Novel Technologies for Waste Management: A Literature Review

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Abstract- In the present situation, waste management has become a basic worry because of quick urbanization, social, monetary exercises and fast ascent in human population. The proportion of solid waste generated by the world is steadily increasing. The rise in environmental pollution caused by unmanaged solid waste management is terrifying and hence has become a matter of concern for the government. Improper handling of waste collection and inappropriate disposal of solid waste has resulted to become a source of water, land and air pollution. This ultimately creates risks and threats to human health and the environment. There is a need to implement suitable waste management techniques for a particular area and its waste situation. This paper highlights the literature review of current trending techniques for urban solid waste management. The study would upgrade the solid waste management reform; boost its management and efficiency to ensure the practical solutions for solid waste collection process, monitoring and management for green environment..

Index Terms— Waste management technologies, Solid waste management, municipal solid waste management (MSWM).

1 INTRODUCTION

Solid waste management is one of the basic and fundamental services provided by municipal authorities in the developing country to keep cities clean and hygienic. Current existing system is manual, slow, statistically invalid, inefficient and outdated. In the developing countries, waste management is a serious issue as rise in urbanization and economic development is leading to major growth in quantities of waste materials. The environment pollution due to unmanaged solid waste is drastic and hence has become a social issue. Several urban cities do not have ideal waste management techniques which have resulted in dumping of waste in open areas, burning or burying of waste causing serious environmental issues. If the existing situations of waste management are not handling correctly, it would lead to major environmental concers which can cause threats to living beings on earth. Improper mangement of waste can be a dangerous health hazard and can cause spread of deadly infectious diseases. Municipal solid waste production is rapidly increasing every year. From 1960, waste generation has increased tremendously by a factor of 2.6 [1]

Improper waste management can has resulted to in a cycle affecting everything around our atmosphere. If the generated waste is left unattended lying around, it can invite disease spreading insect like flies, mosquitoes, rats etc. resulting an unhygienic living environment. These infected insects then originate serious diseases like malaria, diarrhea, jaundice, plague etc. Animals which graze on such waste areas can spread on diseases via food chain. Also the waste not being collected can clog storm water run off leading to formation of sluggish water bodies that become breeding area for disease causing agents.

To overcome the increase in generation of waste we need to develop an effective, innovative and robust waste management system that can upgrade the present system as well as be time and cost efficient. This situation of waste management can be only addressed by importing the latest technologies in the existing system. In this paper we will review proposed models for the solid waste management.

Reduce, reuse, recycle, sorting, segregate, processing, and disposing are vital steps of waste management [2]. According to World Bank global review world cities generates about 1.3 billion tonnes of MSW annually, the amount is expected to reach 2.2 billion tonnes by the end of 2025 [3]. Solid waste management sector comes under the duty of local government, and reasonable portion of budget is allocated for this [2]. Poor collection of waste leads deterioration of environmental aesthetics, local flooding, land, air, and water pollution [3] [4]. All these issues leads to severe human health hazards.These can only be minimized by implementing effective techniques for waste management.

To overcome the severe consequences of poor waste mana gement and human health risks recently many new technologies have been introduced. These are more environmentall sound and efficient. While the choice and application of such technology depends upon different factors including country's economic condition, priorities, and types of waste generated [5].

The objective of the paper is to compile recently introduced technologies in the sector of MSWM. MSWM comprises a huge network of activities from storage to disposal. There is a need for developing countries to shift their focus on latest technologies for waste management. Then only environmental contamination and human health risks due to the poor waste management can be avoided. This paper briefly coveres those latest and innovative technologies of waste management from storage, collection, recycling, processing, energy recovery and final disposal.

2 METHODOLOGY

Strong waste administration basically endeavors the collec-tion of waste from the source and does unmistakable strides for its removal. This can be cultivated either by treating the waste or finally orchestrating it on a land-fill area. The essential procedures engaged with strong waste administration are: Collection of waste, Transportation of waste and Disposal or preparing of waste.

Collecting the generated waste from their source is an important step in solid waste management. Effective collection of solid waste and its segregation decides how well solid waste is managed. Usually collection of waste is done manually by the workers of the municipal cooperation.

Moving of gathered waste from source is a greater amount often finished with the help of bullock trucks, three-wheelers, tractors, trucks and so on. Numerous urban communities these days have actualized the utilization of water controlled vehicles (hydraulics driven vehicles) for the assort-

ment of waste. The majority of these vehicles are antiquated and not in an incredible condition. Generally squander is stacked in these vehicles physically. The gathered waste is then purged in an exchange station or material preparing office or a landfill removal site.

Disposal of waste is the most ignored aspect of solid waste management. The current practices which are used are profoundly obsolete and unscientific. Most of the municipal authorities dump the solid waste gathered on a dumping site or yard inside or exterior to the city. These sites are not covered and subsequently end up in becoming the breeding spaces for flies, rats and other disease causing agents. The leachate i.e. the liquid formed through the rotting of organic waste produced in these sites penetrates through the ground and pollutes the underground water posing a serious threat to health and environment.

3 Technologies Used For Segregation Of Waste

One of the vital building blocks in SWM system is segregation of solid waste. Solid waste includes of sort of things like metal pieces; plastics etc., several of those materials area unit reusable and may be used as input to alternative sys-tems. For eg, organic waste will be accustomed to generate biogas and its residue will be used as biofertilizers for plants. The metal items will be used for recycle. Plastic wastes are non-bio-degradable. It can not be simply droped on the lowland nor will it be disposde by burning. Throughout burning plastics area unit rotten into the halocarbon gases which may have an effect on the layer. It's needed to treat and segregate solid waste for correct SWM.

In [12], a composting method for solid waste management has been proposed. In this work, different technologies are discussed for the segregation of waste. To name some of them are Magnetic separation, Eddy current separation, and Air classification, wet separation etc. used for the separation of ferrous, non-ferrous, plastic, glass and organic waste. To proceed with that, firstly waste is separated into different sizes by using Screen or trammel and each dimension of obtained waste is processed separately. For all these things the paper presents a mechanical system. Prime purpose of size segregation in a composting plant is to facilitate further separation. It is much easier for people or machines to further separate materials of a similar size, as small items are not buried under large ones.

In [13], an ideal type of Eddy current separator has been proposed. Here, the separation process takes place in two stages-Firstly the strongly conducting particles are separated on the upper part of the drum. Secondly the remaining undecided and poorly conducting particles are separated at the lower part of the magnetic drum. The dynamic eddy-current separator has permanent magnets incorporated into it which separates the small metallic nonferrous. The material is then sent along a conveyor belt with a series of sensors underneath. These sensors detect different types of metal which are then separated by a system of fast air jets which are linked to the sensors.

In [14] an effective segregation system has been developed which assists in the separation of different types of plastics. The two famous concepts of NIR spectroscopy & multivariate analysis have been used and designed. The systm is implemented by embedimg Raspberry Pi to segregate the plastics. The calculative algorithm and GUI were developed using Python programming language. This system was able to differentiate among five types of plastics.

In [15] a sorting method has been proposed to sort the solid waste. The system is made of two components- one is the optical sensor and the other is the mechanical separating system. In this system three parameters are taken into consideration color, shape and dimension of the waste for separation of the waste material. The mechanical sorting device has a compressed air nozzle which is controlled by a computer. The target particles which are detected by sensor are blown out of the main waste stream.

Electrostatic separation and induction sorting method have been proposed in [16].This technique sorts the granular mixtures as the electric forces are acted upon the particles whose average size is approximately 5 mm. In this method, three distinguished electrostatic processes of separation are employed which processes differenttypes of mixtures: (i) role-type electrostatic separator whose basic purpose is to sort mixtures containing metal/plastic particles (for example copper/PVC); (ii) plate-type electrostatic separator, which is used to sort mixtures containing metal/metal particles (for example copper/lead) and the third; (iii) free fall electrostatic separator, which is used to sort mixtures of plastic/plastic particles (for example PVC/PE). This new technology has been implemented primarily for industrial waste segregation.

In [17], a method called X-ray fluorescence has been proposed for the segregation of materials. This method identifies the elemental composition of different materials with X-ray fluorescence. Considering this analysis, objects with specific elements are detected and then can be separated from the material stream. This sorting system can help to identify and treat materials such as glass, ceramics, metals, minerals, plastics.

A methodology called Programmable Logic Controller has been presented [18].This is used to segregate metal waste from waste materials. In this model the waste will be given as an input to the conveyor belt. This conveyor belt has metal Sensors clamped within it which will detect the metals. A robotic arm is employed which will extract the metal waste and deposit it into a bin.

An image processing method is used to segregate medical waste has been proposed [19], which also avoids the possibility of infections when handled manually.

Paper [20] proposes an on-board global positioning system (GPS) data recorder as a methodology. This method collects field data on the movements of solid waste collection vehicles at transfer stations.

4 Technologies Used For Waste Management

4.1 Solid Waste Management Planning using GIS and Remote Sensing Technologies

A case study on solid waste management of a city in India that is Aurangabad City has been proposed [6]. This case study includes a design of a plan for the allocation of waste bins in the area by employing use of GIS and remote sensing tech-

nologies. Several aspects were taken into consideration while planning the waste management. The first step was to analyze the location of the existing waste bins in the area. The plan concern was to verify the comfort and discomfort of the users from the existing bin location.

4.2 Solid Waste Monitoring and Management using RFID, GIS and GSM

In [7], the solid waste monitoring and management system have been proposed by employing use of radio frequency identification (RFID) coupled with intelligent systems. The system consists of three components - RFID system, GSM and GIS for tracking vehicle position. The proposed system is competent enough to monitor the solid waste collection process. Also it can manage the overall collection process along with tracking the vehicle position through the GIS database which in turn can overcome the drawbacks of the existing system such as use of minimal route, low fuel cost, clean environment and available vehicle.

4.3 Integrated Sensing Systems and Algorithms for Solid Waste Bin State Management Automation

In [8], an ingenious solid waste bin has been proposed for an effective and dynamic waste management system. This paper presents two facts viz. a methodology to implement and executes an integrated sensing system and an algorithm for solid waste bin which can be used to automate the solid waste management process. Various sensing methods have been unified and have combined their conviction that offer the detection of bin condition and its parameter measurement. The integrated sensing system incorporates a rule-based decision algorithm which offers a proficient and automatic bin status monitoring system. The algorithms with the sensing systems have led to an intelligent bin which is very efficient for solid waste management automation to optimize collection routes and improve collection efficiency.

4.4 Optimal Planning of Door-to-Door Multiple Materials Separated Waste Collection

In [9], the problem of planning the door-to-door waste collection of multiple materials for a municipality is considered. A novel mixed integer linear programming model is articulated and resolved. A multiobjective optimization model is put forward, which aims to minimize operational costs and possible inefficiencies of the recycling system. The proposed model is experimented on a real case study and a mixed integer programming heuristic algorithm is employed to provide a solution. The obtained results are studied and conclusions are drawn. In this paper, the basic new feature presented is related to the formulation and solution of a multiobjective optimization problem. A mixed integer linear programming model is formulated and resolved by means of an RANS MIP heuristic.

4.5 An IoT Based Green Waste Management System

Internet-of-Things (IoT) has introduced a wide scope of developing applications that approach towards the Smart City vision. Urbanization is a common movement of current society and is growing rapidly demandanding smart solutions for waste management in the cities. A possible solution of this problem is the use of IoT based waste management systems. In [10], the proposed system implements an idea of building smart bins which are connected with the cloud setup of the city authority and will provide constant updates regarding the waste status of the bins. A crucial issue in this case is to provide power to these smart bin establishments. This problem can be handled by embedding reusable energy sources such as solar panels. In this paper, a design is peresented using IoT and cloud based framework for waste management. The smart bins are intermittently connected to the cloud data storage to share their waste status. City authority is given required web interfaces to manage smart bin installations. Garbage collectors are given mobile applications to help planning garbage collection routes dynamically.

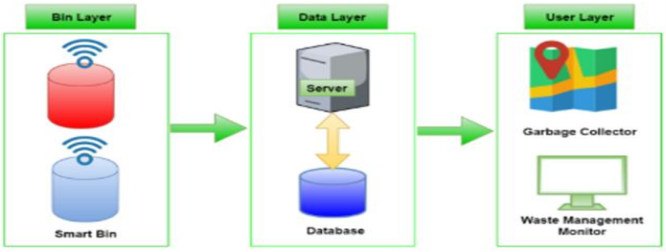

Fig.1 Architecture of IoT based waste management system [10]

Fig. 1 explains the proposed architecture of the system. The proposed system is divided into three parts: Bin layer, Data layer and User layer. Bin layer consists of Smart Bin that is designed to collect garbage status data. The data layer contains a centralized server that stores garbage related data collected from different smart bins installed in different parts of the city. For the user layer there are two types of users: garbage collector and system monitor. Both of these users can access the garbage status data of various smart bins as required. Below Fig. 2 shows the system design of smart bin.

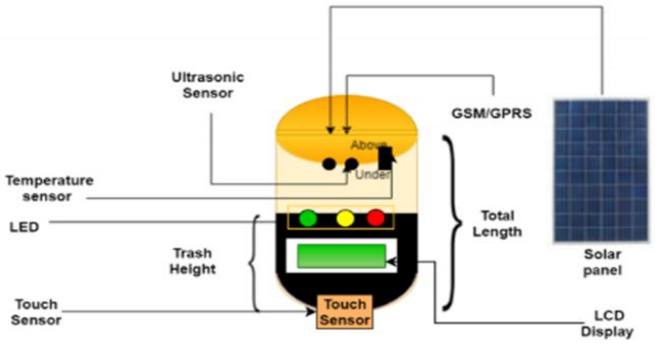

Fig.2 System design of smart bin

4.6 Wireless Sensor Network Prototype for Solid Waste Bin Monitoring and Management

This [11] paper presents a new framework for solid waste bin monitoring system by employing use of wireless sensor network. Wireless Sensor network has an ability to respond quickly as soon as someone throws waste inside the bins. The system architecture makes use of two communication technologies namely ZigBee and GSM/GPRS and a set of carefully chosen sensors to monitor the status of solid waste bins in real time. The system comprisses a three tier structure having

lower, middle and upper tier. The lower tier contains bin with sensor node installed in it which measures and transmits bin status to the next tier. The middle tier consists of the gateway whicht stores and transmits bin data to control station. Control station co-exists in the upper tier that stores and analyze the data for further use. An energy efficient sensing algorithm is also embedded in the first tier which collects the bin parameters. This system can help to minimize the operation costs and outflow by feeding the collected data to a decision support system for route optimization.

5 Conclusion

This paper presents various technologies used for waste management and waste segregation. From this technologies implemented we can conclude that, different methods and technologies have been proposed to bring improvements in solid waste management and segregation of waste. Every technique is unique in its own way and have their own drawbacks and advantages. This extends a future scope for the research and development of the suitable technologies for the solid waste management and segregation.

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