An Assessment on Community perception of Electronic Waste (E-waste) Management in Dhaka City

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Abstract

Electronic waste (e-waste) has emerged as a significant environmental and health concern in the 21st century, with its rapid generation creating threats to both human health and the environment. This paper presents a view of the current scenario of e-waste management in Dhaka city. Globally, an estimated 20–50 million tonnes of e-waste is generated annually, with most of it originating from Asian countries. Improper handling of e-waste can cause harm to the environment and human health due to its toxic components. Efforts to manage e-waste focus on practices like reuse, recycling, and disposal. In Dhaka, rapid economic growth has led to an emerging market for electronic gadgets and home appliances, resulting in increased e-waste generation. However, there is a lack of public awareness and adequate information on e-waste hazards. Despite the significant volume of e-waste generated, it lacks proper waste management guidelines and regulations. This paper presents community perceptions, their awareness level and their uses pattern. It also gives the idea about the importance of public awareness campaigns to promote responsible e-waste management. Additionally, the paper discusses the challenges faced by Dhaka city in managing e-waste and recommends strategies and model proposal for reducing e-waste generation, strengthening waste management regulations, and promoting environmentally friendly recycling practices.

Keywords: E-Waste management, Dhaka city, Waste management regulations, Recycling practices.

1. Introduction

E-waste management is a process to collect e-waste, recover and recycle material by safe methods, dispose of e-waste by suitable techniques to reduce its adverse impacts on environment. E-waste can be defined as used electronic devices including all automated machineries in household, computers, entertainment electronics, mobile phones sets, Air coolers, televisions, stoves, oven, electronic Medical electronic equipments, refrigerators etc, whether sold, donated or discarded by their original owners. These e-waste contains hazardous chemical forms of mercury, Lead, Cadmium, Zinc, Chromium etc, has a great impact on our health, existence and environment. In recent years, the rapid proliferation of electronic devices has led to a significant increase in e-waste worldwide. The global e-waste generation in 2019 was about 53.6 million metric tons (MMT) and is predicted to cross 74.7 MMT by 2030 (Tiseo, 2021).E-waste consists of generally 60.2% of different metals, e.g., Fe, Au, Pb, Hg, Cr, Cu, and Cd; 15.2% of plastic materials, 5% metals-plastics mixtures, 12% tubes, and screens, 2% cables, 2% printed circuit boards (PCBs) and others (Widmer et al., 2005). Only 17.4% was documented to be collected and properly recycled of this (Tiseo, 2021). Bangladesh, with its overgrowing population and increasing urbanization, is no exception to this global trend. Bangladesh produces 3 MMT of e-waste each year (Mahmud et al., 2020).In Bangladesh, 15% of child laborers die as a result of e-waste recycling, and over 83 percent are exposed to harmful compounds and get sickened, forcing them to live with long-term diseases (Roy et al., 2022). Around 15% of the overall waste generated in Dhaka (mainly inorganic) and 475 tons of e-waste are recycled daily. Though it is a common practice in Bangladesh to reuse electronic devices, there is a lack of formal e-waste disposal facilities where the informal sector is more active (Hossain et al., 2010). Dhaka, the capital city of Bangladesh, stands at the forefront of this e-waste challenge. The city, known for its bustling streets and vibrant economy, is also grappling with the management of electronic waste generated by its inhabitants. The management of e-waste is a pressing issue due to its adverse environmental and public health implications. In Dhaka, where the disposal and recycling of e-waste are often informal and unregulated, the problem becomes even more acute. The improper handling of e-waste can lead to the release of hazardous substances, posing significant risks to both the environment and human health. Before discussing e-waste's adverse health effects, understanding its scale and risks is crucial. International efforts highlight the urgent need for cooperation and awareness. This paper explores e-waste management in Dhaka, proposing next steps for improvement and prevention of harm.

2. Objective of the Research

- To identify the major sources and types of e-waste in Bangladesh.
- To assess current e-waste management practices and policies in Bangladesh.
- To assess E-Wastes impacts on human health and environment.

3. Literature Review

3.1. E-waste management policies in Bangladesh

Municipal Solid Waste (MSW) is trash or garbage that consists of everyday items, e.g., product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries. The organic-rich MSW generates in homes, schools, hospitals and businesses. Whereas e-waste contains only the waste portion of electric products e.g., mobile phones, computers, televisions, VCRs, stereos, copiers, fax machines, etc. In Bangladesh, e-waste is often misunderstood and categorized as MSW. So primarily, the rules, regulations and policies established for MSW management have been applied to e-waste management (Alam and Bahauddin, 2015). In Bangladesh, e-waste was first identified as a potential source of harmful chemicals incorporated into the medical waste (MW) management guidelines (Yousuf, 2011). The first draft was done in 2011 by the government of Bangladesh (Alam and Bahauddin, 2015). The administrative ministries establish some acts/rules for properly handling e-waste, and some other rules are still under discussion, which is presented in figure 01. The Bangladesh Environmental Protection Act, 1995, was updated on June 10, 2021, with the announcement of the Hazardous Waste (e-waste) Management Rules, 2021. This rule applies to electrical gadgets such as home appliances, control systems, medical devices, automatic machines, IT, and communication equipment. It specifies obligations for the product manufacturer, assembler (collector), seller, and consumer (Kengo, 2021). According to Section 15(1) of the Bangladesh Environmental Protection Act, 1995, anyone found guilty of violating these laws faces a maximum penalty of two years in prison or a fine of up to two hundred thousand takas (Kengo, 2021). However, implementations of proper regulations and standards for e-waste management in Bangladesh have not been established. In environmental protection, many concerned agencies and departments lack the authority to make decisions. The baseline data on natural capital and areas of ecological concern is sparse. Furthermore, the Ministry of Environment and Forestry (MoEF) lacks the necessary resources, facilities, and logistical support to evaluate and track the effects of disposing of e-waste in the open environment (ESDO, 2012).

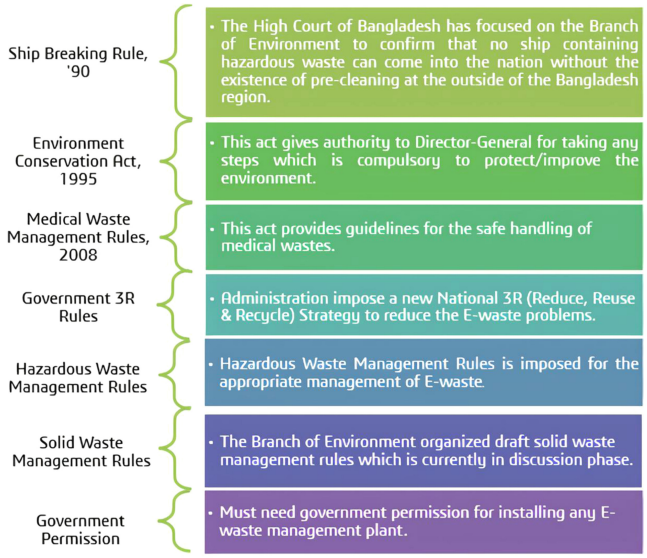

Fig.01: E-waste policies by the Bangladesh government (Masud et al., 2019).

3.2. E-waste Generation of Bangladesh

Electronic waste has been increasing at the rate of 20 per cent every year in Bangladesh amid lack of regulations. The data was revealed in a workshop held in Dhaka on Tuesday. Keynote speaker Abtab Khan Shawon said cell-phones alone produced 10,504 tonnes of e-waste in the last two decades, says a news release. Every year around 296,302 TV sets are scrapped and generate approximately 0.17 million tonne of e-waste. While e-waste generated from ship breaking yards each year accounts for more than 2.5 million tonnes. Approximately 50,000 children are informally involved with e-waste collection. Their exposure to e-waste causes more than 15 per cent of death, he said. Non-government organisation Voices for Interactive Choice and Empowerment (VOICE) and Association for Progressive Communication (APC) organised the workshop titled 'Efficient Use of Digital Technology and Effective E-Waste Management in Bangladesh'. Participants from different stakeholder groups warned that contamination of the highly toxic components in soil, groundwater and air threatens environment as well as health of the workers and communities exposed to. A draft of 'e-waste management rules' was amended in 2011 and 2017. But no progress has been visible till to date. The speakers demanded establishment of e-waste treatment plant at grassroots with the involvement of electronic goods producers.(Mahmud, 2021, Prothom Alo)

3.3. E-waste Recycling Scenerio

The bulk amount of e-waste generated worldwide in recent years has increased significantly due to new technologies, changes in media, and the penetration of giant tech companies in the global market (Kusch and Hills, 2017). The e-waste management in developing countries is not keeping pace with consumption. Therefore, largescale e-waste recycling facilities are needed (Garlapati, 2016). Recycling e-waste allows the recovery of materials such as gold, copper, glass, aluminum, lithium,

plastic, and more. However, the toxic, heavy metals and other harmful substances create difficulties in recycling, which must be carefully disassembled (Lucier and Gareau, 2019). In the first stage of the recycling process, the collection of electronicproducts through recycling bins, specific collection points, oron-demand collection services is executed. The mixed e-waste is then taken to specialized electronics recyclers (Lucier and Gareau, 2019). The collected e-waste is then moved to the safe storage system. E-waste then goes to the manual sorting process, where some items are separated and reused or recovered value materials from them. The shredded e-waste undergoes mechanical separation, e.g., magnetic and water separation(Cui and Forssberg, 2003). In the recovery stage, the separated and treated materials are ready for sale and reuse. Some specific materials, e.g., plastics and steel, join another recycling stream. We studied the recycling stream of RTS (UK) and AST (South Africa) recycling companies. They recycle cell phones, CPUs, RAMs, printers, PCBs, computer monitors, copiers, and tablets. Initially, they collect the e-waste from authorized pickup points and store them in their facility. Initially, the sorting of e-waste is executed by trained employees. Then, the hazardous materials are removed and disposed of carefully. The material processing takes place, the reusable materials are sold, and the materials that need further processing join other recycling streams. In Bangladesh, government and privately funded projects on ewaste recycling have been initiated in recent years. Azizu, a private company worked in the e-products import and retail industry and then established its recycling plant. It has been operating since 2006 and has set up an e-waste recycling factory in Narayanganj to turn the by-products into reusable items. It has completed 256 projects and connected with more than 47 business partners (Molla, 2017). It has separate divisions for collection, segregation, logistics, and warehouse. In recycling process, workers' health risks are still not being prioritized in these recycling industries. Govenment should take initiatives to improve the e-waste recycling process. Bangladesh has no specific policies for the implementation of e-waste management. The private organization would fail without automation, advanced technology, and collaboration with government.

3.4. E-waste: Bangladesh perspective

Based on the income capacity customers' use non- brand televisions and lifetime of these sets are not more than 3-5 yrs. Most of the time about 60% repairer repair non–brand sets and about 20% repairer repair around 170 brand TV sets in a year. So these non brand TV sets are mainly liable to produce e-waste. About 50% assembler companies are sold out the generated waste, 30% are dumped, 20% are stored for long while. 30% repairers stored the old and damage TV sets for repairer and further uses, 15% dumps it, 5% didn't want to inform. Among the customers 40% sold rejected sets to the repairers, 10% through away and 20% reuses it after repairing. Survey gives us can easily illustrate the dumping management scenery of total Dhaka city. When compared with world e-waste disposal on percentage basis, Bangladesh account for 7% annually.(Islam, 2016)

4. Scope Studied

The scope of the study was mainly on electronic waste management system. Other types of waste including organic, recyclable, soiled, and toxic were not included. Specifically, electronic waste was the fastest growing component of the waste stream and continued to grow each year. Participants of the survey also included organizations, governments and how their Policies and regulations could play a role in the outcome of how electronic waste recycled or managed.

5. Methodology

This study aims to evaluate the types and amount of e-waste generated in Bangladesh and explore potential management strategies. The methodology involved an extensive literature review using various databases such as Scopus, Web of Science etc, to understand global and Bangladesh-specific e-waste generation trends. This survey followed the methods mentioned below.

- Literature Review.
- Scope and Objective selection for Study
- Prepare Questionnaire for survey.
- Study area.
- Survey procedure.
- Data Analysis.
- Taking People perceptions and suggestions.
- Model Suggestion.

Socio-environmental and Health Concerns: The study investigated the socio-environmental and health concerns associated with e-waste, along with the economic opportunities of e-waste recycling, using assessment models. The objective was to assess the awareness level of workers regarding the impacts of e-waste on human health and the environment. The study found that Bangladesh has a limited database on recent e-waste generation and associated waste management practices. The review focused on understanding the current scenario of e-waste in Bangladesh, along with the challenges and opportunities associated with it.

6. Data Collection and Participant Profile

6.1. Data Collection

The primary purpose of the survey was to collect information about electrical and electronic equipments disposal and recycling and also determine the knowledge and awareness of the people about e-waste in Dhaka city. The survey was conducted in-person offline. The medium of the survey was Bangla for an in-person survey.

6.2. *Study Area*

Three selected areas and reason for selection mentioned below:

- **Bashundhara R/A:** This area, known for its universities, was selected to gather insights from university students due to its high population of young people who are likely to be active users and disposers of electronic devices.
- **Patuatoli:** This location was chosen due to the high concentration of electronic and hardware shops, making it an ideal area to study e-waste generation and disposal patterns among retailers and consumers.
- **Tejgaon Industrial Area:** This area was selected because it is an industrial hub, where a significant amount of e-waste is generated from manufacturing processes. Studying e-waste management practices here provides valuable insights into industrial e-waste management challenges and opportunities.

Participants number from three different places shown in the following figure 02, The low number of survey participants was due to the short time frame within which the survey was conducted.

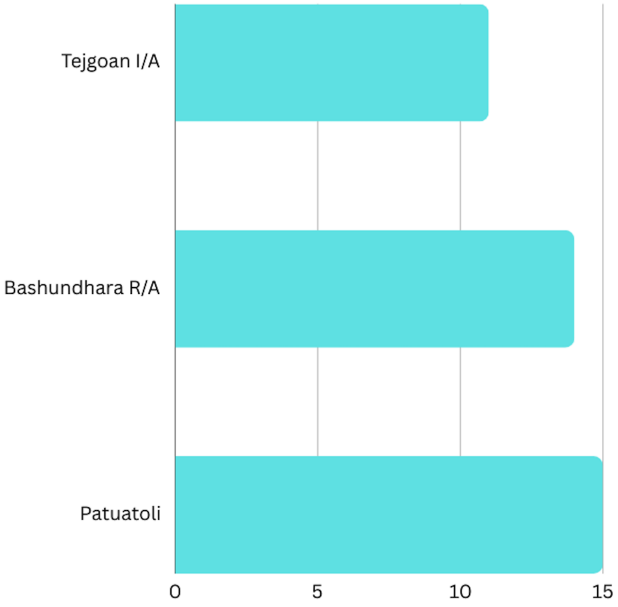

Fig.02: Participants number from different area.

6.3. *Participants Overview*

A total of 40 individuals took part in the survey, sharing their valuable insights. This data offers a comprehensive overview of the varied perspectives within the city, enriching our understanding of the surveyed population. Most of response collected from age gap of 20-30 year, a little from 18-20 year and a good number from 30-40 year senior group. Men were the dominant number in participate as women are shy to participate Their Age and gender profile given in figure 03 and 04.

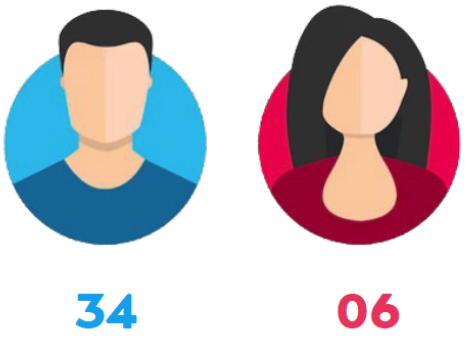

Fig.03: Gender profile.

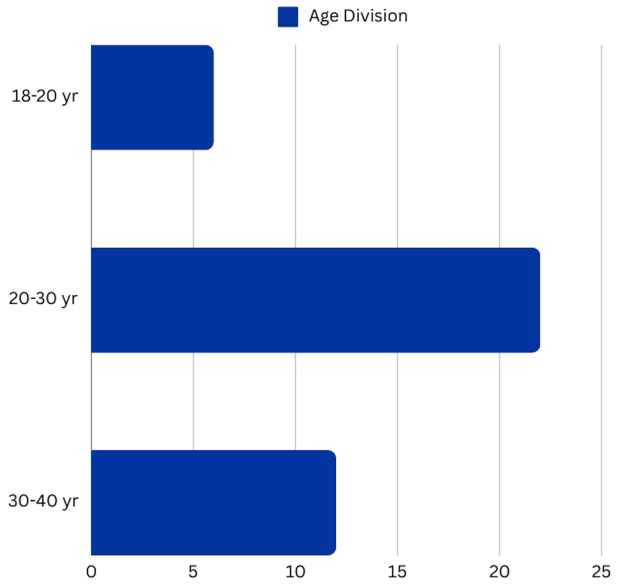

Fig.04: Age division of the participants.

7. Data Analysis and Findings

This section represents findings during our fieldwork and discuss the factors that affect how electronic waste is managed in Dhaka city. We discussed about things like budget, policies, how aware people are, and what the people we talked to said about managing electronic waste and analysed on:

- Device Usages pattern of respondents.
- Primary Sources of E-Waste: Participants Perspective.
- Awareness and Management Practices of Electronic Waste.
- Community Perceptions and Suggestions.
- Effects of E-Waste on Health and Environment.

7.1. Device Usages pattern

From survey device usages pattern chart given on figure 05 and 06. The graph of figure 05 illustrates the electronic devices used by participants in the survey. Out of 40 respondents, 40 reported using mobile phones, making it the most commonly used device. Following mobile phones, laptops were used by 34 participants. Nine participants reported using printers/scanners, while 22 participants used televisions. Additionally, 32 participants reported using refrigerators. The "other" category includes various electronic devices used by 21 participants. Overall, the majority of participants reported using mobile phones, laptops, and televisions, highlighting their widespread use among the surveyed population.

The graph of figure 06 shows that among the participants, 22.5% reported frequently changing their electronic devices. Another 20% stated they change devices every 1-2 years, while 25% reported changing devices every 2-3 years. A smaller percentage, 5%, reported changing devices every 3-5 years. The remaining 27% reported changing devices as needed, depending on their condition. This data suggests that a significant portion of participants prefers to upgrade their devices regularly, with a considerable number doing so based on need rather than a specific time frame.

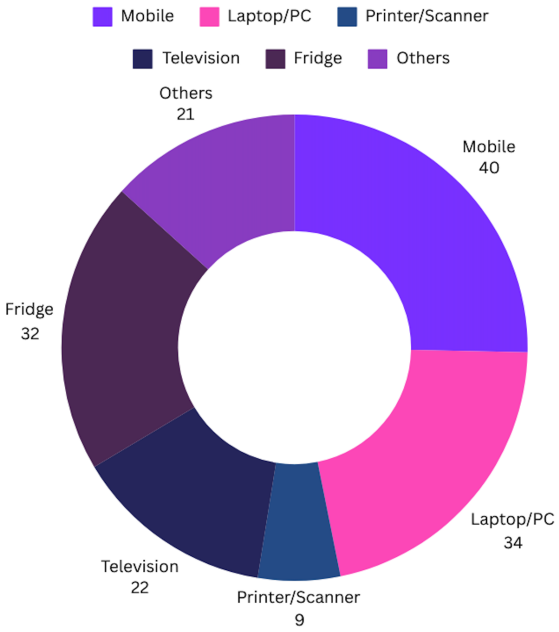

Fig.05: Most used device.

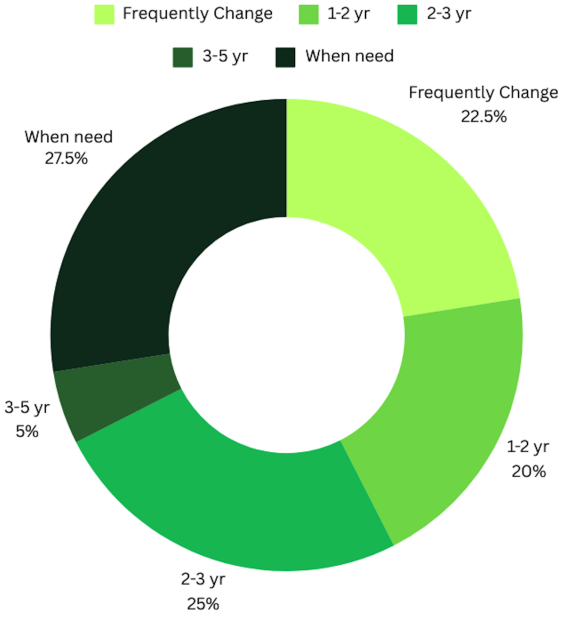

Fig.06: How often people changes their devices.

7.2. Primary Sources of E-Waste: Participants Perspective

7.2.1. Material Source: Disposed by People

These materials represent common items that people dispose of as electronic waste (e-waste). Among them are batteries, toys, chargers, bulbs, phones, refrigerators/air conditioners, car materials, multiplugs, and televisions. As technology advances and new products are introduced, older electronic devices and accessories are often replaced, leading to the disposal of these items. Proper management of e-waste is essential due to the

potential environmental and health hazards associated with improper disposal methods. Understanding which materials are frequently disposed of as e-waste can help policymakers and waste management authorities develop more effective strategies for recycling and managing electronic waste.

7.2.2. *Main Source: From Where Mainly Disposed More*

The main sources of electronic waste disposal are as follows:

- Industry: 60%
- Household: 10%
- Shops: 10%
- Repair markets: 10%

The majority of e-waste, approximately 60%, is disposed of by industries. Household disposal accounts for 10%, as do shops and repair markets. These statistics highlight the significant contribution of industrial activities to the generation of electronic waste, emphasizing the need for effective management strategies to handle this growing environmental challenge.

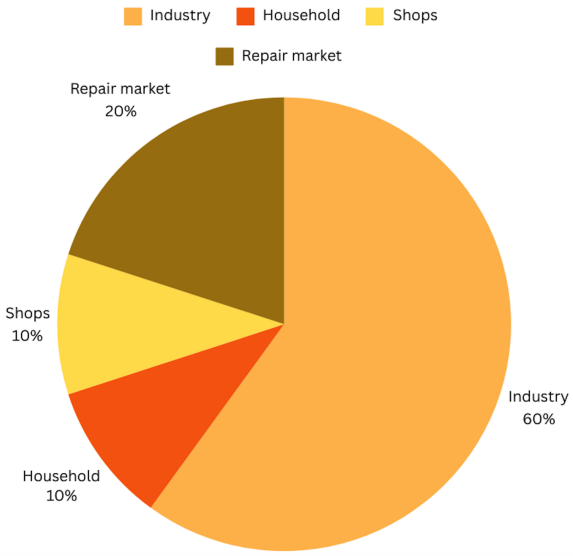

Fig.07: Main sources of e-waste.

7.3. *Awareness and Management Practices of Electronic Waste.*

i. Many people are unaware of the environmental impact of e-waste, which poses serious threats due to hazardous materials. Electronic devices contain toxic substances such as lead, mercury, and cadmium, which can pollute the environment if not disposed of properly. Lack of awareness about these hazards leads to improper disposal practices, contributing to pollution and health risks.

ii. Lack of awareness significantly contributes to pollution and health risks associated with e-waste. However, awareness about e-waste has been growing as people recognize the hazards of improper disposal. Efforts to educate the public about the environmental and health impacts of e-waste are crucial for promoting responsible disposal practices.

iii. With technological advancements, efforts for responsible e-waste management are increasing. Governments, organizations, and individuals are becoming more aware of the need to recycle and properly dispose of electronic devices. Many countries have implemented e-waste management policies and programs to address this growing environmental challenge.

iv. As a consequence of increased awareness, few people fully understand the consequences of dumping electronic waste. Proper disposal and recycling of e-waste are essential to prevent environmental pollution and protect public health. More education and outreach are needed to ensure that individuals and businesses understand the importance of responsible e-waste management.

7.3.1. *Ways of Dumping Electronic Devices*

The data from figure 08 indicates various ways in which people dispose of their electronic waste. While some choose designated disposal sites or sell their e-waste to vendors or markets, others simply discard it in available areas. Unfortunately, a small percentage resort to burning, which can have severe environmental and health consequences. Understanding these disposal practices is crucial for developing effective e-waste management strategies.

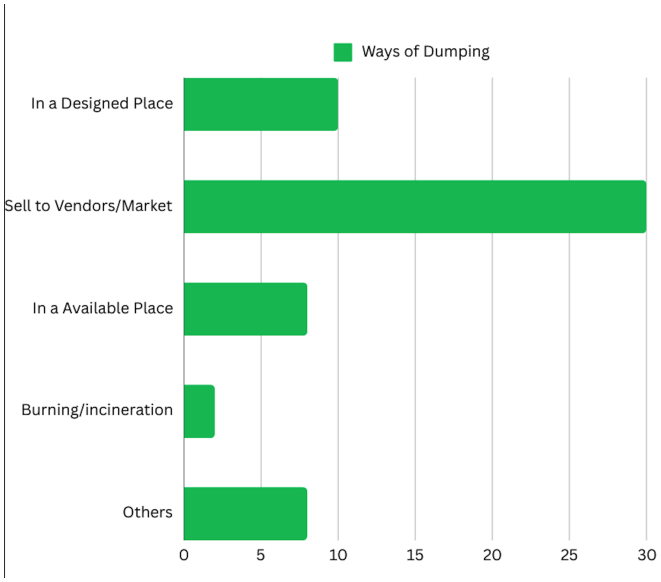

Fig.08: Ways of dumping.

7.3.2. *Sources of Knowledge About E-waste*

The graph of figure 09 provides insight into the sources from which people acquire knowledge about e-waste. Among the

surveyed individuals, the Internet emerges as the most popular source, with 35 people relying on online resources for information. Social media platforms follow closely behind, with 29 people using them as a source of knowledge about e-waste. Traditional media such as newspapers and TV are also significant sources, with 16 and 8 people respectively turning to them for information. Surprisingly, only 2 people rely on books for e-waste information. These findings underscore the increasing importance of online platforms in disseminating information about e-waste, while also highlighting the need to diversify sources to ensure comprehensive understanding and awareness of this critical environmental issue.

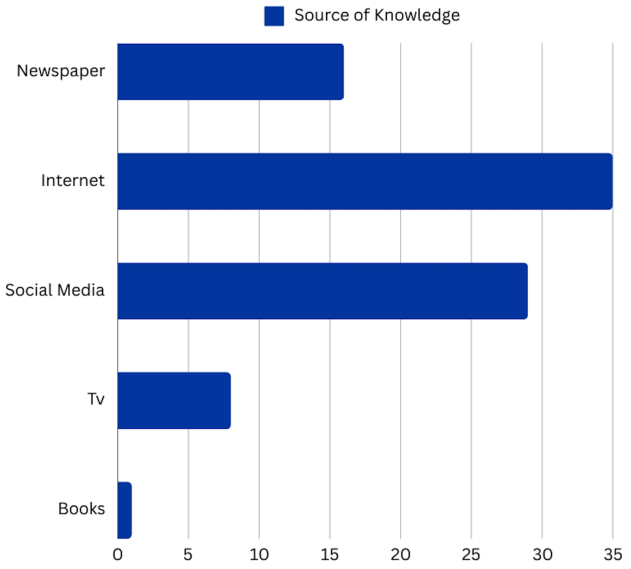

Fig.09: Sources of knowledge of e-waste.

7.3.3. *Awareness Level on E-waste*

The graph from figure 10 presents an overview of the level of knowledge about e-waste among the surveyed individuals. It indicates that a significant portion, accounting for 60% of respondents, have only a little idea about e-waste. Alarmingly, 36% of the respondents admitted to having no idea about e-waste at all. Conversely, only a mere 4% claimed to possess a proper understanding of the subject. These findings underscore a concerning lack of awareness and understanding regarding e-waste and its associated environmental and health hazards. It highlights the urgent need for comprehensive educational campaigns to increase awareness about e-waste management practices and their importance in mitigating environmental pollution and health risks.

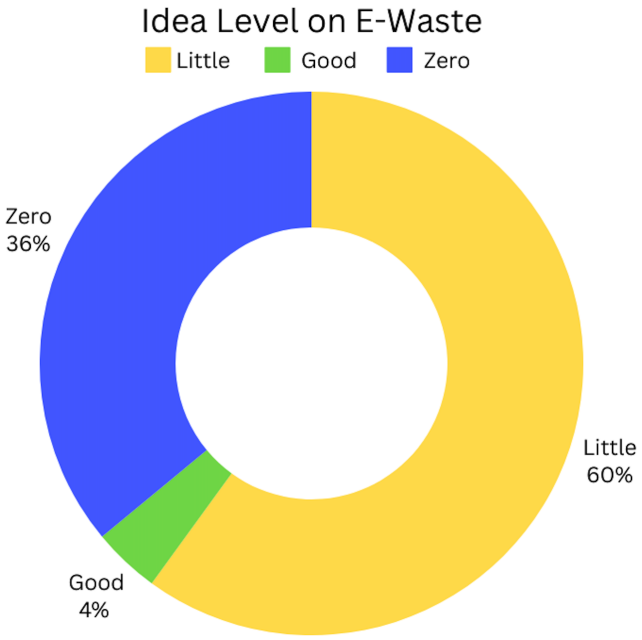

Fig.10: Idea level on e-waste.

7.4. *Community Perceptions and Suggestions.*

7.4.1. *Perception*

Residents in Dhaka city feel there is a lack of proper waste disposal infrastructure, leading to visible environmental and health issues. Garbage and waste often pile up in public spaces due to the absence of a proper dumping system, resulting in hazardous pollution. When asked if Dhaka city has a proper dumping system, the majority, comprising 67% of respondents, answered ”no,” indicating widespread dissatisfaction with the current waste management infrastructure. A further 38% responded ”maybe,” suggesting uncertainty about the adequacy of the existing dumping system. Only a small minority, accounting for 5% of respondents, answered ”yes.” These findings highlight the urgent need for improved waste management infrastructure in Dhaka city to address environmental pollution and public health concerns effectively.

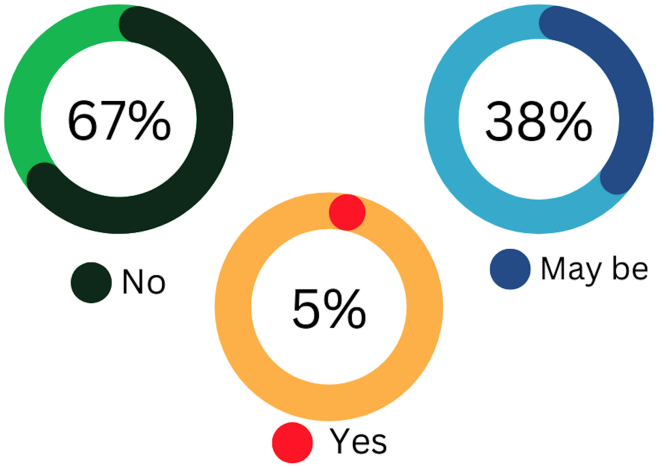

Fig.11: Answer on Dhaka city has a proper dumping system?

7.4.2. *Suggestions*

- The city corporation efficiently collects and separates e-waste from other waste streams.
- A dedicated facility for e-waste disposal has been established, ensuring proper management of electronic devices.
- E-waste is sorted at this facility to determine items suitable for reuse and those that can be recycled.
- Awareness campaigns promoting the principles of reduce, reuse, and recycle (3R) are conducted to educate the public.
- Government intervention is crucial to ensuring the success and sustainability of these initiatives.

7.5. *Effects of E-Waste on Health and Environment*

7.5.1. *Environment Pollution*

Improper disposal of e-waste contaminates soil, water, and air, endangering ecosystems and wildlife:

- Lack of awareness and cautionary information for handling or reusing expired electronic products can expose people to health hazards.
- E-waste threatens soil quality, reducing land productivity for crop production.
- Dumping e-waste illegally without proper measures in place or enforced laws can lead to environmental pollution.
- Bangladesh faces a significant issue with child workers involved in e-waste recycling, with more than 15% of child workers dying during or after the effects of e-waste recycling, and over 83% exposed to toxic substances, leading to long-term illness.(Islam, 2016)
- Approximately 50,000 children are involved in non-formal e-waste collection and recycling processes, with about 40% involved in ship-breaking yards.(Islam, 2016)

7.5.2. *Underground Water Pollution*

Electronic waste contains hazardous materials such as lead, mercury, and cadmium, which can leach into the soil and contaminate groundwater. This contamination poses a serious threat to public health as contaminated groundwater is often used for drinking and irrigation purposes.

7.5.3. *Global Impact*

Improper disposal of e-waste, including export to developing countries, has significant global implications. Local populations and ecosystems in developing countries are at risk due to exposure to hazardous materials from e-waste. Additionally, the export of e-waste contributes to environmental pollution and health hazards in these countries, further exacerbating the global e-waste crisis.

- E-waste is the fastest growing solid waste stream in the world.
- In 2019, an estimated 53.6 million tonnes of e-waste were produced globally, but only 17.4% was documented as formally collected and recycled.
- Lead is one of the common substances released into the environment if e-waste is recycled, stored or dumped using inferior activities, such as open burning.
- E-waste recycling activities may have several adverse impacts on human health. Children and pregnant women are particularly vulnerable.
- ILO and WHO estimate that millions of women and child labourers working in the informal recycling sector around the world may be at risk of e-waste exposure.(WHO, 2023)

7.5.4. *Exposure to E-waste*

Electrical and electronic items contain many different toxic substances. While users are unlikely to have contact with any of these substances when the items are in use, when they become waste, these toxicants can be released into the environment if the devices are managed using environmentally unsound practices and activities. Several unsound practices have been observed at e-waste sites including:

- Scavenging.
- Dumping on land or in water bodies.
- Dandfilling along with regular waste.
- Opening burning or heating.
- Acid baths or acid leaching.
- Stripping and shredding plastic coatings.
- Manual disassembly of equipment.

These activities are considered hazardous to the environment and human health as they release toxic pollutants, contaminating the air, soil, dust, and water at recycling sites and in neighbouring communities. Burning or heating is considered one of the most hazardous activities due to the toxic fumes created. Once in the environment, toxic pollutants from e-waste or produced through unsound recycling activities can travel significant distances from the point of pollution, exposing people in faraway areas to health-damaging substances (WHO, 2023).

7.5.5. *Health Hazards*

Exposure to hazardous materials in e-waste, such as lead, mercury, and cadmium, can have serious health consequences:

- Lead exposure can lead to brain disorders, kidney and neurological damage, and even death.
- Mercury exposure can cause learning disabilities, mental retardation, behavioral problems, and hearing impairment.
- Cadmium exposure can result in lung damage, fragility of bones, high blood pressure, and kidney damage.

7.5.6. *Health Risks of Children*

A range of adverse health outcomes linked to e-waste recycling activities have been posed.

Children and pregnant women are especially vulnerable to the effects of hazardous pollutants from informal e-waste recycling activities. Children are often involved in waste picking and scavenging, burning discarded e-waste and the manual dismantlement of items into component parts. In some countries, children may serve as a source of cheap labour and their small hands give them an advantage in taking apart the smallest items. These activities directly expose children to injury and high levels of hazardous chemicals. Working as a waste picker is hazardous labour and is considered one of the worst forms of child labour by the ILO. In 2020, the ILO estimated that as many as 16.5 million children globally were working in the industrial sector, of which waste processing is a subsector. It is unknown how many child labourers participate in informal e-waste recycling.

E-waste exposure may be linked to the following health effects during pregnancy and in infants and children:

- **Adverse neonatal outcomes,** including increased rates of stillbirth and premature birth.
- **Neurodevelopment, learning and behaviour outcomes,** especially associated with lead released through informal e-waste recycling activities.
- **Reduced lung and respiratory function and increased asthma incidence,** which may be linked to high levels of contaminated air pollution that characterize many e-waste recycling sites.

Children and pregnant women are at higher risk than adults to contaminants released through informal e-waste recycling activities due to their unique vulnerabilities. Children have different exposures to e-waste recycling activities. E-waste recycling activities release toxic chemicals that can cross the placenta and may contaminate breastmilk, for example mercury. Additionally, children are highly sensitive to many of the pollutants released through e-waste recycling due to their rapidly developing bodies, including their respiratory, immune and central nervous systems. E-waste contains multiple known and suspected neurotoxicants, including lead and mercury, that may disrupt the development of the central nervous system during pregnancy, infancy, childhood and adolescence. Some harmful toxicants from e-waste may also impact the structural development and function of the lungs. Changes to children's developing systems from e-waste may cause irreparable harm and affect them for the rest of their lives (WHO, 2023).

7.5.7. *International Agreement and WHO Response*

The Basel Convention controls the transboundary movement of hazardous wastes and their disposal. It is a comprehensive environmental agreement that aims to tackle issues surrounding hazardous wastes, including e-waste and its management. In 2019, the Ban Amendment to the Basel Convention entered into force. It prohibits the movement of hazardous wastes, including e-waste, from countries of the Organisation for Economic Co-operation and Development (OECD), the European Commission countries and Liechtenstein to other states that are party to the Convention. The Basel Convention runs programmes and workshops to develop and deliver guidance on environmentally sound management of e-waste. It also provides states with guidelines to distinguish between waste and non-waste and the transboundary movement of e-waste. Additionally, regional conventions also exist, such as the Bamako Convention and the Waigani Convention. Both these regional conventions have arisen in response to the Basel Convention and aim to further restrict the movement of hazardous wastes, including e-waste, in African and South Pacific countries, respectively.

WHO's Initiative on E-waste and Child Health is contributing to a number of international e-waste programmes and pilot projects in countries in Latin America and Africa. These pilot projects are developing frameworks to protect children's health from e-waste exposures that can be adapted and replicated in other countries and settings. The Initiative aims to:

- Increase access to evidence, knowledge and awareness of the health impacts of e-waste.
- Improve health sector capacity to manage and prevent risks.
- Facilitate monitoring of exposure to e-waste and interventions that protect public health.

In 2021, WHO released its first global report on e-waste and child health, which called for greater effective and binding action to protect children from the growing threat. WHO has developed training tools for the health sector, such as the recently updated training package for health care providers, including a specific training module on lead and on e-waste and child health. Additionally, WHO contributes to multi-agency capacity training tools including a MOOC and a joint course with PAHO (WHO, 2023).

8. Discussion

8.1. *Data Comparison*

This section highlights the differences between our data and other literature or research papers. As we have low number of

respondents, there are significant variations between the data in different sections.

*8.1.1. **Comparision on the Basis of Awareness***

In literature study, we found that out of 319 respondents, 85.89% were aware that some hazardous fractions in e-waste require special treatment for safe disposal, while 14.11% were not aware of this requirement. This indicates that the number of aware respondents is approximately 6.09 times higher than the number of unaware respondents. Therefore, a significant proportion of respondents in Dhaka city are aware of the need for special treatment of hazardous e-waste fractions.(Easin et al., 2022)

However, our data also revealed that the level of awareness varies significantly among respondents. Specifically, we found that:

- 60% of respondents had little awareness about e-waste.
- Only 4% of respondents had a proper understanding of e-waste.
- 36% of respondents had no idea about e-waste management practices.

This comparison between the awareness levels from our study and the findings of other literature or research papers underscores the need for further investigation and targeted awareness campaigns to improve e-waste management practices in Dhaka city.

*8.1.2. **Comparison on Basis of Behaviour and Device Management***

According to the literature, there are four main reasons why people change electronic products: damage, upgrade, theft, and newer product design. 55.49% of respondents strongly agreed that they would change or buy new electrical products to replace damaged products, while 37.93% agreed, 4.08% disagreed, and 2.51% strongly disagreed with this. Most respondents (80.56%) agreed to change products for upgrades, with 59.87% agreeing and 20.69% strongly agreeing. Only 6.58% of respondents strongly disagreed with this reason. A significant majority (86.37%) of respondents agreed to change their products if they were stolen, with 43.89% strongly agreeing. 41.38% of respondents agreed to change electronic products just for the new design, while 25.71% disagreed and 13.48% strongly disagreed. In terms of handling and discarding processes of e-waste, the data from the literature also indicates various practices:

Most respondents (36.99%) stored electronic products at home after consumption.A large percentage of storing e-waste at homes may be due to a lack of knowledge about proper e-waste disposal methods, as there is a lack of door-to-door e-waste collection programs and formal e-waste collection programs. Unfortunately, a small percentage of people resort to burning e-waste, which can have severe environmental and health consequences.(Easin et al., 2022)

On the other hand we found on the question if Dhaka city has a proper dumping system, the majority (67%) of respondents answered ”no,” indicating widespread dissatisfaction with the current waste management infrastructure. A further 38% of respondents responded ”maybe,” suggesting uncertainty about the adequacy of the existing dumping system. Only a small minority (5%) of respondents answered ”yes.” These findings highlight the urgent need for improved waste management infrastructure in Dhaka city to address environmental pollution and public health concerns effectively. In terms of e-waste disposal practices: various methods of e-waste disposal were observed among respondents, including designated disposal sites, selling to vendors or markets, discarding in available areas, and unfortunately, burning. Understanding these disposal practices is crucial for developing effective e-waste management strategies.

*8.2. **Model Proposal***

With the rapid advancement of technology, the turnover rate of electronic products has significantly increased, leading to a surge in electronic waste (e-waste). Proper management of e-waste is crucial to mitigate its environmental and health impacts. This model proposal outlines a comprehensive approach to e-waste management, focusing on collection, separation, recycling, and reuse.

1. Collection and Separation:
   - The city corporation will establish a dedicated system for the collection of e-waste, separate from other types of waste.
   - E-waste collection points will be set up across the city to facilitate convenient disposal for residents.
2. Sorting and Segregation:
   - Upon collection, e-waste will be sorted to identify usable and non-usable items.
   - Usable e-waste will be separated for reuse, while non-usable e-waste will be designated for recycling or safe disposal.
3. Recycling and Disposal:
   - Non-usable e-waste will be sent to recycling facilities for processing.
   - Materials that cannot be recycled will be disposed of in accordance with environmental regulations to prevent pollution and health hazards.
4. Reuse and Repurpose:
   - Usable e-waste, such as components and materials, will be sent back to the manufacturing company.
   - The manufacturing company will utilize these materials to produce new electronic products, thereby closing the loop on e-waste management.
5. Benefits:
   - Environmental Sustainability: Proper management of e-waste will reduce environmental pollution and minimize the strain on natural resources.

- Health Protection: By preventing the improper disposal of e-waste, this model will mitigate health risks associated with hazardous materials.
- Economic Advantages: The recycling and reuse of e-waste will create a sustainable supply chain, reducing production costs for new electronic products.
- Circular Economy: This model promotes a circular economy by reusing and repurposing materials, contributing to long-term environmental and economic sustainability.

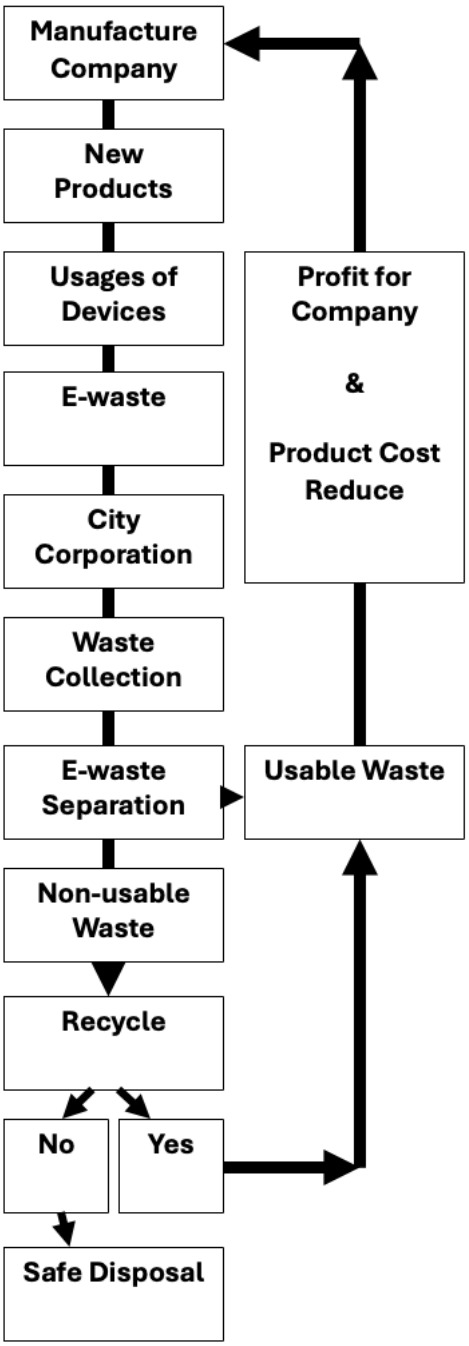

Fig.12: Proposed model for e-waste management.

Implementing this model will establish an efficient and sustainable e-waste management system in Dhaka city. By incorporating collection, separation, recycling, and reuse, this model ensures the proper disposal of e-waste while maximizing resource efficiency and minimizing environmental impact. It represents a significant step towards creating a cleaner, healthier, and more sustainable urban environment.

9. Regulation and Recommendation

1. Efficient Collection and Separation:
   The city corporation should prioritize the efficient collection and separation of e-waste from other waste streams. By implementing proper collection and separation protocols, e-waste can be managed more effectively, minimizing its environmental impact. This would involve establishing specific collection points for e-waste and ensuring that it is properly segregated from other types of waste. Efficient collection and separation are essential first steps in the proper management of e-waste within the city.
2. Establishment of Dedicated Facility:
   Establishing a dedicated facility for e-waste disposal is crucial for ensuring the proper management of electronic devices. This facility would provide a centralized location for the safe disposal and recycling of e-waste, reducing the environmental impact of improper disposal. With a dedicated facility in place, e-waste can be handled and processed in a controlled environment, minimizing the risk of environmental contamination. Such a facility would also facilitate the proper sorting of e-waste to determine items suitable for reuse and those that can be recycled.
3. Sorting of E-Waste:
   E-waste should be sorted at the dedicated facility to determine items suitable for reuse and those that can be recycled. Proper sorting of e-waste is essential for maximizing resource recovery and minimizing environmental pollution. By separating e-waste into reusable and recyclable components, valuable materials can be recovered and reused, reducing the need for new raw materials. Sorting e-waste also ensures that hazardous components are properly disposed of, further reducing the environmental impact of electronic waste.
4. Awareness Campaigns:
   Conducting awareness campaigns promoting the principles of reduce, reuse, and recycle (3R) is essential for educating the public about responsible e-waste management practices. These campaigns can help raise awareness about the environmental and health hazards associated with improper e-waste disposal. By encouraging individuals to reduce their e-waste generation, reuse electronic devices where possible, and recycle old electronics, these campaigns can help minimize the environmental impact of electronic waste. Public education and awareness are crucial components of any effective e-waste management strategy.

5. Government Intervention:
   Government intervention is crucial for the success and sustainability of e-waste management initiatives. The government should provide support and resources to implement and maintain effective e-waste management strategies. This may include implementing regulations and policies to govern the proper disposal and recycling of e-waste, as well as providing funding for e-waste management programs. Without government intervention and support, it will be challenging to address the growing problem of electronic waste effectively.
6. Monitoring and Regulation:
   Monitor e-waste trafficking and shipment into and within Bangladesh to prevent illegal dumping and ensure compliance with regulations.
7. Expansion of Waste Collection Services:
   Expand waste collection and transportation services to cover all parts of the city and improve access to proper waste disposal facilities.
8. Integrated Management System:
   Focus on building an integrated e-waste management system that encompasses collection, sorting, recycling, and disposal.
9. Product Flow Analysis:
   Conduct a complete product flow analysis in the urban environment to understand the life cycle of electronic products and identify opportunities for waste reduction and resource recovery.

Implementing these recommendations will require coordinated efforts from government agencies, private sector stakeholders, and the general public. By working together, we can create a more sustainable and environmentally friendly approach to e-waste management in Dhaka city as well as in Bangladesh.

10. Conclusion

The management of electronic waste (e-waste) presents a significant challenge for cities like Dhaka, where rapid urbanization and technological advancement have led to a surge in electronic consumption. This paper has examined the current state of e-waste management in Dhaka city, highlighting the environmental, health, and economic implications of improper disposal practices. Through a comprehensive review of existing literature and primary data collection, this study has provided valuable insights into the scale of the e-waste problem in Dhaka city and identified key challenges and opportunities for improvement. The findings reveal a pressing need for effective e-waste management strategies that prioritize collection, separation, recycling, and public awareness. While efforts have been made to address the issue, such as the establishment of dedicated e-waste collection points, there remains much room for improvement. The recommendations put forward in this paper, including the development of an e-waste policy, efficient collection systems, capacity development for recyclers, and public awareness campaigns, offer a roadmap for addressing the e-waste challenge in Dhaka city. By implementing these recommendations, stakeholders can work together to create a more sustainable and environmentally friendly approach to e-waste management. This will not only help mitigate the environmental and health risks associated with e-waste but also unlock economic opportunities through resource recovery and recycling. Ultimately, effective e-waste management is not only a matter of environmental stewardship but also a prerequisite for sustainable development and a healthier future for all residents of Dhaka city. It is imperative that policymakers, government agencies, businesses, and the public collaborate to turn these recommendations into action and ensure a cleaner, greener, and more sustainable urban environment for generations to come.

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