E-waste related statutes in Bangladesh and the negative impacts of e-waste on the environment and human health: an analysis

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Abstract: Technology has made the life of Bangladeshi people very flexible with new inventions. Here the people depend on technological devices. These devices, along with various facilities, have also invited a series of problems mostly due to the lack of proper management. The Bangladeshi citizens often leave electronic devices that went bad or became unusable, in landfills, rivers, canals, and open spaces. As these devices possess a variety of toxic substances, dumping huge amounts of electronic waste can pollute the environment and threaten human health. As a result, it is important to take the required measures to prevent potential e-waste-related problems. In spite of the alarming levels of e-pollution in Bangladesh, the concerned authorities are yet to take any effective step or formulate any legislation to prevent the existing e-pollution. Moreover, the prevailing environmental laws are not adequate to address the issue and its application are still largely absent.

Keywords: approach; Bangladesh; e-waste; environment; policy.

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1   Introduction

Generally, 'electronic waste (e-waste)' is a term that applies to all secondary electronic products such as computers, phone sets or mobile phones, electronic entertainment devices, refrigerators (colloquially fridge), TV sets, whether sold, donated, or discarded by the initial owners. E-waste is the informal and short name of the electronic goods that go bad or reach the end of 'useful life' (Alam and Bahauddin, 2015). Some of the common electronic products are televisions, VCRs, computers, copiers, stereos, and fax machines. A significant number of these items can be refurbished or recycled and reused (Babu et al., 2007). Regrettably, electronic discards have become one of the emerging concerns for Bangladeshi society. Televisions and computer monitors, audio and stereo equipment, Computers and monitors of computers along with the keyboards, VCRs and DVD players, Video cameras, CFL bulbs, mobile or cell phones, telephones, and several wireless devices, Video game consoles equipment are often liable for causing e-waste in Bangladesh (Chatterjee and Kumar, 2009). Bangladesh has an emerging demand for power, mobile, and home appliances, in addition to rapid economic growth. As a result of these demands, the amount of locally manufactured electronics products has risen, as has the market for reusing these products (Yousuf and Reza, 2011). Equipment is mostly reconstructed and recycled in both semi-formal and informal sectors. These electronic wastes are harmful to human health and the environment (Masud et al, 2019). At present, Bangladesh lacks awareness and has ample information gap on e-waste hazards. Waste or, e-waste produced by electrical and computer gadgets, is increasingly increasing, with estimates indicating that 72 billion tons are generated annually worldwide (Alam and Bahauddin, 2015). For sure, the digital revolution has resulted in a huge increase in the quantity of e-waste, but the use of hazardous chemicals has also altered its consistency. The explosive growth of the electronics and hardware industries has increased the demand for electronics (Yang et al., 2013). Consumers are being forced to dispose of their old electronic goods due to rapid improvements in electronic device functionality and the availability of improved products. This has resulted in an unprecedented rise in Electronic waste. Bangladesh, like many other countries of the word, grappling with a serious problem as a result of that e-waste production (Sudipta et al., 2017). Consumers, producers, organisations, lawmakers, and legislators in Bangladesh face a major challenge in raising public consciousness of the environmental, social, and economic aspects of e-waste. Over the years, it has been found that a significant amount of e-waste is exported from western countries to Asian countries for disposal. Due to rising labour costs and limited raw materials, it appears that the recycling industry in Western countries will be unable to operate at full capacity (Shamim et al., 2015). Therefore, western countries are bound to look for alternative destinations for disposal. They look for a place that has a low labour cost and is weak at environmental laws enforcement. E-waste is often hazardous to the environment because it contains poisonous substances such as Pb, Cr6, Hg, Cd, and flame retardants (Ahmed, 2011). E-waste disposal combined with solid urban waste is polluting the soil in developing countries like Bangladesh (Rana et al., 2016). Since there is no formal recycling technology, non-formal operators mine precious metals for the sole purpose of profit. Metals are extracted in non-formal units by dipping a printed circuit board in acidic/alkaline solutions and heating/burning the PCB (Salam et al., 2008). These methods are harmful not only to the workers but also to the environment, which is a major concern for e-waste management in a developing country such as Bangladesh. This study aims to address the

causes of e-waste, the existing problem caused by it, analyses the impacts of electronic waste on human health and the environment. Furthermore, this study will analyse the relevant e-waste policy and its gaps. Significantly, this study will provide few recommendations that can bring an end to the e-waste generation through policy and law.

2 Material and methods

Both primary and secondary data were used in the research. All of the current paper's related data and knowledge were gathered and used from primary and secondary sources. Books, journals, various national and international law papers, Acts, and other secondary data sources are among the secondary data sources. To complete it successfully, information was collected chronologically from various books, journals, booklets, proceedings, newsletters, souvenirs, and consultancy reports available in the libraries of Daffodil International University, Bangladesh. According to the selected data (collected from the selected stations between 2019 and 2020), in every year Bangladesh produces approximately 2.7 million metric tons of electronic waste, just 20-30% of waste is recycled, leaving the remainder to be discarded in different water sources i.e. ponds, rivers, drain etc., posing a serious threat to human health and the atmosphere (Hossain et al., 2020). The e-waste categories and corresponding data were personally determined and analysed by the author. The current e-waste management in Bangladesh has a range of flaws, including incentivisation problems, unsanitary conditions of informal recycling, inadequate law and regulation, low knowledge, and a lack of corporate enthusiasm to resolve the critical issues. In spite of the alarming levels of e-pollution in the country, the concerned authorities are yet to take any effective step or formulate any legislation to prevent the existing e-pollution. Due to the growing number of e-products as a result of rapid technological and industrialisation, the situation is expected to worsen in the coming days. The current study makes some important recommendations to the relevant authorities in order to stop the generation of e-waste in Bangladesh through policy and law.

3 Results and discussions

The use of technology in Bangladesh has increased over the years. The country's current issue is how to use technology in a sustainable and healthy manner. The waste from electronic equipment has emerged to be a curse as people throw the useless and unusable products in open places and water bodies without thinking about its impact on the environment and human health. Moreover, Bangladesh imports a significant number of scrap ships legally and illegally each year, and the southern part of Bangladesh is the main destination of these ships used for shipbreaking. Many heavy metals and harmful chemicals are released into the atmosphere during shipbreaking, and oil spills onto land and different types of water bodies. Bangladesh is unable to import scrap ships due to contractual obligations, and importers are using illegal channels for making more profit, leaving the country more vulnerable to e-waste. The toxic products and electrical and electronic waste, carried by scrap ships, include electronics, clothes irons, mirrors,

lamp/light bulbs, etc. Bangladesh generates approximately 2.7 million metric tons of e-waste per year. Shipbreaking yards are the source of the most e-waste, according to annual estimates (2.5 million metric tons). On the opposite, television set waste is the second most abundant, accounting for 0.182 million metric tons of e-waste (Chatterjee and Kumar, 2009).

**Figure 1**   E-waste in Bangladesh (see online version for colours)

Source: The Daily Star

Figure 2   Graphical representation of e-waste in Bangladesh (see online version for colours)
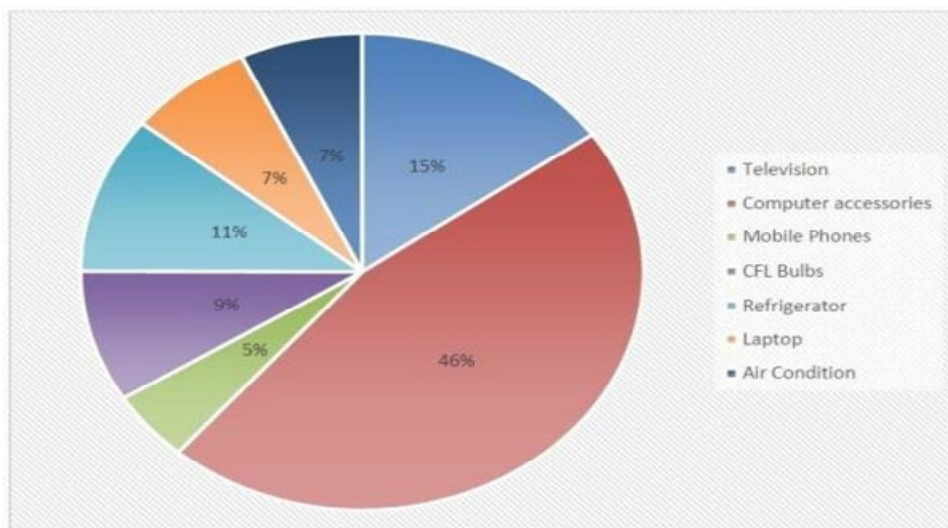
Source: WJSE

It is undeniable that Bangladesh has become one of the world's leading producers of e-waste. But, the country is yet to make any inventory to address the extent of this emerging problem so far. The goods below generate e-wastes in Bangladesh:

1   In the year 2006, Bangladesh had a sum of 600,000 personal computers, 1,252,000 television sets, and 2,200,000 refrigerators.

2   Two years later, in 2008, the overall number of TV viewers had risen to 10.3 million. Around 59, 85,000 television sets are scrapped each year, resulting in around 90000 metric tons of Electronic waste.

3   Bangladesh had a sum of 58.36 million mobile phone users at the end of December 2020.

4   Shipbreaking produces around 2.5 million tons of e-waste/year.

5   In the last two decades, mobile phone sets have delivered 10,504 metric tons of toxic e-waste.

6   In the last ten years, the information and telecommunications sector has also produced about 37,000.00 metric tons of e-waste.

7   Mobile phone users have sharply increased in Bangladesh over the years. Mobile phones have become one of the fast-growing market sectors in the country. Bangladesh has a huge number of active mobile phone users. There are most likely more than three basic cell phone sets in the region. Since the average lifespan of a cell phone is around a year, the country is getting over one core mobile phone set as e-waste per year.

Figure 3   Generation of e-waste in Bangladesh (see online version for colours)
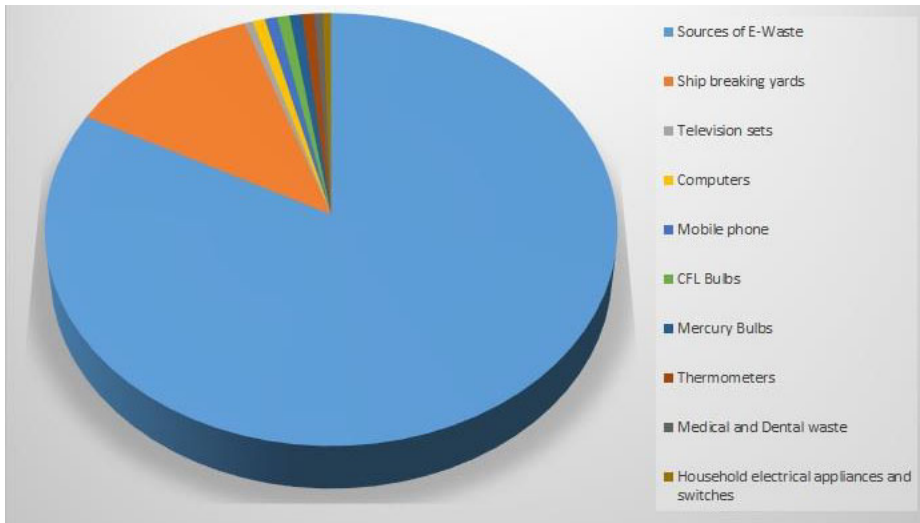
Source: Springer

Recycling in Bangladesh has become very difficult, often harmful, and dangerous due to a lack of proper waste management policies and guidelines (Pawar et al., 2015). In Bangladesh, the reuse of e-equipment is a regular phenomenon (Lawrence and Lelieveld, 2010). Rather, the recycling and dismantling of e-equipment have turned into an emerging business. Since Bangladesh's formal sector lacks an e-waste dismantling facility, all recycling is done in the informal sector. There are 120,000 urban poor from the informal sector in the recycling chain of Dhaka, Bangladesh's capital city (Kannan et al., 2007). Around 475 tons (15% of the total generated waste in Dhaka city) are recycled per day while the rest are dumped into rivers, canals, ponds, sea, lakes, and open spaces.

4   E-waste and its impacts on environment and human health

Merging human rights with environmental problems creates a mutual standpoint for the people who are affected by it. This process creates a right-based platform for environmental safety. However, it puts the affected people at the core of this matter. Intellectuals from all over the world came to this conclusion after various researches. Most of the people who come to this mutual standpoint are either affected by environmental crisis or pollution. This enunciation of human rights makes some openings to achieve the rights for the affected people. It plays an important role both in overseas and local areas to get the appropriate justice through an authorised process. The most affected part of the community to this environmental crisis has something to gain from this judicial process. It may soothe their scars at least by gaining some political support. Human rights and environmental ruins have a reciprocal relationship. It's like the two ends of a rope. Sometimes, exploitation of human rights can create an environmental disaster. On the other hand, at times, environmental collapse can manipulate human rights too. The world is getting wrapped by the wire of technology. One of the most dangerous causes of environmental pollution is e-waste. It's a slow poisoning but

certainly kills. There are numbers of electronic wastes and thousands of particles that are merging into our earth every second and making the environment hostile. Metals or chemicals are used to make these electronic wastes. Mercury-based products, such as batteries, electronic circuit boards, and CRTs, are among the deadliest components of digital waste (Gibson and Tierney, 2006). Besides, there are certain plastic wastes that carry brominated flame retardants and it is one of the major concerns for environmental pollution. Sometimes, mishandling of these serious components during the waste management process may lead to catastrophe.

If one of these highly sensitive substances somehow outflows or merges into the atmosphere then it may cause serious damage to the surroundings. Reports say, mismanagement during waste dumping, continuously affecting our soil, food, and nearby water reservoir and lives in it. The experimental observation took place at the shipyard of Chittagong in Bangladesh. It exposed that the soil of that area was contaminated by the excessive appearance of various chemicals such as cobalt, arsenic, selenium, cadmium, antimony trioxide, and chromium (Sthiannopkao and Wong, 2012). There is another major concern regarding this waste management system. Most often, these electronic wastes are burnt which makes the air toxic and paves the way for a new environmental crisis.

Figure 4   Negative impacts of e-waste on environment & human health (see online version for colours)
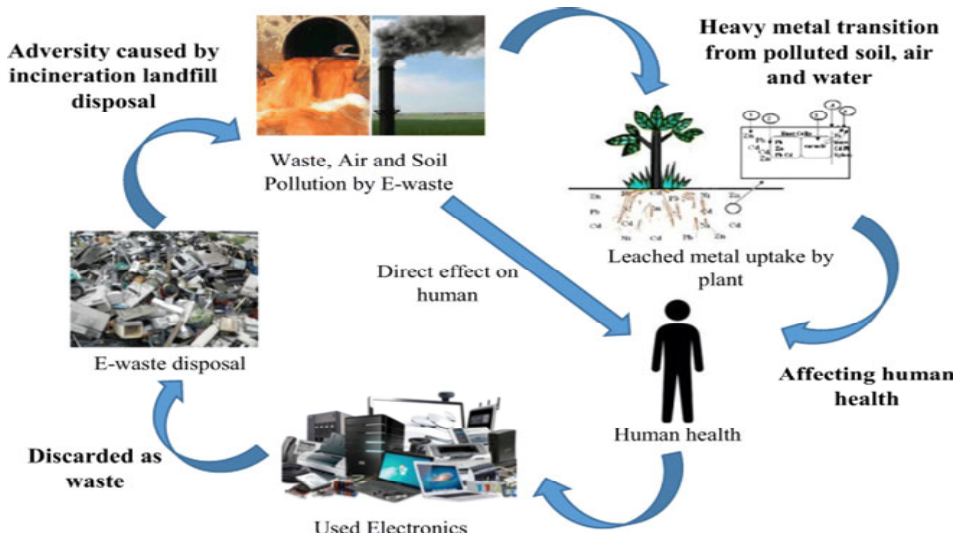
Source: Springer

India, the neighbouring country of Bangladesh is also affected by e-waste. E-waste is emerging as a serious public health and environmental issue in India (Joon et al., 2017). India is the fifth largest electronic waste producer in the world; approximately 2 million tons of e-waste are generated annually and an undisclosed amount of e-waste is imported from other countries around the world (*The Hindu*, May 2016). Annually, computer devices account for nearly 70% of e-waste, 12% comes from the telecom sector, 8% from medical equipment and 7% from electric equipment. The government, public sector companies, and private sector companies generate nearly 75% of electronic waste, with

the contribution of individual household being only 16% (Habib and Kumar, 2019). Like India, China receives pollution from both ends of the supply chain: during production process and by allowing electronic waste to be recycled and dumped in the country. Electronic waste is a serious environmental issue in China and China is the largest importer of e-waste and is home to most of the world's largest dumpsites (Ni and Eddy, 2019). Rapid economic growth, coupled with the world's increasing demand for electronics has dramatically increased the amount of e-waste being disposed of. Roughly 70% of this global e-waste ends up in China.

Not only these electrical wastes pose a threat to environmental ruins but also create substantial risk for the human body. Workers at the electrical waste disposal plants suffer from various diseases in Bangladesh like other developing countries. Research shows that people who work in electrical waste plants are more likely to suffer from nausea, headache, and respiratory complications. It is not wise to say that the people who only work inside the waste dumping plants suffer from these complications rather the whole neighbourhood is highly affected by this environmental hazard. However, these contaminate the soil, food, and rivers and indirectly make the environment hostile for living. Most often, people who deal with electrical waste are found consuming waste particles inside their bodies, mostly through dust inhalation and dietary intake. These electronic wastes can lead to serious damage to health such as upsetting the nervous system, causing brains to function imperfectly, damaging kidneys and liver, and also could make newborn babies suffer serious birth defects (Kojima et al., 2009). The main reason behind e-waste pollution is the lack of an appropriate disposal system. Most people don't know how to handle these sensitive products and this can lead to hazardous scenarios. One of the major concerns about this e-waste is its illegal or unsafe dumping into the land which can significantly damage the fertility rate of or land resulting in less production of crops. The problem is identified vividly but either the authorities are not taking necessary measures to make sure our environment is as safe as it is possible or the law that exists to ensure the proper disposal of this waste is not good enough to change the scenario. Geographically, Bangladesh has a huge advantage as it has many rivers and frequent rainfall. However, if the deadly chemicals from the waste can make their way to the underground water reservoir once, the blessing could turn into a curse in a moment.

5 The existing policy and legislation gaps regarding e-waste

The government of Bangladesh enacted a National Environmental Policy in 1992 to regulate all practices that pollute and damage the environment. The government later passed the Environment Protection Act of 1995 to control, preserve, and enhance environmental quality, as well as to track, prevent, and minimise pollution. The Medical Waste Management Rules of 2008 are only concerned with waste management problems in the medical sector, including e-waste (Dana, 2011). Electrical and Electronic Waste Rules, 2011 is the most recent initiative in Bangladesh, and it includes the following features: Any manufacturer, distributor, collection centre, refurbished(s), selling etc. are subject to these laws. It specifies the producer's responsibilities, as well as the responsibilities of dealers and refurbishes, collection centres' responsibilities, and individual or bulk consumer responsibilities, as well as the responsibilities of dismantlers and recyclers/preprocessors.

The Department of Environment was the first body formed in Bangladesh for environmental protection in 1977 under the Environment Pollution Control Ordinance, 1977, followed by the Ministry of Environment and Forest. Later, in 1992, the National Environment Policy went into effect, regulating all practices that pollute or destroy the environment. The Environmental Protection Act (ECA), 1995 subsequently allows DoE to undertake any action that is appropriate for maintaining and enhancing environmental quality and for controlling, avoiding, and reducing pollution (Bangladesh Environmental Protection Act, 1995). The Act also gave the Department of the Environment the authority to give environmental approval for any new project. The Environment Conservation Regulations, 1997, separate industries and projects into various categories based on their emissions load and potential environmental effects, in accordance with the ECA's subsequent rules. Despite the fact that certain clauses and mandatory regulations encourage business sectors to develop waste management systems, none of the acts or rules address e-waste. The Bangladeshi government, on the other hand, is working on a solid waste management strategy that could include e-waste. Meanwhile, the Medical Waste Management Rules, which took effect in 2008 under the Environmental Conservation Act 1995, only deals with waste management issues in the medical sector, including e-waste. The rules described related definitions; formation of the authority and responsibility; license issue and cancellation; responsibility of registered vendors; segregation, packaging, transportation, and hoarding; elimination and purification; classification waste for medical waste management. It addresses waste management issues mainly in the context of medical wastes but not in other contexts. On the other hand, the Ozone Depleting Substance (Control) Rules 2004 have been prepared also under the Environmental Conservation Act 1995. Ozone-depleting substances are prohibited to use under the schedule (1) column (2) of this rule. In addition to that according to regulation 4 of subsection 2 of the Rules, anybody could not produce, import, and export ozone-depleting substances. And the National 3R Strategy for Waste Management, 2009 is the solid waste management rules based on the 3R principle as well as hazardous waste management rule (3R means reducing waste, reusing, and recycling resources and products). The strategy clarifies the concepts of reducing, reusing, and recycling. Reducing refers to choosing to use items with care to reduce the amount of waste generated. Reusing involves the repeated use of items or parts of items that still have usable aspects. The Strategy facilitates four manuals on four different types of wastes: solid waste, biomedical waste, industrial waste, and agricultural waste. It does not address e-wastes, as a separate category of waste. However, the recycling of e-waste is required to be regulated due to the presence of hazardous constituents in the components of waste electrical and electronic assemblies. Bangladesh governments should encourage e-waste recycling under public-private partnership mode, cleaner production and eco-design practice and environmental product labelling, etc. National Environmental Management Action Plan (NEMAP) is an environmental planning exercise undertaken by the government through MOEF. In companion with the NEP Plan was carried out in three phases between 1992 and 1994. During the first phase undergoing rapid environmental degradation was identified. The second phase saw prioritisation of sectoral issues. Finally, the third phase witnessed an elaborate public consultation exercise with assistance from NGO personnel, academicians, lawyers, journalists, and other professionals. This exercise was intended to reflect people's concerns and priorities in the plan as well as raising public awareness about environmental issues (Khan, 2009). However, the e-waste issue was not addressed in it. Bangladesh has an international

commitment to take measures on e-waste management in terms of the movement of hazardous wastes. But in the whole framework that categorically focuses on the environmental aspect of the country, it is found that only the Seventh Five Year Plan has provided some suggestions and measures, and programs for e-waste management. The Plan suggests rules and regulations that will particularly look after the e-waste issues. Besides, it proposes some programs for e-waste management. In addition to that National ICT Policy has addressed e-waste related problems in a trivial manner. Other than these two policy instruments, the whole policy framework on the environment lacks focus on the issue of e-waste in the country.

The implementation of e-waste policies in Bangladesh, including waste reduction measures such as extended producer responsibility (EPR), can be very beneficial. This law gives Bangladesh the policy structure needs to deal formally with e-waste issues and to rapidly monitor the lessons gained from developing countries' e-waste legislation and management. However, if the e-waste policy is adopted by developed countries without taking into account local socio-economic circumstances and challenges, it can be counterproductive.

National Environment Policy was adopted in 1992 to protect the environment of Bangladesh. However, no particular law or ordinance is available at present for e-waste management and recycling in the country. Bangladesh has several acts and rules such as The Environment Conservation Act, 1995, The Environmental Court Act, 2000, and The Environmental Conservation Rules, 1997. The Environmental Protection Act, 1995 subsequently allows DoE to undertake any action as it seems fit for maintaining and enhancing environmental quality and for controlling, avoiding, and reducing pollution. E-waste concerns have also been discussed in the government's National 3R (reduce, reuse, and recycle) policy. Hazardous Waste Management Rules and Solid Waste Management Rules are currently being created. Since both guidelines haven't been finalised yet, there's still time to include e-waste management concerns. Bangladesh has signed the Basel Convention prohibiting transboundary movement to hazardous waste. Government approval is required for any kind of waste import. The Supreme Court of Bangladesh has also ordered the Department of Environment to ensure that all shipbreaking yards operating without permission from the Department of Environment ceases operations. The government has also been told not to allow any ship carrying hazardous waste into the country unless it has been pre-cleaned at the source or beyond Bangladesh's borders. The court has also found the lack of cooperation from the concerned ministries for ensuring conformity to the environmental laws. It further orders the government to ensure that ships are only broken after safe working conditions are guaranteed for employees and proper recycling arrangements are placed into place for hazardous waste and environmental safety.

6   Conclusions

Bangladesh is yet to take any effective step to put an end to generating e-waste or proper disposal of this sludge. Following actions could be taken as part of the way forward:

- identifying and creating a reservoir of e-waste in large cities of Bangladesh

- formulation of applicable e-waste disposal regulations and guidelines with consulting the concerning stakeholders

- establishment of efficient collection manuals for selected e-waste

- introduce registration as well as efficiency improvement programs for e-waste recyclers

- environmental management systems are being implemented in the e-waste sector

- establishing e-waste tracking a mechanism so that the inventory can be kept updated

- raising awareness through the development of communicative materials i.e. posters, leaflets, brochures, TV spots, etc.)

- supervision of e-waste trafficking and shipment in order to serve the purpose.

- taking the most effective steps by the Bangladesh government soon to overcome the existing policy and legislation gaps regarding e-waste.

- like Canada and the USA, the Bangladesh government should introduce the 'National Model for e-waste Stewardship' regarding e-waste.

At present, solid waste management has become one of the biggest challenges for Bangladesh. The emergence of e-waste has also fuelled the problem urging to assess. For the time being, a comprehensive evaluation of the current and future scenario of e-waste and its management, including quantification, characteristics, established disposal practices, environmental impacts, and so on, is needed. To ensure environmentally sustainable e-waste management, institutional infrastructures such as e-waste import, collection, transportation, treatment, storage, recovery, and disposal must be installed at the national and/or regional levels. E-waste collection, trade, and recycling centres should be promoted in cooperation with private entrepreneurs and manufacturers. E-waste policy creation can necessitate a paradigm shift in perception from a waste problem to an opportunity for Bangladesh's green growth. As a result, the implementation of the e-waste policy will necessitate a more personalised approach, in which e-waste is discussed as part of the national development agenda, which includes GEA and SEA as part of national policy planning.

Acknowledgements

References

Ahmed, F.R.S. (2011) 'E-waste management scenario in Bangladesh', in *WEEE/E-Waste Management Workshop on Take-Back System*, pp.13–15, DOI: 10.1515/pesd-2015-0005.

Alam, M. and Bahauddin, K.M. (2015) 'Electronic waste in Bangladesh: evaluating the situation, legislation and policy and way forward with strategy and approach', *Environment, Development and Sustainability*, Vol. 9, No. 1, pp.81–101.

Babu, B.R., Parande, A.K. and Basha, C.A. (2007) 'Electrical and electronic waste: a global environmental problem', *Waste Management Resource*, Vol. 25, No. 4, pp.307–31108.

Chatterjee, S. and Kumar, K. (2009) 'Effective electronic waste management and recycling process involving formal and non-formal sectors', *International Journal of Physical Sciences*, Vol. 4, No. 13, pp.893–905.

Dana, T. (2011) 'Unhygienic living conditions and health problems: a study in selected slums of Dhaka City', *International Journal of Sustainable Development*, Vol. 2, No. 11, pp.27–33.

Gibson, K. and Tierney, J.K. (2006) 'Electronic waste management and disposal issues and alternatives', *Environmental Claims Journal*, Vol. 18, No. 4, pp.321–332.

Habib, M.A. and Kumar, H. (2019) 'India finally has plan to fight air pollution. Environmentalists are wary', *The New York Times*, 11 January [online] https://www.nytimes.com/2019/01/11/world/asia/india-air-pollution.html (accessed 23 June 2021).

Hossain, S., Rahman, M.A., Chowdhury, M.A. and Mohonta, S.K. (2020) 'Plastic pollution in Bangladesh: a review on current status emphasizing the impacts on environment and public health', *Environmental Engineering Research*, Vol. 26, No. 6. DOI: https://doi.org/10.4491/eer.2020.535

Joon, V., Shahrawat, R. and Kapahi, M. (2017) 'The emerging environmental and public health problem of electronic waste in India', *Journal of Health and Pollution*, Vol. 7, No. 15, pp.1–7.

Kannan, S., Misra, D.P., Dvonch, J.T. and Krishnakumar, A. (2007) 'Exposures to airborne particulate matter and adverse perinatal outcomes: a biologically plausible mechanistic framework for exploring potential', *Environmental Health Perspective*, Vol. 114, No. 11, pp.1636–1642.

Khan, M.M. (2009) 'Governance and management of environmental policies in Bangladesh' presented in the *Conference Environmental Policy: A Multi-National Conference on Policy Analysis and Teaching Methods held in KDI School of Public Policy and Management*, Seoul, Korea, 11–13 June [online] http://www.umdcipe.org/conferences/epckdi/18.PDF (accessed 24 June 2021).

Kojima, M., Yoshida, A. and Sasaki, S. (2009) 'Difficulties in applying extended producer responsibility policies in developing countries: case studies in e-waste recycling in China and Thailand', *Journal of Material Cycles and Waste Management*, Vol. 11, No. 3, pp.263–269.

Lawrence, M.G. and Lelieveld, J. (2010) 'Atmospheric pollutant outflow from southern Asia: a review', *Atmospheric Chemistry and Physics*, Vol. 10, No. 22, pp.11017–11096.

Masud, M.H., Akram, W. and Ahmed, A. (2019) 'Towards the effective E-waste management in Bangladesh: a review', *Environmental Science and Pollution Research*, Vol. 26, No. 1, pp.1250–1276, DOI: https://doi.org/10.1007/s11356-018-3626-2.

Ni, H.G. and Eddy, Z.Y. (2019) 'Law enforcement and global collaboration are the keys to containing e-waste tsunami in China', *Environmental Science & Technology*, Vol. 43, No. 11, pp.3991–3994.

Pawar, H., Garg, S. and Kumar, V. (2015) 'Quantifying the contribution of long-range transport to particulate matter (PM) mass loadings at a suburban site in the north-western Indo Gangetic Plain (NW-IGP)', *Atmospheric Chemistry and Physics*, Vol. 15, No. 16, pp.9501–9520.

Rana, M.M., Sulaiman, N.B., Sivertsen, M.F. and Nasreen, S. (2016) 'Trends in atmospheric particulate matter in Dhaka, Bangladesh, and the vicinity', *Environmental Science and Pollution Research*, Vol. 23, No. 1, pp.17393–17403.

Salam, T.H., Siddique, M.N.A. and Alam, A.M.S. (2008) 'Characteristics of atmospheric trace gases, particulate matter, and heavy metal pollution in Dhaka, Bangladesh', *Air Quality, Atmosphere & Health*, Vol. 1, No. 2, pp.101–109.

Shamim, A., Mursheda, A.K. and Rafiq, I. (2015) 'E-waste trading impact on public health and ecosystem services in developing countries', *International Journal of Waste Resources*, Vol. 5, No. 188, DOI: https://doi.org/10.4172/2252-5211.1000188.

Sthiannopkao, S. and Wong, M.H. (2012) 'Handling e-waste in developed and developing countries: Initiatives, practices, and consequences', *Science of the Total Environment*, Vol. 463, No. 1, pp.1147–1153.

Sudipta, C., Javed, S.A. and Biswa, P. (2017) 'Reusing and recycling practice of E-waste in Dhaka City', in *International Conference on Engineering Research, Innovation and Education (ICERIE)*, pp.1–7, *International Conference on Engineering Research, Innovation and Education*, Shahjalal University of Science and Technology, Bangladesh [online] https://www.researchgate.net/publication/314872269_Reusing_and_Recycling_Practice_of_E-Waste_in_Dhaka_City (accessed 23 June 2021).

The Hindu (2016) *India fifth largest producer of e-waste: study*, 15 May [online] https://www.thehindu.com/sci-tech/energy-and-environment/India-fifth-largest-producer-of-e-waste-study/article14340415.ece (accessed 20 June 2021).

Yang, X., Sun, L., Xiang, J., Hu, S. and Su, S. (2013) 'Pyrolysis and dehalogenation of plastics from waste electrical and electronic equipment (WEEE): a review', *Journal of Waste Management*, Vol. 33, No. 2, pp.462–473.

Yousuf, T. and Reza, A. (2011) 'E-Waste management in Bangladesh: present trend and future implication', *Proceedings of 2011 World Congress of International Solid Waste Association*, 17–20 October, EXCO Daegu, Korea. DOI: 10.13140/2.1.3261.7927.