideas and results on which his study will be built.
- Writing - The second literature review phase involves writing this foundation of ideas into a section of the research report for the joint benefit of the researchers and readers. For the researchers, it establishes the background in the field. It provides a summary of the thinking and research necessary for the readers to understand the study.

## 2.4. REVIEW OF RELATED LITERATURE

In India, the amount of E-waste generated is rising rapidly. With the increasing dependence on electronic and electrical equipment, the country is expected to increase its e-waste generation. However, managing the same is a significant challenge the government faces. For example, in India, only two authorized small E-waste dismantling facilities are functioning in

Chennai and Bangalore. Nevertheless, the increasing e-waste generation is asking for many more such units nationwide. There is no large-scale organized E-waste recycling facility in India, and the entire recycling exists in an unorganized sector.

Moreover, management practices often need to be better designed and have a lot of health and environmental repercussions. The involvement of the urban poor, especially women and children, and illegally imported E-waste from developed countries further exaggerates the problem of E-waste in India. The need for more public awareness regarding the disposal of electronic goods and the inadequacy of policies to handle the issues related to e-waste has enhanced the problem in India. In most cases, most e-waste remains unattended in households and public offices. Rarely do some sectors, like some IT companies, practice Extended Producer Responsibility or Take Back Policies. Due to the lack of awareness, some people discard E-waste with regular municipal solid waste, a highly dicey practice. People tend not to care about the waste's faith once discarded, thus satisfying the principle of out of sight, out of mind. Indian people are still trying to realize the associations between the cause of e-waste generation and its detrimental health and environmental effects. Another critical factor in the Indian context is that although the information technology revolution started in India in the early 1990s, the first rule exclusively dealing with E-waste came up only recently after almost 20 years in the form of e-waste (Management and Handling) Rules, 2011. Proper implementation of the e-waste (Management and Handling) Rules, 2011 is essential to address the ever-growing pile of E-waste in the country.

**Jahan (2023)** conducted a study, "Evaluating The Level of Knowledge and Awareness Regarding E-Waste among University Students in Bangladesh." This research looks at electronic waste. E-waste entails significant worries in Bangladesh due to its large production and lack of proper recycling facilities. In their study, they used non-probability sampling to gauge information about university students' knowledge, awareness, perceptions, and disposal behaviors regarding electrical and electronic waste or e-waste. The study aims to evaluate university students' awareness, understanding,

and involvement in sustainable e-waste management methods. The report also examines Bangladesh's e-waste recycling processes and the country's present legal framework. The study's findings revealed that while consumers know what electronic e-waste is, they need more awareness about its recycling and management. It also helps to increase environmental awareness and sustainable e-waste management practices among university students in Bangladesh.

**Jain (2023)** conducted a study, "Review on E-waste Management and its Impact on the Environment and Society". This theoretical paper focused on Electronic trash, often known as E-waste, a type of garbage generated by electronics in the industrial world; trash is one of the most challenging and rapidly expanding issues. E-waste comprises old or end-of-life electronic appliances such as computers, laptops, televisions, generators, DVDs, mobile phones, freezers, and other items that their original owners typically discard due to their short lifespan. It contains several hazardous constituents that negatively impact the environment and, more importantly, human health if not properly managed. Because it includes harmful chemical elements, E-waste proves to be a significant difficulty. E-waste is believed to be the future of communications, but due to the short life span of various appliances, they are being trashed and polluting the environment. Many groups and governments from multiple nations have implemented a variety of ways to address the problem and threat to the environment and human health. Hence, this review presents a compendium of various sources of e-waste, environmental hazards, their composition and characterization, and e-waste scenarios in India and the world. For the sake of the future, handling and processing techniques and e-waste recycling should be used. Their paper mainly outlines the issue of e-waste, covering the improvement and plan to tackle it.

**Maphosa et al. (2022)** conducted an "E-Waste Awareness and Practices of Zimbabwean University Students: A Descriptive Study." Their study insists that Africa's cyberspace is experiencing unprecedented growth as the continent joins the global village to spur socio-economic development.

Information and Communication Technologies (ICT) have become part of everyday life. When they reach the end of their working life, they become electronic waste (e-waste) and should be appropriately discarded. However, the continent is streaming towards a significant crisis as obsolete ICT equipment is indiscriminately disposed of to the detriment of the environment and public health. It also helps to assess university students' e-waste awareness and practices. The cross-sectional study was conducted amongst university students in Zimbabwe. The results showed that the four independent variables (lack of knowledge, policies, poor practices, and handling) positively influenced e-waste management by university students in Zimbabwe. Poor handling had the most potent effect on e-waste management of the four independent variables, with a regression coefficient of 0.420 and the lowest significance of 0.000. Although the knowledge of e-waste was high, students needed to gain knowledge of policies/laws that regulate environmental and health management. Advanced understanding of e-waste did not translate into responsible management as e-waste was kept at home, transported, and stored with municipal waste. There needed to be designated bins for collecting it. Most respondents needed clarification on what was happening regarding the generation, handling, storage, transportation, and final disposal of e-waste. By analyzing students' knowledge and practices, universities should intensify e-waste management advocacy by incorporating e-waste matters into their learning curriculum. They insist that the government should enact policies that govern the management of e-waste and will provide a framework for institutions to set up local-level policies that promote green initiatives.

**Juma and Kagoya (2022)** conducted a study, "An Assessment of Electronic Waste Knowledge, Attitude, Intentions, and Risk Perception of Sustainable Electronic Waste Management from a Developing Country Perspective." This study assessed E-waste knowledge, intentions, E-waste attitude, and E-waste risk perceptions regarding sustainable E-waste management practices among key government decision-makers using the Theory of Planned Behavior (TPB). Questionnaires were analyzed using Partial Least Squares-Structural Equation Modelling (PLS-SEM)

multivariate statistical technique. Findings indicate that the sustainable E-waste management practice model, based on E-waste knowledge, E-waste intentions, E-waste attitude, and E-waste risk perceptions, explains 56.2% of the sustainable E-waste management practice variance. Additionally, E-waste attitude, knowledge, and intention significantly influence sustainable E-waste management practices. E-waste attitude demonstrates the most robust prediction of sustainable E-waste management practices from a government employee's perspective. Using the context of the theory of planned behavior (TPB), the study found that e-waste attitude is the most crucial predictor of the sustainability of e-waste management practices, followed by e-waste knowledge. Secondly, by applying the PLS-SEM approach, the study adds E-waste risk perception and E-waste knowledge as an extension of the Theory of Planned Behavior. Practically, valuable insights and understandings encouraging environmental awareness and sustainable E-waste management among citizens plus recommendations are provided.

**Raudha and Msolla (2021)** conducted a study, "Assessment of Factors Affecting Electronic Waste Management within University Students' Environment". This study aimed to assess factors affecting the awareness of electronic waste management among University students. The study was conducted at a university in Tanzania; the case for the study was not disclosed for security reasons. In particular, the study focuses on factors such as user awareness, budgets, and policy and their link to e-waste management. The study was motivated by the fact that students in higher learning institutions face the challenge of e-waste accumulation, which is increasing steadily. The study adopted the mixed research approach. In total, the study used 377 respondents to address its objective. In addition, the study used a probability sampling technique to obtain the sample for the study. Further, the study cleaned data and used descriptive statistics to respond. The findings revealed that the university students' awareness of electronic waste management could be higher. Also, findings showed that the University needs a budget allocated for electronic waste management, and there is a lack of policy at the University to provide students with an

awareness of electronic waste management. Students should be empowered with electronic waste management knowledge.

**Mahosa (2021)** in the study "Students' Awareness and Attitudinal Dispositions to E-Waste Management Practices at a Zimbabwean University," Environmental experts are concerned that e-waste is growing faster than recycling or reusing initiatives. Universities from developing countries often import used electronic and electrical equipment to improve student's access to technology. Significant challenges include the need for explicit action plans on handling e-waste and the absence of infrastructure in developing countries. The study examines students' awareness and attitude toward e-waste management practices at a Zimbabwean university. The research summarizes complex issues related to improper e-waste management in a developing country, leading to environmental and health degradation. The researcher collected data from 216 students through an online questionnaire, and data were analyzed using Statistical Package for Social Sciences (SPSS) version 26. The results show that most participants disposed of e-waste with municipal waste. The participants acknowledged that lack of awareness, policies, and the unavailability of collection points and recycling facilities significantly impair e-waste management. Knowledge of the effects of e-waste on the environment and human health did not translate into appropriate e-waste management practices. The study challenges policymakers to develop e-waste policies and establish e-waste value chains that sustain the e-waste ecosystem. The study insists that the University establish local e-waste policies, identify designated e-waste collection points, and deploy primary recycling plants. He also said the institution should launch e-waste clubs to create more awareness, knowledge, and positive attitudes toward e-waste management.

**Ranjani (2021)** conducted a study, "E-Waste Management Education - A Study among Students of Osmania University." The Indian Government's ability to safeguard the country's environment depends on policies and education systems. The disposal of e-waste is one of the world's significant challenges today. Hence, humans are asked to reduce, reuse, and recycle

their waste. Even the most learned people are unaware of the segregation of objects to reduce, reuse, and recycle. These three words, if followed by every person, would be helpful to protect our environment. Given the volume of e-waste a typical college campus can produce, adopting a waste management strategy designed to maximize participation is essential. A successful recycling program should operate with an infrastructure for on-site collection that is free and accessible. On-campus accessibility will maximize collections and foster widespread organizational support. Research on awareness regarding effective ways of handling e-waste among university students after the implementation of the WEEE policy in India is limited. Therefore, the current study aims to educate students of Osmania University regarding the 3 R's, that is, recycle, reduce, and reuse e-waste.

**Sivannatham and Govindarajan (2020)** conducted a study, "Attitude and Skills on E-Waste Management among Undergraduate Students." In their research, they found out the attitudes and skills of undergraduate students regarding E-waste management. A survey method of research was used. A sample of 210 students was selected from different colleges in the Thanjavur district through the Simple Random sampling technique. The self-developed E-Waste Management attitude and skills questionnaire was used to collect the data. It was found that all the students, irrespective of their attitude and skills, of the existence of e-waste. The result of the research is that there is no significance in attitude and skills of E-waste management in undergraduate students of gender, locality, subject, and type of management. Hence, the hypothesis of research is accepted.

The researchers **Ray et al. (2020)** conducted a study to analyze California's future recycling infrastructure requirement. This study utilized a time-series materials flow analysis model (MFAM) to calculate the total e-waste amount in the upcoming days. They estimated the overall cost of setting up the Material recovery facility (MRF) because recycling became elevated in California due to the landfill disposal ban followed in that city. Other than this, the intentional activities of the initial e-product customer's behaviour were also the reason for the increased e-waste recycling. The cost of CPU

goods increased in 2005, and the recycling costs decreased. This increased the total capital amount for the MRF. This study analysis showed that CPU recycling increased to nearly 8. ion in 2013, and LRT monitors replaced CRT devices. The study concluded the fact that the overall average increased MRF was about 60, and the increased capital amount was about 16 million for the CPU recycling in California

**Sharma et al. (2019)** conducted a study, "E-Waste Awareness among Medical Undergraduates in a Tertiary Care Teaching Hospital in Delhi, India: A Cross-Sectional Study." Globally, around 44.7 million metric tonnes of e-waste was generated in 2016. India, the second most populous country in the world, generated 2 million metric tonnes of e-waste in 2016. About 5000 metric tonnes of e-waste are imported into India every year. In their paper, they highlight the need to study awareness of e-waste among the consumers who generate it. The primary objective is to assess the knowledge regarding e-waste among medical undergraduate students as they are also the consumers of electronic equipment that constitutes e-waste. The present study was cross-sectional and was done among 300 medical undergraduate students of a tertiary care hospital and teaching institution in Delhi, India. A pretested, semi-structured, self-administered questionnaire was used to gather information from study participants. Descriptive statistical analysis was performed. More than two-thirds of the (77.3%, 232) study participants were aware of the concept of e-waste. Out of these 232 students, only about half had adequate knowledge about equipment contributing to e-waste and constituents of e-waste. A common reason for purchasing new electronics was a desire for new technology. The study result showed that a significant percentage of students (22.7%) have yet to hear of the concept of e-waste. Their practices related to e-waste handling were hazardous from both health and environmental aspects. This is an area of concern in this era of growing ecological deterioration. There is also a need to study general public awareness so that appropriate measures can be undertaken.

**Patil (2019)** conducted a study, "A study on awareness of youth towards e-waste concerning Nashik city." In the study, he insists that technology has given many products to modern human beings to simplify their lives. However, the generation of e-waste has also increased manifold in the past few years, which poses a severe challenge for the 21st century. Not handling e-waste effectively includes pollution, hazardous materials like lead, mercury, and cadmium, entering the ecosystem, waste of critical natural resources, health issues of sanitation workers who handle such waste without proper training, and many more. Thus, it is essential to have effective e-waste management. The first step towards achieving this is to create awareness about e-waste. Their study showed that the survey showed youth awareness about e-waste in Nashik City. However, as of now, waste is segregated only into two categories: dry and wet waste. Priority should be given to spread awareness about e-waste and its proper disposal. It has been concluded from the study that the general awareness regarding what constitutes e-waste, awareness about e-waste, and the benefits of recycling are well known to the youngsters of Nashik City. However, they need to be made aware of proper disposal methods. Also, most respondents must be made aware of any recycling centers nearby. International E-Waste Day was first celebrated on 13 October 2018, also known to a few respondents. Authorities can attempt to popularize this day by roping relevant and contemporary personalities to popularize the concept of recycling e-waste. That shall help increase awareness of e-waste and, in turn, more responsible behavior towards correct disposal for reuse and recycling of e-waste.

**Govindarajan and Sivannatham (2019)** in their research paper titled "Attitude on E-waste management among undergraduate students in Thanjavur district." The normative survey method was adopted in this study. Attitude was the variable used for the study. Three hundred twenty samples of undergraduate students from government and aided Arts and Science College in Thanjavur district of Tamil Nadu were selected for their research the investigators developed the attitude questionnaire. The results of the study showed that the research is that there is no significance in the attitude

of E-waste management in undergraduate students of gender, locality, type of management, and subject.

**Shevchenko et al. (2019)** Authors in this paper have explained consumer awareness of e-waste; they have said that electronic items consumers use has a huge range of materials like critical minerals and precious metals. It confirms that recycling these is compulsory for future use; many energy-renewable solutions are mainly available. Further, they said that improper end-of-life treatment of products can harm human health and the environment. To increase consumer collection in the end-of-life of products, they have used incentives to attract consumers. It is a reward to the consumers on the cost of the proper collection for the transactions, satisfying the consumer for the end of life of electronic items. Further, the authors talked about the consumer behaviour methods of e-waste. They explained methods like reuse and recycling, how a collection of e-waste is separated, and incentives for consumers to end the life of products. The authors have also discussed the e-waste management legislation and extended producer responsibilities. By explaining the challenges of e-waste management, they have talked about e-waste collections, storing e-waste as household things, and incentivizing consumers to return waste. We must implement electronic bonus card systems at the end of the product's life. In conclusion, they have stated that consumer behaviour is important for waste management. The economic incentives are to be given to the consumer in return for waste, but the critical issue is who will pay this incentive to the consumers. One solution they have is that incentives should be distributed to manufacturers, distributors, and municipalities as recycling costs are redistributed nowadays. The second and most important issue, they stated, is a need for connection companies to connect to produce purchasing, purchase, and collect data. There is a need to monitor the collection rate based on specified e-waste categories. An amount of bonus is possibly given in the country to accomplish the highest recycling rate, and the incentive cost is shared between the manufacturer, distributors, municipalities, and stakeholders who are also responsible for those collecting sites. The bonus amount could

be based on the economic damage caused by environmental pollutants because of improper e-waste disposal.

**Ghaffar et al. (2018)** authors of this paper have shown that the study provision through virtualization focuses on saving overall expenses there is a need for reduction of e-waste on hardware resources those are costly after some time causes e-waste. They aimed to highlight the harms of e-waste, the importance of the reduction of e-waste, how e-waste can be reduced through virtualization, and the contribution of e-waste towards the green computing functionality of virtualization. Data centers, power consumers, and virtual environments are technologies to reduce energy or use computing in information to optimize communication technology, discovered as visualization. To find the solution to server utilization, resource management, load balancing, e-waste collections, and recycling virtualization is an optimization technique they have revealed through systematic research. Due to its ability to varying information facilities to combine hardware resources and decrease energy costs. The study encompasses virtualization technology and e-waste reduction. By controlling e-waste, the harmful effects of computing on the environment can be reduced through proper implementation of virtualization, which causes the environment and makes computing green at a major level.

**Islam and Huda (2018)** studied "Reverse logistics and closed-loop supply chain of waste electrical and electronic equipment (WEEE)/E-waste: A comprehensive literature review". Their study showed four steps involved in the RL and CLSC of e-waste, namely designing and planning reverse, distribution, conceptual framework, and qualitative analyses, which were identified and reviewed.

**Singh and Amin (2018) i**n this paper, the authors suggest that the e-waste pollution problem is increasing globally. Thousands of tons of e-waste are coming to India from many developed countries like Canada, USA, and Europe. In developing countries, the electronic industries are increasingly fast-paced manufacturing industries in terms of demand and supply, which is based on the lifecycle of the material throughout the world. Further, the

authors in this paper have explained that this paper overviews e-waste control in India, compared with other countries. It includes the effects of recycling, e-waste management, the environment and health. This is to compare the e-waste management rules of India with global, international policies and regulations of e-waste, lifecycle assessment, integrated waste management and recovered and recycled materials by safe methods which raise awareness of e-waste and transferring used e-waste to developing countries should have the possible maintainable result of e-waste management for decreasing the bad effects of informal recycling. To conclude, the authors have mentioned that a major importer of e-waste is developing countries in the world because of informal collection systems. The increasing problem of e-waste is still in many developing countries and underdeveloped countries because of a lack of awareness, legislation by the government, skills, labour technology, and improper processes of e-waste, which has harmful effects on human health and the environment in terms of global warming and due to change climate. E-waste processing comprises hazardous components, and informal sectors handle the process.

**Mishra et al. (2017)** article on Exploring the awareness regarding e-waste and informal handlers in Musheerabad Area of Hyderabad its health hazards. In this article, the authors said that centres from sixty in the locality were conducted in a randomly selected twenty-six waste handling descriptive cross-sectional study. Four handlers were randomly selected between the ages of 18 and 45. A semi structured schedule total of 104 handlers were interviewed. Interviews were also conducted among ten owners of such centres. 72% of the handlers did not know what E-Waste they said about and about health risks, 71% were unaware of any protective gear not used, 85% of improper handling of e-waste, and 16% acknowledged health issues. E-waste was appropriate, while 77% realized that their handling of. Informal e-waste handling does not cause most owners to feel t any issues, and no awareness drive by any agency reported that there was. The need for awareness programs or campaigns through this study highlighted that to ensure the safety among the waste handlers on proper e-waste management should be there. This paper describes the

concept of e-waste, delivering a brief understanding of and concern for e-waste related to e-waste generation in India and health and environmental issues.

**Lakshmi et al. (2017)** conducted a study, "A Review Study of E-waste Management in India." They explained that E-waste or Electronic waste refers to electronic goods that are dumped out or unwanted. Each year, around 50 million tons of e-waste are produced. Depending upon the nature of the reaction, there are possibilities for dangers depending on the situation. Discarded computers, batteries, and other electrochemical wastes may result in unwanted results. So, being aware of e-waste and other physical wastes is essential. The situation is alarming as India generates about 1.5 lakh tonnes of e-waste annually, and almost all of it finds its way into the informal sector as there is currently no organized alternative. The authors of this paper, have discussed e-waste handling strategies in India's present scenario of e-waste management and possible. The Indian scenario can be divided into three parts: the management of e-waste, which has main sections: Collections, Recycling or Recovery, and Disposal. They have listed a few suggestions to optimize the use of available resources of both formal and informal stakeholders for properly handling e-waste. E-waste collections should be made at local, urban, district, and state levels so that the amount of e-waste can be collected. Registered e-waste recycler's representatives will guide collectors about the e-waste and its harmful effects. Door-to-door collections need to be set up by one-to-one contact or phone with the help of formal or informal collectors. The collected e-waste needs to be transported to the registered recycler's destination. We need to fix the items' rates to be given to the user. Finally, they said that the e-waste management system must be rationally designed.

**Subhaprada and Kalyani (2017)** in their research paper titled "Study on awareness of e-waste management among medical students." Their interventional cross-sectional study surveyed II MBBS students at Kurnool Medical College, Kurnool, Andhra Pradesh. A predesigned questionnaire was administered as a pre-test, followed by a health educational intervention

session for 100 study subjects selected by simple random sampling and a post-test two weeks later. Out of 100 study subjects, four did not participate in the post-test. So, a total of 96 questionnaires were considered for analysis. 56.25% of the students were males and 43.75% were females. Their primary source of information regarding e-waste management was the Internet (30.2%), followed by family & friends (16.6%). There was a statistically significant gain in knowledge regarding e-waste management among the study subjects after the educational intervention at $p<0.05$. Health education to create awareness regarding the hazards and management of e-waste is the need of the hour to reduce, reuse, and recycle e-waste

**Zaib et al. (2017)** The authors emphasize green computing, recycling sustainability, sustainability, data centers, and Energy Star. Energy Satirise systems green computing is moving research into energy-saving methods for home computers. From E-hazards to finding a way to handle computers, the environment and societies try to save. in green computing study emphasis on current trends, challenges related to the field of green computing, and green computing's future trends; meanwhile, to collect relevant information to fulfill this research, it is qualitative research, discrete interviews used by the researcher to achieve green computing observations Information Technology is putting efforts in all its sectors. A liable way to address the problem of global warming is to decrease paper usage, equipment recovery, virtualization, cloud computing, power management, near-green computing, and green manufacturing, which are the key creativity of green computing. To achieve the green computing provisions, original computing advances and applications are needed to sustain information and communication technology (ICT).

**Raj et al. (2017)** India is moving towards the digital age, and rising e-waste management is necessary for sustainable growth. The sale of mobile phones, especially smartphones, is increasing rapidly in India. It is also thrown out or not used in the same phase. It is important to create awareness of end-of-life management of short-life cycled products concerning their servicing, reusing, remanufacturing, recycling, and making a greener design.

Remanufacturing seems to be a good strategy to reduce the e-waste falling in landfills. Mostly, people's mindsets must be changed so they do not pollute our earth with toxic materials. Schools should develop awareness about the conservation of resources, reducing waste, using mobile phones to their full EOL, buying green manufactured electronic products, and safe disposal of hazardous wastes.

**Lolikar (2017)** this report shows that the hazard of electronic waste is the existing strategy of its appropriate management, and options can be implemented. Electronic waste, like landfilling paper, discusses the existing solutions, such as incineration and recycling. The four strategies for successfully managing electronic waste are Reuse, Reduce, Recycle, and Refurbish. To reduce electronic waste, this paper discusses e-waste management; recycling is the only way. The root of giving solutions to the management of e-waste researchers believes that education is the. One of them is cloud computing. Collection of e-waste data Web server application for real-time and material flow real-time monitoring. The main issue in pushing forward the SAAS platform is data security in cloud computing. In India, e-waste generated and recycled is available, but there is no accurate quantity estimate. In e-waste management, awareness of public, consumer, and local governments' improper disposal of e-waste is challenging.

**Motochi et al.(2017)** this paper's authors mention virtualization towards green computing and environmental sustainability. The environment has become a key concern in the perfect world, and global warming is increasingly attracting attention in many discussions. Moreover, energy usage in data centers has become an alarm, bearing in mind that the more energy is used, the more it affects the environment with emissions that eventually cause global warming. This paper recognizes the virtualization environments and accepted green computing environments and then recognizes how virtualization could be used to achieve environmental sustainability. Hence, green computing is a synchronized and bearable method for accomplishing greener, healthier, collaborating technological desires without a safer environment for the current and future generations.

**Kumar et al. (2017)** authors in this paper have stated that more than 90% of the informal sector manages India's e-waste. Because of low infrastructure and operational costs, they can make a profit and lead the market, and they are not responsible for expenses like rent or legitimate wages; they do not invest in modern Technology and are not bound by any laws and regulations. The safe management of waste is authoritative and, as per the future scenario, is done in a structured manner with sustainable recycling technologies, sufficient resources, effective legislation, and monitoring mechanisms. The lack of origination leads to the adoption of inefficient techniques, and this study proposes one such process innovation to channel the electronic waste being produced in dissimilar regions of the country. The unorganized sectors consist of informal businesses and a variety of other businesses not governed by severe health and environmental regulations. Use environmentally sound processes. The authors have discussed the disposal methods of e-waste in I, including recycling and disposing of the product's end-of-life products. There is a need to create a list of informal workers by getting the help of recyclers, dealers, and retailers, which could help reduce the informal e-waste processing. Any chemicals or burnings are not used by the formal recyclers, unlike the informal recyclers, and the roles and responsibilities of informal sectors need to be defined. Mainly around collection and segregation. The informal sector workers must create awareness, skill upgrades, and process efficiency to build capacities amongst environmentally sound processes.

**Udhayakumar (2017)** the author explains the waste disposal methods conducted in Chennai. E-waste production in India the author describes the dire situation in management. This large-scale organization is part of both large-scale and small-scale industries. Further, he stated that workers working in recycling waste are in serious condition due to fewer awareness programs and a lack of training. The author mainly highlights the environmental impacts of recycling e-waste, disposal, and e-waste production, as well as the need for suitable management hazards of e-waste. The electronic waste policy will reduce the growth rate of waste products from the business sector and house appliances. Suitable laws by the local as

well as the central government, along with effective management strategies, are the keys to an eco-friendly world.

**Patil (2016)** the author of this paper, focuses on e-waste management through green computing. As a product of this urbanization process, the paper presents that the dumping of e-waste is the basic problem in our society that has metamorphosed. E-waste leads to the accumulation of at odds toxic metals as these products are not biodegradable; gradual declaration of these take to lead, cadmium, groundwater contamination in turn, the living systems as a thorough going causing severe health hazards besides confusion affects the plant unlovely and. Therefore, proper e-waste management has become a pressing query on this point. Numerous sources of electronic waste This paper opposes their effects and recommends steps for managing these toxic and dangerous wastes in the development process to sustain hazardous wastes. A specific well-outlined stream at the assortment stage of the segregation of electronic waste is a good approach for facilitating ulterior, well-organized usage and use. However, using supplemental price materials and generating an extremely mixed waste stream doesn't encourage using parts. A lot of easier separation of tiny electrical products would build usage. At the moment, varied corporations have developed extremist high cutting UHS technology, a distinct assortment of waste because it will recycle and not use chemical additives.

**Debnath et al. (2016)** In this paper, authors have shown that e-waste management is one of the wide ranges of things that green computing encompasses, and e-waste is a threat to the world's end-of-life electronics equipment. In 2014, the global amount of electronic waste was 41.8 million metric tons. Part of the computer consists of these electronic substances, which are the hardware. To implement green computing a good potential leaves the proper management of e-waste. The authors said that e-waste management is scant and focuses on green computing. The research questions provoked are is it possible to implement green computing using e-waste management. For green computing to establish e-waste management was, as a parameter, the main objective of their study.

**Chaturvedi et al. (2016)** In this paper, the authors have mentioned that in India, there is a lack of awareness of the poor effects of end-of-life products, which is the main alarm of e-waste management among several investors. Officials are made aware of e-waste. It is essential for the government, its management, and the hazards of e-waste. To raise awareness of e-waste management, this project's main purpose is to form capability amongst central and science & technology officials and associated departments, railways, defence and state government departments.

**Lobo et al. (2016)** authors have mentioned that quick modification, changes in media tapes, technology software, MP3, falling prices, and electronic waste around the globe planned undesirability have resulted in a fast growing surplus. Because of the presence of poisonous waste, electronic waste has become a matter of concern. Hazardous substances are present in electronic goods; if not properly managed, they can have adverse effects. Do not care about the environment that people do not understand. The 3 R's can be used to manage e-waste in paper and glass management properly. Many electronics stores offer proper disposal services. A lot of health problems E-waste is dangerous to humans and to the environment which will cause. The authors have discussed the usage of computers CO2 generated by computers and the techniques used to manage e-waste. CO2 emission from information communication technology is called cyber warming. Further, they talked about the e-waste business through e-waste treatment and incentives for the recovery of e-waste. They have discussed the precious metals that can be extracted from producing electronic waste items. Proper information is not provided to or by manufacturers or producers, nor does India have e-waste recycling plants. A maximum amount of e-waste is still imported into India.

**Kumar and Karishma (2016)** authors of this paper have mentioned that in India come across many challenges in the current practices of e-waste management like unsafe conditions of informal recycling, the difficulty in vectorization, pathetic and unproductive regulations in consumers, less awareness and to address the problems unwillingness on the part of the stakeholders. As a result, with no special precautions, toxic materials enter

the waste watercourse, the environment, and human health to avoid the known contrary impacts. When economically valuable materials are discarded, the resources are wasted. Poisonous substances are the major challenge in reducing E-waste over reuse, recycling recovery, and reducing labour intensive to recycle intermediate Technology; waste recovers safely, and one or more stakeholders managing E-waste are accountable. The level of awareness should be increased using advertisements, and in the prospectus, e-waste issues should be included. In conclusion, this author shat that is a need to implement a management chain to reverse e-waste supply. Waste kinds of e-waste must be collected and delivered for recycling parts from e-waste and disposed of hazardous materials that provide environmentally sound management.

**Sivathanu (2016)** conducted a study titled "User's perspective: knowledge and attitude towards E-waste. This paper suggests the various pathways to create awareness so that the consumers' attitudes towards e-waste can be changed, which would help Soy handle e-waste properly and focus on content and effective e-waste management. He discusses the disposal of e-waste, the consumer's awareness, and preference. In this study, he has shown five factors towards proper disposal and awareness of toxic effects on human health, management of E-waste, which is awareness of environment hazards, awareness of E-waste Management awareness of proper disposal, and by various stakeholders and awareness of convenience of recycling. Six hundred consumers conducted a primary survey using a questionnaire in Pune. Towards efficient and effective E-waste management, he s, suggested various pathways to create awareness towards e-waste disposal. Roles in e-waste management further describe that consumer awareness and scrap dealers are essential obstacles in e-waste management behaviour plays important. Lack of consumer awareness and sales of e-waste. In Pune, he explained that in the research conducted, general consumer awareness about e-waste is good. Still, various proper disposal practices of e-waste consumers are unaware of e-waste collection centers and rules. Reusing, recycling, and repairing are also important for proper e-waste management and to spread awareness. In another part of

India, regarding waste management, he has suggested that the same survey should also be conducted to increase awareness.

**Gangly (2016)** explained that in India, the existing e-waste management system is an unhealthy condition of informal recycling from little disadvantages similar to inadequate legislation and public awareness regarding e-waste. Economically priced materials are discarded, or unhealthy informal recycling conditions are developed during informal recycling. no legislation dealing exclusively with electronic waste exists; further, he describes that to date, Guidelines require receiving Hazardous Waste Management (HWM), treating and transporting hazardous waste, and for disposal or dumping, which also demands the prohibition of imported hazardous waste. It comprises stakeholders like manufacturers, consumers, regulators, maintainable e-waste strategy, municipal authorities, state government, and the influence of e-waste policymakers, which can be strictly reduced.

**Heacock et al. (2016)** the authors of this paper have raised concerns about children's health awareness of e-waste processing and the potential harm it poses. They want to increase awareness of e-waste health issues triggered by the environment. At NIEHS (2014), collaborating centres of environmental health, through e-waste centres, to address prevention and involvement policies will support children's health. Further, to increase capacity, buildings reduce the exposure schemes, which prevent or waste decrease the disease burden among children whenever international stakeholders convene around children's environmental health.

**Supian et al. (2015)** published an article, "Current Waste Generation of e-waste and challenges in developing countries: An overview". According to the study, most consumers were unaware of the proper way to dispose of e-waste, and government and institutional promises were not kept because there was insufficiently strict and consistent enforcement. In addition, low-cost equipment and manual segregation were prevalent, and the informal sector played a significant role. To achieve best practices in e-waste management, the research suggested that methodical e-waste management

policies and guidelines in developing countries must be improved. Additionally, because proper treatment comes with high capital and maintenance costs, the problems in these developing nations are made even more difficult by a lack of financial support.

**Gupt and Sahay (2015)** in their study "Waste Management and Extended Producer Responsibility," suggested that the financial responsibility of the producers and separate collecting and recycling agencies contribute significantly to the success of the extended producer responsibility-based environmental policies. Regulatory provisions, takeback responsibility, and financial flow are the three most essential aspects of extended producer responsibility. The presence of the informal sector hurt the regulatory provisions.

**Bhoi et al. (2014)** studied "E-Waste Management and its Consequences: A Literature Review." In their study, they insist that most of the waste is inherently dangerous. It will degrade to provide leachate, which can contaminate water and make lowland gas explosive. Additionally, owing to the risks related to lowland sites, there needs to be more relaxed needs for developing, operating, and medical care. Most design authorities want a figured-out quarry for landscaping instead of a lowland website that nobody wants in their "backyard." Product style should be used to reduce not solely waste's character and quantity but conjointly maximize end-of-life utilization. Makers, retailers, users, and disposers ought to share responsibility for reducing the environmental impacts of merchandise. A product-centered approach should be adopted to preserve and shield the setting.

**Iyer (2014)** The study was conducted, "A Study on the Attitude Towards e-Waste Collection and Safe Management in Academic Institutions in Bangalore." His study explained that the electronic and electrical products discarded or reaching their end of life are called e-waste or electronic waste. With the booming Indian economy and faster technology changes, product life cycles have become shorter. Due to the toxic materials in these products, recycling or disposing of them in a safe and environmentally friendly

manner is essential. The lack of organized segregation processes has created more harm to the people involved in the process. The constitution of India says that everyone has the right to live pollution-free lives. This study would help us understand the awareness level and attitude of students and faculties towards e-waste segregation in academic institutions in Bangalore as they are one of the significant producers of e-waste due to the implementation of Information and Communication Technology (ICT) in Higher Education.

**Sivakumaran and Sivaramanan (2013)** in their study "E-Waste Management, Disposal and Its Impacts on the Environment," confirmed that the public awareness and cooperation of manufacturers are essential for advancing the e-waste management system. Also, the government is responsible for allocating sufficient grants and protecting the internationally agreed environmental legislation within their borders. Licensing certifications like stewardship may ensure security to prevent illegal smugglers and handlers of e-waste. As e-waste is a known primary source of heavy metals, hazardous chemicals, and carcinogens, diseases related to skin, respiratory, intestinal, immune, endocrine, and nervous systems, including cancers, can be prevented by properly managing and disposing of e-waste.

**Jadhav (2013)** study, "Electronic Waste," observed that proper e-waste management would help efficient sourcing and collection up to extraction and disposal of material, ensuring that e-waste will turn into lucrative products and business opportunities. The manufacturers have to take responsibility for adopting the guidelines for manufacturing sound environment products, and sustainability management should start from the product manufacturing stage, raw material selection, product, and process design can be the critical factors for the design of environmental practices, which can facilitate the recycling and reuse. The study explained that e-waste has become a matter of concern in electronic goods because of the presence of toxic and hazardous substances, and it has opposing effects on the environment if not properly managed. Many countries have driven trade connected with waste to introduce interference in environmental issues. Henceforth, to accept sustainability practices, there is a strong need to tackle

the growing threat of e-waste. The informal sector consumes 90% of the e-waste generated in India. Different hazardous materials are found in the e-waste. This paper shows the waste composition of Indian and global e-waste and finds hazardous materials, as well as guidelines for manufacturers and public awareness on proper disposal and best available practices. In conclusion, the Author has explained that many countries can have standards for the proper management of e-waste, which include the collection of e-waste, proper extraction, and safe disposal. There is a need for manufacturers to give take-back offers to consumers. In India, the informal e-waste sector consumes ninety percent of the total. There is a need to educate people regarding reuse, recycling, and disposal of waste, as well as how to be responsible for the environment.

**Begum (2013)** the Author of this paper, explains that discarded electrical devices are described as waste electrical and electronic equipment or e-waste. There is no proper consent on the terms resale, reuse, and refurbishing industries or for the product not to be used for planned purposes. In developing countries, electronic waste processing informally may seriously cause health and pollution. Developing countries mostly reuse and repair electronic items. Most electronic items like CRT contain toxic chemicals like cadmium and lead. Recycling and disposal of e-waste might involve significant risks to workers and the environment, and to avoid unsafe exposure, care must be taken in recycling operations and landfilling. Electronic material management should be careful, and the environmental danger of using electronics must be exaggerated. The main problem in e-waste management is the ignorance of governing rules. A governing rule will be enabled if the implementation body exists properly. A good governing rule must need proper collection and recycling. Furthermore, he stated that governing rules for people and the environment must ensure healthy standards. Further, he explained that many laws are already there, but still, there is no guideline on how to apply those laws for proper e-waste management or how to apply them to e-waste management. The first and foremost step towards waste management is to see the current policies that define e-waste recycling clearly, and the main and important legislation for

e-waste needs to be formulated to fill the gap that is not covered by current laws. It is important to update the current policies and the need to appeal to recyclers to make the recycling process safe and effective.

**Singh et al. (2013)** Authors have mentioned that e-waste is generated from electronic equipment that enters their lives. It is a fruitful gift with the help of the advancement of technology, which includes mobile phones, desktops, PCBs, I.C.s, etc. To reduce E-waste, the concepts of the 3Rs are Reduce, Reuse, and Recycle, which should be implemented. Hence, this paper discusses the problem of E-waste and its management. E-waste can be achieved by recovery, reuse, and sustainable product design, accepting several techniques like decreasing volume.

**Mohammed et al. (2013)** Authors in this paper have mentioned that arsenic, cadmium, antimony, lead, chromium, Mercury, beryllium, selenium, and brominated flame retardants electronics gadgets contain toxic metals that pose threats to health and environment. The respiratory tracts, kidneys, skin, and brain of adults, as well as these refractory metals in children's possessions, are of major concern. Plants and microorganisms are employed to govern the menace of electronic wastes. Governments should promulgate laws and import proper waste recycling technologies to create public awareness and private waste management in developing countries where e-waste is enormous. Using minimum amounts of these toxic metals, electronic companies also have to maintain the hazards of waste by making portable products that are completely less poisonous than heavy metals use their alternatives which are having.

**Kiddee et al.(2013)** Electronic waste management approaches: An overview," e-waste can be managed by developing eco-design devices, properly collecting e-waste, recovering and recycling material by safe methods, disposing of e-waste by suitable techniques, forbidding the transfer of used electronic devices to developing countries, and raise awareness of the impact of e-waste. Each tool is limited, but they can complement each other to solve this issue. A national scheme such as EPR is a good policy for solving the growing e-waste problems. They explained

that the toxic materials currently in e-waste, with management strategies, their possible environmental and, in certain countries, human health influences which are being used. In developed countries, many tools, including life cycle assessment, material flow analysis, multi-criteria analysis, and extended producer responsibility. It has been developed specially to manage e-waste. To progress eco-design devices, the extremely substantial terms in e-waste controlling are properly gathering e-waste, recovering and recycling substantially by safe methods and suitable techniques to dispose of e-waste, and raising awareness of the effect of e-waste. In conclusion, the authors have stated that e-waste is increasing because innovative models and advanced technology generate huge amounts of electronics, mostly consumer products. E-waste consists of many materials, some of which are environmental hazards and for human health if not managed properly. Many case studies prove that these hazards are affecting the surrounding environment. The authors have discussed the four methods for eco-friendly systems and design: systems: collection, recovery, recycling of e-waste, and disposal of e-waste.

**Anam and Syed (2013)** Authors in this paper thought recycling of e-waste talking about green computing. Green computing is a practice of eco-friendly efficiency that uses computing resources. The main goal is to reduce the use of hazardous materials, and the product's lifetime maximizes energy efficiency. currently, through the computer industry, the paper represents numerous green creativities, as well as issues that have been raised regarding these initiatives. It presents a study about green computing and the e-waste recycling process. The main purpose is to reduce pollution and reduce overall environmental impact. Green computing eventually motivates us to discover alternative technologies. They have mentioned that recycling is the most effective solution for end-of-life electronics to the growing e-waste problem in recycling raw materials. Recycling reduces the amount of greenhouse gas emissions. Further, they mentioned that the manufacturing of new products causes it. benefits in inspiring an eco-friendly via going green in technology and a cleaner environment,

laterally with our welfare by falling costs, preserving energy, and cutting down on waste.

**Panda (2013)** the Author of this paper, has stated that during the last two decades, the use of electronic gadgets resulting in soil, water, and environmental pollution has led to the generation of a huge amount of electronic waste. Therefore, the greatest concern of environmental scientists and activities worldwide is pollution control and environmental safety. A major problem in our society is the dumping of electronic waste in this urbanization. Because these wastes are not biodegradable, the accumulation of various toxic grade deposition of these e-waste leads to metals like lead(Pb), Cadmium(Cd), Mercury, and pollutes the soil and the groundwater. A whole causing severe health hazards Affects the plant animals and the living system and disorders. Thus, an insistent demand of the time proper management of this electronic waste has become. This paper recommends the effects of e-waste and the management of toxic elements and the sources of e-waste hazardous waste to make the development process green and sustainable. Isolation of electronic waste into the exact well, definite stream at the collection stage is an effective simplification approach. It can recycle various wastes and does not use any chemical additives, succeeding in efficient Ultra-High Shearing (UHS) technology.

**Shagun et al. (2013)** the authors of this paper mention that electronic waste is used in electronic devices. Many electronics are good, recyclable, and non-recyclable, including discarded computers, office equipment, entertainment electronic devices, mobile phones, televisions, refrigerators, etc. Many public policy advocates use the term e-waste to apply broadly to all surplus electronics. In technology, quick variations are there. Variations in media like MP3, tapes, software, falling prices, and global strategy have resulted in an undesirability in a fast-growing electronic waste surplus. This paper presents an overview of the problem and suggests concrete solutions to tackle the issue.

**Yoheeswaran (2013)** The author of this paper stated that in India, the e-waste generation rate is increasing by 15% and is expected to cross

800,000 tons in 2012. The major amount of recycling is E-waste, and informal sector recovery of the acid stripping methods using basic methods like open burning. Human and environmental methods are both harmful. Many rules and legislation are available at the global and national level, but legislation is not governed in the informal sector. These articles deliver e-waste recycling in formal and informal sector situations and legislation at the national level. E-waste is increasing day by day, more than recycling or disposal. Disposal numbers of the informal sector are more than those of the formal sectors for e-waste recycling. We need to create public awareness regarding proper waste disposal. The discarded e-waste material should be collected, whereas formal sectors should recover and dispose of e-waste, separate it, transport it by informal sectors, and recycle it.

**Sivaramanan (2013),** the author of this paper, states that WEEE has become a major problem, toxic emissions of waste mixed with virgin soil and harmful effects of air causing either direct or indirect to the entire biota, and the straight effect contains the releases of acids, toxic mixtures indirect effects such as bio magnification including heavy metals, chemicals. Many private firms recycle e-waste and then dismantle, separate, and export it. However, they also involved regulations currently being followed to endorse firms, such as e-steward certification by Basel Action Network in the U.S. In conclusion, the Author has stated that manufacturers need cooperation for better e-waste management and to make people aware of issues. The government is also responsible for assisting manufacturers/producers and consumers and spreading awareness for the advancement of e-waste, heavy metals, and hazardous chemicals that should be handled properly.

**Bhat et al. (2012)** has explained that this paper emphasizes the recovery of precious metals from e-scrap. A different strategy for its management is an integrated model of development. This paper marks an effort to recommend a different integrated model for the management of e-waste and for the extraction of precious metals using a grouping of hydro-metallurgical and bio-metallurgical processes. Using cyanide: The substance practice contains

the discharge of gold or silver from the e-scrap. For proficient e-waste management to strengthen the processing, the model proposed by the function elements employed will help. A feasible study was also conducted using low-cost bio-sorbents to discover the probability of removal or recovery of silver. The Author has explained that the generation of e-waste from households, I.T. sectors, commercials, and Industries at a grand scale, the same as municipal solid waste, which is growing due to population, new modern advanced technology, and because industrialization is expected to increase in the future. They have suggested that this solution's problem is a proposed model for reusing and recycling precious metals from e-waste.

**Herat and Agamuthu (2012)** authors have explained that around 20-50 million tonnes of e-waste are generated annually in Asian countries. The world generates Inappropriate handling of e-waste because of its toxic components, which can cause damage to human health and the environment. Many countries around the world are struggling to deal with this emerging threat. The importance of end-of-life e-waste management through reuse, servicing, recycling, disposal, and cleaner, green design production is gaining much attention in e-waste generation through upstream reduction. In developing countries, very few are absent or environmentally sound in the management of e-waste. Authors explaining e-waste management problems have said there is a lack of policies and infrastructure on proper e-waste management. E-waste recycling plays a major role. This process includes three steps: collection, storing, or dismantling, and pre-processing/end-processing of e-waste; all these three activities are handled by informal sectors in developing countries, which results in environmental impacts.

**Borthakur and Singh (2012)** authors of this paper focus on India's electronic waste and its policies. E-waste is faced by developing countries that are either imported unlawfully or internally generated; the exception is India's enormous tasks related to the generation of waste and its management. However, E-waste in India is rationally poor in the present management practices related to and has probable risk. The authors have

explained two ways of handling e-waste: landfilling and incineration. Landfilling has environmental risks, but incineration has advantages in reducing e-waste volume and utilizing energy resources. Furthermore, the policy-level initiatives are not being implemented appropriately. E-waste, along with its policy-level suggestions, is a serious problem that is looked at in the paper. In India, issues related to e-waste were found during the study, and there is a vital need to address the consequences to avoid their detrimental effects. Problems related to e-waste are the insufficiency of policies on e-waste, which is enhancing the problem in India, and public awareness concerning the removal of electronic goods. A huge amount of e-waste remains unattended in households and public offices. In conclusion, these authors have stated that there is no public awareness of the disposal of electronic goods due to the insufficiency of policies on handling and controlling the management of e-waste. Maximum e-waste remains unattended. Developing countries are facing enormous challenges related to generating and managing E-waste, which is either internally generated or imported illegally; India is no exception. However, the existing management practices related to E-waste in India are reasonably poor and have the potential to risk both human health and the environment. Moreover, policy-level initiatives need to be implemented appropriately. The austere problem of e-waste and its policy-level implications are examined in this paper. During the study, it was found that there is an urgent need to address the issues related to e-waste in India to avoid its detrimental future consequences.

**Bala and Goel (2012)** authors have shown that e-waste is popular and is the informal name for electronic products. The current study was done on college students to determine consciousness and was directed at presence, threat, and management. A random sample of 200 students was selected to discover awareness among students, including students from different colleges of Noida city, e-waste management professionals, and nonprofessional streams, and a survey research method was used through a Simple Random sampling technique. The self-developed E-waste Management Awareness Inventory (EWMAI) was used to collect the data.

It was found that all the students, irrespective of their stream, were aware of e-waste. However, the students of the professional streams have more awareness of the danger of e-waste than those of the non-professional streams, and students of both streams need to be made aware of proper e-waste management. This study found that all the students in their respective streams were aware of e-waste. Students in the professional stream had more awareness than students from the nonprofessional stream. Much of the electronics turned over for recycling in the U.S. is in Asia. A recent investigation revealed that they are either recycled with little or no regard or disposed of by worker health and safety. Circulates are inexpensive labor, the foremost reasons are lack of environment and the toxic effluent of the developed. In this way, the world's poorest nations will flood. The campaign is critical to consumer awareness, and the public can attribute consumerism to a new responsibility. It is energy efficient, designed for easy upgrading when buying electronic products, and is less toxic using recycling.

**Uddin(2012)** has defined the significance of the problem of unrestrained dumping and e-waste discloses of crude recycling. E-waste is recommended for the good management of technologies. As per this study, 95 percent of electronic waste is recyclable. However, the environment, rather than landfilling loose recycling, can cause more harm. In our country, there is a lack of legislation, and this dangerous form of recycling is aiding. Therefore, to find environmentally sound, there is a need to outline and apply rules for regulating this waste and feasible methods for recycling and disposing of this needed immorality cost-effectively. Authors have said that a major portion of the e-waste generation is done domestically and illegally handled in a rough manner, which hurts the environment. And also about the lack of legislation that increases the hazard of recycling. Further, he has suggested an urgent need to implement regulations for sound e-waste management. Manufacturers and retailers should be there to reduce waste problems.

**Zhang et al. (2012),** authors have mentioned that E-waste recycling has become a hotly debated global issue. This study analyzes the environment,

taking a case study of the economic and social implications of China's e-waste recycling in the developing world. Further, local economic and social conditions are taking into account more practical approaches, and the principles of extended producer responsibility and the increasing environmental distraction from inappropriate e-waste disposal have been recommended for improvement. More effective measures apart from these legislative methodologies to reduce the harmful environmental significance of recycling procedures with advanced technologies, have been suggested for setting up regional e-waste disposal centres in the backyard. Moreover, manufacturers should assume responsibility for reducing environmental hazards from their products. Protecting the environment and people from the hazards of e-waste is the government's responsibility. Expended Producer Responsibility(EPR) that assists producers is implemented to cover the cost-effectiveness and efficiency of collection, recycling, and disposal.

**Soomro and Sawar(2012),** this paper's authors focus mainly on Energy consumption, the current and future trends of green computing, e-waste recycling, green computing, and green I.T. They have mentioned that around 90 percent of those computers are idle during the weekend, and around 30 percent to 40 percent, according to the Environment Protection Agency, of personal computers even after office hours. All electronics are currently recycled. Established on the Gartner, over 133,000 PCs are rejected by U.S. approximations, and homes and businesses are rejected by less than 10 percent daily. Technology is an active contribution to achieving the goal of green computing; it's not a passive observation. Initiatives towards green computing, cloud computing, equipment recycling, paper usage reduction, virtualization, power management, and I.T. industries also take green manufacturing as the key initiatives towards green computing. Efforts by government and non-government organizations are also appreciable. Current efforts are mainly to reduce energy consumption and e-waste, but the future of green computing will depend on the efficiency of green products.

According to the study "Environmental and Health Challenges of the Global Growth of Electronic Waste" by **Liu et al. (2012),** communities exposed to e-waste should pay close attention to the hereditary effect, specifically cytogenetic damage. Long-term genetic impacts are a crucial issue within the context of the health concerns in e-waste recycling locations. Most of these recycling facilities have been in operation for more than ten years, with prolonged exposure to harmful elements in e-waste. Both the immediate surroundings and people may experience the expanding effect. Additionally, the researcher advises nations to construct centers of excellence for e-waste evaluation and management, drawing on already existing trash management and recycling businesses to lessen biological consequences. E-waste management, including recycling, exports, and imports, should be developed by establishing reasonable regulations in both emerging and developed nations.

**Wassenhove (2011)** stated that a growing stream recycles used electrical materials and enforces collection legislation for environmental electronics products. With e-waste regulation based on their experience with producers managing, they have found that the consequences of such regulation from an operations perspective are strong, and there is a need for research. As a discipline of economics demonstrating the edge of system design and finding suitable e-waste take-back implementation operations, concentrated research can be instrumental in how producers respond to them for different business environments. Through this paper, they highlight research desires from the perspective of product take-back legislation for e-waste demanding problems. Applying examples from present take-back laws, they have shown that operational factors considerably affect the efficiency of take-back legislation in achieving desired policy objectives. The Author has talked about the advance recycling fee, which is collected from the consumer on the product at the time of selling product as it is done in California as disposal fees, the recycling cost by the end users as done by Japanese, and recycling subsidies as it is done by producer or by government and about deposit refund that is a tax of production and consumption based on subsidy.

**Bhutta et al. (2011)** the Authors mention that at least 81% of e-waste goes to the landfill, electronic waste management of the EOL. Reducing e-waste recycling is the key. Recycling has benefits in the computer product life cycle rec at every stage. To impose harder laws, a challenging approach is to minimize the prohibited discarding of electronics. Some states of the U.S. govern e-waste are ensuring a much greater implementation. In developing countries, these laws are strictly enforced strongly and suggest a way to prevent those who make a certain kind of donation. Recycling, reuse, and dispose electronics at all levels will teach them and their communities, enlightening people about how to behave more responsibly toward the environment. Certainly, a global solution to electronic waste is a universal problem. The authors have talked about the environmental benefits of recycling computers about the emission of electronic waste is reduced by recycling, and how air and water pollution can also be reduced, which are raised at the time of making new products. Educating people on the 3 R's of e-waste and disposing of electronic items is necessary.

**Rahman et al. (2011)** stated that regulatory agencies must be established in each district, comprehensive laws governing the management and disposal of hazardous wastes must be written, strict laws prohibiting the dumping of waste must be enforced, the polluter-pays principle and expanded producer responsibility must be adopted, and NGOs and the private sector must be encouraged and supported in their efforts to address the issue.

According to **Zaccai (2008)** consumer behaviour is vital in environmental actions, such as buying environmentally friendly electronics, retaining and using electronics to lessen their harmful ecological effects, and criticizing disposal procedures. Environmental ethics serves as a bridge between the other two disciplines.

**Kahhat et al. (2008)** stated in their article "Exploring e-waste management systems in the United States "that some states are adopting e-waste regulations. However, the U.S. still needs to regulate the complete e-waste situation, including the residential and non-residential sectors. Federal-level

policies and regulations present the best way to address the e-waste situation (U.S. GAO, 2005) as they will overcome the lack of rules in most states and standardize regulations and policies in the country. This will create a more efficient national e-waste management system. In this scenario, the e-market for returned deposit system will be the mechanism for residential customers to dispose of their devices in a way that motivates collection, recycling, and reuse of e-waste.

## 2.5. SUMMARY

Although the knowledge of e-waste was high, students needed to gain knowledge of policies/laws that regulate environmental and health management. Advanced understanding of e-waste did not translate into responsible management as e-waste was kept at home, transported, and stored with municipal waste. There needed to be designated bins for collecting it. Most respondents needed clarification on what was happening regarding the generation, handling, storage, transportation, and final disposal of e-waste. By analyzing students' knowledge and practices, universities should intensify e-waste management advocacy by incorporating e-waste matters into their curricula. The government should enact policies that govern the management of e-waste, and this will provide a framework for institutions to set up local-level policies that promote green initiatives. This study explores awareness of e-waste management among rural and urban students. The primary research investigation of underlying factors for e-waste management and related practices among students. This landscape informs the reader that the author has indeed assimilated all previous significant works in the field into the research. Prior research shows a considerable difference in students' attitudes toward e-waste management and pollution concerning their educational background, social settings, and family environment. Many researchers proved in their study that awareness of e-waste management could help students understand which students have sustainability issues.

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## 2.6. RESEARCH GAPS

The research and survey study determine the feasibility of combining E-waste awareness among college students, which has not been explored much in Indian research. The factors that affect e-waste management awareness and related practices in the context of urban and rural students have also yet to be investigated as per the study of the various articles. The level of e-waste management awareness about gender, stream of study, and locality among college students is a significant research gap. Estimating awareness of e-waste management among prospective teachers is another research need for the current scenario.

# CHAPTER-III
# METHODOLOGY

## 3.1.INTRODUCTION

Research is essential for opening new doors in any branch of knowledge. Research inculcates scientific and inductive thinking and promotes the development of logical habits of thinking and organization. It brings vividness, completeness, and comprehensiveness to complex problems through careful investigation or inquiry. Research methodology involves systematic procedures by which the researcher starts from the initial identification of the problem and moves to its conclusions. The method of research outlines the entire research plan. It describes what must be done, what data will be needed, what specific data-gathering tools will be used, and how the data sources will be selected. It is very much essential in systematic research. Research methods address problems in both research design and data analysis. The success of any research depends largely on the suitability of the method, tools, and techniques used to collect data. Thus, this chapter describes the research design as the research method or strategy, sample design, choice of research tools, and statistical techniques used for the present study. The methodology is a process that reveals all the methods and techniques used by the researcher during his research problem. The role of methodology is to carry out the research work scientifically and validly. Adapting suitable methods can raise the efficiency and dignity of the research work. The success of any research mainly depends on the tools and techniques and the proper methods adopted in the research process. This chapter details the sample selected, the tools used, the statistical technique employed, and the procedures followed in the different stages of the present study.

Knowledge of the research methodology is essential for all those who either take an active role in conducting research or desire to keep abreast of new educational developments. Research has proved to be an important and powerful tool in leading to man's progress. The methodology reflects the authenticity and vividness of the whole research work. A well-organized and sound methodology directs and leads the investigators to

where they desire to reach. A brief description of the method and procedure followed in the present study is given in this chapter. For the present study, the 'Descriptive Survey Method' is used. The descriptive survey method is the most commonly used research method in education, and it tries to highlight the conditions and relationships that exist and the opinions that the significant stakeholders of education hold.

This chapter mainly deals with the following significant aspects.

1) Population
2) Sampling
3) Data Collection
4) Statistical technique of the data

Research is a systematic attempt to obtain answers to meaningful questions about a phenomenon or event. Paul and Leedy define research as the means to solve problems and push back the frontiers of human ignorance. Redman and Mory define Research as a systematized effort to gain new knowledge. Kerlinger states, Scientific research is systematic, controlled, empirical and critical investigation of hypothetical prepositions about the presumed relations among natural phenomena." Research is an intellectual activity that establishes new knowledge and discovers new truths about certain events or events. It intends to verify the existing knowledge to enable the researcher to understand, predict, or control the events of the world.

## 3.2. OBJECTIVE OF RESEARCH

The research intends to fulfil the following objectives:

- To provide an answer to the question through the application of scientific procedures.
- To discover the hidden truths and facts to formulate theories, principles, etc.,
- To familiarize myself with and gain new insight into phenomena.
- To bring out the real nature and character of the individual, situation, or group.

- To test a hypothesis of a causal relationship between variables.
- To determine the frequency with which something occurs or is associated with something else.

## 3.3. IMPORTANCE OF RESEARCH

The significance of research can be rightly understood in the words of Francis Bacon "Research is a power of suspending judgment with patience, of meditating with pleasures, of asserting with caution, of correcting with readiness and arranging thought with scrupulous plan". It helps in the development and establishment of sound theories. It also helps in the modification of behaviour according to the challenges of time and consequences. Thus research is structured inquiry that utilizes acceptable scientific methodology to solve problems and create new generally applicable knowledge.

## 3.4. CHARACTERISTICS OF RESEARCH

The specific characteristics of research are

- It is an intensive and diligent investigation towards solution of a selected problem.
- Research emphasizes the development of generalization, theories, and facts.
- It is reliable, verifiable and exhaustive.
- It based on observable experience or empirical evidences.
- It demands insight and imagination.
- It is essentially interdisciplinary in approach.
- It evolves out of the thirst and urge for doing things newly or to answer unsolved problems.
- It should be carefully recorded and reported.
- It is deductive, logical and objective.
- It is replicable and transmittable.

## 3.5. METHODS OF RESEARCH

Research is an intensive and diligent investigation towards solution of a selected problem. The types of research methods are

❖ Descriptive Method

In the words of Best and Khan (2005) "Descriptive research describes and interprets what is. It is concerned with conditions or relationships that exist, opinions that are held, processes that are going on, effects that are evident, or trends that are developing. It is primarily concerned with the present, although it often considers past events and influences as they relate to current conditions". It provides a method of investigation to study, describe and interpret what exists at present.

❖ Experimental Research

Experimentation provides a method of hypothesis testing. According to John.W.Best. "Experimental research is the description and analysis of what will be or what will occur, under carefully controlled condition". The logical association between manipulated factors and observed effects are established by controlling or removing other influential factors.

❖ Historical Research

Historical research has been defined as the systematic and objective location, evaluation and synthesis of evidence in order to establish facts and draw conclusions about past event (Borg, 1963). It involves exploring the meaning and relationship of events, and as its resource it uses primary historical data in the form of historical artefacts, records and writings. It attempts to find out what happened in the past and to reveal reasons for why and how things happened.

## 3.6.RESEARCH DESIGN

Research design is a mapping strategy. It is essentially a statement of the object of the inquiry and the strategies for collecting the evidences, analysing the evidences and reporting the findings. Thus it includes the following components:

- ❖ Research strategy or Research method.
- ❖ Choice of research tool.

- Sampling design.
- Choice of statistical techniques.

The research design of the present study has been sketched out in this chapter.

## 3.7. METHOD ADOPTED IN THE PRESENT STUDY

In psychology, much of the natural scientific type of researches has been conducted using the descriptive techniques that are used to interpret the results recorded of the behaviour under investigation. In the present study the research problem, **"Awareness on E-waste Management among College Students in Tirunelveli District"** The goal of this study is to evaluate the awareness about the harmful effects of e-waste in the environment and human health among the younger generation. It is a multifaceted phenomenon, thus keeping in mind the study's purpose and population. The investigators have adopted a descriptive method with the survey as a technique for the present study.

## 3.8.WHY SURVEY TECHNIQUE WAS SELECTED

Survey research is most widely used non-experimental type of educational research. Descriptive surveys serve as direct source of valuable knowledge concerning human behaviour. Survey has the basic connection of "the act of looking over or beyond". Data are ever changing and survey research portrays a brief moment in time to enhance our understanding of the present (Leedy & Ormrod, 2001). In the words of John.W.Best (1989) "survey method gathers data from a relatively large number of cases at a particular time". For the present study the investigators would like to meet a large number of students with a special attention in e waste management awareness. The information is collected through a highly structured questionnaire and from a large number of respondents represents a specific population. The nature and objectives of the study compelled the investigator to use this normative survey method. As the survey technique suits the current problem of research "Awareness on E-waste Management

among College Students in Tirunelveli District", the investigators have used this technique for his study.

The main hallmark of descriptive research family is the survey technique. The normative survey approach is followed in studying local as well as state, national and international aspects of educational evaluation and generalization and direct towards proper understanding and solution of significant problems. According to John W. Best, "the survey is extensive and cross sectional dealing with a relatively large number of cases of a particular time and yielding statistics that are abstracted from particular cases. Survey is one of the techniques used in the analysis of fact finding. Survey means viewing and interpreting things rigorously and comprehensively. It is the most widely used method too. Typically survey gathers data at a particular point in time with the intension of describing the nature of existing conditions (of what exists),Identifying standards against which existing conditions can be compared, Determining the relationships that exist between specific events and how to get there According to Sukia (1981) "Survey method is a method of collecting and analysis of responding responses as specific population collected through rightly structured questionnaire or even interview". It is not only a way of collecting data but also analyzing results statistically, systematically.

### 3.9. STEPS IN SURVEY METHOD

According to William Wireman (1985) the detailed steps in a survey method are as follows;

1. Planning
2. Development and application of sampling plan
3. Construction of questionnaire
4. Data collection
5. Translation of data
6. Data analysis
7. Conclusion and Reporting

### 3.9.1 Planning

The plan of action has to be drawn up to ensure scientific and objective merits of the study. Definition of the problem, operational definitions of variables, review and development of the survey design should be clearly drawn out.

### 3.9.2 Development and Application of Sampling Plan

The geographical area to be covered, the sample to be selected and detailed sampling procedure, should be defined and formulated.

### 3.9.3 Construction of Interview Schedule or Questionnaire

The tools of investigation generally used are interview schedule or questionnaire and the like. A specified investigation should require specified tools of inquiry. If no readymade tool is available, a suitable one will be prepared in a systematic manner. The tools should be tested in a pilot sample before it is administered to the vast sample.

### 3.9.4 Data Collection

The data will be collected from the proposed group of persons or sources with the help of the tool to be employed in the study. The participation of primary, middle and high school students are imperative to ensure comprehensiveness and authenticity of the data.

### 3.9.5 Translation of Data

Depending upon the extensiveness of the survey data and upon the nature of the material collected the handling of data usually takes initial tabulation and construction of category systems as necessary and technical preparation for analysis.

### 3.9.6 Data Analysis

Analysis of data comprises, various approaches designed to restrict the phenomena in their constitutional parts with a view to obtain greater insight into specified aspects. The statistical analysis of data is principally based on

counts of numbers of units that fall into different classes and subclasses, where quantitative responses have been obtained total for the classes are secured. From these numbers and totals, the arithmetic means can be computed for the different classes. Basic summary table can then be compiled more critical analysis can be applied to the data.

### 3.9.7 Data Collection Procedure

The collection of data is an extremely important of all research endeavours, for the conclusion of a study are based on what data reveal. As the result, the kind of data to be collected, the method of collection to be used, and the scoring of the data need to be considered with care. The term data is referred by Fraenkel &Walen (1993,) as the kinds of information researchers obtain on the subjects of their research. An important decision for every researcher to make during the planning phase of an investigation, therefore, is what kinds of data he or she intends to collect. The device the researcher used to collect data is called an instrument. After deciding on the sample for present study, the researcher contacted the principals of the selected schools and requested permission through a permission letter to administer the test and to collect data.

### 3.9.8 Conclusion and Reporting

After collecting and analysing the data, the researches have to accomplish the tasks of drawing inferences following by reporting. It is only through interpretation that the research can expose relations and processes that come under his findings. Research report is considered a major component of the research study for the research task remains incomplete till the report has been presented. As the problem selected for the present study is concerned with one of the current problems, the investigators decided to employ the survey method for the collection of data.

## 3.10. METHOD

In the present study, the investigators applied normative survey as a method. The normative survey method studies, describes and interprets

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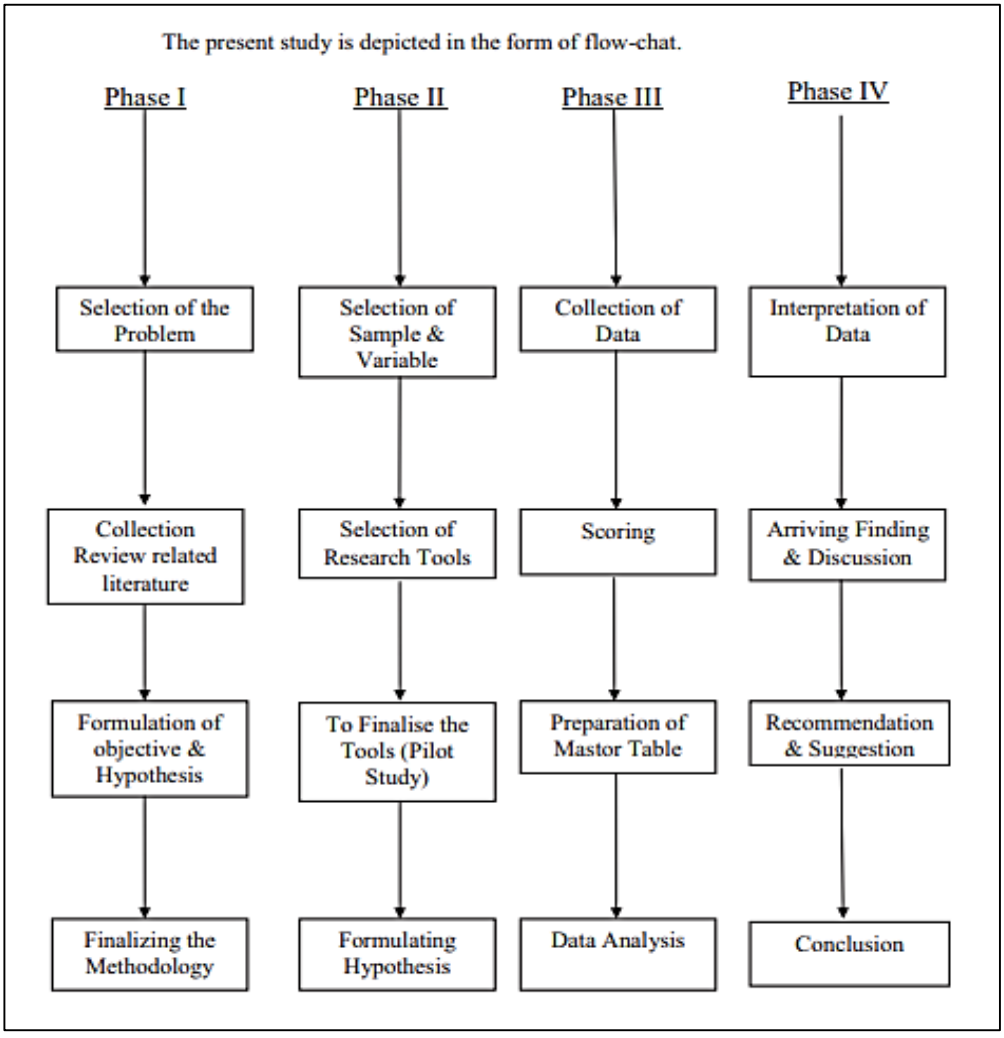
what exists at present. The investigators have collected information from the college students in Tirunelveli District of Tamil Nadu.

### 3.11.SAMPLE

The investigators collected data from the college students in Tirunelveli District. 500 college students were involved for the present study.

***Fig.3.1. Design of the Present Study***

The present study is depicted in the form of flow-chat



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***The following demographic variables were selected for the present investigation.***

| | |
|---|---|
| Gender | Male / Female |
| Locality of Residence | Rural / Urban |
| Type of the College | Girls / Co-education |
| Stream of Study | Arts/ Science |
| Type of Management | Autonomous./Non-Autonomous |
| Type of Family | Joint / Nuclear |
| Father's Education Qualification | School/Degree/Profession |
| Mother's Education Qualification | School/Degree/Profession |
| Father's Occupation | Government /Private /Self-employed |
| Mother's Occupation | Government /Private /Self-employed |

## 3.12.CHARACTERISTICS OF SURVEY METHOD

- It is essentially cross sectional approach.
- Its versatility is its greatest strength, which supports in collection of much information like characteristic, attitude, opinion, experience and expectations.
- It involves clearly defined problems and definite purpose.
- It requires expert and imaginative planning careful analysis and interpretation of the data gathered and skilful reporting of the findings.

- ❖ It does not seek to develop an organized body of the scientific principles.
- ❖ It provides information useful to the solution of local problems.
- ❖ It suggests course of future development.

## 3.13.ADVANTAGES OF SURVEY

Survey may be qualitative and quantitative.

- ❖ It gathers data from relatively large number of cases at a particular time.
- ❖ Survey technique is used to gather the desired information easily and less expensively.
- ❖ It sensitizes the researcher to unanticipated or unknown problems.
- ❖ Description may be either verbal or expressed in mathematical symbols.
- ❖ It is concerned with the generalized statistics.
- ❖ It is extensively useful in all disciplines.
- ❖ It gives very detailed description of the phenomena.
- ❖ Within an appropriate sample, survey may aim at representation and provide generalized results.
- ❖ It is relatively easier to administer, and need not require much of field work.
- ❖ It may be repeated in the future or in different settings to allow comparison to be made.

## 3.14.RESEARCH TOOLS

Tools are administered to the sample subjects to collect evidence or data. Research tools employ various distinctive ways of describing and qualifying the data. Some critical research tools are questionnaires, interviews, and rating scales. Like the tool in a carpenter's box, each research tool is appropriate to follow a particular purpose in a given situation. When selecting measurement tools, careful considerations must be undertaken when designing any research project. This will ensure the tool chosen clearly and accurately measures the phenomenon under observation. Firstly,

the researcher should determine their needs and the tests applicable in calculating the variable under observation. Secondly, the variable is defined and assessed on how narrow or wide it can be. Thirdly, the researcher should determine whether the variable is measurable or not. The researchers should select a tool that fits well with the collected data and allows easy analysis. Without the powerful tool, no data can be collected. A good research tool must satisfy validity, reliability, objectivity, accuracy, and predictability. It must be economical using time and money, too.

## 3.15.TOOL USED

A properly constructed and administered questionnaire may serve as a most appropriate and useful data gathering device. A Questionnaire consists of a number of questions printed or typed in a definite order on a form or set of forms (Kothari, 1988). It is the popular and highly flexible tool for collecting the data with qualitative information from a relatively large number of respondents. Hence, the "Questionnaire" seems to be apt for the phenomenon of investigation. In this study of "Awareness on E-waste Management among College students in Tirunelveli District", the investigators have developed a well- designed questionnaire consisting E-waste Management Awareness Scale was constructed and validated.

## 3.16.DEVELOPMENT PROCESS OF THE TOOL

E-waste Management Awareness Scale (EMAS) was constructed by the *Vasanthi Medona,L., Maria Saroja,M., & Michael Jeya Priya,E.(2023)* with the objective to measure the awareness level of college students. Systematic procedures were followed in the process of tool construction like:

- Planning
- Preparing
- Trying out and Evaluating

### 3.16.1.Planning

The following steps include the activities and task performed in the planning for construction of the tool:

- ❖ The objective of the tool was fixed to measure the level of Awareness
- ❖ The content area and dimensions was defined.
- ❖ Decisions over the type and number of items to be included in the scale under each dimension were outline.
- ❖ A three-point scale with scoring key according to nature of items, positive and negative was sketched out.

### 3.16.2. Preparation of items

This step requires understanding and mastery of the subject content and skill for preparing the statements. Hence the items are drawn out from various sources and the items were preliminary item pool is prepared.

### 3.16.3. Sources of items

Review of Indian and international studies and literature based on e-waste management Awareness Ideas, opinions, suggestions, information's regarding awareness on e-waste management were gathered from experts, professors, teachers, parents and students. After a vigilant scrutiny of the available sources 80 statements were framed by the investigators.

### 3.16.4. Criteria for selection of items

It should be in simple and clear statement form, with no sort of ambiguity in its meaning or language.
Items should be appropriate to respondent's level.

- ➢ It should be arranged in an order from easy to difficult.
- ➢ Compound and complex sentences should be avoided.
- ➢ An item should express only one opinion and
- ➢ The statement should not lead to multiple interpretations.

### 3.16.5.Pooling of items

E-waste Management Awareness Scale focused on thoughts, habits and which leads and reflects awareness of college students in their college in

behavioural terms are prepared and pooled. Thus there were 50 statements in the EMAS at this stage.

### 3.16.6. Establishing Validity

According to Lee Cronbach "validity is the extent to which a test measures what it purposes to measure". Prior to the administration of the tool, the investigatorto bring forth the expert's judgement, regarding the suitability, adequacy, objectivity and clarity of the pooled items. The newly constructed tool was given to experts, in the field of education for the establishment of "Face Validity", which is a subjective statement that the tool appears to cover the relevant content, and "content validity", which involves the systematic examination of the content to determine whether it covers a representative sample of the domain to be measured. Expert's opinion on the clarity, and suitability in measuring the particular dimension. Arrangements of items in random order and were subjected to expert's scrutiny. Some items were modified, deleted and rearranged based on their suggestions. Thus the face validity and content validity of the tool was established. Thus, 80 statements were retained in EMAS.

### 3.16.7.Trying Out

- The main task of try out is to improve and modify the language ambiguity and difficulty. The subjects are selected from the population for which the test is designed. It helps to:
- To refine the instrument.
- To identify the difficult items and to delete the ambiguous or difficult statements.
- To estimate reliability index of the tool.
- It enables the investigators to select the required number of items for inclusion in the final form of scale Final tool is prepared.

### 3.16.8.Pilot study

Pilot study is a preliminary try out of the instrument with a small number of individuals. The purpose of pilot study is to refine the instrument including

the correlation of deficiencies. A pilot study is not the major data collection of the data. Before finalizing, the rough draft of the (EMAS) consisted of 80 statements. The tool was administered to 100 college students studying in St. Johns College and Sarah Tucker College. The questionnaire was distributed to 100 students to know whether the items included in the questionnaire. On basis of their responses Scoring was done and Item vs. Item whole correlation was calculated. Ambiguous items were deleted. Only items having high level precision were retained.

### 3.16.9.Item whole correlation

Karl Pearson's product moment correlation co-efficient was calculated between the item score and the total score to find validity index of the item. In this method each item score is correlated with the total scale mean score. The items which are significant at 5% level are accepted and selected. The table value at 5% significance level is 0.195. Hence, statements with correlation value above or equal to 0.195 were selected. Items having validity index below 0.195 were deleted from the draft questionnaire, thus 28 items were deleted. So the final tool contained 50 items. Thus, the validity of the tool was established. The validity indices are given in the following.

***Table 3.1. Item Vs Whole Correlation of E-Waste Management Awareness Scale***

| Item No. | $\gamma$ value | Remarks | Item No. | $\gamma$ value | Remarks |
|---|---|---|---|---|---|
| *1. | 0.139 | Deleted | *41. | 0.021 | Deleted |
| *2. | 0.180 | Deleted | 42. | 0.219 | Selected |
| 3. | 0.430 | Selected | 43. | 0.260 | Selected |
| 4. | 0.288 | Selected | *44. | 0.129 | Deleted |
| 5. | 0.281 | Selected | 45. | 0.285 | Selected |
| 6. | 0.394 | Selected | 46. | 0.319 | Selected |
| 7. | 0.329 | Selected | *47. | 0.130 | Deleted |
| *8. | 0.149 | Deleted | *48. | 0.072 | Deleted |
| *9. | 0.145 | Deleted | *49. | 0.145 | Deleted |
| 10. | 0.393 | Selected | *50. | 0.148 | Deleted |

| | | | | | |
|---|---|---|---|---|---|
| 11. | 0.303 | Selected | 51. | 0.334 | Selected |
| 12. | 0.413 | Selected | 52. | 0.202 | Selected |
| *13. | 0.075 | Deleted | 53. | 0.261 | Selected |
| 14. | 0.441 | Selected | 54. | 0.195 | Selected |
| 15. | 0.371 | Selected | 55. | 0.221 | Selected |
| *16. | 0.073 | Deleted | *56. | 0.115 | Deleted |
| *17. | 0.064 | Deleted | 57. | 0.197 | Selected |
| 18. | 0.239 | Selected | *58. | 0.171 | Deleted |
| 19. | 0.202 | Selected | 59. | 0.198 | Selected |
| *20. | 0.142 | Deleted | *60. | 0.016 | Deleted |
| *21. | 0.099 | Deleted | 61. | 0.308 | Selected |
| 22. | 0.356 | Selected | *62. | 0.024 | Deleted |
| 23. | 0.379 | Selected | *63. | 0.061 | Deleted |
| 24. | 0.276 | Selected | *64. | 0.173 | Deleted |
| 25. | 0.346 | Selected | 65 | 0.382 | Selected |
| 26. | 0.342 | Selected | 66. | 0.311 | Selected |
| 27. | 0.297 | Selected | 67. | 0.217 | Selected |
| 28. | 0.427 | Selected | *68. | 0.045 | Deleted |
| 29. | 0.386 | Selected | *69. | 0.048 | Deleted |
| 30. | 0.392 | Selected | 70. | 0.227 | Selected |
| *31. | 0.125 | Deleted | 71. | 0.274 | Selected |
| 32. | 0.429 | Selected | 72. | 0.318 | Selected |
| 33. | 0.198 | Selected | 73. | 0.248 | Selected |
| *34. | 0.143 | Deleted | *74. | 0.077 | Deleted |
| *35. | 0.110 | Deleted | *75. | 0.089 | Deleted |
| 36. | 0.414 | Selected | 76. | 0.195 | Deleted |
| 37. | 0.205 | Selected | 77. | 0.321 | Selected |
| *38. | 0.087 | Deleted | 78. | 0.233 | Selected |
| *39. | 0.034 | Deleted | 79. | 0.197 | Selected |
| 40. | 0.199 | Selected | 80. | 0.196 | Selected |

At 5% level of significance, for 98 *df* the table value of $\gamma$ value is 0.195

### 3.16.10.Establishing Reliability

Reliability refers to the consistency of scores and stability of test for a certain population. The investigators employed split half method to establish the reliability of the tool. This method of estimating reliability involves both the characteristics of stability and equivalence. In this method result obtained from one half of the scale items being checked against the result from other half of the items. This method is appropriate for testing co-efficient of homogeneity. The whole tool was split into two halves-odd and even numbered statements. The responses were scored and reliability coefficient of correlation between the two sets of scores was calculated. The reliability index of the tool was estimated by the Spearman Brown formula. The reliability index of EMAS is found to be 0.64.

***Table.3.2.Split-Half Reliability Value of the Tool***

| S.No. | Tool | Spilt-half 'γ' value |
|---|---|---|
| 1. | E-waste Management Awareness Scale (EMAS) | 0.64 |

### 3.16.11.Description of the Tool

Personal Data form-The personal data form is used to collect general information of the college students. It includes some personal information about the respondents such as gender, nature of college, stream of study, locality of residence, type of family, father's education qualification, mother's education qualification, father's occupation and mother's occupation.

### 3.16.12.E-waste Management Awareness Scale (EMAS)

The investigators have used a Self-made Questionnaire of E-waste Management Awareness Scale (EMAS) developed by the investigators *Vasanthi Medona,L., Maria Saroja,M., & Michael Jeya Priya,E.(2023)* for collecting data for this study. It is intended to measure the level of Awareness on E-Waste Management among college students. The scale consists of **50 Statements**. The statements are of positive and negative in nature.

***Table.3.3. Nature of items***

| ITEMS | ITEM NUMBERS | NO. OF ITEMS |
|---|---|---|
| Positive | 4, 15, 19, 20, 21, 22, 23, 24, 25, 33, 34, 35, 36, 41. | 14 |
| Negative | 1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 26,27, 28, 29, 30, 31, 32, 37, 38, 39, 40, 42, 43, 44, 45,46, 47, 48, 49, 50. | 36 |

### 3.16.13.Scoring Key

In the Scoring key, a score is a number assigned to an investigators to provide a quantitative description of respondent's performance on a particular test. Scores are assigned to all the responses. All the statements would be scored for the EMAS in the following manner for the positive and negative questions.

***Table.3.4.Scoring Key of E-waste Management***

| RESPONSE | CHOICE | |
|---|---|---|
| | Positive | Negative |
| Agree | 1 | 2 |
| Disagree | 2 | 1 |

### 3.16.14.Area of the Study

The investigators had selected Tirunelveli district for their study.

### 3.16.15.Population

"Population is defined as a group of individuals that have one or more characteristic is common that are of interest to the researchers". The researchers have confined the population of the present study only to college students studying in various college of Tirunelveli.

### 3.16.16.Sample and Sampling Design

According to John, a sample, as the name implies, is a smaller representation of a larger whole. W. Best (2008) "A sample is a small proportion of the population that is selected for observation and analysis. By observing the characteristics of the sample, certain inferences can be made about the characteristics of the population from which it drawn".

The investigators have derived the sample for the present study from 500 students studying in college from various colleges in Tirunelveli. The most basic form of probability sample is the simple Random Sampling technique. With the simple random sample, each unit in the population has an equal probability of inclusion in the sample. Gay (1987) reports: "Random sampling is the best single way to obtain a representative sample. The investigators have used the Simple Random Sampling Technique for this study.

### 3.17.Administration of the Tool

The investigators personally visited the colleges with the permission of the concerned Head of the colleges. The personal data form along with E-waste Management Awareness Scale (EMAS) was distributed to the students. The students were given enough time to respond to the item of the tools.

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## 3.18.Colleges Selected for Study

***Table 3.5. Sample Wise Distribution of the Colleges***

| S.No. | NAME OF THE SCHOOL | NO. OF SAMPLES |
|---|---|---|
| 1. | St. Xavier's College, Palayamkottai. | **102** |
| 2. | C.S.I.Jeyaraj Annapackiam College, Nallur | **82** |
| 3. | St. John's College, Palayamkottai. | **78** |
| 4. | Sarah Tucker College, Palayamkottai. | **82** |
| 5. | Sri Sarada College for Women,Tirunelveli | **77** |
| 6. | Rani Anna College , Tirunelveli | **79** |
| **TOTAL** | | **500** |

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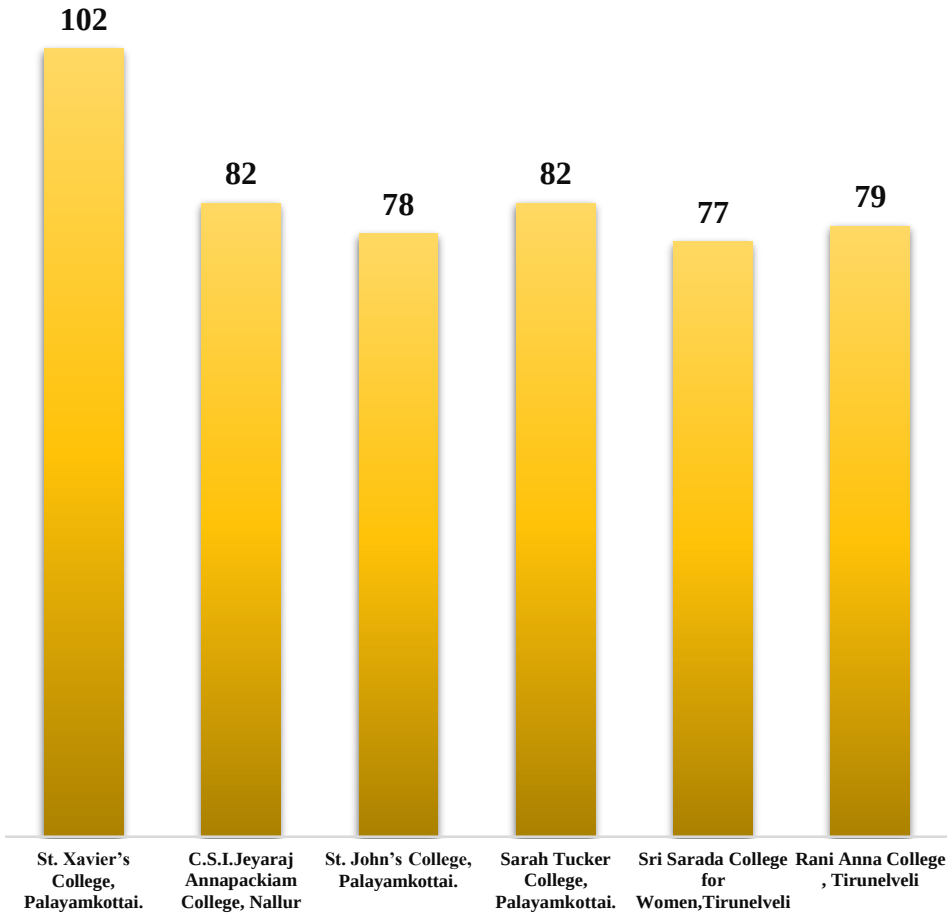
**Fig.3.2.** ***Sample Wise Distribution of the Colleges***



*ISBN: 978-93-5834-438-7*

***Table.3.6.Distribution of the sample in terms of Gender***

| Sex | No. of .students | Percentage |
|---|---|---|
| Male | 207 | 41 |
| Female | 293 | 59 |
| Total | 500 | 100 |

***Figure- 3.3 Distribution of the sample in terms of Gender***

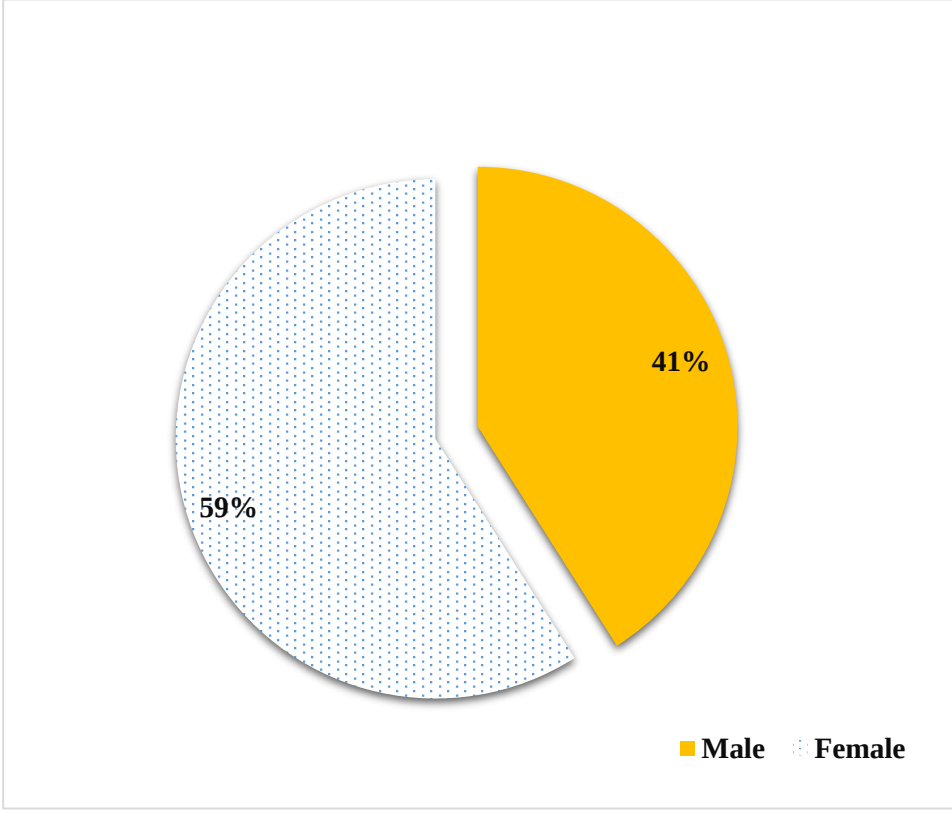


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***Table.3.7.Distribution of the sample in terms of Locality of Residence***

| Locality of Residence | No.of Students | Percentage |
|---|---|---|
| Rural | 287 | 57.4 |
| Urban | 213 | 42.6 |
| Total | 500 | 100 |

***Figure- 3.4 Distribution of the sample in terms of Locality of Residence***

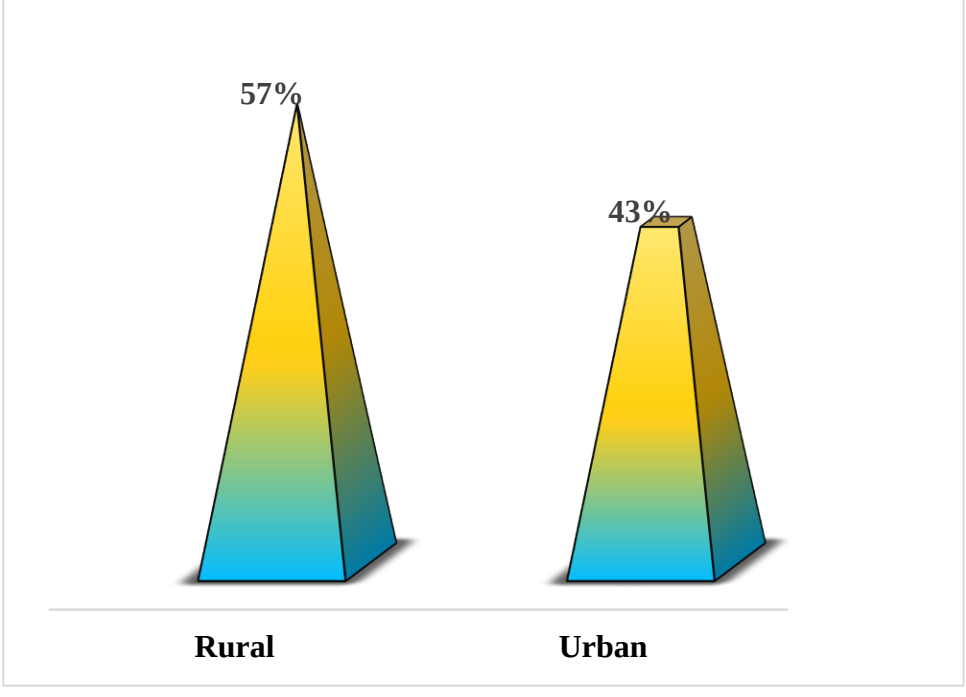

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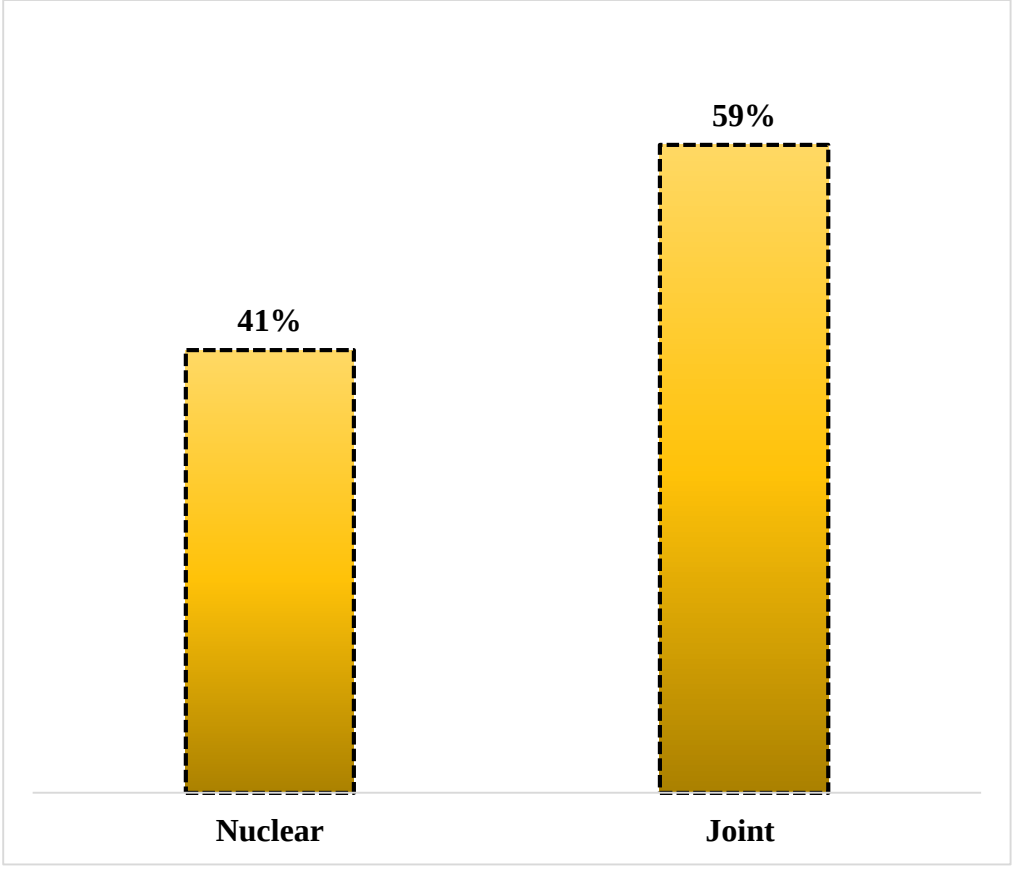
***Table.3.8.Distribution of the sample in terms of Type of Family***

| Type of Family | No. of Students | Percentage |
|---|---|---|
| Nuclear | 203 | 40.6 |
| Joint | 297 | 59.4 |
| Total | 500 | 100 |

***Figure.3.5. Distribution of the sample in terms of Type of Family***



*ISBN: 978-93-5834-438-7*

***Table.3.9.Distribution of the sample in terms of Stream of Study***

| Group of the study | No. of students | Percentage |
|---|---|---|
| Arts | 258 | 51.6 |
| Science | 242 | 48.4 |
| Total | 500 | 100 |

***Figure.3.6. Distribution of the sample in terms of Stream of Study***

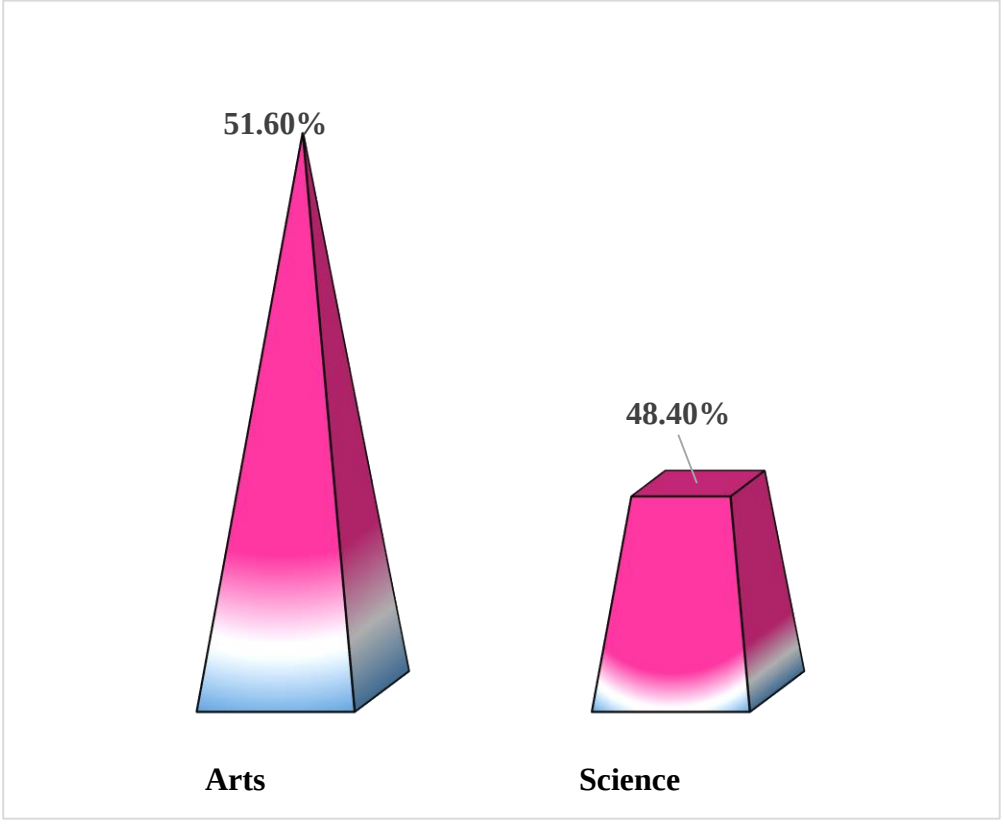


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***Table.3.10.Distribution of the sample in terms of Type of College***

| Type of College | No. of Students | Percentage |
|---|---|---|
| Girls | 379 | 75.8 |
| Co-education | 121 | 24.2 |
| Total | 500 | 100 |

***Figure.3.7. Distribution of the sample in terms of Type of College***

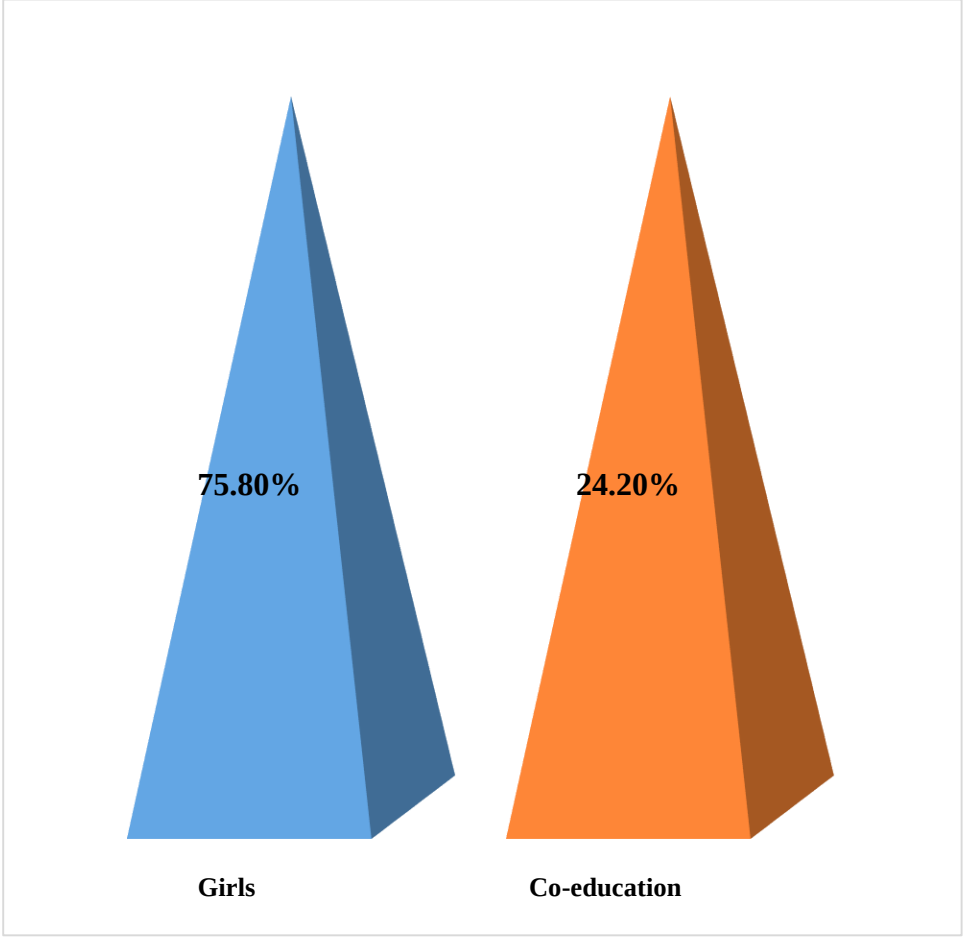

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***Table.3.11.Distribution of the sample in terms of Type of Management***

| Type of Management | No. of Students | Percentage |
|---|---|---|
| Autonomous | 262 | 52.4 |
| Non-autonomous | 238 | 47.6 |
| Total | 500 | 100 |

***Fig.3.8.Distribution of the sample in terms of Type of Management***

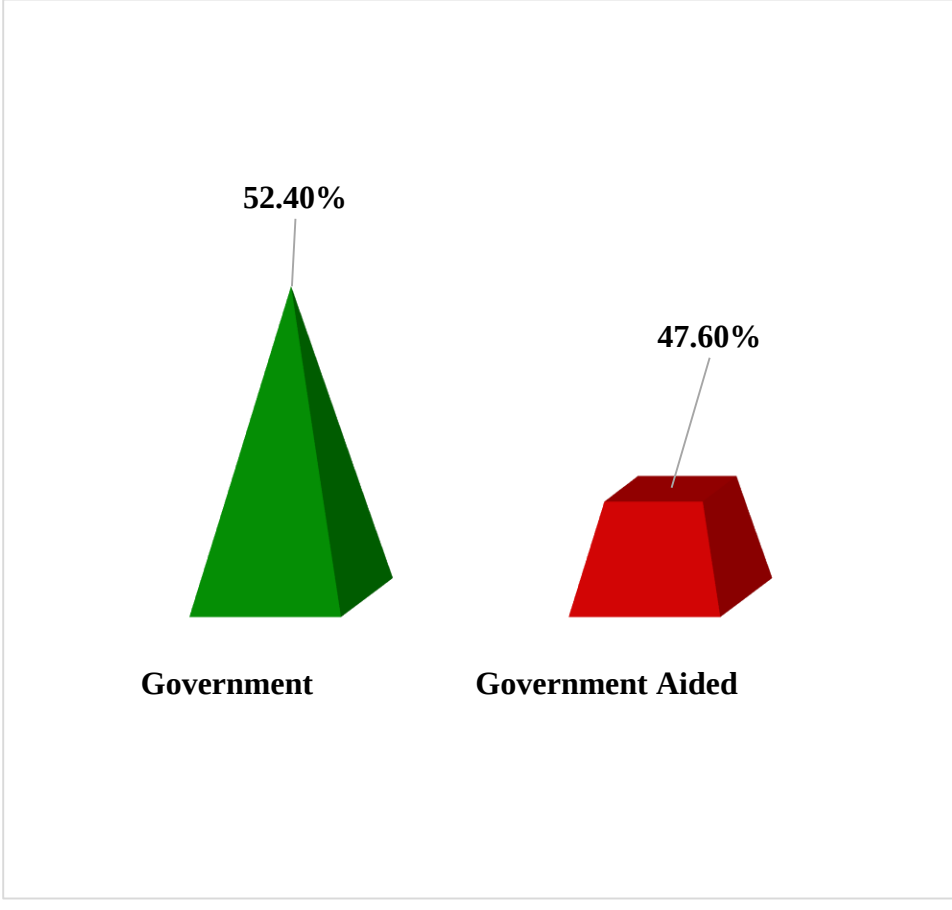

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***Table.3.12.Distribution of the sample in terms of Father's Education Qualification***

| Father's Education Qualification | No. of Students | Percentage |
|---|---|---|
| School | 199 | 46 |
| Degree | 213 | 34 |
| Professional | 88 | 20 |
| Total | 500 | 100 |

***Fig.3.9.Distribution of the sample in terms of Father's Education Qualification***

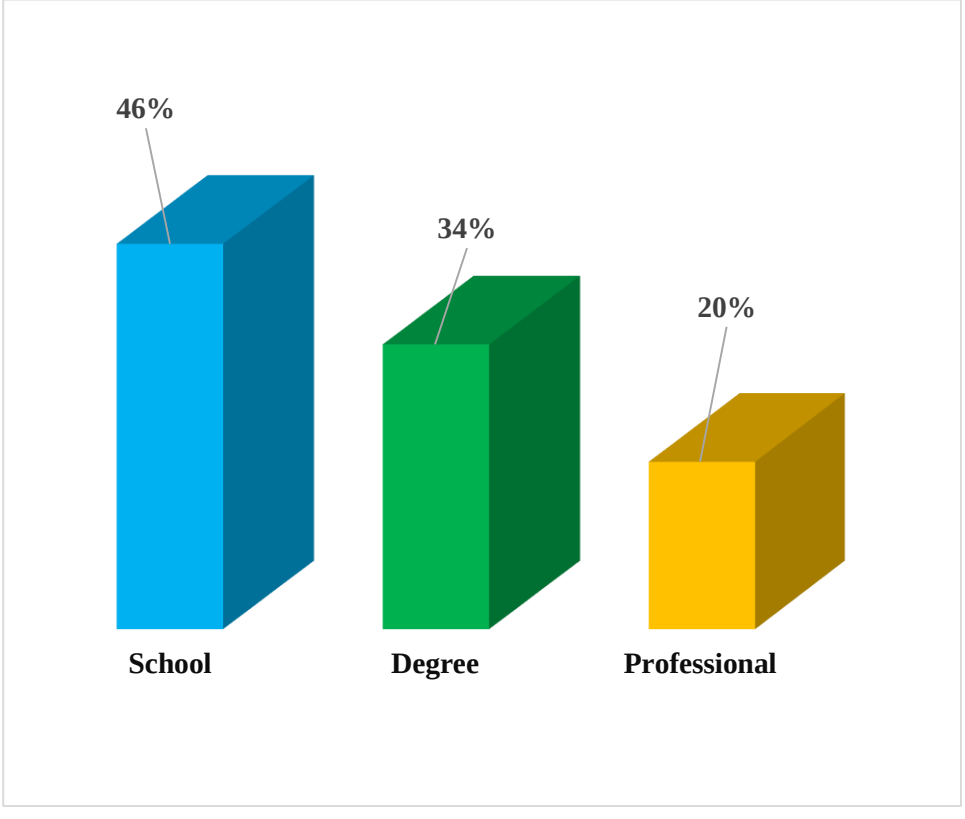

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***Table.3.13.Distribution of the sample in terms of Mothers Education Qualification***

| Mothers Education Qualification | No. of Students | Percentage |
|---|---|---|
| School | 223 | 44.6 |
| Degree | 132 | 26.4 |
| Professional | 145 | 29 |
| Total | 500 | 100 |

***Fig.3.10.Distribution of the sample in terms of Mothers Education Qualification***

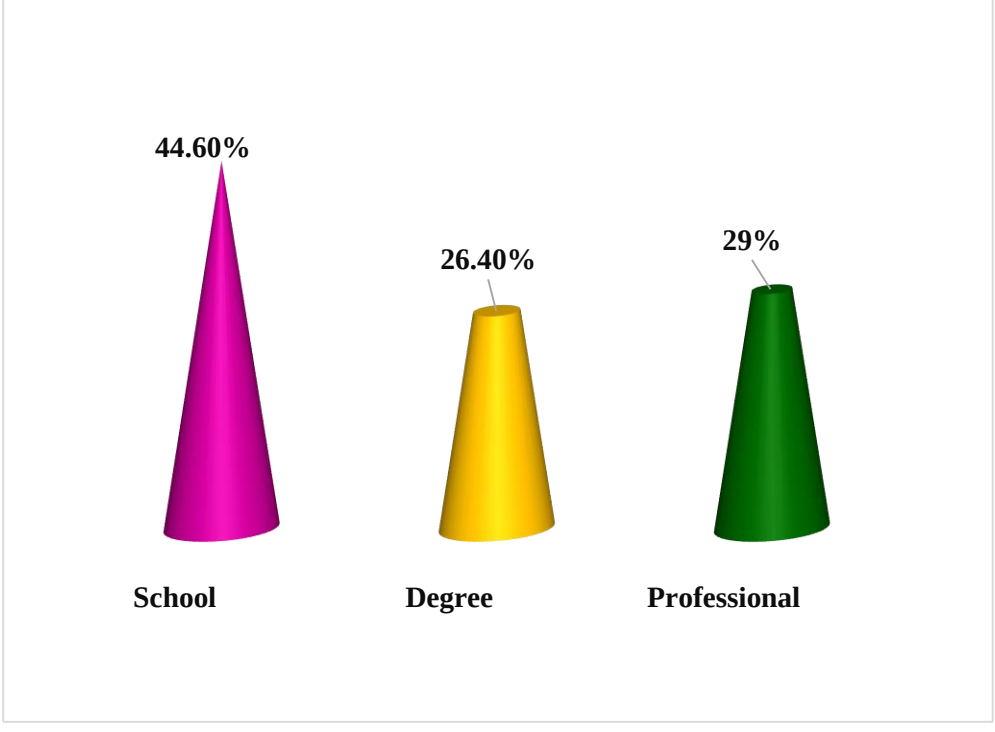

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***Table.3.14.Distribution of the sample in terms of Father's Occupation***

| Father's Occupation | No. of Students | Percentage |
|---|---|---|
| Government | 47 | 9 |
| Private | 101 | 20 |
| Self- employed | 352 | 71 |
| Total | 500 | 100 |

***Fig.3.11.Distribution of the sample in terms of Father's Occupation***

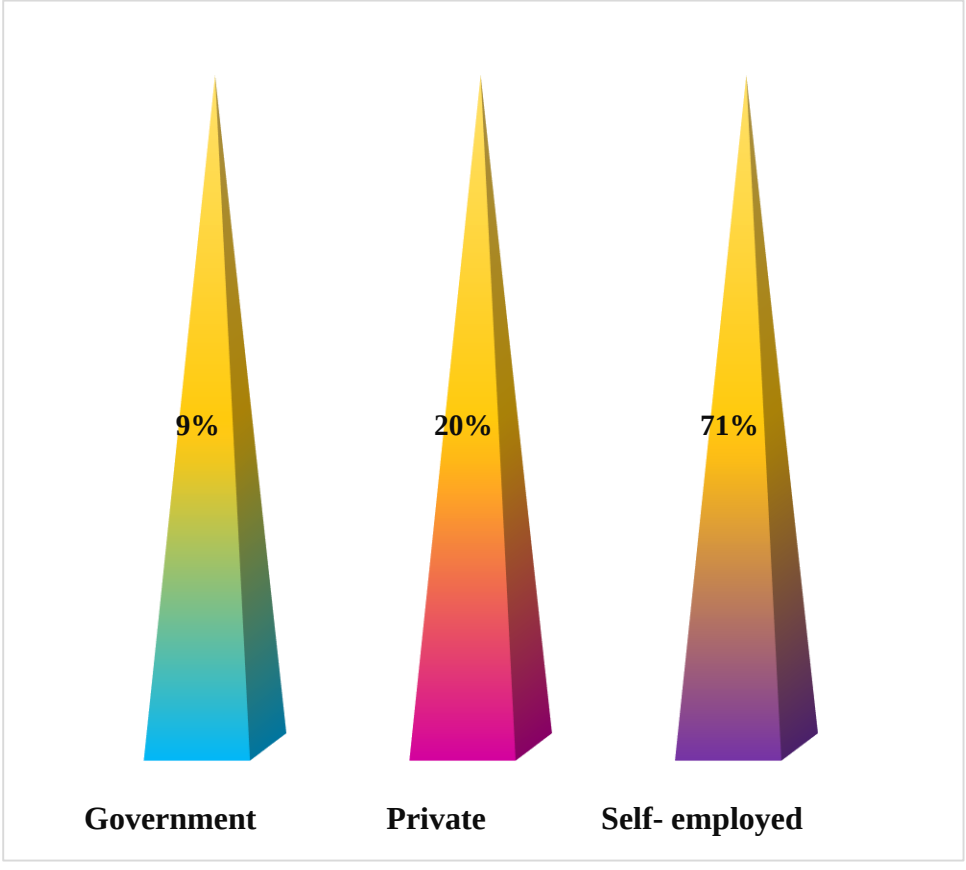

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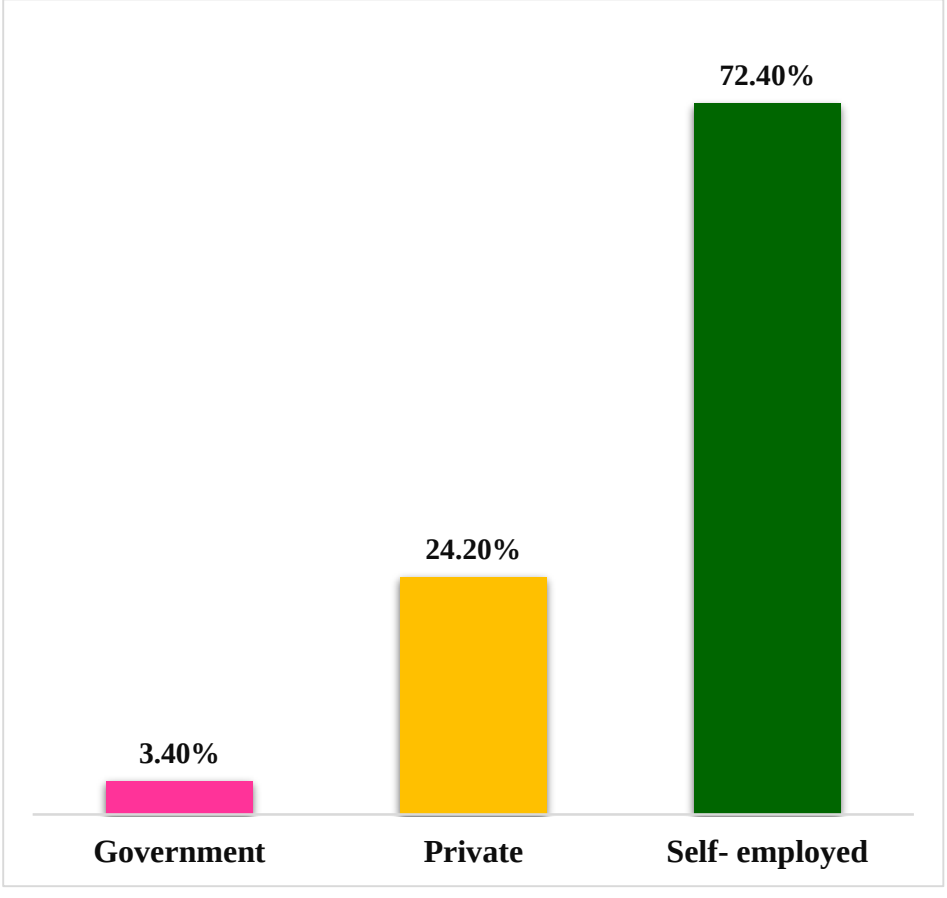
***Table.3.15.Distribution of the sample in terms of Mother's Occupation***

| Mother's Occupation | No. of Students | Percentage |
|---|---|---|
| Government | 17 | 3.4 |
| Private | 121 | 24.2 |
| Self- employed | 362 | 72.4 |
| Total | 500 | 100 |

***Fig.3.12.Distribution of the sample in terms of Mother's Occupation***



## 3.19.STATISTICAL TECHNIQUES USED

Statistics signifies the method or methods of dealing with numerical facts. According to Croxton &Cowden, "It is a science of collecting, summarizing, analyzing and interpreting numerical facts". Since research often yields such quantitative data, statistics is an essential tool of measurement and research. "The real purpose of statistical methods is to make sense of facts and figures, to prove the unknown, and to cast light upon the situation." Statistics help conclude facts affected by various causes in any department of inquiry. Thus, the primary purpose of statistical analysis is to draw general conclusions and inferences or make predictions based on particular facts and evidence.

## 3.20.USES OF STATISTICS IN RESEARCH

The advantages of statistical thinking's and operations in research are:

- It permits the most exact kind of description.
- It forces us to be definite and exact in our procedures and in our thinking
- It enables us to summarize our results in a meaningful and convenient form.
- It facilitates us to draw general conclusions.
- It enables us to predict.
- It enables us to analyze some of the causal factors underlying complex and otherwise bewildering events. Research is based on statistics and statistical techniques that are used in data analysis.

For analyzing and interpreting the data the investigators have used the following statistical techniques:

## 3.21.STATISTICAL TECHNIQUE USED FOR THE PRESENT STUDY

### *1. Arithmetic mean*

The mean is a simple arithmetic average. It is a common place knowledge that to take the average of a set of raw score we simply add all the scores up and divide it by the total number of scores (Aggarwal, Y.P, 2000) .The

investigators have used the following formula to find out the arithmetic mean:

$$\overline{X} = \frac{\Sigma x}{N}$$

Where,

$\overline{X}$ = Arithmetic mean
$\Sigma$ x = Sum of scores
N = Total number of scores

In the present study, the investigators have used arithmetic means to study awareness of e-waste management, including background variables like gender, location of residence, type of family, stream of study, type of management, and type of college.

**Uses of Mean**

- ❖ It is the more stable, reliable, accurate and widely used measure of central tendency.
- ❖ In computation equal weightage is given to every item in series.
- ❖ It provides a good basis for comparison.
- ❖ It can be used for further analysis and algebraic treatment.

*2.* ***Standard deviation***

"The square root of average of all deviations of scores from the mean of a given series or frequency distribution is known as standard deviation". It is also called as "mean square error". The word standard deviation was coined by Karl Pearson. It is denoted by $\sigma$ (Sigma) or S.D. (Bhandarkar,2007).

The investigators have used the following formula for calculating the standard deviation.

$$S.D = \frac{1}{N} \times \sqrt{N\Sigma x^2 - (\Sigma x)^2}$$

Where,

S.D. = Standard Deviation
$\Sigma x$ = Sum of scores
N = Total number of items

In the present study, the investigators have used Standard Deviation to study awareness of e-waste management about background variables like gender, location of residence, type of family, stream of study, type of management, and type of college.

**Uses of Standard Deviation**

- ❖ It provides the more reliable measures of variability.
- ❖ It is used when the distribution is normal.
- ❖ It is stable and less fluctuating hence, widely used in sampling theory.
- ❖ It is used in the study of symmetrical frequency distribution.
- ❖ It is used in co-efficient of correlation.

*3.* ***t-test***

Theoretical work on 't' distribution was done by W.S. Gosset in the early 1908. Gosset was employed by the Guiness Brewery in Dulbin, Ireland which did not permit employees to publish research findings under their own names. So Gosset adopted the pen name 'student' and published his findings under this name and there after the 't' distribution is commonly called students 't' distribution (Sharma, 2006)

The investigators used the following formula to calculate the 't' test.

$$t = \frac{M_1 - M_2}{\sqrt{\frac{S_1^2}{N_1} + \frac{S_2^2}{N_2}}}$$

Where,

$M_1$ = Mean of the I group
$M_2$ = Mean of the II group
$S_1$ = Standard deviation for the I group
$S_2$ = Standard deviation for the II group
$N_1$ = Size of the I group
$N_2$ = Size of the II group

In this study, the investigator used the t-test to test the hypothesis at a 5% significance level. In the present study, the investigators have used the 't'

test to study awareness of e-waste management about background variables like gender, location of residence, type of family, stream of study, type of management, and type of college.

**Uses of t – test**

It is used for process of determining the significant difference between two means of the two groups. It can be used for large as well as small sample.

### *4. ANOVA (Analysis of variance)*

The technique of analysis of variance was first devised by sir Ronald Fisher, an english statistician who is also considered to be the father of modern statistics as applied to social and behavioural sciences. The analysis of variance, as the name indicates deals with variance rather than with standard deviations and standard errors (Aggarwal, 2000).

The investigators used the following formula to calculate ANOVA. :

$$F = \frac{MeanSquareVariancebetweenthegroups}{MeanSquareVariancewithinthegroup}$$

In the present study the investigator has used ANOVA for studying awareness on e-waste management with regards to background variables like fathers education qualification, mothers education qualification, fathers occupation and mothers occupation

**Uses of ANOVA**

- It is used to evaluate more than one main effects and interaction effects of two or more factors in one experimental situation.
- It considers both types of effects in term of between or among variance and within variance.
- It is used for more than one independent variable effect.
- It is used for more than one classification like one way analysis variance, two way analysis variance and three or more ways analysis variance.

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# CHAPTER – IV
# ANALYSIS OF DATA

## 4.1 INTRODUCTION

The analysis of data is the most skilled task in the research process. It calls for the researchers' own judgment and skill. Analysis means a critical examination of the assembled and grouped data for studying the characteristics of the objects under study and for determining the patterns of relationship among the variables relating to it. Statistical analysis of data serves several major purposes. It summarizes large mass of data into understandable and meaningful form. Statistical analysis facilitates identification of the caused factors underlying complex phenomena. It aids the drawing of reliable inferences from observational data. Data are collected and analysed in order to predict or make inference about situations that have not been measured in full. Statistical analysis also helps making estimations or generalizations from the result of sample surveys. It is useful for assessing the significance of specific samples results under assumed population conditions. Analysis of data is the essential factor in its relevance to the solutions of the problems. The analysis and interpretation of data represent the application of deductive and inductive logic to the research process. The data are often classified by division into subgroups and are then analysed and synthesized in such a way that hypotheses may be verified or rejected. The final result may be new principles or generalization. Data are examined in terms of comparison between more homogeneous segments within the group; and by comparison with some outside criticism.

The analysis of data serves the following main functions:

1. To make the raw data meaningful
2. To test null hypotheses
3. To obtain the significant results
4. To draw some inferences or make generalizations
5. To evaluate parameters

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## 4.2. OBJECTIVE TESTING

### Null Hypothesis 1

***The level of awareness on e-waste management is moderate***

***Table 4.1. Level of e-waste management among college students***

| Variables | | Low | | Average | | High | |
|---|---|---|---|---|---|---|---|
| | | N | % | N | % | N | % |
| Gender | Male | 45 | 21.74 | 104 | 50.24 | 58 | 28.02 |
| | Female | 53 | 18.09 | 181 | 61.77 | 59 | 20.14 |
| Locality of Residence | Rural | 61 | 29.47 | 99 | 47.83 | 53 | 18.09 |
| | Urban | 45 | 21.74 | 109 | 52.66 | 59 | 20.14 |
| Type of Family | Nuclear | 46 | 22.66 | 99 | 48.77 | 58 | 28.57 |
| | Joint | 63 | 21.21 | 170 | 57.24 | 64 | 21.55 |
| Stream of Study | Arts | 53 | 20.54 | 136 | 52.71 | 69 | 26.74 |
| | Science | 50 | 20.66 | 138 | 57.02 | 54 | 22.31 |
| Type of College | Girls | 188 | 64.16 | 109 | 52.66 | 82 | 27.99 |
| | Co-education | 44 | 21.26 | 25 | 12.08 | 52 | 17.75 |
| Type of Management | Autonomous | 64 | 21.84 | 109 | 52.66 | 89 | 43.00 |
| | Non-autonomous | 25 | 12.08 | 149 | 50.85 | 64 | 21.84 |
| Father's Education Qualification | School | 36 | 18.09 | 115 | 57.79 | 48 | 24.12 |
| | Degree | 43 | 20.19 | 124 | 58.22 | 46 | 21.60 |
| | Professional | 19 | 21.59 | 50 | 56.82 | 19 | 21.59 |
| Mother's Education Qualification | School | 47 | 23.15 | 94 | 24.35 | 82 | 21.24 |
| | Degree | 44 | 17.05 | 50 | 20.66 | 38 | 14.73 |
| | Professional | 33 | 13.64 | 38 | 14.73 | 74 | 19.17 |
| Father's Occupation | Government | 9 | 19.15 | 23 | 48.94 | 15 | 31.91 |
| | Private | 20 | 19.80 | 51 | 50.50 | 30 | 29.70 |
| | Self- employed | 69 | 19.60 | 211 | 59.94 | 72 | 20.45 |
| Mother's Occupation. | Government | 2 | 5.88 | 6 | 31.58 | 9 | 47.37 |
| | Private | 8 | 42.11 | 74 | 19.17 | 39 | 63.93 |
| | Self- employed | 80 | 20.73 | 200 | 51.81 | 82 | 21.24 |

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It is revealed from the above table 4.1 that among male college students 21.74% have low, 50.24% have average and 28.02% have high level of awareness on e-waste management. Among the female college students 18.09% have low, 61.77% have average and 20.14% high level of awareness on e-waste management.

It is revealed from the above table 4.1 that among rural college students 29.47% have low, 47.83% have average and 18.09% have high level of awareness on e-waste management. Among the urban college students 21.74% have low, 52.66% have average and 20.14% have high level of awareness on e-waste management.

It is revealed from the above table 4.1 that among nuclear family college students 22.66% have low, 48.77% have average and 28.57% have high level of awareness on e-waste management. Among the joint family college students 21.21% have low, 57.24% have average and 21.55% have high level of awareness on e-waste management.

It is revealed from the above table 4.1 that among arts stream college students 20.54% have low, 52.71% have average and 26.74% have high level of awareness on e-waste management. Among the science stream college students 20.66% have low, 57.02% have average and 22.31% %have high level of awareness on e-waste management.

It is revealed from the above table 4.1 that among girl's college students 64.16% have low, 52.66% have average and 27.99% have high level of awareness on e-waste management. Among the co-education college students 21.26% have low, 12.08% have average and 17.75% have high level of awareness on e-waste management.

It is revealed from the above table 4.1 that among autonomous college students 21.84% have low, 52.66% have average and 43.00% have high level of awareness on e-waste management. Among the non-autonomous

college students 12.08% have low, 50.85% have average and 21.84% have high level of awareness on e-waste management.

It is revealed from the above table 4.1 that 18.09% of college students whose fathers are educated up to school level have low, 57.79% have average and 24.12% have high level of awareness on e-waste management. Among the college students whose fathers are degree holders 20.19% have low, 58.22% have average and 21.60% have high level of awareness on e-waste management. Among the college students whose fathers are professional 21.59% have low, 56.82% have average and 21.59% % have high level of awareness on e-waste management.

It is revealed from the above table 4.1 that 23.15% of college students whose mothers are educated up to school level have low, 24.35% have average and 21.24% have high level of awareness on e-waste management. Among the college students whose mothers are degree holders 17.05% have low, 20.66% have average and 14.73% have high level of awareness on e-waste management. Among the college students whose mothers are professional 13.64% have low, 14.73% have average and 19.17% % have high level of awareness on e-waste management.

It is revealed from the above table 4.1 that 19.15% of college students whose fathers are government employees have low, 48.94% have average and 31.91% have high level of awareness on e-waste management. Among the college students whose fathers are private employees 19.80% have low, 50.50% have average and 29.70% have high level of awareness on e-waste management. Among the college students whose fathers are self-employed 19.60% have low, 59.94% have average and 20.45% have high level of awareness on e-waste management.

It is revealed from the above table 4.1 that 5.88% of college students whose mothers are government employees have low, 31.58% have average and 47.37% have high level of awareness on e-waste management. Among the college students whose mothers are private employees 42.11% have low,

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19.17% have average and 63.93% have high level of awareness on e-waste management. Among the college students whose mothers are self-employed 20.73% have low, 51.81% have average and 21.24% have high level of awareness on e-waste management.

**Null Hypothesis 2**

There is no significant difference between college students in their awareness on e-waste management with respect to their gender.

**Table 4.2.DIFFERENCE BETWEEN MALE AND FEMALE COLLEGE STUDENTS IN THEIR AWARENESS ON E-WASTE MANAGEMENT**

| Gender | N | Mean | Std. Deviation | t-value | Remarks |
|---|---|---|---|---|---|
| Male | 207 | 27.63 | 4.21 | 3.56 | S |
| Female | 293 | 26.25 | 4.31 | | |

***(At 5% level of significance the table value of 't' is 1.96)***

It is inferred from the above table that the calculated 't' value 3.56 is greater than the table value 1.96 at 0.05 level of significance. Hence the null hypothesis is rejected. Thus there is significant difference between male and female college students in their awareness on e-waste management.

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**Null Hypothesis 3**

There is no significant difference between college students in their awareness on e-waste management with respect to locality of home environment.

**Table 4.3.DIFFERENCE BETWEEN RURAL AND URBAN COLLEGE STUDENTS IN THEIR AWARENESS ON E-WASTE MANAGEMENT**

| Locality of Home Environment | N | Mean | Std. Deviation | t-value | Remarks |
|---|---|---|---|---|---|
| Rural | 287 | 27.39 | 4.24 | 2.91 | S |
| Urban | 203 | 26.26 | 4.32 | | |

***(At 5% level of significance the table value of 't' is 1.96)***

It is inferred from the above table that the calculated 't' value 2.91 is greater than the table value 1.96 at 0.05 level of significance. Hence the null hypothesis is rejected. Thus there is significant difference between rural and urban college students in their awareness on e-waste management.

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**Null Hypothesis 4**

There is no significant difference between college students in their awareness on e-waste management with respect to type of family.

**Table 4.4. DIFFERENCE BETWEEN NUCLEAR AND JOINT FAMILY COLLEGE STUDENTS IN THEIR AWARENESS ON E-WASTE MANAGEMENT**

| Type of Family | N | Mean | Std. Deviation | t-value | Remarks |
|---|---|---|---|---|---|
| Nuclear | 203 | 30.78 | 4.46 | 1.75 | NS |
| Joint | 297 | 31.53 | 4.86 | | |

***(At 5% level of significance the table value of 't' is 1.96)***

It is inferred from the above table that the calculated 't' value 1.75 is lesser than the table value 1.96 at 0.05 level of significance. Hence the null hypothesis is rejected. Thus there is no significant difference between college students in their awareness on e-waste management

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**Null Hypothesis 5**

There is no significant difference between college students in their awareness on e-waste management with respect to their stream of study.

**Table 4.5.DIFFERENCE BETWEEN ARTS GROUP AND SCIENCE GROUP COLLEGE STUDENTS IN THEIR AWARENESS ON E-WASTE MANAGEMENT**

| Stream of Study | N | Mean | Std. Deviation | t-value | Remarks |
|---|---|---|---|---|---|
| Arts | 258 | 30.69 | 4.63 | 2.85 | S |
| Science | 242 | 31.86 | 4.56 | | |

***(At 5% level of significance the table value of 't' is 1.96)***

It is inferred from the above table that the calculated 't' value 2.91 is greater than the table value 1.96 at 0.05 level of significance. Hence the null hypothesis is rejected. Thus there is significant difference between arts group and science group college students in their awareness on e-waste management.

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**Null Hypothesis 6**

There is no significant difference between college students in their awareness on e-waste management with respect to their nature of college.

**Table 4.6.DIFFERENCE BETWEEN GIRLS AND CO-EDUCATION COLLEGE STUDENTS IN THEIR AWARENESS ON E-WASTE MANAGEMENT**

| Nature of College | N | Mean | Std. Deviation | t-value | Remarks |
|---|---|---|---|---|---|
| Girls | 379 | 47.71 | 4.790 | 1.080 | NS |
| Co-education | 121 | 48.18 | 4.403 | | |

***(At 5% level of significance the table value of 't' is 1.96)***

It is inferred from the above table that the calculated 't' value 1.080 is lesser than the table value 1.96 at 0.05 level of significance. Hence the null hypothesis is rejected. Thus there is no significant difference between girls and co-education college students in their awareness on e-waste management

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**Null Hypothesis 7**

There is no significant difference among college students in their awareness on e-waste management with respect to their type of management

**Table 4.7. DIFFERENCE BETWEEN AUTONOMOUS AND NON-AUTONOMOUS COLLEGE STUDENTS IN THEIR AWARENESS ON E-WASTE MANAGEMENT**

| Type of management | N | Mean | Std. Deviation | t-value | Remarks |
|---|---|---|---|---|---|
| Autonomous | 262 | 47.26 | 5.204 | 3.038 | S |
| Non-autonomous | 238 | 48.45 | 3.992 | | |

***(At 5% level of significance the table value of 't' is 1.96)***

It is inferred from the above table that the calculated 't' value 3.038 is greater than the table value 1.96 at 0.05 level of significance. Hence the null hypothesis is rejected. Thus there is significant difference between government and government aided college students in their awareness on e-waste management.

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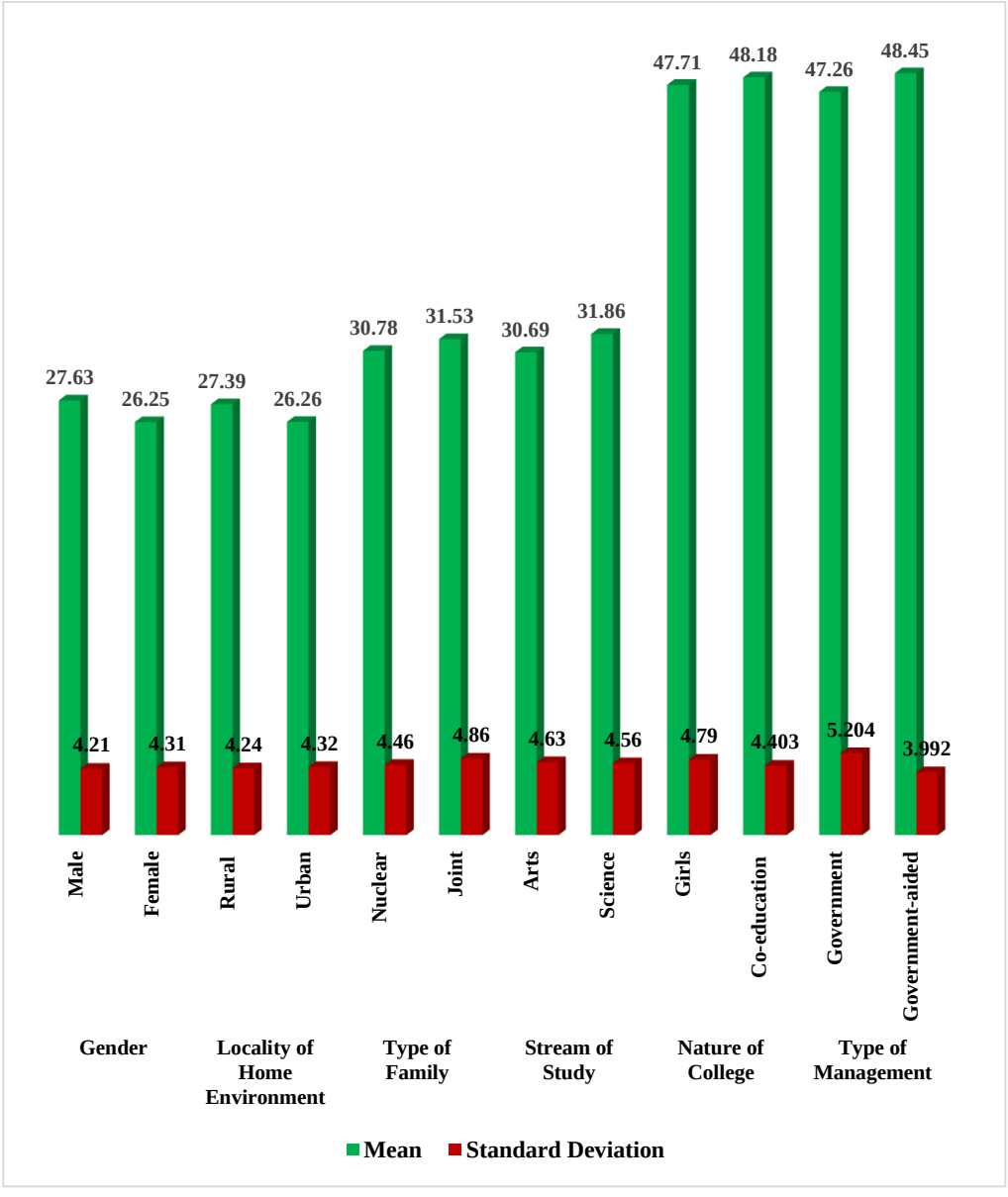
***Figure.4.2. The graphical representation shows the mean score and standard deviation of awareness on e-waste management among college students in Tirunelveli District***



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**Null Hypothesis 9**

There is no significant association between father's education qualification of college students and their awareness on e-waste management with respect to fathers' education.

**Table 4.8. ASSOCIATION BETWEEN FATHER'S EDUCATION QUALIFICATION OF COLLEGE STUDENTS AND THEIR AWARENESS ON E-WASTE MANAGEMENT**

| Category | Degrees of Freedom | Calculated '$\chi^2$'Value | p-value | Remarks at 5%level |
|---|---|---|---|---|
| Fathers Education Qualification | 3 | 3.42 | 9.49 | NS |

***(for 3 df, at 5% level of significance, the table value of '$\chi^2$' is 7.815)***

It is inferred from the above table that the calculated'$\chi^2$' value 3.42 is less than the table value 7.815 at 0.05 level of significance. Hence the null hypothesis is accepted. Thus there is no significant association between father's education qualification of college students and their awareness on e-waste management.

**Null Hypothesis 10**

There is no significant association between mother's education qualification of college students and their awareness on e-waste management with respect to fathers' education.

**Table 4.9. ASSOCIATION BETWEEN MOTHER'S EDUCATION QUALIFICATION OF COLLEGE STUDENTS AND THEIR AWARENESS ON E-WASTE MANAGEMENT**

| Category | Degrees of Freedom | Calculated '$\chi^2$'Value | p-value | Remarks at 5%level |
|---|---|---|---|---|
| Mother's Education Qualification | 3 | 7.33 | 9.49 | NS |

***(for 3 df, at 5% level of significance, the table value of '$\chi^2$' is 7.815)***

It is inferred from the above table that the calculated'$\chi^2$' value 3.42 is less than the table value 7.815 at 0.05 level of significance. Hence the null hypothesis is accepted. Thus there is no significant association between mother's educational qualification of college students and their awareness on e-waste management.

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**Null Hypothesis 11**

There is no significant association between father's occupation of college students and their awareness on e-waste management.

**Table 4.10. ASSOCIATION BETWEEN FATHER'S OCCUPATION OF COLLEGE STUDENTS AND THEIR AWARENESS ON E-WASTE MANAGEMENT**

| Category | Degrees of Freedom | Calculated '$\chi^2$'Value | p-value | Remarks at 5%level |
|---|---|---|---|---|
| Father's Occupation | 3 | 6.30 | 9.49 | NS |

***(for 3 df, at 5% level of significance, the table value of '$\chi^2$' is 7.815)***

It is inferred from the above table that the calculated'$\chi^2$' value 6.30 is less than the table value 7.815 at 0.05 level of significance. Hence the null hypothesis is accepted. Thus there is no significant association between mother's educational qualification of college students and their awareness on e-waste management.

**Null Hypothesis 11**

There is no significant association between mother's occupation of college students and their awareness on e-waste management.

**Table 4.11. ASSOCIATION BETWEEN MOTHER'S OCCUPATION OF COLLEGE STUDENTS AND THEIR AWARENESS ON E-WASTE MANAGEMENT**

| Category | Degrees of Freedom | Calculated '$\chi^2$'Value | p-value | Remarks at 5%level |
|---|---|---|---|---|
| Mother's Occupation | 3 | 2.74 | 9.49 | NS |

***(for 3 df, at 5% level of significance, the table value of '$\chi^2$' is 7.815)***

It is inferred from the above table that the calculated'$\chi^2$' value 2.74 is less than the table value 7.815 at 0.05 level of significance. Hence the null hypothesis is accepted. Thus there is no significant association between mother's occupation of college students and their awareness on e-waste management.

## 4.3.CONCLUSION

The present chapter describes the statistical analysis and the results obtained from the collected data whether to reject the null hypothesis or to accept it. The next chapter deals with summary, findings and conclusion of the present study.

# CHAPTER-V
# FINDINGS, INTERPRETATIONS, RECOMMENDATIONS AND SUGGESTIONS

## 5.1.INTRODUCTION

In present life, technology has taken revolutionary growth due to human efforts for getting more benefit but apart from this revolution's benefit, the problem of disposing of e-waste reigns, as humans know how to use the gadgets but not to dispose them. The environment pollution caused by the e-waste is irreversible and is yet to be realized by the masses, particularly in developing countries. So, e-waste is a wide problem in country and cause of people's suffocation from e-waste's hazardous problem. The study is conducted because healthy environment is a part of our life. The problem can be solved only by instilling awareness in people about e-waste and management of electronics. the e-waste problem is because most of the people are using electronic gadgets but they do not have proper knowledge of its management and disposal. It is felt that they are unaware. Environment education plays a significant role in the formal education system. It aims to produce a healthy sustainable environment for us to live in, and this is only possible if the future generation is active participants in teaching learning process and the practical education imparted to them mitigate the problem of e-waste and make our environment friendlier for all living organisms.

## 5.2.FINDINGS OF THE STUDY

E-waste management is necessary in meeting global sustainable development goals for 2030, including reducing risk health complications and death due to hazardous and toxic composition in e-waste and exposure to the surrounding environment.

1. The level of awareness on e-waste management is moderate
2. There is significant difference between male and female college students in their awareness on e-waste management.
3. There is significant difference between rural and urban college students in their awareness on e-waste management.

4. There is significant difference between arts and science stream college students in their awareness on e-waste management.
5. There is significant difference between autonomous and non-autonomous college students in their awareness on e-waste management.
6. There is no significant difference between nuclear and joint family college students in their awareness on e-waste management.
7. There is no significant difference between girls and coeducation college students in their awareness on e-waste management.
8. There is no significant association between father's education qualification of college students and their awareness on e-waste management.
9. There is no significant association between mother's education qualification of college students and their awareness on e-waste management.
10. There is no significant association between father's occupation of college students and their awareness on e-waste management.
11. There is no significant association between mother's occupation of college students and their awareness on e-waste management.

## 5.3.INTERPRETATIONS

### Interpretation related to finding no.2

There is significant difference between male and female college students in their awareness on e-waste management.

From table 4.2, it is evident that the calculated t-value3.077 is greater than the table value 1.96 which is significant at 0.05 level. Thus the null hypothesis is rejected. The mean awareness (27.63) of male college students, which is significantly higher than the mean awareness (26.25) of female college students. Hence, the null hypothesis is rejected. This may be because male students get the opportunity to gain knowledge through social media. They also know that segregating metals and components while disposing of e-waste affects workers. Male students are more aware of the

sustainability of natural resources when integrating e-waste management than female students. They also participate in outdoor activities like awareness campaigns and serve as members of eco clubs, which helps them enhance their awareness attitude. The male students also have positive behaviour towards the management of e-waste. They know that dumping E-waste into seas or barren islands leads to water pollution, affecting the aquatic and marine ecosystems. Their eagerness to participate in community outreach programs and organize events and workshops on e-waste recycling effectively raises their e-waste awareness. Media campaigns, such as television and radio ads, also raise awareness of e-waste and its environmental impact. Female students need to understand e-waste management better and have knowledge of health and the environment. Female students show less care about recycling e-waste, though, and despite being aware of the risks that e-waste poses to human health and the environment, students treat it like regular trash. They either keep electronic trash without a purpose or discard it with regular trash, indicating they are reluctant regarding e-waste management.

This result is supported by the study conducted by Cynthia S. Subhaprada & Kalyani P (2016) Study on awareness of e-waste management among medical students. In their study they showed that 56.25% of the male students have high awareness on e-waste management compared to female students.

**Interpretation related to finding no.3**

There is significant difference between rural and urban college students in their awareness on e-waste management.

From table 4.3, it is evident that the calculated t-value 3.077 is greater than the table value 1.96 which is significant at 0.05 level. Thus the null hypothesis is rejected. The mean awareness (27.39) of rural college students, which is significantly higher than the mean awareness (26.26) of urban college students. Hence the null hypothesis is rejected. This may be because rural students are closer to nature than urban students. They show eagerness to participate in community outreach programs. They participate in events

and workshops to learn about e-waste awareness and e-waste recycling. They also know the critical aspect of extended producer responsibility (EPR). EPR puts additional responsibility on us, the product manufacturer, to not only produce durable quality products but also take back obsolete products and manage the e-waste. Through club activities, they gain awareness by organizing door-to-door waste collection. Ensure public participation in a community-based primary collection system. They also understand waste minimization through in-house backyard composting, vermicomposting, and biogas generation. They also know that the disposal of e-waste is a global environmental and public health issue, as this waste has become the most rapidly growing segment of the regular municipal waste stream in the world. Rural students are more aware that e-waste contains hazardous constituents that may negatively impact the environment and human health. They also understand that due to the lack of adequate infrastructure to manage wastes safely, these wastes are buried, burnt in the open air, or dumped into surface water bodies. They gain knowledge through social media regarding e-waste's direct health risks when it degrades and the internal chemicals are released into the environment. This result is contradicted by the study conducted by Sivannatham,R.,& Govindarajan,K.(2022). In their study attitude and skills on e- waste management among undergraduate students they proved that there is no significance in attitude and skills of E-waste management in undergraduate students of gender, locality, subject and type of management.

**Interpretation related to finding no.5**

There is no significant difference between arts and science stream college students in their awareness on e-waste management.

From table 4.5, it is evident that the calculated t-value 3.077 is greater than the table value 1.96 which is significant at 0.05 level. Thus the null hypothesis is rejected. The mean awareness (30.69) of arts stream students, which is significantly higher than the mean awareness (31.86) of science group students. Hence the null hypothesis is rejected. This may be because science students are more aware of e-waste management and its

consequences on human health. They also understand the metabolic changes due to the e-waste dumping in landfills and water bodies. They know the impact of lousy e-waste recycling practices creates significant e-waste health issues and harms the wider environment. They also gain insights through environmental talks, seminars, and conferences that Mercury traces present in e-waste are highly poisonous, affecting the brain, digestive, reproductive, kidneys, and liver. They also know that e-waste diseases can be caused by inhaling, eating, drinking tiny amounts of mercury, or skin contact. Their curriculum helps the students understand the category of e-waste, its significance, and the ways to overcome the problem. Their attitude towards e-waste management increased compared to the arts stream students by participating in various environmental activities like seminars, symposiums, panel discussions, and debates, which helped them understand more about the adverse effects of e-waste in the environment.

This result is supported by the study conducted by Sivannatham,R., and Govindarajan,K. (2020) in their study they find that science students have high level of e-waste management skills compared to arts students.

**Interpretation related to finding no.8**

There is significant difference between autonomous and non-autonomous college students in their awareness on e-waste management.

From table 4.8, it is evident that the calculated t-value 3.077 is greater than the table value 1.96 which is significant at 0.05 level. Thus the null hypothesis is rejected. The mean awareness (48.45) of autonomous college students, which is significantly higher than the mean awareness (47.56) of non-autonomous college students. This may be because autonomous college students have less awareness than autonomous college students. The students from autonomous colleges eagerly participate in the environmental-related campaign. They also gain knowledge about e-waste disposal, carbon, and plastic footprint. Through Newspapers, electronic media, and social media, students gain awareness of e-waste and the benefits of recycling. They know that E-waste collection centers in educational points like schools and colleges can be NGOs, Post offices, Banks, hospitals, and cinema halls, which will help reduce the accumulation of e-waste in the

environment. Management encourages them to participate in awareness programs and campaigns on e-waste management conducted by NGOs and government officials. They know about the 4 R methods e-waste can be adequately managed: Reduce purchases, reuse old gadgets by donating them, recycle unused electronic items, and Repair unwanted items for reuse and to increase the life of the product. Hence the null hypothesis is rejected. This result is contradicted by the study conducted by Sahitha Mol and Sonia (2015). In their study they find that there is no significant difference between government and government aided students in their awareness on e-waste management

## 5.4.RECOMMENDATIONS

The knowledge and positive practices on e-waste can be enhanced by adding topics and hands-on activities regarding e-waste in the curricula. The use of social media in disseminating information on e-waste must be enhanced at schools and colleges. Future research could focus on the effectiveness of social media in information dissemination and raising awareness of the environmental and health effects of e-waste. Empowerment and training of environmental clubs at universities must include the management of e-waste. Positive behaviour towards the management of e-waste must be developed among students from the early years of school to university. The government should enact policies that govern the management of e-waste, and this will provide a framework for institutions to set up local-level policies that promote green initiatives.

## 5.5.EDUCATIONAL IMPLICATIONS

The world is facing many environmental problems, such as global warming and pollution, which are affecting us adversely. This study focuses on e-waste, a significant cause of environmental deterioration. The educational implications of the study are as follows:

- The knowledge and positive practices on e-waste can be enhanced by adding topics and hands-on activities regarding e-waste in the curriculum.

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- The use of social media in disseminating information on e-waste must be improved at schools and colleges.
- Empowerment and training of ecological clubs at universities must include the management of e-waste.
- Positive behaviour towards the management of e-waste must be developed among students from the early years of school to university.
- The government should enact policies that govern the management of e-waste, and this will provide a framework for institutions to set up local-level policies that promote green initiatives.
- The college curriculum should be revised regarding environmental education and include the e-waste chapter.
- Topics related to e-waste awareness should be included in the college curriculum.
- Special orientation classes to enhance e-waste awareness must be organized for college students.
- Content related to e-waste management must be included in the self-study course.
- Students should be encouraged to participate in e-waste awareness programs.
- Educating students about the 4 R's, which are Recycle, Reduce, Reuse, and Repair from primary education onwards.
- Encourage students and community members to donate their old computers, mobile phones, and printers to non-profit organizations or charity centers.
- Teachers should organize extracurricular activities regarding e-waste management practice. So they will become familiar with their responsibilities regarding the environment.
- The teacher should assign project work amongst the students, which will help all the students participate in environmental activity and learn about the environment in collaboration.
- The teacher should include nature visit programs to nearby areas where they will encounter the problems of their immediate surrounding and their effect on their environment.

- Collection Booths in the college campus can take the initiative towards installing e-waste disposal bins at their campuses for accessible collection of e-waste, which, due to lack of proper collection mechanism, are disposed of in a manner posing severe environmental and health hazards.
- The teacher must cater to the students' affective domain by instilling and arousing social and moral values among students regarding e-waste.
- Parents should encourage students to manage their discarded electronic materials by recycling or reselling them to others.
- Teachers should sustain their attitude by looking for positive development in students from different socio-economical groups rather than acquiring bookish information.
- Awareness of Green products should be promoted through various awareness programs.
- Educational policymakers should reform the curriculum offered in the arts and science stream textbooks.
- Various activities related to environmental education, like essay writing, science clubs, fairs, and excursions, can be arranged in schools and colleges.

## 5.6. CONCLUSION

E-waste management is necessary in meeting global sustainable development goals for 2030, including reducing risk health complications and death due to hazardous and toxic composition in e-waste and exposure to the surrounding environment (Islam et al.,2021). There is an increase in the usage of electronic items, and there is a steady growth in the sale of electronic goods by the industries involved in producing electronic items. The channel of distribution of electronic items has been made more accessible in terms of comfort, which leads to the easy procurement of electronic goods at the convenience of residents. There must be proper awareness of the consequences of electronic goods so that every consumer can utilize them without harming the environment. Improper consumption

leads to the accumulation of electronic waste, which deprives the ecosystem. The government must create policy decisions and mechanisms to control electronic waste and promote the recycling of electronic goods. The knowledge of the hazards of electronic goods would elevate the individual citizens' awareness, thereby creating a better community through electronic waste disposal behaviour.

Electronics has become one of the world's largest and fastest-growing industries. Over the last 25 years, it has experienced phenomenal growth, which has led to a rapid increase in obsolete electronics, which, in turn, has significantly caused a hike in the generation of electronic waste in industrialized countries. With the advent of technology, exponentially growing industrialization, the emphasis of the Government on the Digital India Initiative, growing consumer preferences towards technological products, and falling consumer electronics prices, electronic waste generation is inevitable. However, as of now, waste is segregated only into two categories: dry and wet waste. Priority should be given to spread awareness about e-waste and its proper disposal. It is the birth right of every citizen to live in a pollution-free environment, to get good air to breathe, and to have safe water to drink. As long as these basic rights are denied or a conducive atmosphere is not created, a nation cannot claim its unique and sustainable development.

Our country faces significant challenges in protecting the environment from further damage. Population growth and consumerism make the task all the more difficult for the Indian Government. The Indian Government's ability to safeguard the country's environment depends on policies and educational systems. Disposal of e-waste is one of the significant challenges facing the world today. The incineration of e-waste also emits toxic gases and fumes, resulting in air pollution, which causes humanity to suffer from inhalation, ingestion, and skin problems. Most of the developed and developing nations dispose of E-waste by landfilling. Due to the lack of facilities, the progressive increase in E-waste will spoil the fertility of the soil used for agriculture. Like acids and sludge obtained from improperly burning and melting E-waste, the remains will lead to soil acidification. Several awareness programs about e-waste management need

to be conducted in the city. The usage of waste products in private and public sectors will be high, so it needs to get knowledge on waste management.

Hence, humans are asked to reduce, reuse, and recycle their waste. Even the most learned people are oblivious to the segregation of objects to reduce, reuse, recycle and repair. These four words, if followed by every person, would be helpful to protect our environment. Youngsters could be sensitized by bringing awareness in them through different activities, charts, newspapers, magazines, seminars, debates, speeches, street play, drama, public meetings, different media like television, Internet and social media like Facebook and WhatsApp. The youth waste management practices are crucial because this tech savvy generation contributes to the waste menace and they are also responsible in providing creative solutions to solve the near future environmental waste issues. Children need to have the appropriate orientation, the required skills, positive attitude and commitment to take the initiative towards solving existing environmental problems and preventing new ones to arise in other to live sustainably. The study attempted to record the growing concern about awareness of e-waste management concerning environmental and health issues. The existing sector gap and a large percentage of management through the informal sector are also studied. Tirunelveli is one of the smart cities in Tamilnadu, and it has many IT, automobile, and other small-scale industries. The study witnessed that the civic society must be aware of e-waste. The government bodies must integrate all the stakeholders, conduct frequent awareness and collection campaigns, ensure the EPR capabilities of manufacturers & retailers, and provide training to unskilled labour. The recent ban on plastic is well received in Tamil Nadu. The Government also tightened the production of non-reusable plastic. The same can be extended to the unsafe throw of e-waste by levying heavy penalties and mobilizing multiple collection points. The prevention of e-waste must be ensured through the **"Reuse - Reduce –Recycle and Repair strategy."**

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## ABBREVATIONS

BFR -Blood flow restriction

CPCB -Central Pollution Control Board

EEE -Electrical and electronic equipment

ELCINA -Electronics Industry Association of India

EOL- End of Life

IMRB -Indian Market Research Bureau

IoT -Internet of Things

MoEF -Ministry of Environment and Forests

PBDD- Polybrominated Dibenzo-Dioxin

PBDE -Poly-Bromine Flame-Retardant Ethers

PCB-Polychlorinated Biphenyls

PCB-Polychlorinated biphenyls

PCDD- Polychlorinated Dibenzodioxins.

PCDF- Polychlorinated Dibenzofurans

UNU -United Nations University

WEEE -Waste of Electrical and Electronic Equipment

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**APPENDIX**

**ROUGH TOOL**

**ST. IGNATIUS COLLEGE OF EDUCATION (AUTONOMOUS)**

**PALAYAMKOTTAI.**

Topic: Awareness on E-Waste Management among College Students in Tirunelveli District

Investigators: Dr.L.Vasanthi Medona Dr.M.Maria Saroja and Mrs.E.Michael Jeya Priya

Dear Students,

We request you to read the given statements and tick the answers. It shall be of immense helpful to our project. We promise that the details furnished by you would be kept confidential and used only for our research purpose.

Thanking you

Place: Yours faithfully,

Date:

Investigators

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**PERSONAL DATA**

| | | | |
|---|---|---|---|
| Gender | ☐ Male | ☐ Female | |
| Locality of Residence | ☐ Rural | ☐ Urban | |
| Type of the College | ☐ Girls | ☐ Co-education | |
| Stream of Study | ☐ Arts | ☐ Science | |
| Type of Management | ☐ Autonomous | ☐ Non-Autonomous | |
| Type of Family | ☐ Joint | ☐ Nuclear | |
| Father's Education Qualification | ☐ School | ☐ Degree | ☐ Profession |
| Mother's Education Qualification | ☐ School | ☐ Degree | ☐ Profession |
| Father's Occupation | ☐ Government | ☐ Private | ☐ Self-employed |
| Mother's Occupation | ☐ Government | ☐ Private | ☐ Self-employed |

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## TOOL

Kindly read the following carefully and put a tick mark (√) against any of the answers

| S.No | Statements | Agree | Undecided | Disagree |
|---|---|---|---|---|
| 1. | E-waste management training received from school. | | | |
| 2. | Recycling is best way to conserve resource. | | | |
| 3. | E-waste management is essential for environmental sustainability. | | | |
| 4. | E-waste pollution will reduce landfill space. | | | |
| 5. | E-waste can cause environmental pollution. | | | |
| 6. | Electric and electronic devices contain hazardous materials. | | | |
| 7. | Repairing broken electric devices is one way to reduce E-waste. | | | |
| 8. | E-waste management will help to reduce e-waste problem. | | | |
| 9. | E-waste recycling imposes positive environmental impacts. | | | |
| 10. | High demand for electrical and electronic products will increase E-waste. | | | |
| 11. | E-waste management should be widely disseminated to the public. | | | |
| 12. | E-waste contains precious metals like gold, copper, platinum, and aluminum. | | | |
| 13. | Over exposure of E-waste materials leads to brain disorder. | | | |
| 14. | Improper disposal of E-waste materials causes disease in human beings. | | | |

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| | | | | |
|---|---|---|---|---|
| 15. | Deprived recycling procedures lead to environmental issues. | | | |
| 16. | Penalty should be charge who have not e-waste management plan. | | | |
| 17. | Government should regulate industrial activities. | | | |
| 18. | Disposal of E-waste in the environment affects the food chain. | | | |
| 19. | Inappropriate handling of e-waste may lead to direct exposure to toxic chemicals. | | | |
| 20. | Over usage of mobile phone has an adverse effect on children's health. | | | |
| 21. | It is duty of my school to create awareness about e-waste | | | |
| 22. | Poor E-waste disposal practices lead to skin infection. | | | |
| 23. | E-waste recycling imposes positive environmental impacts. | | | |
| 24. | The accumulation of e-waste causes deleterious effects on the environment. | | | |
| 25. | Mismanagement of e-waste leads to brain disorders. | | | |
| 26. | E-waste recycling helps to recover valuable resources. | | | |
| 27. | Digital dumping grounds help to segregate e-waste easily. | | | |
| 28. | Proper e-waste disposal procedures minimize the risk of data breaches. | | | |
| 29. | The 3Rs in e-waste management help to maintain a socially sustainable life cycle. | | | |
| 30. | The burning of electronic materials increases carbon dioxide levels in the atmosphere. | | | |

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| | | | | |
|---|---|---|---|---|
| 31. | E-waste is hazardous, complex and expensive to treat in an environmentally sound manner. | | | |
| 32. | E-waste management helps to reduce the e-waste problem in the atmosphere. | | | |
| 33. | The toxic elements present in e-waste lead to pollution. | | | |
| 34. | We have law for environment protection. | | | |
| 35. | Reselling old gadget helps to reduce accumulation of e-waste materials. | | | |
| 36. | The concentration of toxic elements affects the food-chain cycle. | | | |
| 37. | Informal e-waste management affects both the environment and the economy. | | | |
| 38. | Potential wastage of raw materials arises due to the overproduction of E-goods. | | | |
| 39. | The scrap dealers need to show more interest in the safe disposal of E-waste. | | | |
| 40. | Unsafe recovery of metals such as copper and silver/gold traces electronic materials leads to pollution. | | | |
| 41. | Informal e-waste management affects both environment and the economy. | | | |
| 42. | The subsequent solid e-waste generation leaves toxic substances in the environment. | | | |
| 43. | Lack of large capacity warehouses to segregate E-waste materials. | | | |
| 44. | Persons who are handling e-waste have chance of direct exposure to inhaling toxic chemicals. | | | |
| 45. | The fertility of the soil is reduced due to improper dumping of e-waste. | | | |

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| | | | | |
|---|---|---|---|---|
| 46. | Unsafe recovery of metals such as copper and silver/gold traces of electronic materials leads to pollution | | | |
| 47. | Rudimentary methods increase electronic traces in the atmosphere. | | | |
| 48. | Lack of research on safe disposal of hazardous electronic waste. | | | |
| 49. | Parents keep old electronics in storeroom. | | | |
| 50. | E-waste has adverse effect on children intelligence. | | | |
| 51. | The valuable parts of the e-materials can be reused as secondary raw materials. | | | |
| 52. | The burning of electronic waste produces vast quantities of toxic metals like cadmium and mercury. | | | |
| 53. | Electronic scraps voluntarily can be donated to reduce the over production of Electronic goods. | | | |
| 54. | Toxification is created in the water due to improper disposal of e-waste materials. | | | |
| 55. | The effects of toxic elements of e-waste can be avoided by refurbishing. | | | |
| 56. | People are unaware of consequences of reckless e-waste disposal. | | | |
| 57. | Acidification due to toxic elements can kill marine and freshwater organisms | | | |
| 58. | Burning of wires is the production of carbon dioxide. | | | |
| 59. | Toxic elements released from E-materials harm ecosystems. | | | |
| 60. | Electronic waste produces carcinogens which cause lung and skin cancer. | | | |

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| | | | | |
|---|---|---|---|---|
| 61. | Poor awareness and sensitization of e-waste management affect human resources. | | | |
| 62. | E-waste word heard from my parents. | | | |
| 63. | Special law framed for e-waste management. | | | |
| 64. | It is not my duty to manage electronic discarded. | | | |
| 65. | Online app for tracking e-waste disposal or recovery helps reduce e-waste dumping. | | | |
| 66. | Compensation should be provided to those affected while dealing with electronic waste management. | | | |
| 67. | The chemical pollutants present in e-waste mixtures affects humans directly. | | | |
| 68. | I feel difficult to manage my old electronics. | | | |
| 69. | Do not have e-waste chapter in textbook. | | | |
| 70. | Less focus in the curriculum about e-waste stems. | | | |
| 71. | e-waste is the cause of cancer and brain disorder in prenatal babies. | | | |
| 72. | E-waste recycling centers must be implemented in all the cities to collect waste materials. | | | |
| 73. | Modern technology invention is required to minimize the e-waste materials. | | | |
| 74. | Soaking electronic circuits in powerful sulphuric, hydrochloric, or nitric acid solutions separates metals from the electronic pathways. | | | |
| 75. | Indians use unscientific method in recycling. | | | |
| 76. | Industrial intervention is necessary to curb the e-waste issues. | | | |

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| | | | | |
|---|---|---|---|---|
| 77. | Crude and unskilled approaches to e-waste management have adversely contribute to e-waste problems. | | | |
| 78. | Frequent change in electrical appliances and electronic gadgets is the subsequent cause of e-waste generation | | | |
| 79. | Pregnant women and children are more vulnerable to the action caused by e-waste disposal. | | | |
| 80. | Recycled e-waste materials could be used to make new products. | | | |

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**FINAL TOOL**

**ST. IGNATIUS COLLEGE OF EDUCATION (AUTONOMOUS)**

**PALAYAMKOTTAI.**

Topic: Awareness on E-Waste Management among College Students in Tirunelveli District

Investigators: Dr.L.Vasanthi Medona Dr.M.Maria Saroja and

Mrs.E.Michael Jeya Priya

Dear Students,

We request you to read the given statements & tick the answers. It shall be of immense helpful to our project. We promise that the details furnished by you would be kept confidential and used only for our research purpose.

Thanking you

Place: Yours faithfully,

Date:

Investigators

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## PERSONAL DATA

| | | | |
|---|---|---|---|
| Gender | ☐ Male | ☐ Female | |
| Locality of Residence | ☐ Rural | ☐ Urban | |
| Type of the College | ☐ Girls | ☐ Co-education | |
| Stream of Study | ☐ Arts | ☐ Science | |
| Type of Management | ☐ Autonomous | ☐ Non-Autonomous | |
| Type of Family | ☐ Joint | ☐ Nuclear | |
| Father's Education Qualification | ☐ School | ☐ Degree | ☐ Profession |
| Mother's Education Qualification | ☐ School | ☐ Degree | ☐ Profession |
| Father's Occupation | ☐ Government | ☐ Private | ☐ Self-employed |
| Mother's Occupation | ☐ Government | ☐ Private | ☐ Self-employed |

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## TOOL

Kindly read the following carefully and put a tick mark (√) against any of the answers

| S.No | Statements | Agree | Undecided | Disagree |
|---|---|---|---|---|
| 1. | E-waste management is essential for environmental sustainability. | | | |
| 2. | E-waste pollution will reduce landfill space. | | | |
| 3. | E-waste can cause environmental pollution. | | | |
| 4. | Electric and electronic devices contain hazardous materials. | | | |
| 5. | Repairing broken electric devices is one way to reduce E-waste. | | | |
| 6. | High demand for electrical and electronic products will increase E-waste. | | | |
| 7. | E-waste management should be widely disseminated to the public. | | | |
| 8. | E-waste contains precious metals like gold, copper, platinum, and aluminium. | | | |
| 9. | Improper disposal of E-waste materials causes disease in human beings. | | | |
| 10. | Deprived recycling procedures lead to environmental issues. | | | |
| 11. | Disposal of E-waste in the environment affects the food chain. | | | |
| 12. | Inappropriate handling of e-waste may lead to direct exposure to toxic chemicals. | | | |
| 13. | Poor E-waste disposal practices lead to skin infection. | | | |
| 14. | E-waste recycling imposes positive environmental impacts. | | | |

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| | | | | |
|---|---|---|---|---|
| 15. | The accumulation of e-waste causes deleterious effects on the environment. | | | |
| 16. | Mismanagement of e-waste leads to brain disorders. | | | |
| 17. | E-waste recycling helps to recover valuable resources. | | | |
| 18. | Digital dumping grounds help to segregate e-waste easily. | | | |
| 19. | Proper e-waste disposal procedures minimize the risk of data breaches. | | | |
| 20. | The 3Rs in e-waste management help to maintain a socially sustainable life cycle. | | | |
| 21. | The burning of electronic materials increases carbon dioxide levels in the atmosphere. | | | |
| 22. | The fertility of the soil is reduced due to improper dumping of e-waste. | | | |
| 23. | E-waste management helps to reduce the e-waste problem in the atmosphere. | | | |
| 24. | The toxic elements present in e-waste lead to pollution. | | | |
| 25. | The concentration of toxic elements affects the food-chain cycle. | | | |
| 26. | Informal e-waste management affects both the environment and the economy. | | | |
| 27. | Potential wastage of raw materials arises due to the overproduction of E-goods. | | | |
| 28. | The scrap dealers need to show more interest in the safe disposal of E-waste. | | | |
| 29. | Lack of large capacity warehouses to segregate E-waste materials. | | | |
| 30. | Unsafe recovery of metals such as copper and silver/gold traces of electronic materials leads to pollution. | | | |
| 31. | Rudimentary methods increase electronic traces in the atmosphere. | | | |

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| | | | | |
|---|---|---|---|---|
| 32. | The valuable parts of the e-materials can be reused as secondary raw materials. | | | |
| 33. | The burning of electronic waste produces vast quantities of toxic metals like cadmium and mercury. | | | |
| 34. | Electronic scraps voluntarily can be donated to reduce the over production of Electronic goods. | | | |
| 35. | Toxification is created in the water due to improper disposal of e-waste materials. | | | |
| 36. | The effects of toxic elements of e-waste can be avoided by refurbishing. | | | |
| 37. | Acidification due to toxic elements can kill marine and freshwater organisms. | | | |
| 38. | Toxic elements released from E-materials harm ecosystems. | | | |
| 39. | Electronic waste produces carcinogens which cause lung and skin cancer. | | | |
| 40. | Poor awareness and sensitization of e-waste management affect human resources. | | | |
| 41. | Online app for tracking e-waste disposal or recovery helps reduce e-waste dumping. | | | |
| 42. | Compensation should be provided to those affected while dealing with electronic waste management. | | | |
| 43. | The chemical pollutants present in e-waste mixtures affects humans directly. | | | |
| 44. | Industrial intervention is necessary to curb the e-waste issues. | | | |
| 45. | Crude and unskilled approaches to e-waste management have adversely contribute to e-waste problems. | | | |

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| | | | | |
|---|---|---|---|---|
| 46. | Frequent change in electrical appliances and electronic gadgets is the subsequent cause of e-waste generation | | | |
| 47. | Pregnant women and children are more vulnerable to the action caused by e-waste disposal. | | | |
| 48. | Recycled e-waste materials could be used to make new products. | | | |
| 49. | E-waste recycling centers must be implemented in all the cities to collect waste materials. | | | |
| 50. | Modern technology invention is required to minimize the e-waste materials. | | | |

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# REDUCE.
# REUSE.
# RECYCLE.

Today's technology has undergone a revolutionary change and has helped humans develop and save money and time. But despite the benefits of technology, it has created a massive waste of electronics and gadgets, adversely affecting the environment and people's lives. Toxic e-waste causes various types of diseases among human beings. It can be prevented by providing awareness of e-waste and how to manage an extensive collection of e-waste. Grey goods' waste is more toxic than white and brown goods. This kind of waste poses a severe challenge in disposal and recycling in developed and developing countries. Increased use of electrical and electronic equipment coupled with a vast population and changing consumption patterns is generating waste at an alarming rate in India. This happens due to the advancement or development in technology. These spectacular developments in modern times have undoubtedly enhanced the quality of our lives. At the same time, these have led to manifold problems, including massive amounts of hazardous waste and other waste generated from electrical products. An exponential increase in technology consumption at an individual level boosted e-waste generation. India is among a few countries generating and receiving enormous e-waste, thus positing a threat to our future generations. There is a dire need to explore e-waste awareness and its disposal practices to design policies to avoid the most likely threat to human and environmental health.

**"We cannot solve our problems with the same thinking we used when we created them."**

**– Albert Einstein**