# Eco-Garbage Management System

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**Abstract-**In this paper, residential garbage disposal problem of Indian households is addressed and a solution is presented for residential apartments of smart cities. Due to the lack of disposal systems, garbage management for residential apartments is currently done in an unorganized manner thus, making segregation of wet and dry waste cumbersome and ineffective. Also, there is a constant problem of uncovered garbage and bad odor which invites disease spreading vectors such as flies and mosquitoes. Collection of household waste is also quite irregular in India thus, generating heaps of garbage on the outer side of various societies or circumnavigated areas. So, in order to overcome the aforementioned problems, we have come up with a concrete solution which we believe, if provided right at the source of the waste generation i.e., in the kitchen, it would require lesser efforts to separate various types of wastes later. With this intent, an idea having both concealed and external tunnel system, has been proposed wherein, a concealed tunnel system is planned before construction and an external type is installed for the existing apartments in smart cities. Several research articles linked to the garbage management system have been reviewed, and practically all have some major limitations as well as progress. To ensure environmental hygiene, sustainable urban life and eco garbage management system, we have presented a system which separates the dry waste as well as wet waste and also filters out the water from wet waste.

**Keywords-**garbage management system, waste management system, smart cities, IoT

## 1. Introduction

Suitable garbage management system should be a priority of any developed and developing country to reduce environmental pollution and to ensure the safety of public health. In developing countries, waste management and awareness is an emerging concept. To ensure a sound environment and sustainable development, appropriate management of waste is a must. Nevertheless, in developing countries, lack of infrastructure and unsustainable practices have made waste management worse, which leads to environmental contamination. The open dumping and picking of waste within open dumpsites leads to serious health risks like skin infections and chronic diseases. In slum areas, the situation gets worst because of the high density of population. It is a clear indication that environmental / health issues and poor garbage management are interrelated. The increase in populace, urbanization, and industrial development increases the garbage generation level globally. More than 64% of the populace in the developing countries and more than 84% in the developed countries will be in posh areas by 2050. Hence garbage management is a world-wide issue in terms of various ecological and societal impacts.

Figure 1. An open garbage bin spreading bad odor in one sector of Chandigarh

Figure 2. The collection of biomedical waste in UT Chandigarh

In this paper, authors considereda small urban place i.e., Chandigarh for studying the statistics related to waste generation and its increase in future. According to the UT administration, Chandigarh andanarticle published in the TOI on 16th April 2022, there are 900 health care facilities and the available biomedical waste per dayis approximately 3,500 kg in Chandigarh. 2.01 billion tons of municipal solid waste, out of which at least 33% is not managed in an environment friendly manner is generated globally per year and this count is likely to rise to 3.40 billion tons by 2050. Ranging widely from 0.11 to 4.54 kg, the world on an average, generates 0.74 kg waste per person every day. The net waste which low-income countries will give rise to, is expected to increase threefold by the year 2050. Among other low-income countries, India – still being a developing nation in the world has a huge population within a very small area Chandigarh, which being the capital city of the states of Punjab and Haryana has an area of 114 $km^2$ and accommodates a population estimated at 11 lakhs in the year 2022. By 2030, this number is expected to increase by 9 lakhs, clearly indicating that Chandigarh – The City Beautiful is highly populated and the garbage management of the city is somehow not taken care by the local government. With a moderate density of people currently, Chandigarh needs to be provided with an effective garbage management system in order to achieve cleanliness, hygiene and a much more sustainable environment than at present, a suitable approach to which can dispose waste in such a way that it does not pollute the surroundings and ensures safety of the public health. Fig. 1 (a) shows an open garbage bin spreading bad odor in one sector of Chandigarh. The collection of biomedical waste in UT is based on bar code management system.

Therefore, in brief, the contributions of the paper are,

(i) It provides a very simple garbage management system that is eco-friendly especially, in the societies of smart cities. It also can bring about a great change in people's perspective towards a messy urban life.

(ii) The proposed system is very much easy to handle than the traditional garbage management system in societies. It will also help to secure a worthy urban life.

(iii) The system also provides an automated lid that prevents any kind of physical contact with a garbage bin. With an IoT based application, it helps to avoid the overflow and spreading of waste as bad odor.

The presented work of the paper is organized into six sections. The motivation behind the works, and the contribution of the proposed works in social and environmental aspects are presented in Section 1. The previous existing works, similarities of the existing works and the proposed one, positive impacts, and the research gap are presented in Section 2. The proposed eco-garbage management system architecture and components' layout is delineated in Sections 3. The future work is presented in Section 4. Finally, a conclusion is drawn in Section 5.

## 2. Related Work

Lack of orderly waste collection and management systems, inappropriate waste discharge, and unsuccessful waste management practices have all resulted in severe environmental issues [1]. Because of the encouraging outcomes of IoT technology, number of waste management readings focused on IoT services have been undertaken by investigators/researchers to address the above-mentioned issues in solid waste management. Food processing and construction industries, etc. consistently produce a portion of waste that has notable residue enhancing the significance of the application of waste management practices [2]. A number of articles have been published that cover various traits of waste management schemes/systems. A basic structure that identifies the fullness of garbage bins is presented in [3], in which the data iscommunicated via a wireless network to save power and enhancesfunctioning time. In [4], a food waste gathering system in which data was gathered using radio-frequency identification (RFID) technology and distributed through a wireless network is presented. An automated line follower robotic systemfor waste collection is presented in [5]. To avoid waste disposal outside the garbage bin, a method is proposed wherein monitoring is done not only inside the garbage bin but also around the area. IR sensors are mounted in the garbage bin to sense the unwanted garbage from a bin along with filled level measurement system. A waste treatment along with its management using LoRaWAN technology is presented in [6] where a path optimization is mentioned to collect the waste. For better treatment and recycling, a prototype of smart garbage bin was developedin [7] which focuses on separating the various forms of waste. An integrated GPS module provides geotagging to the bins, a gas detector that senses hazardous gases, an infrared sensor that determines the filled level of the bin, a sound sensor for noise emission control, and a temperature and humidity sensor are all used with each bin. Sensors are linked to a microcontroller, which collect data and send it to a gateway through a LoRa transceiver module. The sensor data from multiple garbage bins will be received using a gateway module with a LoRa transceiver. The data will be processed locally, and the processed data will be sent to the cloud via TCP/IP and the MQTT protocol. The cloud server is enabled in such a way that alerts can be sent according to the waste levels of the bins. An automated cloud-based sensing framework with mobile app-based control is presented in [8]. This work's unique feature is the ability to detect foul gases as well as the amount of waste present in the bins. The presented work in [9] proposes an intelligent bin monitoring schemefor detection of filled levels and sendsthe signalsto a control room for further action.

The investigation shows some key boundaries of currently available solutions like shortrange capabilities, sensing accuracy and inspireconsumers to unlawful access. This motivates researchers toimprovethe garbage management system. To summarize the mentioned related work and the proposed system, a comparison is presented in the Table 1, which shows the various technologies available in the research work, the impact and boundaries of them, and the similarities of the currently available solutions with the proposed architecture. Almost all the works available in literaturefollow the similarapproach for garbage management, mainly concentratingon the waste collection. The proposed Eco-garbage management system focuses on residents of society and garbage management authorities of smart cities for providing them the best solution. This also promises a green environment by confiscatingaccumulation and spillover of rubbish in thesociety.

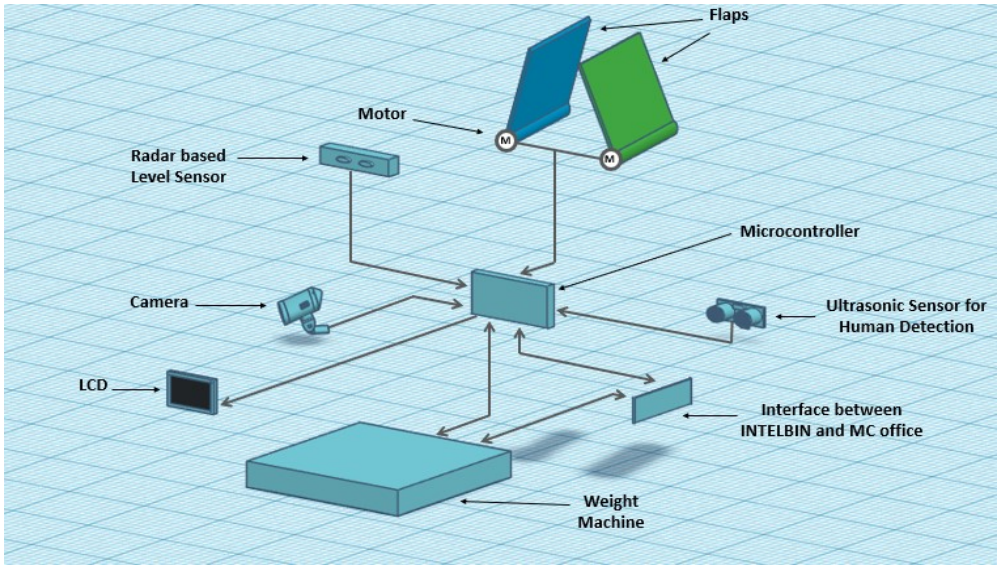
Table 1. Features of some currently available solutions for the garbage management system.

| Comparisons with the proposedsystem | | Technology | Impacts | Boundaries |
|---|---|---|---|---|
| [10] | Notification to authorities | Open StreetMap(OSM),Dijkstra algorithm, Androidapplication | Peoplecandetectnearby dustbin'slocation, social work booster | Anandroid-based application |
| [11] | Bin status check withultrasonicsensorand sendsSMStotheauthorities for collection | GSM,Arduino, Ultrasonicsensor. | Softwarewithpreciselocationofthe dustbins | Notuser-friendly,<br>Practical implementation oftheprototypeisnot mentioned,<br>Display and auto mechanism of flaps not available, practically buzzer not required. |
| [12] | Monitoringthelevelsand sendsmessagetotheauthorities | Ultrasonicsensor, GSMmodule,Strain gauges, PICmicrocontroller, Arduino,Ethernetshield,LCD, RFtransmitterandreceiver | Monitoringofthebins through web | Display and auto mechanism of flaps not available<br>LCD Display not available |
| [13] | Auto mechanism and Display system | Proximitysensor, Ultrasound sensor,Temperaturesensor, ArduinoUNO,LCD,servo motor and Ethernet shield, Real-timeclock | Roadoptimizationtosave timeandfuel | Theautomatedflapsmay misbehaveincertain conditions,<br>No clarity aboutcommunication system working |
| [14] | Binwastelevel checking and information to concerned authorities | Ultrasonicsensor,Cloud-basedandroid application, Microcontrollerisnot mentionedLCDscreen,LED, Force sensor, | It allowsuserstofind anearby dustbin | Doesnotprovidean automatedflapand real-timeconditionofthe bin |
| [15] | Dustbin level checking and accordingly notification to the concerned authorities | Wi-Fi, Arduino, RFID, Ultrasonic sensor. | Use of anultrasonicsensor,Conditionof the dustbincanbemonitoredby a mobileapp | Practical implementation oftheprototypeisnot mentioned.<br>Display and auto mechanism of flaps not provided. |
| [16] | Wastelevel checkingofthe garbage binandinformation tothe concerned authority | RaspberryPi,Ultrasonicsensor,ArduinoUNO, IRsensor, MicrosoftAzure, LCDPowerBI. | Actions for improvementin wastemanagement | Practical implementationofa prototype not mentioned, |
| [17] | Bin garbage level checking andperiodicallyinform the conditionofthebin | Bluetoothmodule,Straingauge,Mobileapplication, GSM, Ultrasonicsensor, | Web-basedmonitoring | Nothing provided related to display andautomatedflap |
| [18] | Wastelevelchecking ofthe | Temperature sensor, Weight sensor,ArduinoMEGA, Ultrasonicsensor,Loadcell, | Renewablepowersource-based system for management of waste | Display and auto mechanism of flaps not available |

| | | | | |
|---|---|---|---|---|
| | binandsendsdatatothe corresponding authority | Photovoltaicsolarpanel, GSM/ GPRS. | | |
| [19] | Status of thewaste level can be determined | sensorandrouterarerevealed | Optimization of road done for saving timeandfuel. | Practical implementationofa prototype not mentioned, Display and auto mechanism of flaps not available |

## 3. Proposed eco garbage management system architecture

The proposed Eco garbage management system is in the form of a dustbin installed in any society which focuses on the waste collection and management of that waste. This bin constitutes of different sections which work simultaneously and results in a **SOLUTION** that people are seeking. To solve this waste problem more efficiently,we are proposing an interface between a container (INTELBIN) and municipal corporation (MC). For its efficient wireless monitoring, a WIFI Module (ESP8266 NodeMCU Wi-Fi Wireless Transceiver Development Board) can be used. The status of the garbage bin can be checked timely and updated online through IOT (Internet of Things) with WIFI module.There is a Central Control System (CCS) that will continuously monitor the bins connected together through Wi-Fi network. As the CCS will login to an IP System, the status of the bins will be displayed with different colors.




Red-Completely Filled

Blue-Moderately Filled

Yellow-Empty

Figure 3. Various components of Eco garbage management system

Figure 4. Odor Removal Device

To solve the problem of scattering of waste around or the odour problem, a message is automatically sent tothe local municipal authorities to empty the bin as soon as it reaches the brim so that it could be used again.For measuring the level of the dustbin, a newradar-based approach is used. This method is very accurate, no calibration is required and multiple output options are available. The system works perfectly if there is a temperature variation. In principle, radar works in a similar way to ultrasonic, but the pulses travel at the speed of light and radar can provide very precise level information and also compensate for fixed structures within the container. These sensors are among the handful of technologies that work well in sticky substances.For the bad odor, an integrated odor sensing device is being fitted inside it which regulates and controls the odor levels and automatically removes any sort of bad odor whenever produced. So, in order to overcome the problems, we have come up with a concrete solution which we believe, if provided right at the source of the waste generation i.e., in the

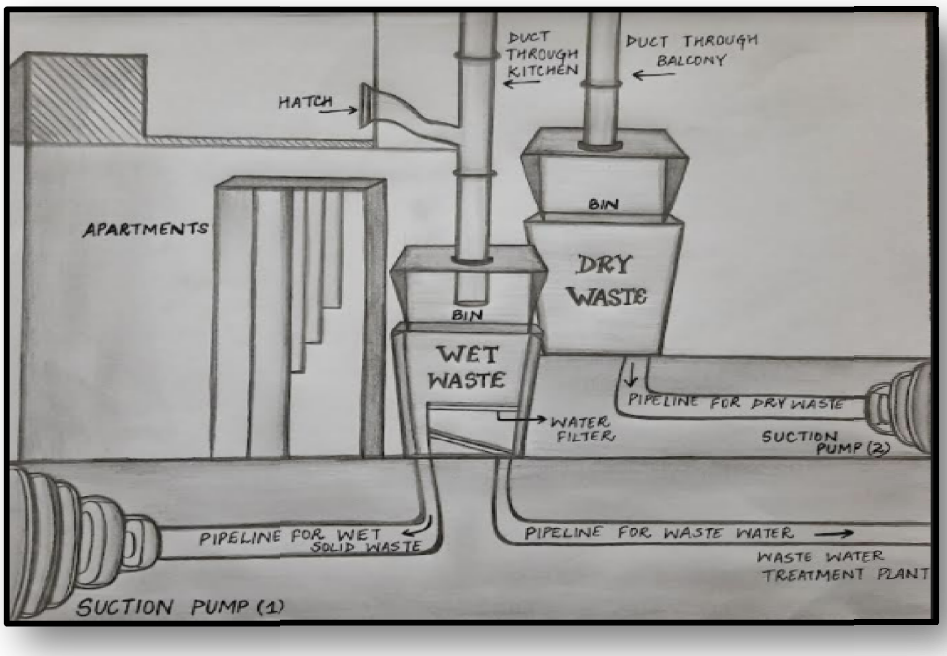



Figure 5. Schematic Layout of the proposed eco-garbage management system

kitchen, it would require lesser efforts to separate various types of wastes later. With this intent, an idea having both concealed and external tunnel system, has been proposed wherein, a concealed tunnel system is planned before construction and an external type is installed for the existing apartments in smart cities. A duct for wet waste is designed in the kitchen and a chute is provided in the balcony for dry waste, both having sustainable industrial turbines at the top to discharge bad odour from time to time. The wet waste collector bin is provided with a water trolley to collect filtered water from the wet waste to be carried by a pipeline to the nearby water treatment plant whereas, the leftover solid waste is collected at a centralized area within the society using a powerful suction pump. Similarly, the dry waste from the 2nd waste collector bin is sucked by the suction pump to obtain another separate heap of segregated waste. After collection of two such heaps, the wet solid waste is used to prepare manure by effectively using the concept of composting for every society or a circumnavigated area. If I were to talk about the disposal of dry waste, the idea also features presence of a smart, covered container at the mouth of the heap collection area with a weighing machine beneath it. This weighing machine constantly measures the weight of the garbage collected and the container has a specialized wireless chip inside it which generates signals and will eventually, send a text message to the Municipal Corporation once the container reaches its maximum limit. The Municipal Corporation can then collect this dry waste and send it to the recycling plant to generate funds for the residential apartments. In order to maximize the promotion and usage of this technology, the Municipal Corporation can also provide relaxation in the garbage collection charges on a monthly basis initially to the society or a defined area which generates the highest weighing waste.

There are two different types of tunnel systems, which can be adopted – concealed and external built. Two different tunnels are provided for both wet and dry waste. The design is made in such a way that it successfully avoids bad odour reaching the residences as there are sustainable industrial turbines on the top of the tunnel, which discharge the bad odour from time to time.

**Key Features**

Our invention also manages multiple sensing elements in a single sensing device along with the weight sensor mounted at the bottom surface of the garbage container which detects the change in weight value to determine the amount of garbage present inside the container. As soon as the garbage covers a threshold value, information will be sent to the MC database for providing the corresponding discount in the monthly water bill of the user. An active foul smell removal device is fitted near the container which continuously compares the foul smell and spreads a fragmented fume (It must be replaced after a certain interval of time).

- Designed to assure proper segregation, flexibility, privacy of each residence, covered collection of waste.
- The user can dispose the waste at any time (No time restrictions).
- There are no chances of dry and wet waste getting mixed.
- The wet waste is used for agricultural purposes. (Manure)
- Funds can be generated in the residential apartments from recycling the dry waste.
- Labor and time is reduced for segregating waste into biodegradable and non-bio-degradable items and subsequent cleaning of big bins is currently installed in the cities.

**Advantages it offers**

- Intelligent and smart enough in detecting the waste and preventing it from being scattered around.
- It only opens when an MC person comes and enters the code.
- Motivating society people to make cleanliness by offering them discount in their monthly bill against using the smart garbage management system.

- Continuous monitoring of the garbage system connected over a Wi-Fi Network.
- 'Make in India' Concept is involved as everything is indigenous and nothing needs to be procured from the outside world or needs to be imported.
- Time and labor costsare also reduced as almost no wasted will be generated outside the container so its maintenance cost is reduced hence saving the time.
- Fast communication enables continuous alerts to the local authorities when the container is about to get full.
- Rugged circuitry and can be reprogrammed from outside if something goes faulty, making it reliable to use.

The flap closing mechanism whenever the container needs to be emptied by the MC person is an important function of this proposed system. Another important add-on will be an interface of the container with the MC to motivate people for raising funds for their society by providingthem discounts in their monthly society bill. An active odor removal device makes it perfectly suitable to place nearby residential area without any worries of foul smell emanating out of the container. Camera continuously watches any moment around the container in residential society for security reasons.

## 4. Future Scope

Although there are many solutions available to this problem yet, the Eco-Garbage Management System for Smart Cities is a well calculated system with high potential in the market because this idea has not been initiated till date thus, having an immense scope especially for high-rise buildings which are a major component of smart cities. The graph below clearly shows the possible growth rate in the coming years for mere chutes but incase, this idea is taken into consideration, there is a high possibility of the aforementioned rate to witness exponential growth. There is still a probability of presence of garbage chutes in minimal number of apartments but the mechanism this particular idea uses, has a totally different concept – a blend of technology and the thought revealing enormous concern for the environment.

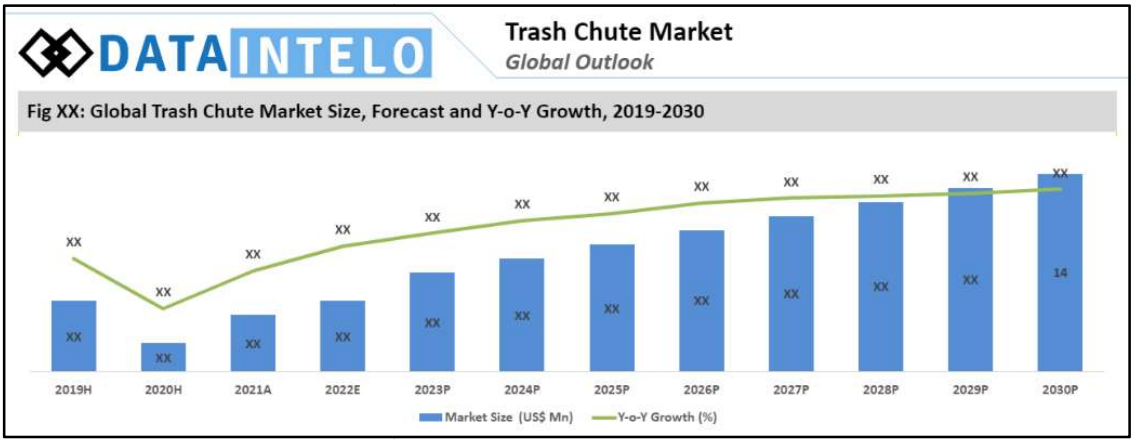



Figure 5.Growth rate in the coming years[https://dataintelo.com/report/trash-chute-industry/]

## 5. Conclusion

Population explosion, increasing industrialization, and rapid urbanization have led the world's environment into complete chaos. Due to the increased levels of waste generation, gradually, it's getting difficult to survive in the densely populated urban areas. Traditional waste management systems are a complete failure to handle such a large amount of garbage. The application of technology and its sophisticated service in every sector has made our lives quite easy. It is high time to apply a technology-based approach to handle these increasing levels of waste. A lot of research is going on regarding the proper waste management system. In this paper, we have proposed an IoT based integrated waste management system, which is acompletely automated system capable of sharing information. It also helps to control the automated lid for certain conditions. An ultrasonic sensor placed inside the bin helps in the continuous monitoring of the garbage level, and the value is shown on the LCD placed in front of the bin. When the garbage bin is full, the GSM module helps to inform the corresponding authorities to collect the garbage. An Arduino board is used to control the whole automated system. That is how the proposed system provides efficient management of waste, eliminating spill over of waste, and avoiding the spread of diseases. The success of the proposed waste management system lies in the welfare of human beings as it helps to ensure a worthy urban life.From the available literature, it is obvious that the current systems are not covering all aspects for a complete placement of smart waste management systems in smart cities. The technologies implemented for the network design are to be assessed in real-time world. The frameworks require to be re-designed for managing house bins in the societies of smart cities.

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