ResearchGate

See discussions, stats, and author profiles for this publication at: https://www.researchgate.net/publication/364609607

A Policy Framework for Improving E-Waste Management in Bangladesh

Chapter · October 2022

DOI: 10.1007/978-3-031-19958-5_95

CITATIONS
14

READS
120

5 authors, including:

Sinthia Ananna
East West University (Bangladesh)
1 PUBLICATION **14** CITATIONS
SEE PROFILE

Iffat Jahan Shorna
East West University (Bangladesh)
1 PUBLICATION **14** CITATIONS
SEE PROFILE

Ahmed Wasif Reza
East West University (Bangladesh)
226 PUBLICATIONS **2,135** CITATIONS
SEE PROFILE

All content following this page was uploaded by Ahmed Wasif Reza on 01 July 2023.

The user has requested enhancement of the downloaded file.

Author Proof

A Policy Framework for Improving E-Waste Management in Bangladesh

Sinthia Sarkar Ananna[1], Nishat Sultana Supty[1], Iffat Jahan Shorna[1], Ahmed Wasif Reza[1], and Mohammad Shamsul Arefin[2,3](✉)

[1] Department of Computer Science and Engineering, East West University, Dhaka, Bangladesh
wasif@ewubd.edu

[2] Department of Computer Science and Engineering, Daffodil International University, Dhaka 1341, Bangladesh
sarefin@cuet.ac.bd

[3] Department of Computer Science and Engineering, Chittagong University of Engineering and Technology, Chattogram 4349, Bangladesh

Abstract. This paper aims to show the importance of e-waste management techniques for environmental sustainability, proposing a policy framework for improving e-waste management in Bangladesh. E-waste is one of the world's fastest-growing waste categories, expanding at a rate of 3–5% each year. Our main focus is to develop a better concept for an e-waste recycling system that is both sustainable and energy-efficient. The study examines the policy, its shortcomings, and the accompanying concerns and options for addressing this rising problem. Therefore, this paper suggests that e-waste policy development may necessitate a more personalized approach. This study provides a thorough overview of Bangladesh's generation of electronic and electrical waste, as well as current, sustainable e-waste management initiatives and the recycling industry. Several environmentally friendly E-waste management strategies have been put forth, along with potential roadblocks to their implementation.

Keywords: E-waste · Sustainability · Recycling trade · E-waste management

1 Introduction

Bangladesh has a rapidly growing economy and a growing market for domestic and international consumers of electric, electronic, and home appliances, among other things. The rising amount of trash generated by manufacturing and supply processes presents a significant concern for many emerging countries, especially in Asia. The purpose of this article is to provide a review of the problems and concerns that Bangladesh has in sustainably recycling its e-waste. In recent years, equipment reuse or recycling, as well as dumping, have caused a problem. This electronic waste creates various environmental and health risks to living and non-living organisms. Growing public awareness of electronic waste's environmental, social, and economic ramifications among buyers, producers, institutions, politicians, and lawmakers is the main issue in Bangladesh. In

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2023
P. Vasant et al. (Eds.): ICICO 2022, LNNS 569, pp. 1–11, 2023.
https://doi.org/10.1007/978-3-031-19958-5_95

Author Proof

recent years, a substantial amount of e-waste has been transported for disposal from Western countries to Asian nations. Bangladesh utilizes around 3.2 million tons of electronic items each year, according to the Bangladesh Electronic Machinery Marketing Association (BEMMA). According to several surveys, the huge majority of e-waste is transferred to China and India. Pakistan, Bangladesh, Ghana, Nigeria, and Kenya have also been highlighted as hotspots for e-waste. 75 to 80% of the 20 million to 50 million metric tons of e-waste produced each year is estimated to be exported to developing countries, mostly in Asia and Africa, for "recycling" and disposal. There is currently no specific regulation or policy for e-waste management and recycling, and no established facility for hazard-free e-waste recycling. The informal sector in Dhaka and Chittagong recycles the majority of the electrical devices. Bangladesh generates roughly 2.8 million metric tons of e-waste each year, according to an ESDO survey. In the previous 21 years, mobile phones have only created 10,504 metric tons of harmful e-waste. Every year, over 15% of child laborers in Bangladesh die as a result of e-waste recycling, and over 83% are exposed to harmful chemicals and become sick, forcing them to live with long-term diseases. Around 50,000 youngsters are active in the informal e-waste collecting and recycling process, with around 40% of them working in shipbreaking yards [1]. Though the number of such wastes may not be particularly significant at this point, proactive steps must be taken to contain it before it reaches unmanageable proportions. Because of the rising size of the waste stream, the existing method of disposal, the possibility for material recycling and reuse, and the fact that these materials include recognized dangerous compounds with major health consequences.

The Environment and Social Development Organization (ESDO) has started research based in Dhaka and Chittagong to analyze the trend of using electronic devices or gadgets, what risks are caused by this e-waste and what are the existing disposal techniques [2]. This study aims to better understand electronic trash or e-waste and its worldwide impact on health and the environment and its recycling trade in Bangladesh. Also from this study, we will find,

- How to manage e-waste in a sustainable way
- What are the procedures for University Departments to recycle electronic scrap and equipment?
- What services do we offer in sustainable e-waste management and recycling?

The objectives of the study are:

- To develop a proper model for an e-waste recycling system that brings sustainability and energy efficiency.
- To reduce investment and operational costs, improve efficiency, and increase sustainability by using a natural renewable power source.
- To inform and aware the users of the dangers of e-waste and digital systems.
- To help businesses and organizations in getting rid of obsolete electronics and safeguard the environment.

The project scope dictates the electronic system's capabilities, which were created to conform to a specific mechanism confined to security and safety procedures.

Author Proof

2 Related Work

The worldwide trade of e-waste between countries for treatment, disposal, or recycling is known as the global waste trade. Many articles highlight the global relationships between developed and developing countries and national and regional analyses. For research publications, we've created a table (Table 1) with some approaches, techniques, datasets, advantages, disadvantages, Results, Research Gaps, and Remarks.

Table 1. Recent and related papers are reviewed in this literary review

Papers	Methods	Datasets	Advantages	Dis-advantages	Results	Research gap	Remarks
[1]	Producers recycled all e-waste items more than their target levels by the method of the EPR system and MSW streams	A description of Korea's e-waste management and recycling practices	Public recognition of the need for waste minimization	Didn't show any sustainable management and trade system	Recycling among consumers who have access to inexpensive storage, the EPR program with increased recycling rates is required	Lack of information about sustainable e-waste management	The process of minimizing and recycling e-waste before final disposal is shown, along with a financial incentive for collectibles and technical progress
[2]	Offered novel assessment methods for e-waste recycling to improve strategies for sustainable e-waste	The management of e-waste and environmental sustainability of Delhi and Jalandhar city in India	The policy limitations for efficient e-waste management with examples and improvement strategies for sustainable e-waste	Has only shown the analysis of e-waste management in India	The improper or illegal handling of e-waste and its unauthorized transboundary movement in developing countries have been demonstrated	Didn't find any trading system but just showed the statement and analysis of e-waste management	In order to achieve environmental sustainability, it is concluded that e-waste is hazardous to both human health and the environment and requires proper treatment
[3]	The hydrometallurgical process is used which is a potential mobile recycling method	Economic and ecological expenses provide a foundation for such setups to be applied	The adaption and potential application of current techniques for recycling e-waste throughout the world	It only focuses solely on the recycling of PCBs and lithium-ion batteries.	The procedures employed by the government and private sector in Pakistan to extract important metals	They didn't show us any form of recycling goods exchange in this paper	They propose an effective strategy in this research that should be adopted in Pakistan to improve E-waste recycling
[4]	E-wastes are sold to the local hawkers, and then they are sent to recycling plants to recycle and also export abroad	The recycling process and condition of Dhaka and Chittagong city	This paper helps to know the previous, current, and future structures of the e-waste management system in Bangladesh	In Bangladesh, there are no proper systems for recycling e-wastes indeed	Bangladesh's current recycling system can be justified as ineffective	No proper information is mentioned as a strong structure for the e-waste recycled process	There are no proper systems for e-waste recycling, but this paper requires mass information about the trading system for recycling e-waste

(*continued*)

Author Proof

Table 1. (*continued*)

Papers	Methods	Datasets	Advantages	Dis-advantages	Results	Research gap	Remarks
[5]	E-waste is classified as recyclable or non-recyclable after it has been collected and the next steps of the disposal process have been completed	The city of Bangalore's e-waste management and environmental sustainability	This study assists in understanding the previous and present approaches to e-waste disposal in Bangalore	There are no effective methods for recycling e-waste in Bangalore	Offers new e-squander management solutions for various Bangalore areas	Didn't create a schematic of the recycling process	The recent state, practices among Bangalore's numerous stakeholders, emphasize the lack of a comprehensive system
[6]	High-temperature processes are used, such as open burning of copper wires and plastic recycling with conventional extruders	The data is calculated from URENCO's data	The disassembly and sorting of e-waste are mostly sold to dealers, who subsequently ship it to China	Vietnam's e-waste recycling industry is more reliant	E-waste is generated through the illicit and legal disposal of end-user and imported new and secondhand products	Couldn't find any trading system by the country's own as they also export e-wastes	Shows the structure of e-waste management in Vietnam which is a very challenging issue in the whole world
[7]	They used SPSS 25 method to carry out the data analysis	They collected their data via an online survey	Their survey focused on awareness factors that distinguish between recyclers' and non-recyclers' experiences	They are not using any strategy to recycle and their e-waste management strategy does not create any utilizing quantitative evidence	Their findings demonstrate how consumer behavior in e-waste recycling and their percentages	Didn't show any type of recycling, e-waste management, or trade system, but only an analysis of customer behavior on e-waste management	This paper is only about the survey of consumer's behavior on e-waste management in Bangladesh

3 Methodology

3.1 Data Collection Methods

The first step in using any technique or methodology is to define the study area's geographical limits. Bangladesh was included in the research area. Moreover, several advanced E-waste management methods are used in various developed countries, which may be a better answer for E-waste management in Bangladesh. This section discusses the strategies that may be possible for Bangladesh, as well as the obstacles that may arise in implementing these advanced techniques.

Bangladesh's current recycling system can be described as ineffective [3]. The advice that follows is based on a careful analysis of a stated E-waste recycling system and offers suggestions for implementing sustainable and acceptable E-waste management in Bangladesh. Because of its low installation costs, this E-waste recycling solvent can also be proposed as an addition to the current solid waste management system [4]. E-waste should be made accessible for reuse in addition to recycling by making them available to consumers and creating the necessary infrastructure [4]. This operation will differentiate the recycling process into various cells across Bangladesh's numerous city corporations.

Author Proof

The city corporation of the relevant metropolitan region will be in charge of running the E-waste recycling system's initial phase. In rural areas, the local cleaning authority will gather the E-waste and send it to the closest city corporation. The divisional recycling factory will then receive the parts of various electric apparatus. Laborers in the municipal recycling factory will disconnect the component from the supply chain of dissimilar parts. The recycled quantities are transferred to the constructors after a proper recycling procedure. Actions involving refurbishment carry non-functional waste microelectronics back to a working state. The whole capacity of materials generated by discarded devices was spurred into new manufacturing circles. The customer receives new merchandise [5]. Figure 1 depicts a proposed concept for sustainable-term E-waste recycling.

i. Dismantling and separating damaged and wasted components

Reusing used electronics has been encouraged by laws that require recycling in different countries' principal waste management systems [6]. The two methods that constitute the majority of the WEEE reprocessing are:

(1) Using the creative design, reduce the amount of discarded waste that needs to be overhauled.
(2) Recovering precious metals used in electrical components. This method is useful because the metal may be sold in return for money, providing immediate economic benefit [8]. The flow diagram in (Fig. 1) depicts the process. In Fig. 1, It has been found that the divided parts can be divided into six segments for any further processing after the electronics have been removed. A four-shaft shredder mechanism controls the shredding process. Magnetic separation is used to remove the iron-rich bits from the conveyor belt, and fingerpicking is used to separate the non-magnetic metal components. Finally, plastic scraps can be processed for retail sales. Complex parts that are enriched with expensive metals, like printed circuit boards (PCBs), are exposed to hydrometallurgical handling to extract the metal. Because the fine metal layer is removed with acid as part of basic washing, cylinder washing is environmentally friendly [9].

In this method (Fig. 1), a glass slurry is produced, which can be recycled. Since direct glass-to-glass recycling is not preferred for CRTs, the manufacturer can perform the recycling after disassembling and classifying the CRT's various components and removing the phosphorous from the glass top. With its reprocessing capacity, the company anticipates recovering 99.9% of hazardous components like mercury. Additionally, by the regulations of the contamination authority, hazardous waste, such as electron guns and related technologies, is returned to formal units for safe disposal [9].

ii. Tracking back silver or gold from e-waste

Utilizing hydrometallurgical, chemical, bio-sorption, or bio-metallurgical techniques, the research presented in this paper suggests a tactical model for recovering silver or gold from electronic waste. The procedure starts with the separation of electronic waste containing silver or gold, which is then put through a hydrometallurgical process using cyanide as a bleaching agent. After this procedure, we are left with either silver cyanide or gold cyanide. After that, they are exposed to a bio metallurgical process that makes use of cheap, easily accessible biomass. In this method, the cyanide of silver or gold bond issues with the biomass in an hour. The recovered mass can then be incorporated

Author Proof

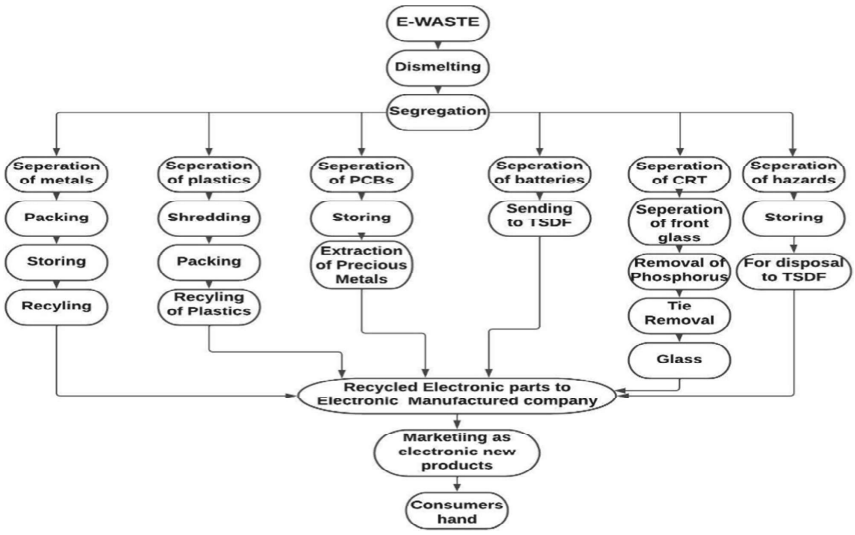

Fig. 1. A general flowchart for the business and procedure of recycling.

into the new electrical circuits as input [10]. A thorough method for recovering pricey materials such as silver and gold, which are widely used in electronics, is shown (Fig. 2). Because of its extensive marketing potential, hydrometallurgy is growing in popularity in developing nations, attracting interest both from the government and private businesses [11].

iii. Energy generation from e-waste that has been recycled

Electric wastes and plastic, which have a high calorific value during combustion, can be a good source of energy if appropriately treated. If used in an environmentally friendly way, electronic chips, which also include a large number of volatiles (about 83.44%), maybe a significant energy source [12]. The most practical of the various technologies is the Catalytic De-polymerization Process Technology (CDPT), which has the potential to generate 40 MJ/kg of energy from the plastic in e-waste. Given the lack of abundant oil resources in Bangladesh, this technology may be the key to empowering the country's energy sector [13, 14].

Recovery and recycling of electric waste can produce significantly more electricity than non-processed waste, claim Cui and Forssberg [15]. For instance, the cost of extracting kg of aluminum from its ore is 1/10 of that price. Re-melting aluminum while generating energy from electronic plastic uses a lot less energy than mining bauxite and can be used to produce aluminum [16]. Figure 3 depicts the materials and energy savings associated with them [17]. Additionally, Anastasiadou et al. and Lancellotti et al. have demonstrated that starting to recover metal-enriched ash is very challenging; as a result, burning the ash and recouping the heat energy is a significantly more cost-effective alternative [17, 18].

Author Proof

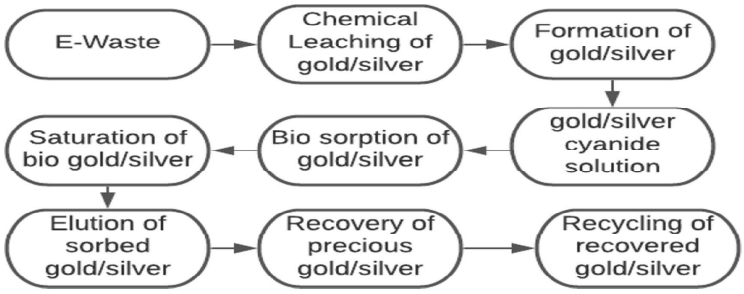

Fig. 2. An integrated model for recovering precious metals (gold and silver) from electronic waste has been presented

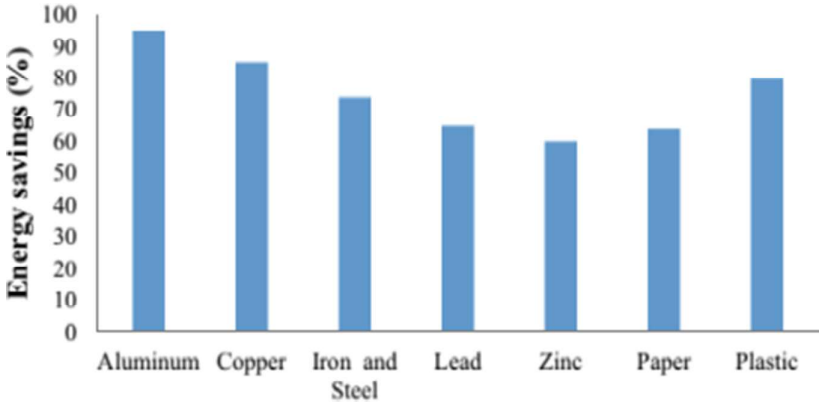

Fig. 3. Expected energy savings from reclaiming materials from E-products [15]

3.2 E-Waste Incineration

Incineration is the process of eliminating waste by burning it. Burning E-waste has the potential to pollute the environment by releasing lead, mercury, and cadmium into the atmosphere. The figure (Fig. 1) evaluates the creation value and competitive advantage, operational time, and environmental attributes. We discovered several output products with differing economic worth for various ways of E-waste recycling in the literature. As a result, it is impossible to quantify the economic benefit of handling all types of e-waste on an equal basis. However, there was enough information to evaluate the efficacy.

3.3 E-Waste Trade

The rules of Bangladesh make it illegal to trade e-waste, as well as its disposal and treatment. Bangladesh is a signatory to the Basel Convention, which prohibits hazardous waste from being transported over international borders. However, to trade recycled products in the manner described above, we must first go through the legal process and then trade legally. Used laptops, monitors, mobile phones, and other electrical devices

Author Proof

are being dumped in Bangladesh. Bangladesh must develop specialized policies and regulations to address e-waste issues. The following steps are suggested:

1. A public awareness campaign should involve both traditional and modern media (newspapers, television) (web, blogs, and social networks). Both policymakers and the general public should be addressed in the campaign.
2. Understanding the existing and future implications of e-waste in the country requires baseline and action studies. More study is needed to determine the existing state of affairs and forecasts future trends.
3. The country is working on a solid waste management policy. Bangladesh requires an all-encompassing e-waste policy. A fact-based campaign aimed at policymakers, as well as efforts to sensitize lawmakers, should be part of the policy advocacy strategies.
4. Pilot projects: The government should conduct pilot projects based on the research findings to build ecologically and socially beneficial e-waste recycling methods across the country.

However, it symbolizes the recommended policy framework for improving E-Waste Management in Bangladesh, based on the preceding discussion.

4 Results and Discussion

We discovered that 97% of lead-acid batteries in Bangladesh are made from recycled batteries and scrap metal. In our paper, we also tried to find the benefits of the e-waste recycling management system in Bangladesh which can ensure a sustainable green environment as well as also create job vacancies by implementing our method of recycling.

We discovered (Table 2) the total amount of electronic items purchased and their waste rates based on our research findings. We attempted to calculate the percentages of reuse and recycling rates based on that rate.

Table 2. The percentages of reuse and recycling rates from E-waste

Name of the accessories	Amount of buying accessories	Wasted (%)	Reused and recycled (%)
Hard disk	75000	40.53%	59.47%
Ram	67200	3.87%	96.13%
Motherboard	210000	25.23%	74.77%
Processor	131000	37.56%	62.44%
Monitor	95000	37.79%	62.21%

(*continued*)

Author Proof

Table 2. (*continued*)

Name of the accessories	Amount of buying accessories	Wasted (%)	Reused and recycled (%)
Printer	75000	10.8%	89.2%
Mobile	74000	32.70%	67.29%
Television	130000	6.54%	93.47%
DVD player	190000	18.26%	81.73%
Refrigerator	59900	6.34%	93.66%
Battery	21900	21.47%	78.54%
UPS	39000	27.18%	72.82%
AC	60000	23.83%	76.17%
Fan	4000	37.75%	62.25%
Energy bulb	81100	34.40%	65.60%

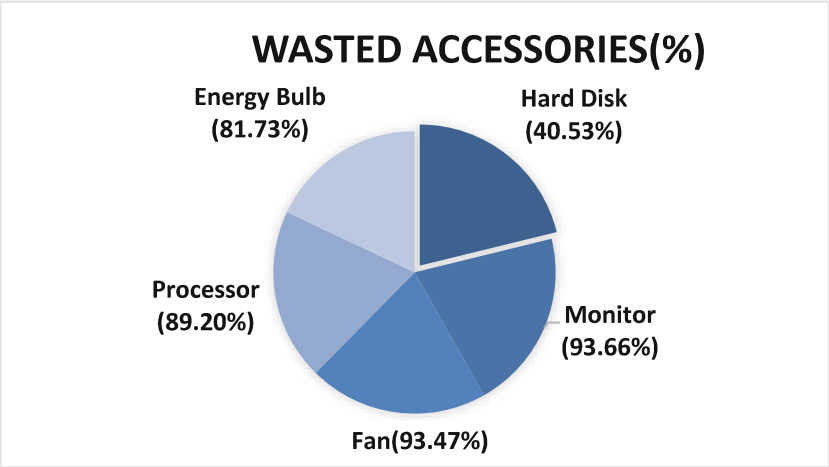

Fig. 4. Wasted rate of electrical accessories

This table is based on our research findings [16], which are displayed (Table 2) and show the amount of e-waste that has been recycled and reused.

After visualizing the table (Table 2), we have displayed the rate of five electronic wastes in Fig. 4 whose rate of waste is maximum, and also, Hard Disk is the most wasted accessory. There are fewer variations between these rates.

After visualizing Table 2, we have displayed the reused and recycled rates of five electrical accessories in Fig. 5 whose rate of waste is maximum where RAM is reused and recycled most from the other accessories. There are fewer variations between these rates.

Author Proof

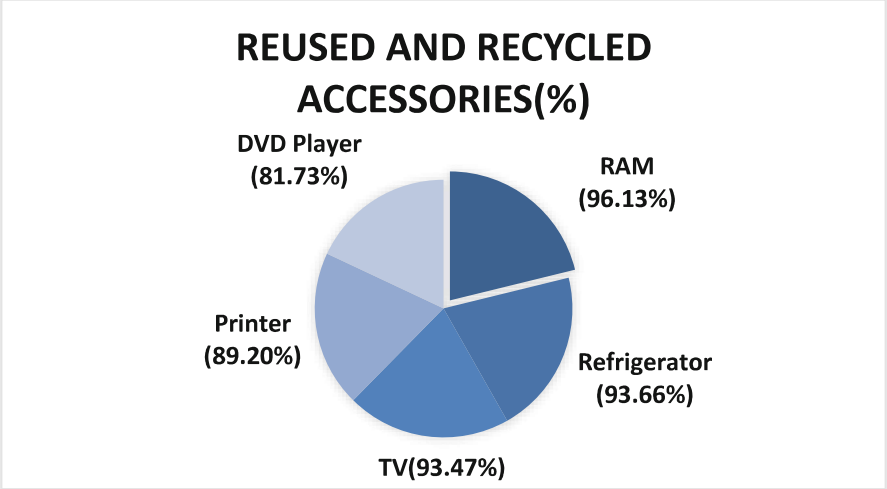

Fig. 5. Reused and recycled rate of electrical accessories

5 Conclusion

Bangladesh must develop dedicated policies and legislation to address e-waste issues. Policies or laws relating to e-waste management should be grouped. Frequently, multiple plans or policies operate independently of one another. Bangladesh lacks comprehensive policies and the capacity to address e-waste issues. Switzerland serves as an excellent example of how to address the growing environmental problem. Many issues require to be resolved, including the enforcement of regulations, training for the unorganized sector, public education campaigns, and an open recycling system. Consumers will be compensated for any defective electrical or electronic devices, ranging from cell phones to laptops. Companies must collect 50% of e-waste in the next five years, according to a goal established by the government. In five categories, the guidelines set threshold limitations for hazardous material usage in 71 electrical and electronic household goods and medical equipment. Also, a campaign would be launched to notify those working in the industry, and a workshop for people from importing, manufacturing, and assembling industries will be held.

References

1. Yousuf, T., Reza, A.: E-waste management in Bangladesh: present trend and future implication, October 2011. https://doi.org/10.13140/2.1.3261.7927
2. Islam, M.N.: E-waste management of Bangladesh. Int. J. Innov. Hum. Ecol. Nature Stud. **4**(2), 1–12 (2016)
3. Masud, M.H., et al.: Towards the effective e-waste management in Bangladesh: a review. Environ. Sci. Pollut. Res. **26**(2), 1250–1276 (2018). https://doi.org/10.1007/s11356-018-3626-2

Author Proof

4. Sudipta, C., Javed, S., Biswa, P.: Reusing and recycling practice of e-waste in Dhaka city, pp. 1–7 (2017). https://scholar.google.com/scholar?cluster=5044519150499755697&hl=en&as_sdt=2005&sciodt=0,
5. Riyad, A.S.M., et al.: E-waste recycling practices in Bangladesh. Int. J. Renew. Energy Environ. Eng. **2**(03), 193–200 (2014)
6. Tian, J., Chen, M.: Assessing the economics of processing end-of-life vehicles through manual dismantling. Waste Manag. **56**, 384–395 (2016)
7. Ananno, A.A., Masud, M.H., Dabnichki, P., Mahjabeen, M., Chowdhury, S.A.: Survey and analysis of consumers' behaviour for electronic waste management in Bangladesh. J. Environ. Manag. **282**, 111943 (2021). https://doi.org/10.1016/j.jenvman.2021.111943
8. Julander, A., et al.: Formal recycling of e-waste leads to increased exposure to toxic metals: an occupational exposure study from Sweden. Environ. Int. **73**, 243–251 (2014)
9. Pathak, P., Srivastava, R.R.: Assessment of legislation and practices for the sustainable management of waste electrical and electronic equipment in India. Renew. Sustain. Energy Rev. **78**, 220–232 (2017)
10. Cui, J., Zhang, L.: Metallurgical recovery of metals from electronic waste: a review. J. Hazard Mater. **158**(2–3), 228–256 (2008)
11. Bhat, V., Rao, P., Patil, Y.: Development of an integrated model to recover precious metals from electronic scrap-a novel strategy for e-waste management. Procedia Soc. Behav. Sci. **37**, 397–406 (2012)
12. Othman, N., Mohd Sidek, L., Ahmad Basri, N.E., Muhd Yunus, M.N., Othman, N.A.: Electronic plastic waste management in Malaysia: the potential of waste to energy conversion ın energy and environment. In: 3rd International Conference on Energy and Environment, ICEE 2009, pp. 337–342. IEEE (2009)
13. Nnorom, I.C., Osibanjo, O.: Sound management of brominated flame retarded (BFR) plastics from electronic wastes: state of the art and options in Nigeria. Resour. Conserv. Recycl. **52**(12), 1362–1372 (2008)
14. Navazo, J.M.V., Méndez, G.V., Peiró, L.T.: Material flow analysis and energy requirements of mobile phone material recovery processes. Int. J. Life Cycle Assess **19**(3), 567–579 (2014). https://doi.org/10.1007/s11367-013-0653-6
15. Cui, J., Forssberg, E.: Mechanical recycling of waste electric and electronic equipment: a review. J Hazard Mater. **99**(3), 243–263 (2003)
16. Hai, Y.K., Schoeung, J.M.: Electronic waste recycling: a review of US infrastructure and technology option. Resour. Conserv. Recycl. **45**, 368–400 (2005)
17. Ahmed, S.U.: Informal sector E-waste recycling practices in Bangladesh. Dhaka, Bangladesh, pp. 13–27 (2011)
18. Karim, R.T., Bari, N., Ashraful, A.M.: E-waste management in Bangladesh. In: 2014 2nd International Conference on Green Energy and Technology (ICGET), pp. 104–109. IEEE (2014)