

A Reverse Supply Chain Model For Smartphone E-Waste Management in Bangladesh: Proposing A Closed-loop Framework

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1. Abstract

Bangladesh has a lot of people who use phones over 180 million subscribers according to the Bangladesh Telecommunication Regulatory Commission in 2024. On average people replace their handsets every 2-3 years. There is no system in place to collect, process or get value from old smartphones.

Existing research (Marufuzzaman et al., 2022) showed that the environmental laws in Bangladesh like the Environmental Conservation Act of 1995 the National Environmental Policy of 1992 and the Medical Waste Management Regulations of 2008 are not good enough for dealing with smartphones. These laws have been used informally for electronics. They do not work well. This paper looks at the problem from an angle as a supply chain management issue. It says that laws alone are not enough we need a system to collect take apart and recover value from phones.

This study is based on the idea of an economy that focuses on collecting old phone materials processing them and reusing them instead of throwing them away. We used concepts from closed-loop supply chain theory and the Extended Producer Responsibility model. We also used data from the Bangladesh Telecommunication Regulatory Commission and other sources. We studied how old smartphones are being handled today. We found that if the amount of e-waste, from smartphones keeps growing it could create opportunities in Bangladesh.

We made a forecast model that uses data to predict how much e-waste from smartphones Bangladesh will have by 2030 and how material we can recover from these phones. We proposed a system for handling smartphones a reverse supply chain framework that supports a formal network for collecting and processing old phones. This framework is based on the idea of Extended Producer Responsibility and integrates with existing supply chains.

Our forecast shows that by 2030 Bangladesh could have between 12,700 and 73,400 tons of e-waste from smartphones every year. This e-waste contains a lot of materials like gold, copper and aluminum which can be put back into use instead of being thrown away. We can recover thousands of kilograms of gold and hundreds of tons of copper and aluminum. The paper concludes with a proposed preliminary data collection instrument for future empirical validation of the model.

Keywords: *supply chain, closed-loop supply chain, circular economy, extended producer responsibility, e-waste smartphone recycling.*

2. Introduction

The smartphone e-waste issue in Bangladesh is redefined in this study as a supply chain management (SCM) design issue rather than merely a regulatory one.

Bangladesh has a robust and effective forward supply chain for smartphones, which includes importation, distribution, and sales; however, there is essentially no official reverse supply chain for gathering, disassembling, and repairing phones when their useful lives are up. Because of this disparity, Bangladesh is unable to develop a circular economy for electronics, in which outdated gadgets are recycled into new goods rather than causing pollution. Strong laws are essential yet insufficient, according to this essay. The e-waste policy cannot be implemented in Bangladesh and the circular economy it aims to establish cannot be realised without physical supply chain infrastructure. It's not just a legal gap or lack of knowledge, it's an infrastructure issue and this study treats it as such.

3. Background of the study

The mobile phone market in Bangladesh is growing fast. In 2014 there were 116.55 million connections (Sun, Muntaha, & Hussain, 2016). By 2024 this number had increased to over 180 million (BTRC, 2024). This means the market is growing at a rate of 4.4 percent every year. Even though the market is getting close to being fully grown people are still buying phones and getting rid of old ones quickly. The use of smartphones has also increased a lot. Because of this phones are becoming waste faster than ever.

Every old smartphone has amounts of bad things like lead, cadmium and mercury. They also have valuable metals like copper, gold, silver and aluminum. These metals are mostly found on the phones circuit board (PCB) (Arslan & Arslan, 2025; San et al., 2016). In a system where things are reused these materials are. Reused instead of being thrown away.

In Bangladesh than 80 percent of electronic waste including smartphones is handled by informal scrap collectors. These workers use acid to get metals out of the waste which hurts their health and pollutes the soil and water. The problem is not that people do not know about the dangers of handling waste (Patel, Vasani, Patel, Viradia, & Khan, 2024). The real problem is that there are not facilities to handle the waste properly.

Marufuzzaman, et al. (2022) revealed that the environmental laws of Bangladesh, including the Environmental Conservation Act (1995), National Environmental Policy (1992), and Medical Waste Management Regulations (2008) (unofficially applied to some e-waste), are not adequately covering the smartphone-specific e-waste. They proposed a particular regulatory structure. The government then introduced the Hazardous (E-waste) Waste Management Rules (2021), which replaced the old Factories Act (1965) (Roy, Islam, Haque, & Riyad, 2022).

But new rules on paper do not create collection centers, licence breaking facilities or formal recycling networks.

This is not a problem unique to Bangladesh but it is unusually acute here. In 2022, the world generated approximately 62 billion kilograms of e-waste, or about 7.8 kilograms per person globally (Global E-Waste Monitor, 2024), and it is projected to rise by six percent from 63.3 million metric tonnes to 74.7 million metric tonnes by 2024. In Bangladesh, the total quantity of e-waste, including ship-breaking and other industrial sources, is about 3 million metric tonnes per year and is growing at a rate of about 30 percent per year (Roy et al., 2022) - far above the global average. Growth is being driven by consumer electronics, with mobile phones being the single largest driver of home appliances.

The combination of growth and lack of proper waste handling makes electronic waste from smartphones a big environmental problem, in Bangladesh. As we will see later this also means that there is an opportunity to create value by reusing and recycling these materials. Offering data and insights in real-time that can be used to optimize resource consumption and lower waste.

4. Problem Statement

Bangladesh’s smartphone economy has two stories going in two different ways. Going forward. From buying parts to putting them then getting them out to stores. The process is well developed, tough to beat and works well. Looking back once a phone is done being used that same process ends completely: taking it back sorting it taking it apart and getting the materials back is not done all. This difference between a strong way to get phones out and almost nothing to get them back is the reason for four big problems.

1. Harm to the environment and peoples health. Without options people who recycle in an informal way take metals out using methods that are not controlled using strong acids. These heavy metals pollute the soil, water and air adding a growing problem for workers and the people living nearby.
2. Losing money. Every phone that is thrown away without being taken back has copper, gold, silver and aluminum that leave the country without being used again. In the e-waste problem in Bangladesh the money lost from not taking back these materials is thought to be several million dollars each year (Parvez, 2020 as cited in Roy et al., 2022)—money that a system that reuses things would get back.
3. Rules that can't be followed. The Hazardous (E-Waste) Management Regulations (2021) and the rules before that were made without places to take back the e-waste or places to properly get rid of it. A rule without places to act is just not a real rule.
4. People in the sector are not part of the system. Now the people who recycle e-waste and small businesses in Bangladesh do it all outside the official economy. Without safety rules without paying taxes and, without following the rules. Without a way to become part of a proper system.

5. Objectives:

- To analyze the management of smartphone e-waste within the supply chain in Bangladesh.
- To chart the existing informal reverse movement of smartphone e-waste in Bangladesh.
- Investigate the possibilities of Extended Producer Responsibility (EPR) and the Circular Economy in tackling this problem.
- Exploration of the challenges in combining the circular economy with the current informal recycling sector in Bangladesh.
- Through a structured reverse supply chain framework, identifying ways to address these challenges.
- To analyze the effects of a circular economy model on Bangladesh's capacity for smartphone recycling and material recovery.

6. Future Scope:

After collecting the main information and completing the previously discussed experimental trials, there are five pathways to move towards establishing a circular economy in Bangladesh's electronics industry.

Scaling up on a large scale. The survey and facility establishment plan can be expanded to include larger cities like Sylhet, Khulna, and Rajshahi. A circular economy can only work well when it is widely implemented. If e-waste continues to follow the same old informal path in many cities, a significant portion of the facilities discussed in this research will not be realised.

Expansion to other types of WEEE or electronic waste. Currently, this research has focused only on smartphones, but by expanding the reverse supply chain and EPR framework, other electronics such as laptops, televisions, and refrigerators can also be included. This is beyond the scope of the current research, but a true circular economy should encompass not just phones, but the entirety of household appliances.

Complete optimisation of facility establishment. Instead of the previously used sample-based weights, a fully resolved p-median model based on real geo-coded data can be used. Only when the correct hub locations are identified does a circular economy transform from an idea on paper into an effective system. A supported trial EPR collection facility. Creating a center with a mobile brand and an authorized recycler like Azizu or JR Recycling to validate the earlier mentioned financing assumptions against actual operational expenses is the initial true assessment of the model's financial feasibility. This addresses a primary suggestion of this document.

Extended monitoring of the integration between informal and formal settings. After the implementation of the proposed informal-sector integration framework, it is crucial to track collectors' earnings, security circumstances, and formalization rates over time to determine if the RMG-sector comparison is valid in reality. The circular economy leaves out those who presently engage in this work. It cannot be deemed comprehensive.

7. Literature Review

A study on e-waste policy and environmental framework in Bangladesh

Bangladesh is yet to develop a comprehensive legal and institutional framework for electronic waste (e-waste)

management. Alam and Bahauddin (2015) emphasized the need to develop an integrated e-waste management strategy by evaluating existing laws and policies in Bangladesh (Alam & Bahauddin, 2015). Similarly Marufuzzaman et al. (2022) recommended effective regulatory framework and implementation of Extended Producer Responsibility (EPR) for smartphone e-waste management (MAHMUD et al., 2022).

According to data from the Bangladesh Telecommunication Regulatory Commission (BTRC), the number of mobile phone subscribers in the country is steadily increasing, indicating future growth in smartphone usage and e-waste. The Environment and Social Development Organization (ESDO) has noted in their guidelines that uncontrolled e-waste management poses serious risks to the environment and public health and has provided various guidelines for effective management (shahriar, n.d.). Also, Roy et al. (2022) noted that the Hazardous (E-Waste) Management Rules, 2021 is an important policy initiative but its effectiveness is still limited due to lack of adequate infrastructure, monitoring and implementation (Roy et al., 2022).

Research on reverse supply chain, closed-loop supply chain and circular economy

Guide and van Wassenhove (2009) introduced the closed-loop supply chain (CLSC) concept, where the collection, recovery, reprocessing, recycling and remanufacturing of used products are considered as an integral part of the supply chain (Guide & Van Wassenhove, 2009). Their research is recognized as the theoretical foundation of modern reverse supply chain management.

Patel et al. (2024) showed that circular supply chain management plays an important role in reducing smartphone e-waste and increasing valuable material recovery efficiency (Patel et al., 2024). Similarly Noha et al. (2023) noted that the implementation of circular economy in supply chain in Bangladesh is still a policy constraint, is hampered by technical limitations and lack of coordination among stakeholders (Noha et al., 2023).

Research on smartphone e-waste recovery and economic feasibility

Sun et al. (2016) analyzed the volume of e-waste generated from mobile phones in Bangladesh and the potential for recovery of precious metals from it (San et al., 2016). On the other hand, Arslan and Arslan (2025) showed that with modern recycling technology it is possible to effectively recover precious metals from used mobile phones (Arslan & Arslan, 2025).

Parvez (2020) highlighted the business potential of e-waste recycling industry in Bangladesh (Sarker et al., 2025). In addition, various studies on international metal markets indicate that copper, silver and other precious metals may retain economic importance in the future, making smartphone e-waste recycling more economically attractive (*Goldman Sachs Research: Copper Prices to Decline in 2026*, n.d.; *World Bank Predicts Metals Price Rise in 2026*, n.d.).

A Study on Sustainable Supply Chain Management in Bangladesh

Affan et al. (2024) identified weak policy implementation, limited responsibility of producers and inadequate procurement system as the main barriers to implementing sustainable circular supply chain management in the textile industry of Bangladesh (Affan et al., 2024). Fahim and others. (2024) showed that green supply chain management can play an important role in ensuring sustainable development in Bangladesh's ready-made garment industry (Fahim et al., 2024).

Helal etc. (2024) study found that sustainable supply chain practices have a positive impact on improving environmental performance and strengthening the organization's sustainability activities (Helal et al., 2024). Also, as Dhaka and Chittagong are the largest metropolises in Bangladesh, the need for effective e-waste management infrastructure is greater in these regions, according to Demographic Data/Macrotrends (*Chittagong, Bangladesh Metro Area Population (1950-2026)*, n.d.).

The research gap

When we look at what people have studied we can see that a lot of work has been done on e-waste policy reverse supply chain, circular economy, recycling technology and sustainable supply chain management in Bangladesh (Paramita Sarkar et al., 2025).

Most of these studies only talk about the theory behind recycling technology or circular economy. There is not research that suggests a good plan for managing smartphone e-waste in Bangladesh using a reverse supply chain. This plan should include ways to collect e-waste make companies responsible for the waste they produce involve workers and find ways to recover valuable materials. So the goal of this study is to find a solution to this problem and propose an sustainable reverse supply chain model for e-waste management, in Bangladesh.

8. Methodology

8.1 Research Framework

This research employed a combination of two approaches — a mixed-methods framework. On one side, there is the qualitative aspect, including policy-gap analysis and interviews with experts. Conversely, there exists the quantitative aspect, including e-waste predictions derived from secondary data and initial facility-location

modeling. It is crucial to clarify the current stage of this research. The quantitative projections and gap analysis found on secondary data — sourced from BTRC's subscriber statistics and available e-waste growth-rate studies — and this section is comprehensive. The main survey and expert interviews outlined below are merely proposed techniques for the upcoming stage of this research — they have not been carried out in practice, and this paper does not present any primary survey findings.

8.2 Approach to Data Gathering

The secondary data utilized in this research was sourced from BTRC's statistics on mobile subscribers, earlier peer-reviewed estimates of e-waste in Bangladesh (San et al., 2016; Roy et al., 2022), and data on metal recovery rates from PCBs derived from experimental studies (Arslan & Arslan, 2025). The upcoming primary data gathering will consist of a survey using a questionnaire focused on consumer phone disposal habits and informal recyclers in Dhaka and Chittagong, aiming for around 200–300 participants. This will involve a small number of expert interviews with the Environment Department, representatives from mobile brands, and recycling associations. Table 1 displays the preliminary framework of this survey tool.

Section	Target Respondent	Sample Item / Construct
A. Demographics	All respondents	Age, location (Dhaka/Chattogram), occupation, monthly income bracket
B. Disposal Behavior	Consumers	What did you do with your last discarded smartphone? (sold to informal dealer / stored at home / discarded with household waste / other)
C. Awareness	Consumers	Awareness of hazardous materials in smartphones; awareness of any formal collection option
D. Willingness to Use Formal Channels	Consumers	Willingness to use a brand-operated collection point, and what incentive (cash-back, discount voucher) would matter most
E. Current Practice	Informal recyclers/collectors	Current collection volume, methods used (manual disassembly, acid leaching, etc.), safety practices
F. Willingness to Formalize	Informal recyclers/collectors	Willingness to join a trained, formal network; conditions required (training, equipment, income guarantee)

Table 1. Outline the framework for the survey tool (to be implemented during the main data gathering stage)

8.3 Predictive Model for e-waste Production

San et al. (2016) employed estimation techniques and Roy et al. (2022), utilizing the growth-rate method, this research simulates the yearly smartphone e-waste production in Bangladesh across two scenarios. Each scenario's calculation has been started from the same baseline of 2022 — 9,000 tonnes. This number refers only to the e-waste from mobile phones, and it has been taken from Roy et al. (2022), which in turn was based on the methodology of San et al. (2016).

- In Scenario A, a growth rate of 30 per cent has been assumed. This figure is generally used in the literature for the overall e-waste in Bangladesh.
- In Scenario B, a more cautious annual growth rate of 4.44 per cent has been assumed. This figure has been directly derived from the BTRC subscriber numbers — it has been calculated by comparing 116.55 million subscribers in mid-2014 (San et al., 2016) with 180 million subscribers in 2024 (BTRC, 2024).

When comparing the two scenarios side by side, a range is obtained, rather than relying on a single number, which could potentially be much larger. Scenario A can be considered as an estimate that aligns with the literature, while Scenario B can be regarded as a lower limit, which has been created solely based on actual subscriber growth.

8.4 Conceptual Method for Facility Location

This research states that a p-median or centroid-based method will be used to determine where collection centres will be set up in Dhaka and Chittagong. This method is commonly used in creating logistic networks. The main idea is to place hubs in such a way that the distance from the collection centre to people's homes is as short as possible.

To fully utilise this method at the community level, detailed survey data will be needed regarding where people go to drop off items (drop-off points). In this phase of the proposal, the research has only demonstrated how the method will work, and it has been presented as an example at the city level — results have not yet been provided on the specific locations where the centres

will be established.

For example, after obtaining the data, how weighting will work: the estimated population of Dhaka city in 2024 was 23.9 million, and that of Chittagong was about 5.5 million (Population Information, 2024). From this, a weighting ratio can be obtained — approximately 81 and 19. In this phase, a network of a total of ten collection centres will be created based solely on the population — among these, there will be eight hubs in Dhaka and two in Chittagong. Later, when survey data on ward-level drop-off locations is obtained, the p-median method will be used to determine exactly where the centres will be established.

This proportional distribution is presented solely to demonstrate the weighting logic, it does not represent a site-selection outcome on its own, as the population-only distribution overlooks intra-city travel time variations, income distribution, and the density of current informal collectors to account for all these factors, a comprehensive P-Median model and primary survey were designed.

8.5 Methodological Perspective

This research employs two additional analytical instruments to bolster the study.

The initial element is a matrix for gap analysis. It analyzes how the coverage stated by each current policy aligns with the real supply chain infrastructure required for that policy to function.

The second involves a SWOT / Strategic Fit evaluation. This examines the balance between responsiveness and efficiency in the suggested reverse supply chain model, in contrast to Bangladesh's current forward smartphone supply chain. The findings are presented in Table 2.

Dimension	Assessment
Strengths	Uses the existing reach of informal collectors; EPR shifts the cost to brand owners instead of the government; strong incentive from material value
Weaknesses	Needs behavior change from both consumers and informal recyclers; collection-hub locations are not yet confirmed without primary data
Opportunities	Recent regulation (Hazardous E-waste Rules, 2021) creates a policy window; rising global metal prices make the recovery business more attractive
Threats	Informal workers may resist becoming formal if incentives are not strong enough; moving recovered material in/out of the country needs customs coordination

Table 2. SWOT / Strategic Fit summary of the proposed reverse supply chain model

9. Projected Smartphone E-Waste Production and Resource Recovery Potential

Two growth-rate scenarios are employed to define a reasonable range instead of adhering to one specific forecast. Scenario A utilizes the 30 percent yearly growth rate mentioned in the current Bangladesh e-waste studies (Roy et al., 2022). Since this figure is based on actual waste-stream data instead of just subscriber numbers, it inherently accounts for increasing smartphone adoption and decreasing device-replacement intervals, thus serving as a sensible upper-limit estimate. In contrast, Scenario B is independently calculated for this study as a compound annual growth rate (4.44 percent) based on national mobile-subscriber data, 116.55 million subscribers in 2014 (San et al., 2016) compared to 180 million in 2024 (BTRC, 2024). Thus isolating subscriber growth solely as a lower-bound estimate, without accounting for any effects from reduced replacement cycles. Presenting both scenarios prevent the forecast from being tied to a sole assumption, which literature reviewers might interpret as excessively optimistic or too cautious.

Table 3 and Figure 1 present the predictions for the two scenarios outlined. In Scenario A, the smartphone e-waste output in Bangladesh is projected to rise almost eight times from 2022 to 2030, reaching around 73,416 metric tons per year. In the more cautious Scenario B, this flow would rise at a significantly slower pace to around 12,740 metric tons by the year 2030. This significant difference between the two situations indicates genuine uncertainty specifically, the extent to which this rise in e-waste is attributed to subscriber growth (which is decelerating as the market saturates) and how much is linked to shorter phone switching intervals and greater smartphone usage (which Scenario A implicitly presumes through growth rates detailed in the literature) is not definitively understood.

Year	Scenario A: 30%/yr (Roy et al., 2022)	Scenario B: 4.44%/yr (subscriber-CAGR)
2022 (baseline)	9,000 MT	9,000 MT
2024	15,210 MT	9,817 MT
2026	25,705 MT	10,708 MT
2028	43,441 MT	11,680 MT
2030	73,416 MT	12,740 MT

Table 3. Forecast smartphone e-waste generation in Bangladesh, 2022–2030

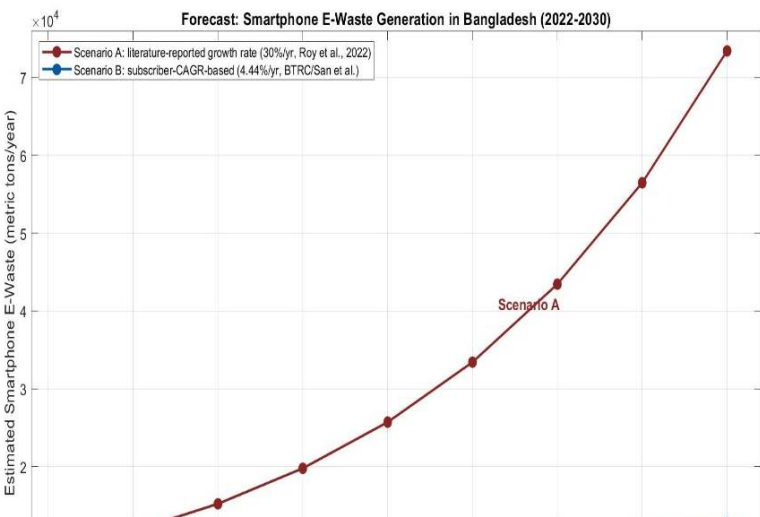


Figure 1: Two-scenario forecast of smartphone e-waste generation, 2022–2030

Using the PCB mass fraction of twenty-three percent as reported by Roy et al. (2022). The per-ton-PCB metal recovery rates from San et al. (2016) Table 4 and Figure 2 convert the Scenario A tonnage forecast into estimated recoverable amounts of gold, precious metals, aluminum and copper for the years 2024 and 2030. In the conservative Scenario B several hundred tons of aluminum and copper each year would still be economically important. In Scenario A the 2030 recovery potential is than three thousand two hundred tons of copper and more than five tons of gold, per year yet none of these metals is being captured in a systematic way today.

Recovered Material	2024 Estimate (tons/year)	2030 Estimate (tons/year)
Gold	1.08	5.23
Precious Metals (Pt + Pd)	0.33	1.59
Aluminum	507.8	666.5
Copper	666.5	3,216.9

Table 4. Estimated Annual Material Recovery Potential (Scenario A)

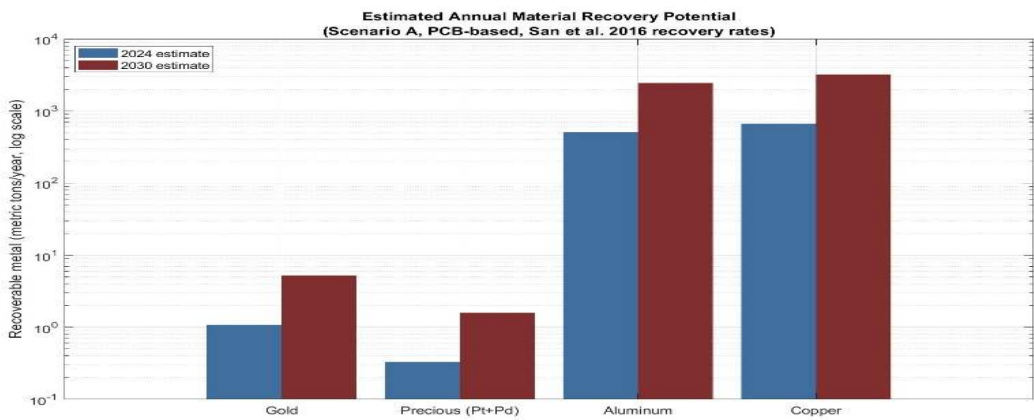


Figure 2: Estimated material recovery potential, 2024 vs. 2030 (log scale)

10. Financial viability of material recovery

To address research objective (an initial assessment of economic viability), Table 5 translates the material recovery estimates from Table 2 into projected market values, utilizing commodity prices from early 2026: gold spot prices are roughly \$5,150 per troy ounce (Money, 2026), while platinum and palladium spot prices average near \$1,928 per ounce (Money, 2026), and LME benchmarks for industrial metals show copper at about \$12,000 per tonne and aluminum at around \$3,150 per tonne (Goldman Sachs Research, 2026; Recycling Today, 2026).

Material	2024 est. value (USD)	2030 est. value (USD)
Gold	\$178,822,319	\$865,963,638
Precious metals (Pt+Pd)	\$20,450,271	\$98,533,123
Aluminum	\$1,599,570	\$7,720,335
Copper	\$7,998,000	\$38,602,800
Total (Scenario A)	\$208,870,160	\$1,010,819,896

Table 5. Estimated annual market value of recoverable material (Scenario A, early-2026 prices)

The projected value for 2030 is approximately US\$1.01 billion — this closely aligns with an independent estimate found in the literature. Roy et al. (2022) independently estimated that a business model for PCB-based metal recovery involving mobile phones and computers could reach approximately \$1 billion per year by 2030. The smartphone-only estimates in this study come from an entirely separate source — forecasts of subscriber-driven tonnage, rather than direct business-model assessments. The similarity in the results from these two distinct methods, being of the same order of magnitude, provides a helpful, although unofficial, cross-validation of the overall opportunity scale — despite the fact that the two studies are not directly comparable.

Gold represents the majority of the total value, despite being just a tiny portion of the total amount retrieved — aligning with the familiar "urban mining" insight that discarded electronics are thought to contain a significantly greater concentration of gold than traditional ore from regular mining.

11. Suggested framework for reverse supply chain

Figure 3 illustrates the suggested reverse supply chain framework. The primary objective of this model is to establish a circular economy, where raw materials from outdated smartphones re-enter production, completing the cycle, without turning into waste. Consumers send back their old smartphones at brand-operated or retail collection points that function under EPR (Extended Producer Responsibility) rules indicating that the expense and duty of collection are borne by the manufacturer or brand instead of the government or the informal sector. Retrieved devices are sent to a sorting and grading facility, where they are classified those that can be fixed and resold, and those that are only fit for material recovery. The devices then proceed to an official dismantling plant, which engages in a distinctly reciprocal relationship with a trained informal collection network — instead of aiming to eliminate informal participants, this approach formalizes and trains them, integrating their current collection abilities into a controlled system. Recovered metals (copper, gold, silver, and others) enter a material recovery phase, which, in essence, can supply raw materials for local or regional manufacturing — this represents the point of closing the loop. This changes the model into a real circular economy.

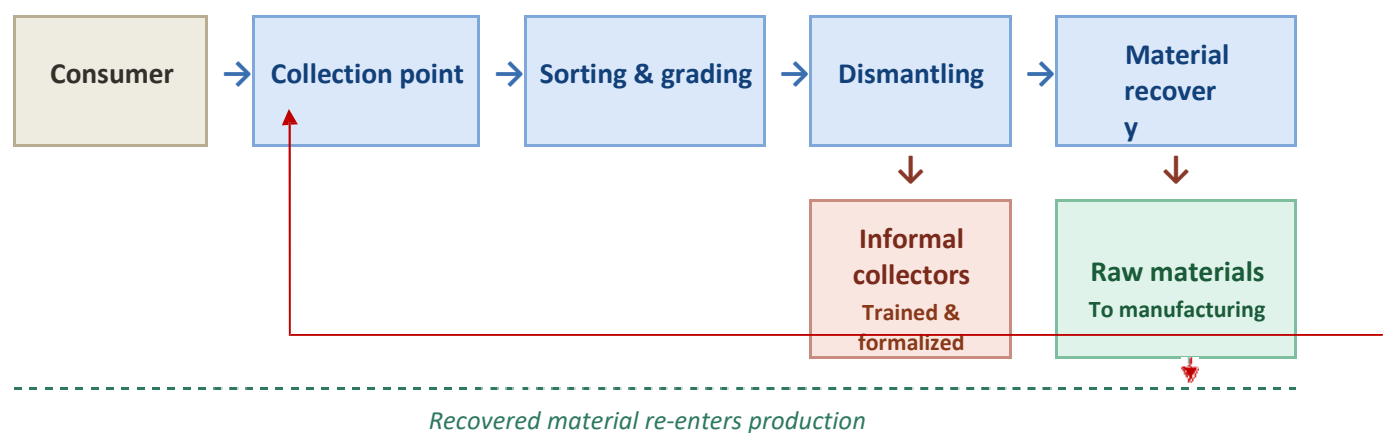


Figure 3: Proposed Reverse supply chain network

11.Case Studies

11.1 Sustainable E-Waste Recycling Abilities that was developed for Azizu Recycling & E-Waste Firm:

Azizu Recycling & E-Waste Firm is one of the certified e-waste recycling firms in Bangladesh. In partnership with Singapore’s TES-AMM, the firm was founded in 2013. The services that is offered here are e-waste collection, disassembly, secure data destruction and eco-friendly recycling services.

7000 metric tonnes of electronic waste can be handled by the plant. But now, at present 30% of the potential can be utilized by them. Ineffective collection system throughout the world is the problem not the technical issue stated by the organization. Informal gatherers collect majority of the e-waste and they fail to arrive at official recycling stations.

Several corporate entities, telecommunication firms and government organizations are addressed by Azizu by implementing an e-waste collection initiative. Eco friendly recycling, recovery of precious metals and raising public awareness is involved with the organization in addition to e-waste collection initiative.

Bangladesh possesses advanced recycling technology and accredited organizations which was demonstrated by Azizu’s experience. However, because of the absence of a functional reverse supply chain and collection network, these institutions’ capacity is not being fully exploited. Thus, the EPR-based Reverse Supply Chain Framework suggested in this research focuses on addressing the vulnerabilities of the current procurement system.

Significant Projects of Azizu Recycling

- Official e-waste collection: Gathering of e-waste from businesses, factories, and residential areas.
- Safe Data Disposal: Safe elimination of private and sensitive data on electronic devices.
- Eco-friendly recycling: retrieval of valuable metals and secure disposal of harmful substances.
- Corporate Partnerships: Collaborative e-waste management with different telecom and industrial firms.
- Resource recovery: Copper, aluminum, plastic, and various valuable materials are reclaimed and utilized in reproduction.

Azizu Recycling-Advantages of its operations

- Decreases environmental pollution resulting from unofficial recycling practices.
- Extracting valuable metals from electronic waste generates economic benefits.
- Aids in the adoption of Circular Economy in Bangladesh.
- Stresses the significance of maximizing the use of current capacity instead of constructing new recycling facilities.
- Encourages sustainable resource utilization and environmentally friendly industrial development.



SOURCE: <https://www.tbsnews.net/bangladesh/azizu-recycling-turning-e-waste-economic-value-1175591>

11.2 JR Recycling Solutions Ltd: Eco-friendly electronic waste management via public-private collaboration

JR Recycling Solutions Ltd is a significant recognized e-waste recycling firm in Bangladesh. The organization engages in environmentally sustainable e-waste recycling efforts and is partnering with the government to enforce the Hazardous (E-Waste) Waste Management Rules, 2021.

Although the collection system is the problem for Azizu Recycling JR Recycling says the main issue is the slow progress of policies. The group says that even though they have the technology and skills official recycling programs are not moving forward the way they should because of delays in how the laws are enforced. 97% of electronic waste in Bangladesh is still managed by people who are not officially registered. This means that getting metals collecting money for the government and recycling in a safe way all suffer big losses. JR Recycling experience shows that just having laws is not enough. It is also important to have implementation, proper control and a strong system, for taking back used products. The study then provides ideas for improving the system and making policies work better.

Significant Projects of JR Recycling

- Public-Private Partnership (PPP): Involvement in executing the National E-Waste Management Policy.
- Eco-Friendly Recycling: Carry out recycling operations in accordance with national and global standards.
- Secure Material Recovery: Reduce environmental contamination while retrieving precious metals.
- Quality assurance and certification: Adhere to global standards for environmental and quality management.
- Encouraging eco-friendly recycling: Focus on enhancing official recycling programs.

Operations of JR Recycling's facilities

- Helps in the execution of Hazardous (E-Waste) Waste Management Regulations, 2021.
- Guarantees safe and eco-friendly recycling of electronic waste.
- Decreases dependence on unregulated and hazardous recycling.
- Improves collaboration among public and private organizations. Stresses the significance of a successful reverse supply chain and execution of policies.



SOURCE: <https://news.mongabay.com/2022/10/bangladesh-e-waste-rules-hang-in-limbo-as-electrical-goods-companies-ask-for-delay/>

12.Limitations:

- Owing to limitations in time and resources, the suggested main survey is confined to Dhaka and Chittagong exclusively. It doesn't include the whole nation.
- The earlier forecast relies on secondary data rather than any actual measurements. Once primary data is gathered, it needs to be validated.
- Gathering trustworthy data from the informal sector poses challenges due to its unregulated and mostly undocumented nature, even though certain precautions are incorporated into the survey design.

- The suggested reverse supply chain model remains in its conceptual phase. An extensive pilot project and complete evidence of the effectiveness of the circular economy lies outside the parameters of this study.
- Metal prices utilized for determining recovery values indicate market conditions from early 2026, and they're shifting rapidly. The future value will rely on the metal's price at that moment.

13.Conclusion:

This study shows how smartphone e-waste's managed right now in Bangladesh and suggests a model based on a reverse supply chain. Research has found that the amount of e-waste is growing a lot because more people are using smartphones in the country. However, there is still no system in place for collecting, sorting and recycling e-waste. Because of this most e-waste is handled in a way leading to pollution, health dangers and loss of important metals. The study shows that managing e-waste can be more sustainable if a good reverse supply chain is set up along, with circular economy ideas and extended producer responsibility rules. At the time it is possible to save useful resources, protect the environment, create economic benefits and help the country develop in a better way.

14.Recommendation:

- Establish a reverse supply chain by setting up enough e-waste collection centers across Bangladesh.
- Extended Producer Responsibility (EPR) policy will work best when manufacturers and importers are required to collect and recycle used smartphones.
- Informal e-waste collectors need to be incorporated into recycling programs and provided with training, protective equipment, and monetary incentives.
- Cooperation among the government, phone manufacturing, recycling companies and associated organizations is essential for proposed model to succeed.
- Campaigns and educational initiatives should be organized to inform individuals about the impact of appropriate management.
- Investment from both public and private sectors is necessary in contemporary, environmentally friendly recycling technologies collection systems and infrastructure.
- Extensive surveys need to be conducted in various regions of the country. Implementation efforts at the level should start by evaluating the effectiveness of the suggested reverse supply chain model through pilot projects and empirical studies.

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