A Comprehensive Survey on Waste Management and its Challenges

Jeba N, Sudha V

Abstract: ***Now-a-days waste management seems to be a challenge in every city right from its inception to its disposal. Waste management involves the collection of waste from its source, transportation and its disposal at the respective location. Garbage collections bins are flooded due to incremental increase in waste which emits foul odour causing health hazards, diseases and environmental pollution. In this paper, we survey on the mechanisms available for scientific collection and disposal of waste along with its challenges. From the descriptive survey we analyse the present scenario in waste management. It is explicit that issues are prevailing in policies and technologies available for the treatment and management of wastes and insufficient trained manpower to collect, dispose and process the wastes.***

Keywords: ***IoT, Waste Management, Smart City, Waste Disposal.***

I. INTRODUCTION

In the era of Internet of Things, cities are inbuilt with sensors and embedded devices its underlying infrastructure. Around 50 percent of the world's population live in cities and the same is expected to gradually increase in the decades to come. Therefore, cities are required to provide the necessary infrastructure to manage the needs of the citizens and meet their fundamental necessities. A smart city is a technologically established city that comprises of a Smart Environment with Smart People who have adapted a Smart Living style. Moreover with the aid of Smart Governance and Smart Economy each of the cities are rejuvenated \cite{RA0}.

Therefore, smart city process for waste collection is a fundamental point in achieving green city environment and well-being of the citizen and its quality should be considered seriously. Wastes generated from urban regions is directly proportional to the steady rate of growth in cities. Human lifestyle and consumption activities have seen a drastic change to the past decades and various types of degradable and non-degradable wastes are produced daily. These wastes must be efficiently managed and decomposed to ensure sustainable development and hygienic standard of living for the residents of smart cities Solid Waste Management is a primary responsibility of the Municipality which includes monitoring and management of waste like door to door collection of solid waste, transporting of waste, scientific treatment and disposal of solid waste, street sweeping, cleaning of open drains, maintenance of waste collection vehicles and other utilities such as public toilets andcomplexes. The process involves tracking the amount of waste that is treated and disposed at the respective processing and disposal site. The functions involved in Municipal waste management are depicted in Figure 1.

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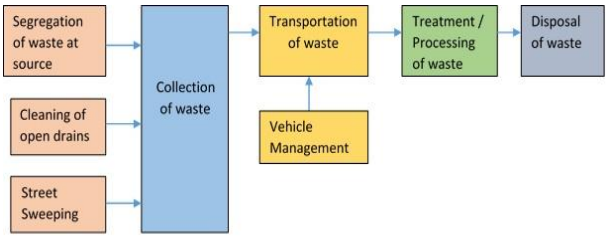

Fig 1 : Mechanism of Waste Management

In an urban city like Coimbatore, where the human population is around 10.09 lakh. The quantity of waste generated daily is 601 MT. The total quantity of waste generated in the city is collected on daily basis and the same is transported and finally dumped at the Dumpsite located at Vellalore-Kurichi Village. Furthermore, Coimbatore City is listed under Jawaharlal Nehru National Urban Renewal Mission (JNNURM) with a sanctioned amount of 96.51 Crore to modernize solid waste management in the city and to do away with the old mechanisms such as littering of domestic and commercial, dumping of waste in open spaces and along roadsides, transportation of waste in trucks and unscientific disposal of these wastes. Dynamic waste collection is a two step process comprising of scheduling and routing. Various technologies and hardwares are used ranging from RFID tags for object tagging, sensors and wireless sensor networks for sensing the information and transferring dat for processing, actuators for stimulation, interaction and feedback mechanism.

II. RELATED WORK

Waste management in general can be explored under its physical infrastructure, the technology with respect to Internet of Things that is deployed to disseminate useful infomation from the underlying physical infrastructure to the distributed servers for analytics and proactive real time decision making as shown in Table 1

CATEGORIES	COMPONENTS
Physical Infrastructure	Bins Fleet of Trucks Depots Dumps Pneumatic Pipes
IoT Technology	RFID Near Field Communication (NFC) Sensors WSN Actuators Camera GPS
Software Anlytics	Dynamic Scheduling Dynamic Routing GIS

Research Focus has had its impact on Solid Waste Management as it has been a major issue that requires investigation. Most of the literature has used wireless communication technologies inorder to reduce the time and cost involved in waste collection, transportation, management and decomposition. We present a comprehensive survey on the adoption of modern tools and technologies for waste management.

The authors in [2] have investigated about a real time intelligent bin, which deploys rule based decision algorithms. The monitoring module used for senses the solid waste data through a wireless sensor network. The system deploys a three level architecture. The smart bins transit their status to the server through an intermediate coordinator, whenever they reach a specific threshold. A set of applications that are run at the server update the status of the dust bin in real time. The major contribution is the construction of a dust bin that has automated real time monitoring based on a set of decision rules. Nevertheless, the challenges encountered are on technical issues such as long range communication and lack of accuracy in GPS location detection.

Automated dustbin with accerlerometer, magnetic proximity, ultrasonic, weight sensing and long lived rechargeable battery was integrated in [8]. The prototype model uses rule based decision to monitor the status of the bin. The authors have performed around fifty-five tests to test the developed prototype. However, route optimization is not achieved and the role of the city residents to ensure the proper functioning of the smart dust bin cannot be validated. As citizens are the major stakeholders and majority of the wastes generated are due to the daily activities of human beings, they must ensure the proper location and working of the smart bin.

Smart Waste Management was achieved with the help of RFID and cell load sensors [10]. RFID is embedded in the bin, RFID reader from smart phones are used to senses the radio waves and convert the bin ID into digital form. The garbage collection truck detects a bin when its few meters away from the bin. With the use of robotic arms, the smart bin is lifted and placed on the vehicle. The application in the smartphone or Personal Digitial Assistant is used to calculate an estimation of the weight and thereby find the amount of waste discharged from an individual house and the respective monthly charges. The digital system will have to save certain data pertaining to the users and the security of this system has to be explored further. The authors in [12] have proposed a theoretical model, where waste collection is done with a capacitive point level sensor, which comprises of two electrodes made of low cost metal tape which is capable of detecting the quantity of paper in the waste bin. A capacitance threshold is fixed to know the exact quantity of garbage in the bin. The model supports recycling of the wastes which will be collected by trucks, which will empty the bin in a single dump.

The authors in [7] have developed a smart bin based on Arduino platform, where the ultrasonic sensors detect when the bin is full and needs to be emptied. When the threshold is reached, a message is sent and a buzzer sounds as a notification. The system has been developed only for a single bin and the it must be enhanced for multiple smart bins.

III. CHALLENGES

Waste dumps have serious impacts on public health as well as the environment. Open dumps release toxic gases from the decomposition of biodegradable waste. Odour emitted from the dumps have adverse effects and breed mosquitoes, increasing the risk of harmful diseases such as dengu and malaria. Respiratory diseases are common in areas where there is uncontrolled littering of wastes at the disposal site. Bacterial infections, allergies, anemia, reduced immunity and inflammation are common in areas with poor waste management. Poor waste management leads to batcerial infections, inflammation, breathing difficulties, anemia, allergies and reduced immunity on the residents fo the city. Recycling ia an important challenge related to waste management. While we promote recycling, we have to make sure that consumers are protected from toxic substances which are found in the wastes. Recyclers have to ensure that the products they manufacture should not contain any hazaardous properties. This includes having checks and control on the recycling as well.

Managing solid wastes is a complex process especially in areas where there are resource constraints. Conventional approach that is followed in most of the municipalities, which are responsible for the collection and disposal of the solid wastes are found to lag in sustainable collection, lack of information on location of the wastes and collection time, real time monitoring of the waste bin status and efficient system for waste transportation. Therefore, delays are present in the present system that is deployed. Moreover, a reliable and responsive waste management system that exploits the use of technology as well as involves all the stakeholders of the process is essential for improving the quality of data collection as well as the quality and service availability for the smart city.

An intelligent model for waste management should provide real time services for planning and implementation of waste collection which includes dynamically adaptable routing solutions for collection trucks and transport wastes to the respective location for decomposition. The system should be flexible and adapt itself in real time and provide optimal solutions for the transportation trucks to collect and dispose wastes.

IV. CONCLUSION

Administration of strong waste management depends on the involvement of its stakeholders and the residents of the locality. Population growth and particularly the development of urban cities is making Solid Waste Management a major issue in Coimbatore. In the present scenario there is inadequate waste infrastructure and waste dumping is seen across the state. Stakeholders should be given sufficient awareness to change their attitude towards waste. Moving waste out of one's boundary does not mean that waste is managed, efforts should be taken to dispose the same at the respective locations. Waste segregation needs to be clearly understood by all as it plays a vital role in waste management. Furthermore,

we have to research on methods to extract maximum resources from residual wastes, as certain countries across the globe extract useful reusable resources from wastes and a very limited percentage of wastes reaches the dumping site. Scientific treatment and disposal mechanisms for waste need to be investigated further for a sustainable environment.

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