

An Automated Waste Management System in Dhaka City

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Abstract

The lack of an ecologically friendly waste management system could be a major concern for Bangladesh. According to Climate Justice, the Vancouver BC space alone might accomplish the goals of reducing generation and more energy-efficient recycling and composting leading to 6.2 million tons of CO₂ savings by displacing organics from disposal and processing activities by 2040. The required landfilling zone is expanding relatively with a massive expansion of waste. The authorized zone for the landfill was predicted to reach 206.31 acres to 309.46 acres by 2020, with a collecting proficiency of 50 percent to 75 percent [1]. In spite of the fact that we perceive waste as a redundant matter with no financial worth irrespective of the time or season since there is no market need for this kind of product. However, it is consistently documented erroneously by properly reusing and recycling garbage. The purpose of this paper is to automate the waste management system in such a way that it leads to various ways and means of converting the waste into resources while also removing the issues that come with it. This paper focuses on the automated waste management system with control ability by a web application remotely with the integration of sensors, cameras, and processing units. This solution, methodology, and implementation have been a demand of the time to the problem and at the same time to demonstrate maximizing waste recycling utilization. The goal is to illustrate how such a system can significantly reduce the environmental impact of waste, optimize resource recovery, and establish a scalable model for managing urban waste management in the metropolis like Dhaka. This research also aims to offer a comprehensive framework for the real-world application of intelligent waste management techniques.

Index Terms: Sensor, Waste Management, Automated Waste Management, Municipal Solid Waste, STS, Mistreated Waste, Web-based Waste Management System, E-waste Management

Introduction

The management of municipal waste is one such core urban fundamental service that impacts a city's public health and environment. This waste management is one of the top immediate and consequential problems of Dhaka City Corporation. City corporations or municipalities are in charge of the management of municipal solid waste (MSW) in Bangladesh, reporting to the ministry of local administration authorities and the engineering department in each large urban area or metropolitan [2]. Dhaka City Corporation (DCC) is in charge of collecting, transporting, and disposing of MSW in Dhaka's 92 legislative regions known as 'wards'. However, despite several initiatives undertaken by the two municipal corporations, Dhaka's solid waste management system has witnessed no significant improvement in recent years.

Following the establishment of the Dhaka North City Corporation (DNCC) and Dhaka South City Corporation (DSCC) in December 2011, authorities aimed to transform the city into a clean, liveable, smart, and digital metropolitan. MSW collection, transportation, and disposal in Dhaka city are also separated into DNCC with 36 wards and DSCC with 56 wards [3]. Both municipal corporations have launched actions to mitigate solid trash using innovative ways in partnership with overseas donor agencies and the Local Government Division.

DNCC and DSCC generally dispose of solid wastes collected from homes or big garbage containers at dump stations and then at two landfills in Aminbazar and Matuail. Even after using the typical landfill procedure, they are unable to intergrain solid waste. Now open dumping is practiced there.

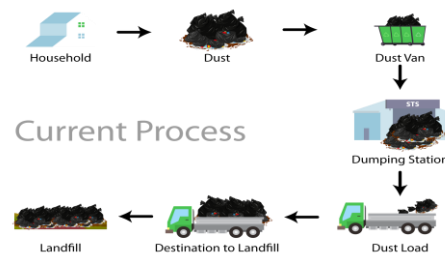


Fig. 1 Existing Waste Collection and Processing Method

Landfills emit millions of tons of methane each year in the United States due to biodegradable wastes like yard clippings, paper, wood, and majorly foods, according to research conducted by Uisung Lee of the Department of Energy (DOE) Argonne National Laboratory [4]. This is due to the presence of enormous amounts of methane in landfill gas, which has a 30 times greater global warming impact than carbon dioxide. It's a challenge that necessitates effective strategy, cooperation, management, and a far-sighted recycling scheme. We are going to introduce a smart waste management system with a recycling scheme.

Data on garbage collection efficiency varies from 37% to 77%, with an average of 55% in various urban areas of Bangladesh [5]. When waste is not collected properly, it will be unlawfully disposed of and this could posture a genuine warning to public health through pollution of the surface and the environment.



Fig. 2 Existing waste management systems' flow [6]

We are going to implement an automated system to reduce waste from the urban environment and to go a step forward to achieve the Agenda of 2030 for Sustainable Development Goals (SDGs) of the United Nations [7]. This smart trash bin (dump station) implementation is based on AI. A CC camera or sensor can notify the system about the current situation of the bin. Thus authorities will monitor the timely trash collection with separate polybags timely or before people's working hours and could help the collector(Truck driver) to choose the fuel-efficient route for the garbage truck to the landfills and then the organic wastes to the recycle station according to the volume of the dump in the stations.

OBJECTIVE

Energy availability has a significant impact on economic and social growth including living standards in the community. Since Bangladesh is an energy- dependent country, a rise in power generation benefits economic development. Under these circumstances, ensuring 100 percent municipal waste collection and recycling of those wastes to generate energy can be a feasible alternative and renewable energy-producing solution by replacing renewable energy with fossil fuel electricity, this method will even keep away large GHG emissions. Furthermore, the implementation of this automated waste collection method with the WtE strategy will aid Bangladesh in its progression to a zero-waste society and the adoption of the principle of circular economy nationwide.

This paper specifically aims to design and propose a smart waste management system for Dhaka city that integrates these principles, focusing on practical implementation strategies and their potential impact on the urban environment. It seeks to address current challenges while providing a roadmap for sustainable waste management and energy production.

LITERATURE REVIEW

According to a study on social awareness of recycling programs in Kota Bharu, Kelantan Malaysia presents that among 384 participants only 31.8 percent were participating in recycling [8]. This demonstrates both that the initiatives taken formerly have now no longer been effective and that automated waste control is required to be advanced to update the prevailing infrastructures. IoT advancements have allowed it to be possible to automate the existing waste management system in many countries.

Waste control is an expensive operation as it involves masses of resources and manpower. Efforts had been taken via means of the authorities to enhance waste control structures through the inauguration of recyclable bins and launching the 3Rs campaign (recycle, reuse and reduce) in many regions [9]. Sensors in the STS (Secondary Trash Station) combined with IoT connectivity enable real-time monitoring of waste collection and bin status which is currently lacking in the waste management system of Bangladesh [10].

The appropriate treatment of municipal solid waste is severe to a society's success. Not only do we have the failure to tackle the problem due to a lack of management but also we have regrettably spread it further already. Poor management practices encourage the accumulation of MSW. These issues exist in Bangladesh, particularly the open dumping tradition and a consequential lack of planning to properly treat the ample amounts of MSW produced by wide urban populations.

METHODOLOGY

Our current work focuses on the three building blocks of waste management – waste collection, transportation, and disposal - with the purpose of automating the present solid waste management system in Dhaka city as this city alone is generating about 70% of the waste every day [11].

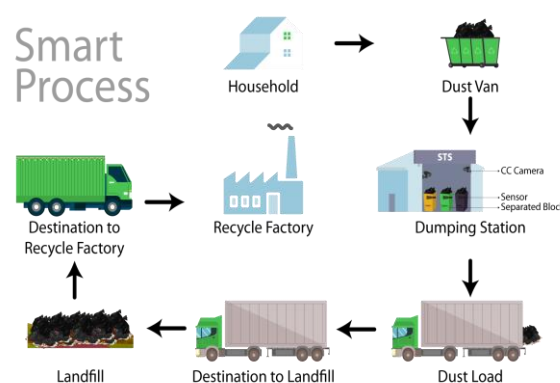


Fig. 3 Smart Waste Management System

Sensors can obtain data from STS such as filling levels. Such data will then be saved in the database for storage and manufacturing. The refined data may then be conducted to analyze and identify the shortcomings

of the present MSW management system, hence improving this system's overall efficiency. The implementation of IoT in dump stations is a step toward a smart city.

Monitoring the Timely Collection of Waste: Because of a lack of superintendence, Bangladesh's waste collection rate is poor. Another challenge is that MSW should be collected and disposed of before working hours. There is also a lack of concern here. Several CC cameras will be stationed at STSs throughout Dhaka. So that, through the system, authorities can look after the timely waste collection remotely.

City Corporation or the authorities who are responsible for collecting the Municipal Waste will strictly provide separate polybags of individual colors to every house. When these wastes arrive at the dump stations, workers will sort them and put them in various blocks based on the color of their bags. The web camera will be used to monitor the waste volume and collection time through the system. As a result, superior authorities will receive real-time data via this mechanism.

Bin Status: Ultrasonic sensors can cover a distance to a variety of objects, independent of shape, color, or surface integrity. The ultrasonic sensors can be used to measure the volume of the waste in this instance. The volume will be determined by the distance between the waste level and the sensor, which we set earlier [12].

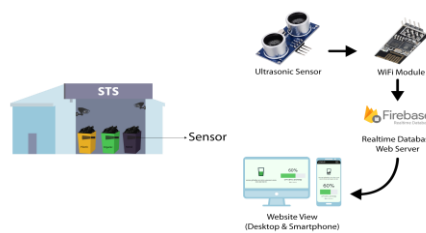


Fig. 4 Problem Solution

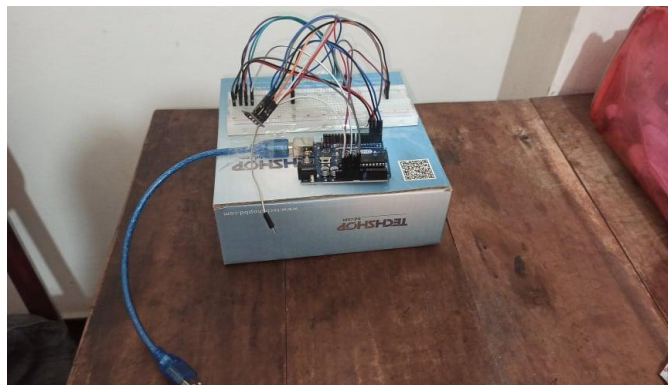


Fig. 5 Sensor Circuit Setup (Demo)



Fig. 6 Implementation of the sensor in a dump bin (Demo)

We've already set a value of 10 as the default. The value of the distance detected by the sensor will be deducted from 10 each time. Following that, we apply the formula to calculate the volume of garbage—const

$$\text{fillPercentage} = ((10 - \text{sensorDistance}) / 10) * 100;$$

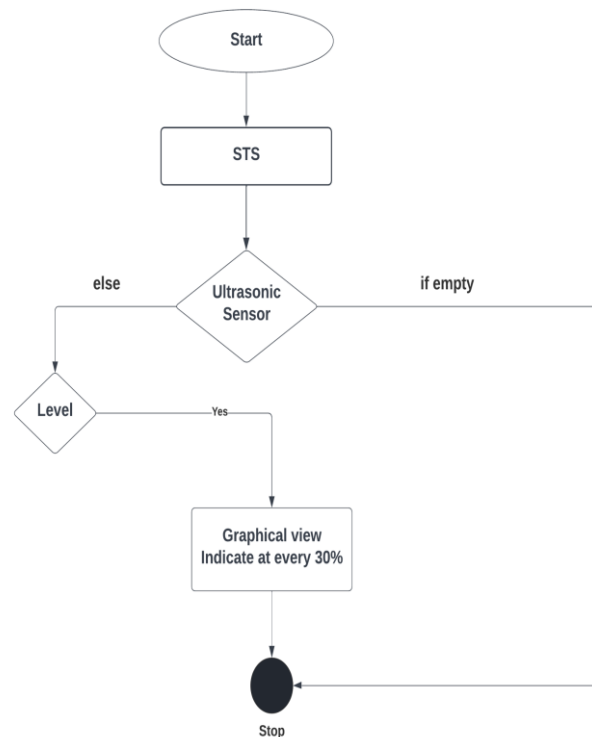


Fig. 7 Work-flow of ultrasonic sensor

The data from the sensors will be sent to the firebase. The data collected (sensorDistance) from the backend is calculated and shown on the front end. According to the volume of the waste, different short messages will pop up on the homepage on the waste collection personnel. Primarily, we have sorted out the messages by 0%, 1%-30%, 31%-70%, 71%-99%, and 100% volume of the waste. For this real-time data collection, a WiFi module has been incorporated. As a result, the collection operator will receive the data and pick a time immediately to remove the waste.

Labor Management: The system can be used to update and maintain financial records as well as workers' work management. The compensation reports of drivers, as well as the duties and trucks allocated to them, are easily inspected by this module.

Truck Management: The truck management module may contain information such as waste vehicle serial numbers, specified locations, and timetables, as well as who is responsible for carrying garbage from the disposal site.

The management of municipal trash is one of the vital fundamental services of the municipality that affect the public health and environment of a city. Increasing energy demand and unsustainable waste management, combined with the ever-developing scarcity of land that is available, have necessitated the development of a national systematic waste collection and WtE strategy. Bangladesh is running on the track where this trash needs to now no longer must be wasted as lots of the ones may be recycled. This automated waste management system and WtE strategy have validated the prospects of heterogeneous waste incineration in Bangladesh in terms of reducing GHG emissions while also generating significant revenue via resource sales and carbon credits.

I. RESULT AND DISCUSSION

A smart waste management system refers to the automation of the waste collection, transportation, and recycling processes in a nutshell. This automation in the waste collection monitoring and disposal process can minimize GHG emissions and contribute to a cleaner environment. The appropriate disposal of garbage can result in the production of power and fertilizer [13]. As a result, the energy produced by this technology may

considerably help to reduce our electricity scarcity and can serve as a baseline for a green-smart city. This cost-effective process of making resources from waste and proper automated management of this will assist to remove the financial barriers of the governments of developing countries. Furthermore, the implementation of this automated waste collection method with the WtE strategy will aid Bangladesh in its progression to a zero-waste society and the adoption of the principle of circular economy nationwide. This automated waste management system and WtE policy have endorsed the prospects of diverse waste incineration in Bangladesh in terms of reducing GHG emissions while also generating substantial revenue from electricity, resources, and carbon credits.

CONCLUSION AND FURTHER SUGGESTED WORK

Civil infrastructure improvements are essential for Bangladesh's economy to grow. Developing high-grade infrastructure that fulfills people's needs while also protecting the environment is critical to attaining successful economic growth.

Though our target was to develop this system with all specifications, we could not do it due to time constraints and certain limitations. We have developed the system with the basic structure and workflow of the MSW management system. So, there are several scopes and opportunities for developing this system from various perspectives. We did not fully design the system from the recyclers' end. There is a large area to design this and create a payment system so that recyclers may pay the local authorities the price of garbage. Another important aspect is the optimum route advice. If a collection operator is assigned to multiple dump stations, the system may display the most fuel-efficient route based on the distance between dump stations and their fill level. If we get the scope and time in the future, we will be honored to develop this in the near term. Further, if we think that many of the waste personnel will not have a smart device or android phone, then there could be introduced another plan to send the bin status or notification as SMS to their mobile phone by using GSM [14]. The system can also offer monthly salaries for municipal labor. Thus this smart waste management infrastructure will make an impact in achieving sustainable development goals and lead Bangladesh to being a digital country. Realizing the full potential of this system will require ongoing research and collaboration with stakeholders. We are one step closer to a more efficient and clean urban environment by resolving these challenges. In the long run, this initiative will contribute to the broader objective of a prospering and sustainable City.

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