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# A Survey on Smart Waste Management Systems

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***Abstract:*** ***The municipal solid waste generation levels are increasing significantly with the ever increasing population, urbanization, migration issues and change in lifestyle. Waste management becomes a challenge faced not only by the developing nations, but also the developed and advanced countries. The efficient management of waste has a significant impact on the quality of life of citizens. The reason is that waste disposal has a clear connection with negative impacts in the environment and thus on citizens' health. Also the quantity of waste near to streets caused to bad smell and bad hygienic condition. It also provides negative impact on tourism. The smart waste management system helps to remove the waste in appropriate time without overflowing and also provides better waste management.***
***Keywords: Cloud SWAM, RFID, Internt of things, Arduino UNO, Smart bin***

## I. INTRODUCTION

The solid waste is increasing in urban and rural areas as the population is increasing and waste management has become a global concern. In order to manage this overflowing garbage we need to take right decision. Mainly there are three types of sources where garbage is generated viz. residential, commercial and industrial. The garbage produced in the residential area can be collected directly from home or by making an arrangement for mass collection in that area and can be lifted using vehicles. In case of restaurants, malls and other commercial establishment garbage can be collected directly from the unit using vehicles. Industrial garbage which includes waste produced in construction sites, various industries can also be disposed using different ways. For effective handling of these wastes like collection and disposal, Internet of Things (IOT) concept is being used, which mainly deals with sensing, actuating, data gathering, storing and processing by connecting physical and virtual devices to the Internet.

## II. LITERATURE SURVEY

Mohammad Aazam, Marc St-Hilaire, Chung-Horng Lung, Ioannis Lambadaris (2016) [1] provides the idea of sensors-based waste bins, capable of notifying waste level status. An automatic waste bin and make use of cloud computing paradigm to evolve a more robust and effective smart waste management mechanism. Waste management is linked to different stakeholders, including recyclers, importers and exporters, food industry, healthcare, research, environment protection and related organizations, and tourism industry Mohammad Aazam et al proposed Cloud SWAM, in which each bin is equipped with sensors to notify its waste level. Different bins for each category of waste, namely: organic, plastic/paper/bottle, and metal. In this way, each type of waste is already separated and through the status, it is known that how much of waste is collected and of what type. The availability of data stored in the cloud can be useful for different entities and stakeholders in different ways. Analysis and planning can start from as soon as waste starts gathering and up to when recycling and import/export related matters are conducted. The system Cloud SWAM provides Timely waste collection. Timely and efficient way of collecting waste leads to better health, hygiene, and disposal. The system provides shortest path to the location of waste bins. So the collectors can plan a better and fuel efficient route. Recycling and disposal by the system s uses separate smart bins for each type of waste. So the stakeholders will be able to see through the cloud and analyze type of waste and its magnitude. So they can do better arrangements and efficient ways of recycling can be adopted in a dynamic way. Resource management by Cloud SWAM is based on the waste generation trends of a particular city and/or area, resources can be effectively managed since the data is available live through the cloud. Food industry planning can done through the Cloud SWAM. Food industry can plan according to the trends of a certain locality. In this way, not only waste material can be minimized, but also, food trends and habits of an area can be coped in a much more operative way. Taxation With CloudSWAM keeping track of each kind of waste, better taxation and fine imposition can be performed on unnecessary waste generation. Big Data practices can be used to reduce waste generation and improve its management. Various healthcare stakeholders can take benefit from the gathered waste management data and foresee what type of diseases a particular locality is more prone to and how to prevent from certain types of insects and bugs from breeding. Waste-based energy production means generating energy from waste in the form of electricity or heat.

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The population rate of the developing nations increases and a proper management of accumulative Municipal Solid Leftover (MSL) grows to be alarmingly increasing for building and maintaining an eco-friendly hazardless space. Dr. N. Sathish Kumar, B. Vijayalakshmi, R. Jenifer Prarthana, A .Shankar (2016) [2] uses tremendous power of RFID technology and presents the development of an electronic monitoring (e-monitoring) system to overcome the problems in the conventional approach. The e-monitoring system is an embedded system that comprises of RFID technology interfaced with Arduino micro-controller and a web base which is completely computerized. . Dr. N. Sathish Kumar et al. designed a smart dustbin in which the dust bin gets blocked when it reaches a threshold value. The ultrasonic sensor measures the waste volume .microcontroller reads the data from sensor and alerts the server. For the verification process RFID tag (ID card of the cleaner) interrupts the RFID reader, the ultrasonic sensor checks the status of the dustbin and sends it to the web server. An android application is used to view the alerts and status at the server end.

RFID technologies do not need line of sight and the RFID waste tag can be read without actually seeing it. An RFID-based waste management system proposed by Belal Chowdhury and Morshed U. Chowdhury (2007) [3] mainly consists of a smart waste (RFID) tag, a Reader and a waste management IT system (i.e., WMITS). A load cell is used to record the weight of bulk waste from each waste bin. A reader device attached to the PDA (Personal Digital Assistant) or a smart phone placed in waste collector vehicle (garbage/recycling truck) enables the chip to transmit its unique identification to the reader device, allowing the bin to be remotely identified. A RFID reader on each waste collector vehicle will ensure that the weight and identity of the waste is passed to the PDA and automatically logged into an integrated database server. The RFID reader can also request any additional information from the waste tag that is encoded on it. When robotic/lifting arms in the waste collector loaded onto the vehicle then the weighting measures the weight of each bin. The bin ID is then used to calculate actual waste disposal charges for each individual household.

Belal Chowdhury and Morshed U. Chowdhury [3] designed a five layer architecture for RFID and sensor based waste management system. The layers are named as physical layer, middleware layer, process layer, data access layer and user interface layer. The physical layer consists of the actual RFID hardware components and it include RFID waste tag, reader and antennas. Middleware layer is act as the interface between the RFID reader, load cell sensor and waste management service providers (i.e., waste collectors, and municipalities) IT system. The important element of RFID and load cell sensor systems is middleware layer , which is viewed as the central nervous system from the waste management system perspective. This layer enables waste management service provider's (e.g., waste collector) a quick connectivity with RFID readers and load cell sensors and also the layer lowers the volume of information that waste management system applications need to process, by grouping and filtering raw RFID and load cell data from readers and sensors respectively. An application-level interface is provided by middleware layer for managing RFID readers, and load cell sensors for processing large volumes of waste data for their applications. The middleware layer is responsible for monitoring physical layer components. The Process Layer provides RFID and sensor based waste management system (business) processes that provide real-time integration into their existing systems. Also this layer enables data mapping, formatting, business rule execution and service interactions with databases. The data access layer is consist of a RDBMS (Relational Database Management System) and applications that allow waste management service providers to create an RFID and sensor "events". This data access layer interacts with the SQL server and includes a data query/loading approach using SQL and customized data (i.e., customer/household information) that are presented to the waste management service provider (i.e., waste collector) for fast and accurate waste (e.g., garbage, recycling, and green) identification Finally, the user interface layer is composed of an extensible GUI (graphical user interface), which allows RFID devices (e.g., waste tag, reader) and load cell sensors in a uniform, user-friendly way to work seamlessly in a Windows environment.

Mohd Helmy Abd Wahab, Aeslina Abdul Kadir, Mohd Razali Tomari and Mohamad Hairol Jabbar (2014) [4] proposed a Smart Recycle Bin that caters for recycling glass, paper, aluminum can and plastic products. It automatically evaluates the value of the wastes thrown accordingly and provide 3R card. The recycle system enables collection of points for performing a disposal activity into designated recycle bins. Such system encourages recycling activities by allowing the points to be redeemable for products or services. The system records the data related to the disposal activities, disposed material, identification of the user and points collected by the user. The user has to touch his card to the specified RFID reader at the recycle bin. Recycle bin doors open and user puts waste one by one. A microcontroller processes information about his user ID and number of wastes and send to a database server. The data base server calculates the user points and updates it. The system provides user login to an online system to check his total points.

Fachmin F olianto, Yong Sheng Low and Wai Leong Yeow (2015) [5] proposed Smart bin system has 3 –tier architecture.The ultra sound sensor installed in every Smartbin senses bin fullness and report readings and sensor statuses. The sensor reading is transmitted to the gateway nod which is installed in every sensor cluster. It forwards the information to the backend server. The

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analytics module in the back end server analyzes data collected by the bin sub system. The analytics module processes fullness readings, compares against predefined rules, and generates event upon exceeding threshold. The bin sub-system sends information to the workstation and it shows meaningful information to users through a graphical user interface.

Keerthana b et al. (2017) [6] designed internt of bins for trash management in India. The smart TRASH management system using sensor, microcontroller and other modules ensures emptying of dustbins appropriately when the garbage level reaches its maximum. Two threshold limits are set for the bins and an alert message is sent to the van that collects the trash if the waste amount reaches these thresholds. The system further allows the people to drop down the trash bags into the bins till it reaches the threshold limit .It waits for the acknowledgment from the van to clear off the bin and if the acknowledgment is not received it is sent again when it reaches threshold limit and the bin gets locked. When bin gets locked it displays the message "Overloaded". Then the dustbin will be monitored for a specific time and when not cleared within cerstain time limit, then a message will be sent to the higher authority who can take appropriate action

TABLE I

ADVANTAGES AND DISADVANTAGES OF SMART WASTE MANAGEMENT SYSTEMS

| | Advantages and disadvantages of different smart waste management systems | | |
|---|---|---|---|
| | Name of the paper | Advantages | Disadvantages |
| 1 | Cloud-based Smart Waste Management for Smart Cities | Timely waste collection, Route optimization Recycling and disposal, Resource management, Food industry planning Taxation, Big Data analytics Healthcare ,Waste-based energy production | System requires number of waste bins for separate waste collection |
| 2 | IOT Based Smart Garbage alert system using Arduino UNO | It is transportable low price RFID tag, the system provides options for the customers to lodge their complaints in case of discrepancies. | Complex design of dustbin compared to other methods |
| 3 | RFID-based Real-time Smart Waste Management System | Waste disposal charge can be calculate, can Track missing/stolen bins quickly and accurately without human intervention, automate customer invoices, enhance cost savings , Improve security. | Metal objects or liquid containers difficult to tag and track with a RFID system, The RFID tag is also affected by objects surrounding it especially metallic objects. |
| 4 | Smart Recycle Bin | Usefullness – to increase the utilization of the particular bin for waste disposal, Assist the authority to effectively and efficiently improve the collection of recyclable waste. The recycling process rewarding points to the user who contribute to waste recycling, Increase , The awareness among citizens | System requires 3R card for waste disposal |
| 5 | Smartbin: Smart Waste Management System | Obtain litter bin utilization - utilization information shows how a bin has been utilized litter bin daily seasonality information.- shows the time when a bin is usually full. | The sensor node was deployed with battery power. Low power consumption sensor node must be used because of its limited power. The sensor node had limited memory size. |
| 6 | INTERNET OF BINS : Trash Management in India | Less expensive Lock based System with acknowledgment alert system. Two threshold limits are being fixed. Reduces fuel usage. Provides clean locality | ZigBee are short range, low complexity, and low data speed. |

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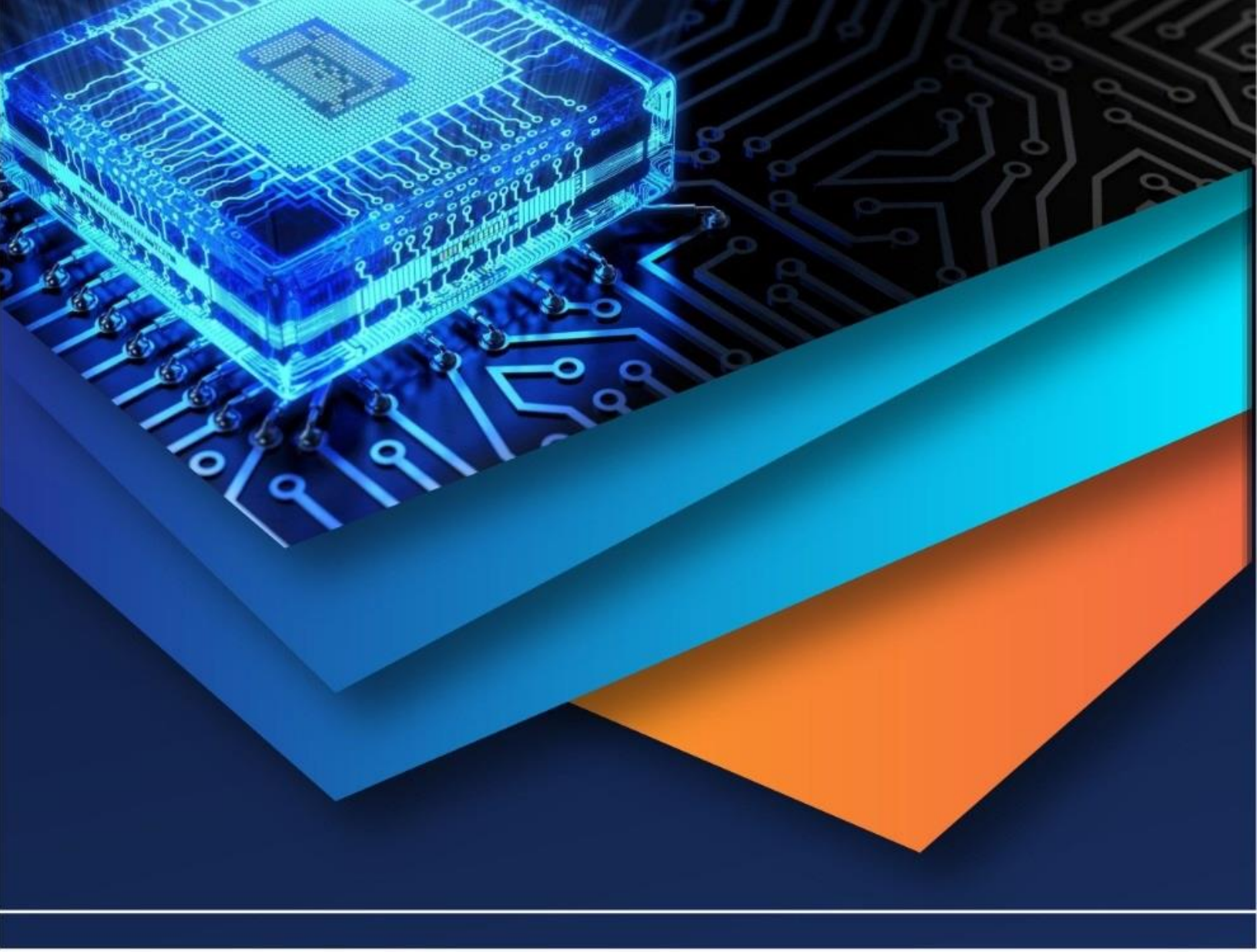
## III.CONCLUSIONS

The population increases day by day and generates million tons of wastes per year. City administrations, municipalities and waste management organizations in different countries faces the challenge to provide efficient and effective system to collect, dispose-off properly, and recycle the waste, keeping health standards and environment friendliness. The smart waste management system collects the wastes in proper time, disposes and recycles in the proper way. The different waste management systems based on different technologies are discussed above and these systems help in better waste management and making the cities clean and efficient. The waste management systems provides better health environment by proper waste management without much human intervention.

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