E-waste Management and Recycling Model for Dhaka with Collection Strategy Application: A More Effective and Sustainable Approach

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E-waste Management and Recycling Model for Dhaka with Collection Strategy Application: A More Effective and Sustainable Approach

Md. Nazmus Sakib[1], Md. Mainul Hasan[1], Anika Faiza[1], Shahinur Rahman Nova[1], Ahmed Wasif Reza[1(✉)], and Mohammad Shamsul Arefin[2,3(✉)]

[1] Department of Computer Science and Engineering, East West University, Dhaka 1212, Bangladesh
wasif@ewubd.edu
[2] Department of Computer Science and Engineering, Daffodil International University, Dhaka, Bangladesh
sarefin@cuet.ac.bd
[3] Department of Computer Science and Engineering, Chittagong University of Engineering and Technology, Chattogram, Bangladesh

Abstract. E-waste, which contains chemicals and metals, is a term used for abandoned electronic devices. The increasing use of electronic devices has made it difficult to handle the enormous volume of e-waste due to a lack of a strong organizational and governmental e-waste management infrastructure in developing countries. To reduce the harm to the environment and human health, scientific methods must be used for e-waste disposal. The Azizu Recycling and E-waste Company Ltd.'s recycling and management models have been analyzed and compared, and a new model with an environmental pollution control system, sustainable reuse plan, detailed recycling process, suggested landfill away from residential areas, and an app system for e-waste collection has been proposed.

Keywords: Electronic gadgets · e-waste disposal · Recycling · Effective execution

1 Introduction

E-waste management involves collecting, recycling, and disposing of e-waste safely to minimize its negative environmental impact. Electronics contain hazardous compounds that can harm human health if they are not properly handled. These compounds can enter our bodies through air, land, and soil, causing harm over time. [1]. The groundwater quality is declining, and it is consumed by humans and animals, which poses health risks [2].

The production of electrical and electronic waste in the country is increasing due to the fact that not all imported or domestically produced electrical and electronic products are made with environmental protection in mind [3]. Separation can be done manually or semi-mechanically in the factory. The local firm Azizu Recycling and E-Waste Limited

collects e-garbage from institutions and waste collection vendors and recycles it to a high standard by separating large aluminum, copper, steel, rubber, and plastic pieces and supplying them as raw materials to other businesses [4].

In our findings, the general public is unconcerned about the dangers of inappropriate e-Waste disposal [5]. The recycling industry in Bangladesh is not paying sufficient attention to hazardous electronic waste imported for reprocessing. There are no scientific studies on IT waste management or systematic research on e-waste management in Bangladesh [6].

Our research objectives are as follows:

  i. To identify the main shortcomings in Bangladesh's e-waste management and recycling process,
 ii. To analyze the existing model to find out the drawbacks,
iii. To propose a more efficient and green model based on comparison data analysis.

This study investigates industrial activities, E-waste practices, and disposal systems in Dhaka to eliminate inappropriate E-waste management structures. It examines the handling of electronic garbage in Dhaka and the trading of improperly treated electronic trash in underdeveloped nations. The study analyzes how various firms manage waste from outdated and worn-out machinery, computers, and other electronic gear, and describes the harm done to the environment and public health. The study is based in Dhaka, Bangladesh, and would be based on observations of the context for the management of E-waste in Bangladesh.

2   Literature Review

The country's registered electronic waste producers and recyclers are required to submit their WEEE management plans, according to the law [7]. The Department of Education held a consultative session on Bangladesh's e-waste management on January 9, 2022 [8]. As many as 92% of businesses agreed with the statement that "We must take a serious view on ensuring that all devices used to equip the workforce throughout the COVID-19 pandemic are appropriately stored and disposed of [8]. The Bangladesh government released "Hazardous Waste (e-waste) Management Rules 2021" on June 10, 2021, to regulate e-waste. E-waste is categorized into six categories, including cooling and freezing devices, televisions, monitors, laptops, notebooks, and tablets, under the Bangladesh Environmental Protection Act of 1995. [7]. The papers [9–18] provided different guidelines and solutions.

Rapid technology advancement results in individuals discarding numerous electronic devices daily, posing a risk to human health due to harmful chemicals, including lead, mercury, and chromium, in e-waste during collection and unprocessed recycling.

3   Materials and Methods

3.1   Data Collection Plan

Our research goal is to propose a new model that is more effective and efficient. The proposed model would be achieved by reducing the cost of waste management and improving the effectiveness of the recycling process.

For our research, we need quantitative data to calculate the present and proposed costs of waste management and recycling to validate our model. We'll obtain the current waste management model by visiting recycling industries in Dhaka and gathering online data.

We planned to conduct an interview with industries we prepared some questions to ask. The questions are:

(i)   How do they collect E-waste?
(ii)   How we could improve the collection method?
(iii)   How much does it cost for the whole process of e-waste collection and management?
(iv)   In what condition do they consider items to recycle?

3.2   Research Process

This study targets to fulfill the objectives mentioned. To solve all the problems it uses both qualitative and quantitative data. Qualitative data will be used to propose a new efficient model and quantitative data will be used to justify our proposed model. Our research process is given below in a flow chart (Fig. 1):
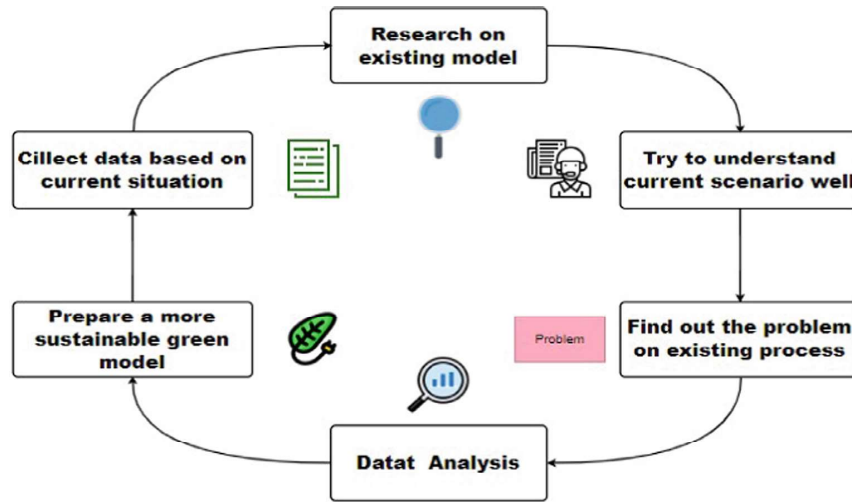

Fig. 1. Research process

The figure shows the research process: collecting and analyzing data on the current E-waste management system to identify its shortcomings, then proposing a more eco-friendly model.

3.3 Data Analysis

The waste stream method was used to estimate waste generation, with consent forms provided to stakeholders, and is based on certain factors, following factors are:

 (i) Total population
 (ii) Stock data
(iii) Products average weight

$$electronic\ waste\ generation\ in\ a\ region = \frac{Total\ Amount\ of\ Electronic\ Waste}{Total\ population\ in\ that\ region} \quad (1)$$

After getting the e-waste generation amount this will impact our proposed result.

4   Results and Discussion

Our analysis shows few concerns about improper e-waste disposal and challenges faced by recyclers. We collected data from field trips and developed sustainable models to improve e-waste management, including landfilling and promoting repair and reusability.

4.1   Recycling Procedure

This is the current scenario of the recycling process of a renowned recycling company which is located beside Dhaka city. Most of the e-waste collected from Dhaka and all over the country is being recycled through this process.

In Fig. 2, the company collects the e-waste. Then they send it to the plant. The company recycles the waste and distributes it to the manufacturers. After the distribution and manufacturing process, the leftover e-waste goes to the recycling plant again. The manufacturers provide the end product to the sellers and the sellers sell them to corporate and household consumers. In the waste collection step, the e-waste which is possible or profitable to recycle goes to be landfilled.

The current model provided and described by recycling companies does not have that kind of effect on environmental and reusability plans. So, we proposed a model which will ensure the reusability plan with environmental safety.

In Fig. 3, the reusability of the products will be checked. If it is ready to repair then will be sent to the recovery section, if not then it will step forward into the next procedure of recycling. The scrap-breaking and pellet-producing section can produce tiny particles of plastics which can pollute the air. A melting furnace does the same. So, recycling companies must ensure environmental safety measurements during the breaking and melting process. For this, they have to set up EPCS (Environment pollution control system) in their facility. This system will purify the air before releasing it into the environment. In this recycling model, green methods like Hydrometallurgical, Pyrometallurgical, and Electrometallurgical were also proposed to make the model greener and environmentally friendly.
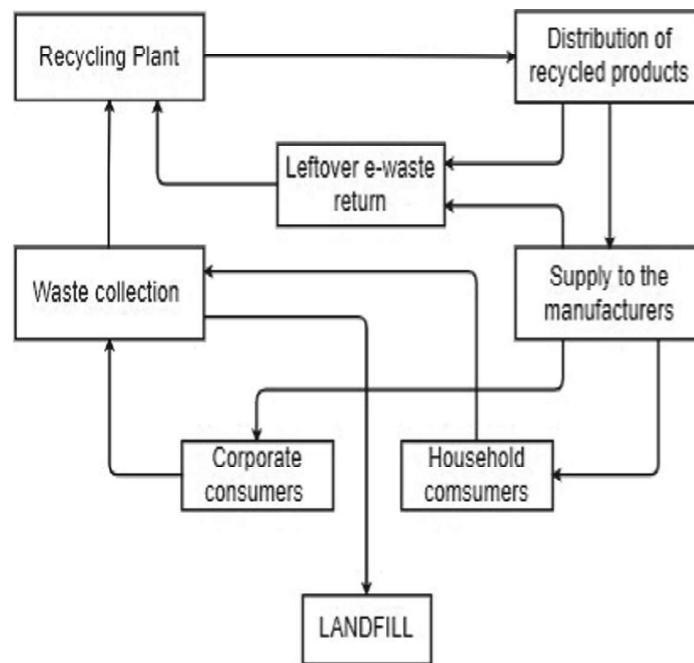
Fig. 2. Current recycling procedure of Azizu

4.2 E-Waste Management

From the collected data we tried to analyze the current situation of e-waste management around Dhaka city. Based on that we draw a process flow model which is shown below.

In Fig. 4, Small scrap dealers gather the e-waste from many sources. The garbage is then sent to the major scrap merchants. Sometimes they sell the electronic parts to the neighborhood repair shop before mailing them. Then, the big scrap dealers provide the recycling businesses with e-waste as the raw material. A part of the garbage that cannot be recycled by recycling firms is exported because of their limited recycling capacity. The businesses recycle the remaining garbage. After recycling, certain e-waste components remained that could no longer be recycled. These parts are disposed of at the disposal facility. The dumping station authority disposes of e-waste in the same manner as they dispose of domestic rubbish. They sometimes set fire to them, causing deadly environmental damage.

By reviewing the pre-mentioned current model, it is easy to notice the absence of some important steps like uninterrupted e-waste collection, repair ability, and safe disposal. In this proposed model we have added these to make the model more acceptable.

In Fig. 5, we proposed to set up a central collection point where the recycling companies will be able to collect the waste easily. Another shortcoming is the absence of a proper repair and reusability plan. We also mentioned it too where only the expert and trained employees will repair the usable products under certain safety measurements. A common mistake is being occurred in the safe disposal section of e-waste. Landfilling
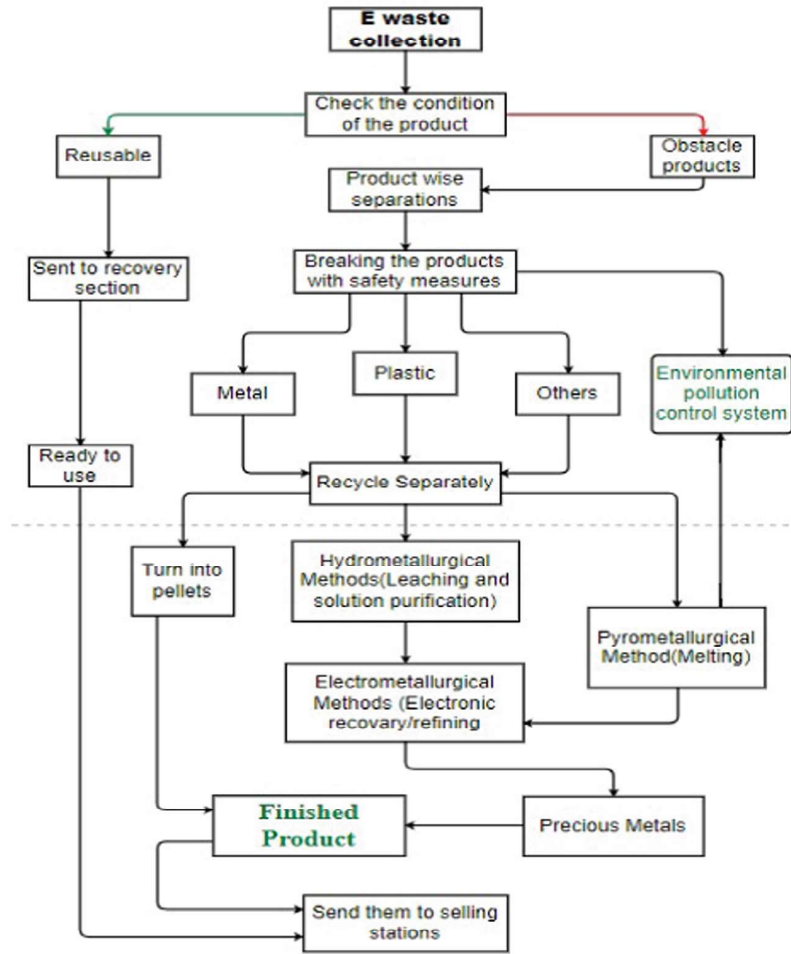
Fig. 3. Proposed model to recycle e-waste effectively

can be a good option to bury the useless e-waste particles which have also been suggested in this model.

4.3   Analysis and Comparison Current and Proposed Model

A detailed comparison between the existing and proposed framework of the e-waste management system and recycling process is given below.

In this Table 1, we identified some comparison issues through which we performed a detailed comparison between the existing and proposed framework of the e-waste management system and recycling process. In the recycling process comparison, we picked up Environmental pollution control, Reusability plan, and Separate recycling to compare the existing model with the proposed one. The management system needed
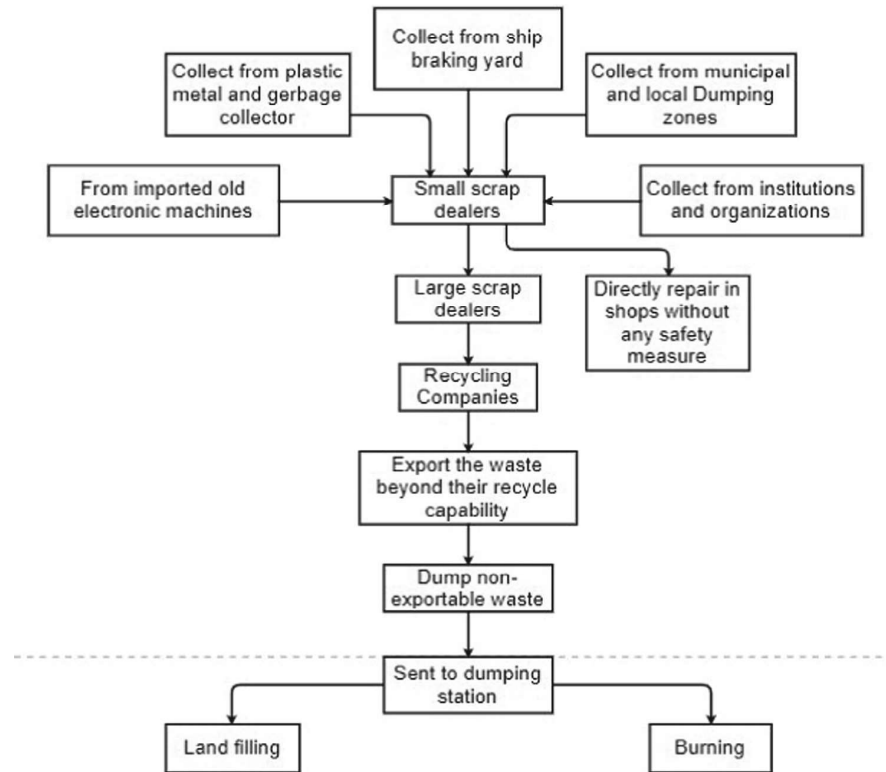
Fig. 4. Current e-waste management process of Dhaka

safe disposal, effective e-waste collection, and repair with experts to make a meaningful comparison.

4.4 Waste Collection

Most people do not know the bad effects of E-waste. The e-waste management system is not so easy though. And also people do not want to waste time on recycling because they are not getting any rewards for it. After analyzing all the collected information, we have designed the current waste collection process which is given below:

In Fig. 6, there are four stakeholders who are engaged in e-waste management. All do their task asynchronously but as they do not have a sequential connection with each stakeholder to the other that's why we can see there are two-time gaps in the model. In that time gap, e-waste pollutes our environment a lot. That's why in our to-be model we tried to remove that time gap.

After analyzing all the shortcomings, we have designed a proposed model of the waste collection process which is given below:

In Fig. 7, the proposed model our basic stakeholders are The mobile application, the User, and Recycle Company. The customer will post about their e-waste through
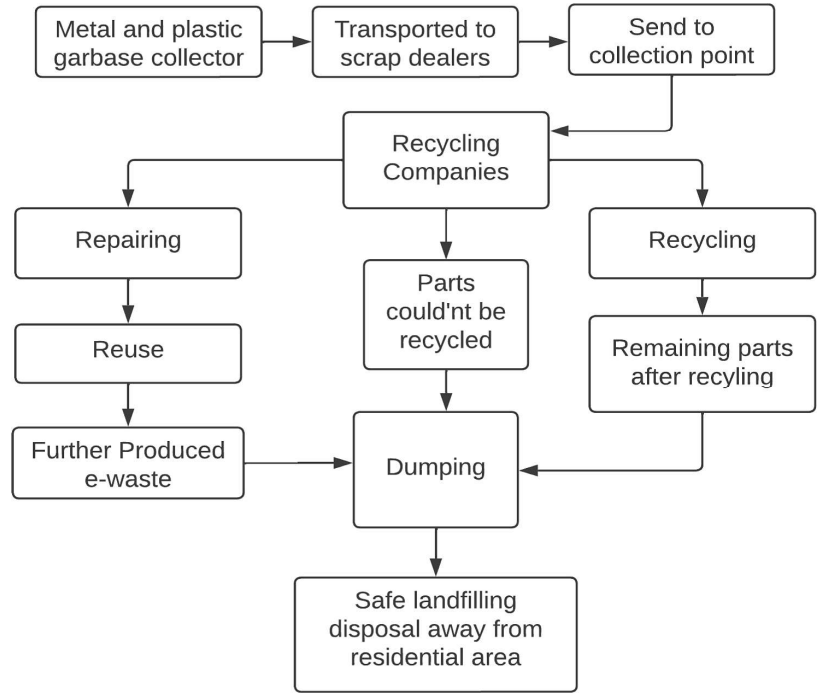
Fig. 5. A proposed e-waste management system for Dhaka

the application. On a scheduled date and time the company can plan to collect all the e-waste area-wise.

Analyzing waste collection through the application, we find that most of the waste comes from households, so conducted an interview with households of different sizes regarding their concerns about e-waste management.

From the Table 2 we can see the number of participants from different sizes of families.

The responses of the participants are given in the Table 3.

From the Table 3 we can see that most of the respondents do not manage the e-waste properly the mentioned reason is the difficulty they face in managing e-waste, 20% think that the current management system is easier, but 90% of the respondents agreed that mobile application can make it easier for them to manage the e-waste properly. That is why we developed a mobile application for e-waste management which will make e-waste management easier.

4.5 Interface of Application

The amount of e-waste is increasing day by day. As the number of e-waste is increasing vastly so if we can make the e-waste management system a little more environmentally friendly then it will impact huge in the future. To make the management system we have

Table 1. Analysis and compare between existing and proposed model

Recycle	Issues	Existing	Proposed
	Environmental pollution control system	The system is absent in the exiting model	Proposed to set up EPCS in the facility
	Reusability plan	The current model does not have a proper reusability plan	Provided a sustainable reusability plan
	Recycle separately	Not mentioned in the model	Shown detailed process
Management	Safe disposal	Follow the traditional burning system	Landfilling away from the residential area
	Effective e waste collection	They do not have any collection point	Proposed to set up collection points and develop app system
	Repair with experts	Directly repair in shops without any safety measure	Will be repaired by experts with safety measure in repairing facility

developed an Android Application using which the house owner easily can contact the recycling companies. The interface of the application is given below:

In Figs. 8 and 9, we can see that users can post their waste details on the app, and the company owner will get notified with location details. They can collect waste from area to area as they have data on the house no, area no of the customers. The recycling companies can manage events in different areas to collect the e-waste through the application. The customers can get a reward in money for the e-waste or they can donate it.

By using the app we can make the e-waste collecting process more efficient and environmentally friendly. As we have seen that e-waste is increasing day by day. After using the app the e-waste collection will be very easy and the time gap will be removed.
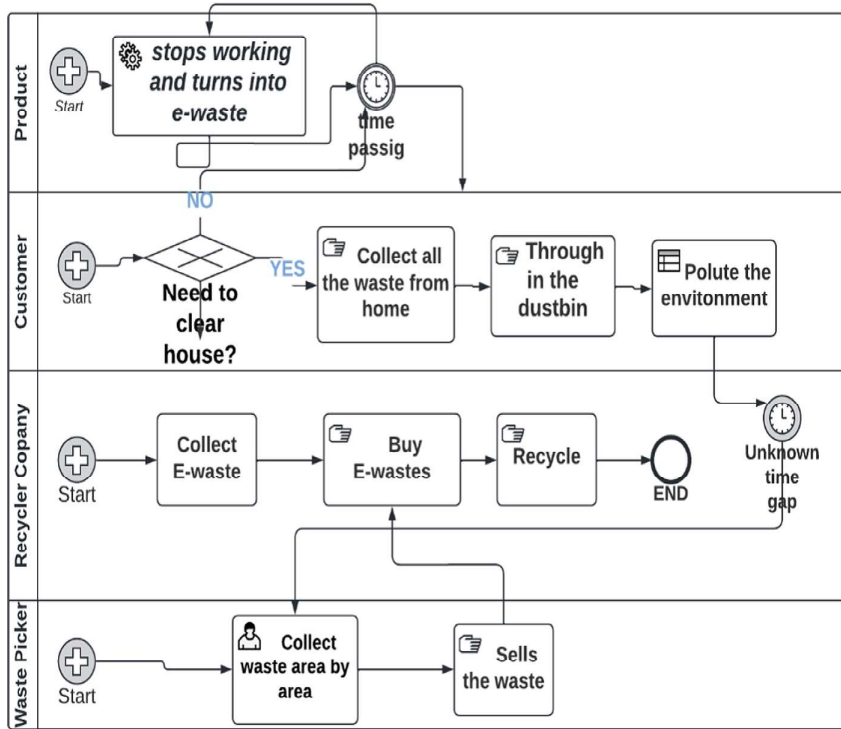
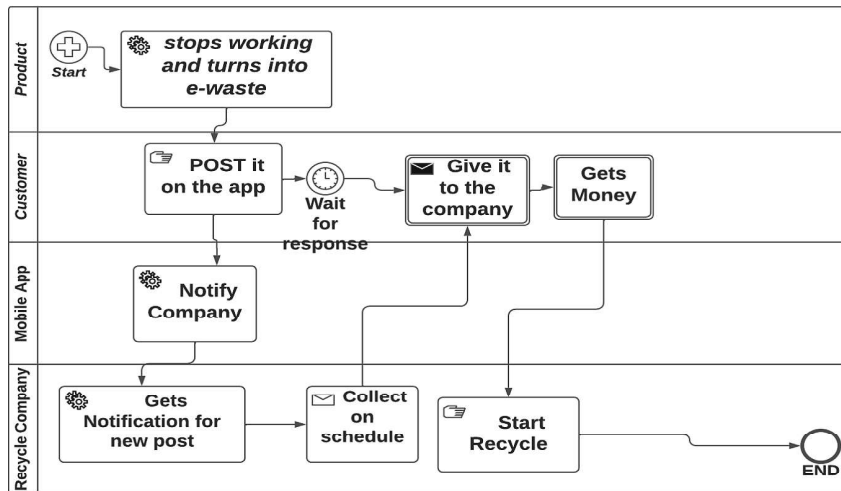**Fig. 6.** Current model of the waste collection process

Fig. 7. Proposed model of the waste collection process

Table 2. Family size of the respondents

Sl. No.	Particulars	No. of members	No. of respondents	Percentage
1	Small family	2	3	30
2	Medium family	Between 2 and 5	4	40
3	Large family	More than 5	3	30
Total			10	100

Source Primary data

Table 3 Responses from the respondents

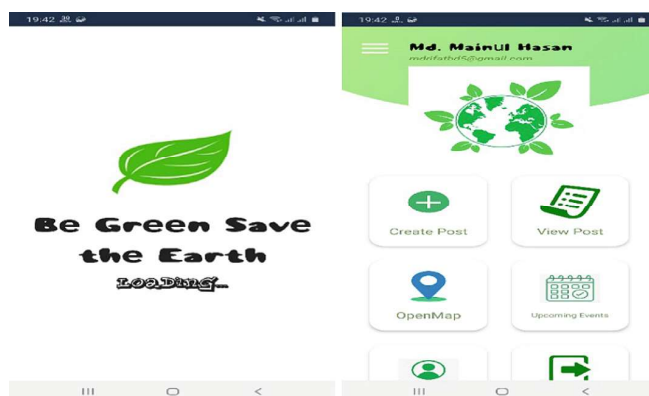| Questions	Yes (%)	No (%)
Do they manage e-waste properly?	40	60
Does the current management system is easier for them?	20	80
Can a mobile application make it easier to handle and connect them with recycling companies?	90	10

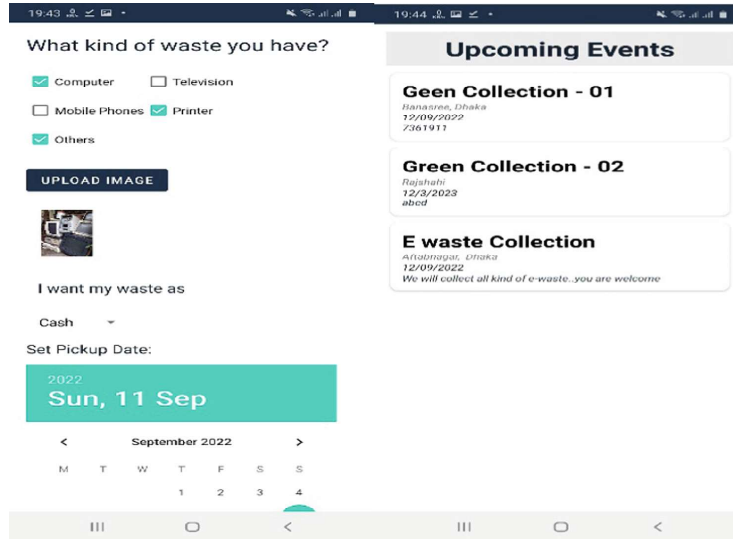**Fig. 8. a** Splash screen **b** dashboard

Fig. 9. a Create post **b** upcoming events

5   Conclusion

The study's only goal was to find a sustainable method of Dhaka e-waste treatment and compare the suggested model to the present paradigm. The current model has some flaws. As a result, the suggested model's faults are fixed. The proposed models are effective and sustainable models for recycling and e-waste management. We have also developed an application for waste collection which will help save time and make the environment less polluted. The recycling of obsolete electronic equipment is critical, but it must be done in a secure and uniform manner. It is unavoidable to improve working conditions for all e-waste company employees. Tons of e-waste are wasted every year, and the situation is only growing worse.

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