TECHNOLOGICAL DEVELOPMENT IN SOLID WASTE MANAGEMENT

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Abstract: Solid waste processing is a major concern with respect to various developing countries. India as a developing country has changing consumption patterns and rapid economic growth. In Urban India 62 million tones of municipal solid waste are generated each year, it is predicted that urban municipal solid waste will be increased to 165 million tons in 2030.[10] The waste management process should be effectively planned to reduce waste dumping in landfills. To manage the waste in a developing country like India it is important to plan the process of collection, transportation, and segregation of waste from the ground level. This paper reviews various technological developments and methods that are implemented to manage the solid waste management process. It also discusses the existing processes and government plans and programs towards efficient waste management. This paper proposes a methodology that can be implemented to manage solid waste processing; an application is developed in order to manage the day-to-day operations of waste management. The data collected from the application can be used for further processing and analysis to get insights about the ineffective activities in the process. By the implementation of this application, the process of collection and transportation of waste management can be systematically managed.

Index Terms **- Solid Waste Management (SWM), Municipal Solid Waste (MSW), Internet of Things, Geographic Information System (GIS).**

I. INTRODUCTION

Solid waste processing and management are essential services that are rendered by a developing country. These services are usually provided by the municipal authorities of the country to maintain the sanitation and cleanliness. Management and processing of waste are also important to maintain a healthy environment. In the current scenario due to urbanization and the financial growth of the country, there is also a massive growth in the amount of waste that is generated. This is a major problem that hinders the development of the country as it causes environmental pollution and health hazards. It not only affects the environment and health but also causes wastage of resources that are not recycled due to improper management and processing, thus a critical issue to be solved. In urban India, as there are no proper collection or processing of waste it leads to dumping of waste on empty land or burning it. Due to the lack of processing in the waste dumped in the empty land, it leads to environmental problems. If these problems related to waste processing is not managed accurately then it would lead to serious issues in the future. Waste can also cause life-threatening infectious diseases[1].

As per the statistics of waste generation 62 million tons of municipal waste generation takes place every year. The waste collected from various sources are segregated into different streams such as Organic waste or Biodegradable waste, then there are dry waste such it can be further segregated as plastic, paper, wood waste, metal waste. Diapers, napkins, cleaning agents are categorized under Domestic hazardous waste. Further, there are bulk generators such as schools, colleges, restaurants, etc. In a study it was found that 7 out of 10% of waste is collected that is 43 million tons and 2 out of 10% that is about 11.9 million tons is treated. About half of the waste is dumped in open sites(31 million tons). Based on a study of India Planning Commission as of 2014, organic waste generated is 51%, whereas non-organic waste is 32% and recyclable waste is 17%. Each person generates up to 450 grams of waste per day that sums up to 62 million tons annually. Anyway, in India daily household MSW varies, it ranges from 170 grams per person to 620 grams per person in small and large cities respectively [10].

To control the rapid rise in waste generated, an efficient system must be developed with proper planning. The system developed must be cost and time efficient to advance the current state of waste processing. This paper aims to review and compare various technologies that can be used to manage the process of collection, transportation and segregation of waste. This paper also proposes a methodology that can be implemented [1].

II. LITERATURE SURVEY

Waste management is very important as it may lead to many consequences leading to diseases, environmental hazardous worldwide. In order to get a solution to the problem, many authors have come up with different ideas using new technologies.

The use of various GIS models in the field of solid waste management. The effective use of technologies such as RFID(Radio-frequency identification) and GPS(Global Positioning System) to advance the processing and effective management of solid waste collection, transportation, and monitoring. By this implementation, there will be a certain reduction in hazards caused [1].

The author has discussed a method by which a safe transport can be provided to the waste transfer process. This proposed model is built using the web technology. The aim of this model is to manage the decisions of transportation of waste based on decision making that is synthesized on the basis of the conservation law. By the effective implementation of this model the transport of the waste will be safer [2].

This paper presents a waste collection management solution. In this model, an intelligent waste bin is developed. An IoT prototype consisting of sensors is used. This prototype can read the data, collect it, and also transmit a large amount of information through the Internet. This data is passed into a spatio-temporal context for processing using smart and optimized algorithms. This helps to manage the waste collected dynamically. Simulations are conducted on various cases to examine the uses of the system in comparison with the traditional system. One of the special features is it not only depicts the based on the daily data but also predicts the future state concerning the factors involved [3].

The author reviews the various technologies for segregation and the processing of solid waste. Techniques for solid waste processing, management and different methods for segregation of waste are discussed [4].

Another method using IoT, even though the municipality asks people to segregate waste it is mostly not done at the ground level. A sensor is used to identify the waste materials that are added to the dustbin. The waste is separated using this sensor data. The data collected from the sensor is stored in a cloud database. The use of microcontrollers and an ultra-sonic sensor makes the system more efficient. This system can only be implemented in a small scale and cannot be extended on a large scale [5].

A model is developed that can be used in apartment type buildings and specific industries. This model has tech bins, conveyor belts, Iot module and underground bit facilities. There are 2 types of bins, one is for wet waste another one is for dry waste which are installed at two sides of the building as per the owners choice. The trash bins are fixed with ultrasonic sensors. It indicates the level of waste filled. When it is filled through an application called "Things view" it informs the municipality [6].

In another paper, the author has discussed a method in which the waste that is collected is converted into useful products at the local municipality itself, rather than collecting it into huge blocks and dumped in landfills. The wastes that are collected can be converted into useful products that are used as for cultivation of farms. It uses a two-level filter system for this. These waste products that are collected can be useful forms such as energy. This paper proposes this system for Tillamook county of Oregon [7].

This paper discusses on the most important challenges of municipal corporations all over the world. It proposes application that is used to monitor the bins through a web server. This information that is collected is sent to the municipal corporation of the smart cities, so it is called as a wireless system. This method optimizes the cost and time required. As the dustbin is filled, the concerned authorities related to the waste processing are alarmed through a SMS (Short message service) via a GSM (Global system for Mobile Communication) module. These modules are fixed in the bins. The major objective of the model is to enhance the use of IoT in solid waste collection and processing systems [8].

This paper proposes a system that mainly focuses on the aspect of segregation of waste and the collection of the waste. In this model a bin is embedded with sensors. It also includes a system used to communicate the various factors of waste processing such as the status check of the bin and scheduling the waste collection when the bin is full. Data processing, management, and visualization are other subsystems for monitoring and analysis purposes. This model meets the need that is defined for effective processing of urban waste management [9].

III. EXISTING PROCESS OF SOLID WASTE PROCESSING IN INDIA

3.1 Waste Management process and programs in India

In India, waste processing and management, segregation of waste that is recyclable is not effectively managed at the root of waste generated. Most of the time due to the inefficient collection of waste, waste is collected from the dumping rather than collecting it from the actual source of generation. The municipal solid waste depots are usually located at places that are inappropriate to reach, this causes littering. The streets are not swept on a regular basis. Transportation of waste does not take place in closed vehicles. Processing of waste is only done in about 35ulbs. The disposal of waste is finally done through methods like illegal dumping. Recyclable waste is collected by rag pickers from waste dumps. This leads to littering of the waste and also causes unsanitary issues [11].

There are various initiative undertaken by Indian government such as Bio-medical Waste Handling Rules, MSW(Municipal Solid Waste) Management Rules, Technical Manual for MSW Management, Technology Advisory Group on MSW Management, ULBs(Urban Local Bodies) Tax-Free Bonds authorized by Indian Government, There is a relief for Income Tax for agencies related to Waste Management, Private-Public Partnership in SWM(Solid Waste Management), PSP(Precinct Structure Plans), Urban Reforms Incentive Fund and setting Regulatory Authority, There are Commercial Accounting System for ULBs, There are financial assistance provided along with Model Municipal Bye-Laws that are framed and circulated for benefit of ULBs[11].

There are various programs and initiatives that are proposed by the government towards the effective management of solid waste yet there are many drawbacks which are leading to dumping of waste in landfills. So implementing various technological implementations in the waste processing and management will make the process more efficient.

3.2 Implementable methods and its feasibility

The methodologies that are feasible for implementation are, a model that can be used in apartment type buildings and specific industries. This model has tech bins, conveyor belts, Iot module and underground bit facilities. There are 2 types of bins one for wet wastes another one is used for dry waste which are installed at both sides of the building as per the owner's choice. These trash bins are fitted with ultrasonic sensors to alarm the level of waste. An automatic lid is closed when the garbage reaches 80% and automatic rotation of conveyor belt is performed. On the rotation of the conveyor belt the database for the bin is turned on for the user to look into an android application known as "Things view" along with the municipal office of that city through mobile communication network, these singles are received by a web based software application which is seen by waste management organization. For effective use this model should be implanted in maximum number of buildings. If it is implemented the waste management of huge buildings are managed effectively. This can be of major advantage in large cities which are developed, as the number of huge buildings are high it will help in the management of waste in those areas. As the application of the model is integrated with the municipality it allows them to collect waste only when it is full. As the process of setting up the model is by the owner ,it makes the method feasible for use. Even the work load of municipality workers are reduced as they have to collect the waste only when full rather than collecting it on daily basis[6].

Another method is using IoT, this is a project that involves the detection of the waste level filled in the trash with the use of sensors. The waste thrown to the dustbin has various kinds of materials in it. So segregation of such material is a tedious job. To avoid this a segregation system is built to recognize the waste and separate it accordingly with the help of a sensor. The data that is collected from the sensor of the IoT module is stored in a cloud database. The use of Microcontroller makes the project more efficient. This project has modules to detect the object type, to analyze the moisture content of waste materials, metal and non-metal segregation, and separation of degradable and non-degradable waste objects. The hardware design includes arduino mega, ultrasonic sensor, metal sensor, buzzer, servo motor and a LCD display. Machine learning technique such as SURF (Speeded Up Robust Features), knn (k- nearest neighbour) is used for image processing. Limitation of this model is that one material of waste can only be added into the trash bin at a particular time, whereas during image processing, the image captured with low light will have varying results. This system can only be implemented in a small scale and cannot be extended on a large scale [5].

This method involves a lot of expenditure for the installation of Iot equipments. In a developing country like India, there is shortage of waste management equipments. In such conditions implementation of Iot based dustbins are not feasible. But if the method is implemented then the amount of human labour involved in constant waste collection can be reduces up to a very good extent. Even the segregation is made easier by this method. As mentioned the limitation of the number of waste materials to be added to the bin is low, this makes the feasibility is of this model also low.

There are many other methods that discuss about implementation of Internet of Things and geological sensor installations in the dustbins located in various part of the city, but these processes turns to be non feasible due to the high implementation costs. Even proper care has to be taken in order to maintain these methodologies. This process might be tedious in a developing country.

IV. METHODOLOGY THAT CAN BE IMPLEMENTED FOR BETTER PROCESSING OF SOLID WASTE

Considering all the above methodology, various methods are proposed for Solid Waste Management and Processing, But as most of it have high implementation cost and managing cost. Another method is proposed, it is to develop a application that manages day-to-day operations of solid waste processing and management as shown in Figure 4.1. If the process such as collection, transportation and transfer are managed from the lower most level then it will effectively impact the whole process of solid waste processing and management. So this application mainly aims at the steps collection, transportation and transfer. This application will be able to digitalize all the data related to various resources involved, and transportation details related to waste collection and management. This will helps in managing the complete process of solid waste management digitally. By implementing this method the process of collection and transportation of waste is done systematically. This data stored in the application, about daily waste management process will also help in the calculation of waste dumped and the cost involved in various stages of the process. In turn also reduces the dumping of solid waste in landfills.

Further, the data stored through the application can be utilized for analysis. To gain insights about any improper activities, taking place in the process. The details about the amount of waste generated are analyzed to get insights on the amount of recyclable waste collected, this will help in the proper recycling of solid waste.

If there are areas in which a particular type of waste is generated in huge quantity then the reason for the same can be depicted. If there is dumping of waste on roads in any area then appropriate actions can be taken on the human resource in that route, in case the work is done inappropriately. Even when the industrial waste exceeds more than the threshold quantity then action can be taken against them.
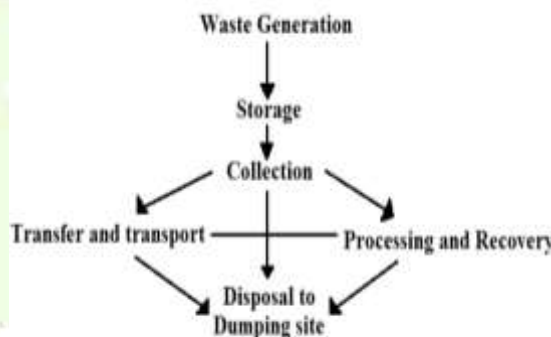

Fig 1: Process involved in solid waste management [12]

IV. RESULTS AND DISCUSSION

By the effective implementation of this methodology the entire process of waste management can be systematically done. As the process of collection and transportation is systematic then the further processes will also be efficient. The data collected from the application can be used for data analysis and the results can lead to further development of the management system. It can also find out the loop holes such as non-efficient workers, if there is improper waste collection in any particular area. This data can also be used to find out any type of illegal waste items dumped or huge quantity of wastes dumped from industrial areas. Appropriate actions can be taken against the same if the data is sent for further proceedings by sending notification to the concerted authorities regarding the same.

V. CONCLUSION AND FUTURE ENHANCEMENT

This paper concentrates on various technological implementations that are used in the process of solid waste processing and management. It overviews the existing waste processing in the country and the various facilities provided and program initiatives by the authorities. It reviews the various methods that can be incorporated alongside the existing system for further development and systematic processing of solid waste in order to reduce the hazards caused due to improper solid waste management. It also discusses the feasibility of the methods implementable. By implementing the proposed methodology collection, transportation and transfer of Solid waste management will be enhanced. The inefficient activities can be identified by analyzing the data collected from the application. So it will enhance the existing system of waste processing. The proposed methodology can be further enhanced by incorporating other methodologies like use of sensors in dustbin to send information regarding the time for waste collection to the authorities.

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