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Evaluation of Garbage Management Based on IoT

Naveen Raja S.M[1], Dr. T. Sathish Kumar[2], Dr. A. Rengarajan[3], Kondalaraopunati[4], G. Nagarjuna Rao[5]
[1]Assistant Professor Department of Computer Science and Engineering
KG REDDY COLLEGE OF ENGINEERING &TECHNOLOGY Moinabad, Hyderabad,
Telangana-501504
Mail : sm.naveenraja@gmail.com
[2]Associate Professor Department of Computer Science and Engineering
Hyderabad Institute of Technology and Management, Hyderabad
Mail :sathisht.cse@hitam.org
[3]Professor, CSE Jain university, Bangalore.
Mail :a.rengarajan@jainuniversity.ac.in
[4]Asst professor Department of ECE HITAM
Mail :kondalaraop.ece@hitam.org
[5]Assistant Professor Department of CSE MLR Institute of Technology, Dundigal, Hyderabad .
Mail :nagarjunarao.gudelli@gmail.com

Abstract
Smart Waste Monitoring: To track the amount of waste in bins and containers, IOT-enabled garbage management systems use sensors and connected devices. These sensors can communicate real-time data to a centralized monitoring system and can identify the fill level. This data aids in streamlining waste collection routes, cutting back on pointless pickups, and enhancing garbage management effectiveness as a whole. Effective Resource Allocation: By giving precise data on waste generation patterns and trends, IOT-based garbage management systems enable optimal resource allocation. This information can be used by municipal authorities to make well-informed decisions on waste collection schedules, resource deployment, and staffing levels. IOT-based waste management solutions have the potential to make trash management procedures more effective and efficient while also being more affordable. The best garbage collection routes, operational cost reductions, and resource utilization may all be achieved with the aid of research into the best deployment strategies for IOT sensors and devices. Environmental Impact and Sustainability: Research Objective: Clearly identify the research objective, for example, by assessing how well IOT-based garbage management systems gather waste and allocate resources. Data gathering: Compile pertinent information on the methods used for trash generation, collection, and resource use. On-site observations, employee interviews, and database access for waste management operations are all effective ways to accomplish this. Gather information on IOT sensor technologies and their capabilities as well. Taken As alternative for Smart Waste Bins, Waste Level, Sensors, AI Recycling, Robots, E-Waste Kiosks. Taken for Evaluation preference is Reliability, Mobility, Service Continuity, User Convenience., and Energy Efficiency. Smart Waste Bins has performed more when compare to with other Real-Time Monitoring: The Internet of Things (IOT) can be used in waste management to enable real-time monitoring of trash cans or bins can be used to enhance garbage sorting procedures. Smart bins with cameras and sensors can automatically recognize and sort various types of rubbish. These smart bins can identify and categorise rubbish by utilizing IOT technology. on their material composition or recycling category.

Keywords: Weighted product method, Waste Management, Smart bins,, Mobility.

1. INTRODUCTION

Globally, improper garbage disposal has grown to be a major problem as a result of the harmful effects that trash generation and buildup have on both human health and the environment. Due to the large volume of garbage that modern civilization produces, it is essential to adopt efficient waste segregation procedures in order to assure correctand ecologically friendly disposal [1].Unfortunately, a lot of people have gotten into the habit of mindlessly throwing things away without thinking about the repercussions. Particularly with regard to industrial trash, it is frequently dumped in open spaces or in unplanned, unregulated locations. The wellbeing of animals, humans, and plants are all seriously at stake as a result of this haphazard approach [1].Since improper garbage management not only upsets the natural balance but also has detrimental consequences on public health, it has become a major environmental concern. We have created a smart garbage management system employing reasonably priced sensor-based technology to address this problem. We have used sensors, such as Ultrasonic/Weight sensors, a microcontroller, and a communication module in place of pricey trash cans. As soon as the dustbins are filled to capacity, this method guarantees fast cleaning. A complaint is made to the higher authorities for appropriate action against the contractor or collector responsible if a trashcan is not cleaned within a certain amount of time. Additionally, the system recognises and handles bogus reports, which lowers corruption throughout the entire waste management system. By reducing the quantityAddressing system flaws that could result in component failures or other types of disruption is crucial, though. The performance of the system needs to be optimised by additional changes and enhancements.[2]. To collect information on the amount of rubbish accumulation, this system makes use of IoT-edged nodes that are mounted in trash cans or garbage collectors. After that, the data is sent to a cloud platform for archiving and display. Employees in the cleaning industry have access to an Android application that downloads data from the cloud. When the trash container is nearly full, an SMS alert is sent to the staff with the shortest route to collect the trash, according to the programme. This system, in contrast to similar ones, uses the cloud, making the gathered data accessible to all authorised staff via the mobile application. The mobile application of this system's distinguishing feature shows the shortest route to visit the geographic regions of the garbage bins that have exceeded the threshold level.This makes it possible to monitor garbage levels in real-time and lessens problems caused by overfilled bins. The system has a broad application and can be implemented everywhere garbage collection and disposal are necessary, including residences, apartments, train stations, businesses, buildings, and schools.[3]With the development of science and technology, automating manual procedures has become a popular trend. Automation is being used in many facets of life because it has advantages over manual labour, including less physical exertion and lower prices. In the modern world, effective waste management presents a big challenge that needs close consideration. Inadequate waste management not only causes health problems but also pollutes the environment. The need to solve this issue is becoming more and more pressing for the agencies in charge of trash management. With continued research in this area, scientists and technologists have created a variety of waste management solutions. We have seen tremendous environmental changes over the last 17 years, including population growth and technological development. These adjustments show the necessity for efficient waste .management practices to ensure clean surroundings and minimize health hazards[4].Garbage containers that are regularly overflowing have a number of negative effects. The emergence of a repulsive and filthy odour in the neighbourhood is one important impact. People frequently place their trash next to the bins once they are full. This buildup of trash eventually releases a pungent odour. As a result, those who arrive later are less likely to approach the trash cans and instead choose to dump their waste nearby. Additionally, if there are any food leftovers, improper disposal could lead to leakage. In turn, this spillage draws animals like cats, dogs, and flies, which worsens the situation.The potential for disease propagation is another drawback. The animals attracted to the waste can also act as carriers of disease, so it's not just the garbage itself that helps spread illness [5]. Nowadays, thanks to the use of Internet of Things (IOT) technology, using applications has grown more convenient. The Internet itself, micro services, and numerous wireless technologies have all been transformed by the Internet of Things (IOT). Through connected devices, IOT makes it easier for clients and servers to communicate. The industrial internet, which entails the interconnection of devices and communication over the internet, is one particular application of IOT. Clients, devices, and servers now interact more frequently as a result of this.Smart dustbins have been introduced in order to solve the problems of piled-high trash and the development of infectious diseases. These trash cans use IR sensors to measure the amount of trash inside of them. Additionally, wet waste is identified using water sensors, allowing for monitoring and segregation of such waste. An LCD panel is used to show the dustbin's state, including whether it is low, medium, high, empty, or overflowing. A GSM modem is activated to send a pre-registered message to a specified mobile number when the amount of waste in the dustbin exceeds 70% of its capacity. This functions as a system-integrated alarm mechanism[6].The traditional approach to manually collecting and monitoring trash is ineffective and time-consuming; as a result, costs are ultimately raised. The internet has swiftly grown and integrated into peoples' daily lives. The Internet of Things (IOT), which enables real-time data transmission and reception through connected devices, is currently gaining popularity. It is now possible to monitor waste data in real-time through the internet by utilizing IOT technologies. In studies on municipal solid waste management (MSWM) in the Arabian Gulf, methods like land filling, composting, recycling, and reuse strategies have been explored.There has been a thorough study of the development of IOT, its technological characteristics, and its several deployment domains There has been a lot of interest in the potential uses of IOT for monitoring daily activities. Researchers have looked into various IOT-based garbage monitoring strategies recently. For instance, smart collecting bins with integrated IR and load cell sensors were suggested by Navghane et al. The smart dustbin system described in is another IOT-based option. It uses a GSM modem to notify the appropriate authorities until the waste is removed [7].The solution outlined in the study uses an intelligent waste management system to minimize human effort, time, and expense. The smart bin, the smart control and monitoring system, and the garbage vehicle make up its three subsystems. The study was split into two phases. Building a system to gather and keep track of waste in numerous containers dispersed across various geographical locations was the initial step. The second section concentrated on putting this strategy into operation in a particular city.The system's functionality can be improved by integrating GPS technology, which can be used to locate the bin and communicate with local waste collection vehicles to arrange for emptying. The system can also use the Internet of Things (IoT) to monitor and provide access to the bins from anywhere[8].The coordinate node, end device node, and web server design make up

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the system's structure. A radio transceiver connects the coordinate node and end device node, with the coordinate node using the ZigBee protocol. There are several sensors used, including a load cell, gas sensor, and level sensor (an ultrasonic sensor). A notification warning of the need to empty a smart bin will be displayed as it gets close to capacity. The responsible authority is able to take extra measures for container cleaning thanks to the data that these sensors' shared data collection devices provide.In a different garbage disposal system that has been examined, an Arduino UNO board serves as the control panel and an ultrasonic sensor is utilised to measure the amount of waste in the bin[9].

In recent years, the Internet of Things (IoT) has become a game-changing invention. It includes establishing wireless networks between various physical devices to allow them to communicate with one another with minimal human involvement. In the context of waste monitoring systems, in particular, the Internet of Things (IoT) technology is essential for keeping a clean environment.The amount of labour needed to monitor rubbish in various locations can be considerably decreased by implementing an IoT-based garbage monitoring system. There is typically less waste produced in areas with a smaller population. However, places with a high population density tend to produce more waste. waste collection vehicles can follow optimised routes to efficiently collect the waste without needing on-the-spot approval by being able to track online where quick clearance is needed.Smart bins that have waste in them for longer than two days can send out rapid alerts to avert unsanitary effects. By 2030, it's anticipated that the population and development of various regions of the world will grow, which would result in a rise in waste production. As a result, the suggested implementation described in this paper may be helpful in solving this problem. The report also offers a mechanism for tracking garbage collection trucks' itineraries that prioritises stopping at trash cans that is more full. The efficacy and efficiency of waste collection can be increased in this way[10].The ecology is significantly impacted by the incorrect treatment of rubbish. The waste that has gathered along the roadside can readily draw rats and insects carrying harmful diseases if recycling and disposal are not managed properly. Waste buildup can result in outbreaks that have the potential to be lethal. The production of garbage must be kept to a minimum in order to maintain the environment. The deployment of a waste monitoring system is required to accomplish this goal .Technology development has led to the emergence of smart cities as a paradigm for urban planning that makes use of both human and technological resources to create thriving urban regions.Smart cities have grown significantly as a result of the Internet of Things (IoT). Since inexpensive actuators and sensors are readily available, technology can be used to help urban waste management systems overcome their difficulties. In order to facilitate information exchange, IoT provides the integration of physical objects with sensor capabilities that may automatically transfer data to a central base station through an IP address. Different internet-based formats can be used to operate the Internet of Things (IoT). By automating waste cleaning procedures and offering more effective solutions, this project intends to investigate innovative approaches for incorporating IoT into environmental sustainability, specifically in the context of trash management.[11].A substantial number of opportunities have been opened up for the development of intelligent, socially relevant smart systems by recent developments in communication technology, notably wireless sensor devices. This has prompted the development of numerous smart technologies, including smart sensors, smart home automation, smart mobile phones, and smart irrigation systems. The concept of the Internet of Everything is made possible thanks in large part to the Internet of Things (IoT), which is essential for enabling connectivity and intelligence among people and objects.IoT has the ability to improve current devices and deliver new smart services in the setting of smart cities. The transformation of waste pickup into Waste pickup as a Service is one example of such an application. Dynamic scheduling and rubbish pickup can be effectively handled online by utilising IoT.The frequency of garbage collection from bins and the dissemination of this information to municipal authorities are the two main problems with smart waste collection. Sensor-equipped smart bins have the ability to detect the amount of waste within the bin and alert the local government. This makes it possible to make prompt plans for bin replacement. Such smart bins are especially helpful in locations where bin usage varies, as standard checks might not be adequate. In order to reduce waste buildup, smart bins also have IR sensors for item identification near the bin and motors and ultrasonic sensors for automated door shutting when the bin is full. Information from the smart bins is typically transmitted to computers using Arduino boards[12].

Unique Identifiers (UIDs) are used to convey data between linked devices in a network known as the Internet of Things (IOT). This interconnectedness allows for automation in many facets of life, whether or not there is human involvement. The Internet of Things (IOT) is a fast developing technology that links computing power, physical items, and sensors to enable devices to produce, trade, and consume data .Integrating IOT and ICT technologies is central to the idea of smart cities, which aims to improve security and efficiently manage a city's resources. Smart cities attempt to enhance quality of life by incorporating a variety of factors, including smart government, smart environment, smart business, smart living, and smart transportation.At the local and international levels, waste management is an ongoing problem. Solid waste is produced by both human and animal activity, and it is wasteful and unwelcome. Usually, waste bins placed at specific locations along roadways and other areas are used to collect residential waste. Monitoring trash cans for collection is frequently a difficult task. It used to be necessary for people to manually monitor various sites for garbage accumulation, which is difficult and time-consuming. Waste management systems today are not as efficient as they may be because they have not completely benefited from technological improvements. At any given place, garbage management and clearance are not guaranteed [10]. An automated waste management system is suggested as a potential solution to this issue[13].

2. MATERIALS & METHODS

Smart Waste Bins : Real-time Monitoring and Alerts: IOT-enabled smart trash cans with sensors allow for real-time fill level monitoring. These containers have the ability to recognize when they reach a certain capacity level and notify waste management staff. This makes it possible for waste to be collected on schedule, preventing overflowing trash cans and preserving cleanliness in public areas.Route Optimization for Waste Collection: Intelligent trash cans can help with route optimization for waste collection. Authorities in charge of trash management can identify the most effective collection routes by gathering information on fill levels from a variety of bins and analyzing the results. This minimizes needless trips to bins with low fill levels and makes it possible for waste collection operations to be more focused and resource-efficient.

Waste Level: Monitoring the amount of trash in the bins enables optimal resource allocation for waste management. Rubbish management authorities can choose the best schedule and frequency of rubbish collection by precisely measuring the fill level. This facilitates efficient resource allocation, resulting in a decrease in pointless travel and an increase in operational effectiveness. Monitoring the amount of waste in the bins assists in preventing overflow, which can result in environmental dangers. Bins that are filled to the brim may overflow, causing litter and perhaps polluting neighboring regions. The risk of overflow and related environmental concerns can be reduced by monitoring the trash level and making sure that it is collected or emptied on schedule, which helps to create cleaner and safer environments.

Sensors: Accurate Data Gathering: In many applications, sensors are essential for obtaining accurate and current data. Sensors can be used to measure waste levels, temperature, humidity, and other pertinent characteristics in the context of waste management. This information offers useful insights into the trash generation trends, facilitating wise resource allocation and decision-making.Efficiency and Automation: Sensors improve process efficiency and enable automation. Sensors in waste management can start automated processes, such as alerting users when waste levels exceed a certain threshold, rerouting waste collectors depending on current data, or managing the functioning of waste compaction equipment. This automation saves time, lessens the need for manual monitoring, and boosts overall operational effectiveness.

AI Recycling: Advanced Sorting and categorization: Recycling systems powered by AI use machine learning algorithms to improve recyclable material sorting and categorization. AI algorithms can accurately detect and classify many materials, including plastics, metals, and paper, by analysing visual and sensor data. As a result, recycling procedures are more effective and better resource recovery is made possible.Waste Management Optimisation: By analysing vast amounts of data and coming to wise conclusions, AI in recycling can improve waste management procedures. Artificial intelligence (AI) algorithms are able to forecast waste production patterns, improve collection routes, and choose the best recycling techniques for certain materials. Through this optimisation, prices are decreased, environmental damage is reduced, and total recycling rates are raised.

Robots: Robotic Sorting and Handling: Sorting and handling recyclable items can be automated by using robots in recycling operations. They can distinguish between different sorts of goods, separate them, and put them in specified bins or conveyors using sophisticated sensors, computer vision, and robotic arms. This automation enhances processing effectiveness, increases sorting accuracy, and decreases the demand for manual labour.Handling Hazardous trash: Robots are essential in the handling of hazardous trash in recycling procedures. To reduce the risk to human employees, they can be fitted with specialized sensors and tools to handle and dispose of hazardous materials securely. Robots are capable of managing hazardous chemicals, disassembling electronic waste, and other jobs, protecting workers and according to environmental rules.

E-Waste Kiosks : Convenient E-Waste Disposal: E-waste kiosks offer people a simple and accessible option to get rid of their unwanted electronics. These kiosks are often found in public areas like shopping malls or community centres, making it simple for individuals to dispose of their unwanted or obsolete electronics. E-waste kiosks promote appropriate disposal of electronic trash by offering designated collection places, lowering the possibility of improper disposal in landfills.

Reliability: Consistent Performance: The ability of a system or product to continuously carry out its intended function without errors or interruptions is referred to as reliability. Reliability is essential in the context of electronic payment systems to guarantee accurate and timely transaction processing. A trustworthy payment system upholds a high level of uptime while minimising downtime and service interruptions, fostering user confidence and system trust. Redundancy and error management: A trustworthy electronic payment system includes strong redundancy and error handling systems. It should be able to seamlessly identify and address errors, such as transaction failures or communication problems.

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Mobility: Flexibility and Convenience: The capacity to conduct business and send payments using mobile devices from any location at any time is referred to as mobility in the context of electronic payment systems. Mobile payment options, such as mobile wallets or payment apps, give consumers the freedom to process payments while on the go, whether they are dining out, buying in-store, or making an online purchase. Since there is no longer a need for real money or credit cards, transactions become easier and more effective. Enhanced consumer Experience: By offering a simple and convenient payment method, mobile payment solutions improve the entire consumer experience. Customers can quickly and easily complete purchases using mobile payments by using only a few clicks on their mobile devices.

Service Continuity: Backup and redundancy systems: The ability of a system or service to continue operating and being accessible despite interruptions or failures is referred to as service continuity. Electronic payment systems frequently include redundancy and backup solutions to guarantee service continuity. In case of a malfunction or outage, this includes redundant servers, network connections, and data centres that can easily take over. Users can continue to conduct transactions without interruption thanks to these redundant systems' contribution to uninterrupted service maintenance and downtime minimization. Disaster Recovery Planning: Having reliable disaster recovery strategies in place is essential for service continuity. Electronic payment systems must plan ahead for potential interruptions like natural catastrophes, cyberattacks, or system outages and have contingency plans in place to resume operations swiftly.

User Convenience: Seamless and prompt transactions: A key goal of electronic payment systems is to make transactions more convenient for users. Users can quickly and easily make payments with electronic payment methods like mobile wallets or contactless cards by tapping or scanning their devices. By doing away with the need for actual currency or card swiping, this streamlines the payment process and saves time.Multiple Payment Options: Users of electronic payment systems have access to a variety of convenient and adaptable payment methods. The use of credit or debit cards, mobile wallets, internet banking, or even biometric authentication is all options available to users while making payments. This diversity makes it possible for users to choose the payment option that best meets their needs and tastes, increasing convenience and guaranteeing a smooth payment experience

Energy Efficiency: Reduced Energy Consumption: To reduce energy consumption and environmental impact, electronic payment systems must take energy efficiency into account. Payment terminals, such as card readers or point-of-sale systems, can be made to work with low-power components and use the least amount of energy possible. Electronic payment systems aid in overall energy sustainability and conservation by reducing energy use. Standby and Power Management: To maximize energy efficiency, electronic payment systems might include power management components. Payment terminals, for instance, can be set up to go into standby mode or shut off automatically after a set amount of time.

Method: By Bridgeman (1922), the Weighted Product Method had been developed. Although the approach has not been extensively used, Yoon and Hwang (1995) claim that it has solid logic and is operationally simple.[1] WPM are frequently used to describe scoring techniques. The Bridgeman-proposed weighted averaged sum product assessment (WASPAS) is a member of the more recent generation of MCDM techniques. With this technique, well-known weighted sum model (WSM) and weighted product model (WPM) methodologies are combined in a novel way.[3] In instances with dynamic environments, it enables excellent ranking correctness. Since it might be difficult for consumers to describe their degree of happiness or discontent with the cloud service providers with regard to the qualities, there is generally confusion in the sharp data.[4]. The approach was used in actual hackers, especially the widespread assaults on Latvia and the Islamic Republic, and the outcomes of the evaluation of the online assaults were given.[5] WPM normalises the performance values of alternatives using equations. It uses many formulae to determine the scores of the choices. The options are ranked by WPM in decreasing order of overall score [10]. In this model, the attribute values are the CSP performance in each measure that is recorded in the history log, while the weights are the QoS preferences supplied by the requesting user.[11] One benefit of WPM is its applicability in both single- and multi-faceted MADMs. The drawback is that there is no solution with an equal weight of the choice vectors instead of real values[12]. The AHP approach is used to determine the relative weights of the various criteria. As a result, the WPM approach is used to rank the potential networks. This technique uses a combination of nets of neurons and utility functions to choose a network. The suggested approach takes use of a fuzzy neural network to gather network-, user-, and terminal-related input criteria and assess each access network's performance [14]. T Multiple Criteria Decision Making (MCDM) models and fuzzy synthesised choices are the foundation of several service choosing methodologies. [21]he findings we have acquired to assess our choice of services offered by the cloud indicated that our model outperforms previous MDMC approaches like TOPSIS, WPM, and the original AHP[17], captures the BDTP extremely well, guarantees Big Data QoS, and scales with the growing number of cloud providers. Through a variety of cloud services from several CSPs, WPM, the SAW, and imposed QoS requirements of Big Data workflows were used[16]. Similar to WSM is the Weighted Product Method (WPM). The primary distinction is that multiplication is required in

WPM rather than addition. The score for total performance is calculated as [18].WPM should be used to promote strict cyber security regulations, according to further research.[13] When choosing a cloud-based cyber security solution, organisations may make educated selections by adhering to the Weighted Product Methodology. The methodical assessment of various criteria and the weights given to them aids in the prioritisation of needs and the choice of a solution that best fits the organization's cyber security goals[25].

3. RESULT AND DISCUSSION

TABLE 1. Data Set

	Reliability.	Mobility.	Service Continuity.	User Convenience.	Energy Efficiency.
Smart Waste Bins	0.2513	0.7897	0.6510	0.5193	0.8496
Waste Level Sensors	0.6328	0.9775	0.6669	0.4478	0.0206
AI Recycling Robots	0.4937	0.3698	0.3597	0.4222	0.3928
E-Waste Kiosks	0.1074	0.0040	0.9872	0.0237	0.8644

Table 1. Shows the data set of garbage management based on IOT of smart waste bins, waste level sensors, AI recycling robots , Ewaste kiosks and their reliability , mobility , service continuity , user continuity , energy efficiency .

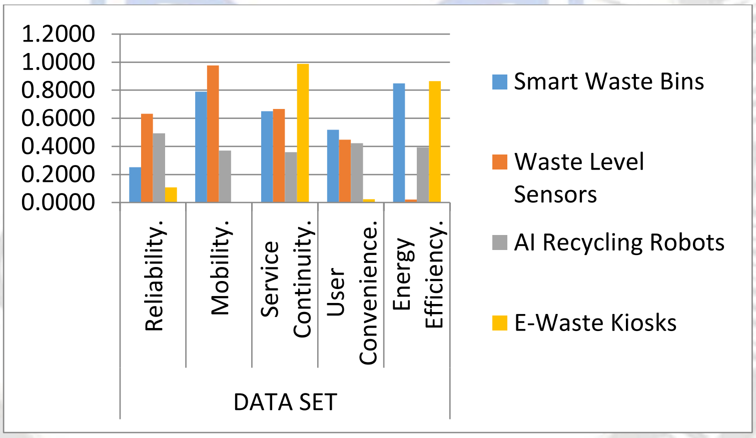

FIGURE 1. shows data set

FIGURE 1. Shows the graph of data set garbage management based on iot of smart waste bins, waste level sensors, AI recycling robots , Ewaste kiosks and their reliability , mobility , service continuity , user continuity , energy efficiency

TABLE 2. Performance value

Reliability.	Mobility.	Service Continuity.	User Convenience.	Energy Efficiency.	
Smart Waste Bins	0.39723	0.80785	0.65938	1.00000	0.98283
Waste Level Sensors	1.00000	1.00000	0.67552	0.86242	0.02385
AI Recycling Robots	0.78020	0.37832	0.36435	0.81308	0.45446
E-Waste Kiosks	0.16973	0.00407	1.00000	0.04565	1.00000

It seems that the table you provided includes different wireless communication technologies, such as Circuit-switched cell, CDPD (Cellular Digital Packet Data), WLAN (Wireless Local Area Network), Paging, and Satellite. The table includes several criteria or metrics for evaluating these technologies, namely data rate (in kbps), geographic coverage, service requirements, and cost. Each technology has been assigned a value for each criterion.

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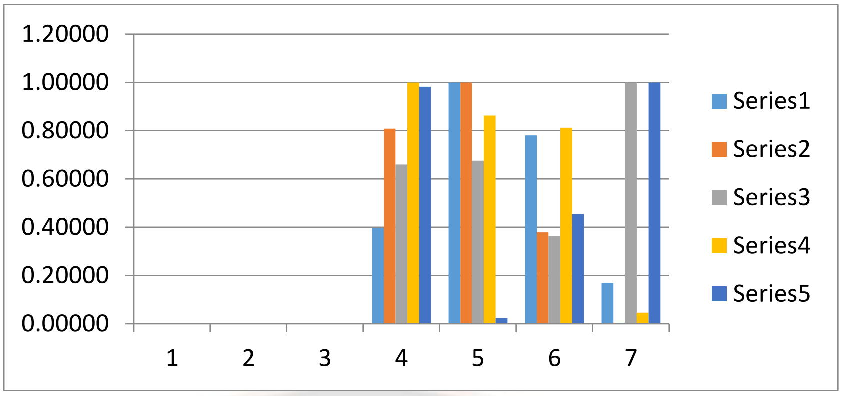

FIGURE 2. Performance value

FIGURE 2. Shows the graph of performance values of garbage management based on IOT of smart waste bins, waste level sensors, AI recycling robots , Ewaste kiosks and their reliability , mobility , service continuity , user continuity , energy efficiency

TABLE 3. Weightages

Reliability.	Mobility.	Service Continuity.	User Convenience.	Energy Efficiency.	
Smart Waste Bins	0.20	0.20	0.20	0.20	0.20
Waste Level Sensors	0.20	0.20	0.20	0.20	0.20
AI Recycling Robots	0.20	0.20	0.20	0.20	0.20
E-Waste Kiosks	0.20	0.20	0.20	0.20	0.20

Table 3. Shows Each technology or solution is represented by a row in the table, and the values in each row (0.20 for each category) seem to indicate equal weight or importance assigned to each criterion. However, without further context or information, it is difficult to determine the specific meaning or interpretation of these values..

TABLE 4. Weighted normalized decision matrix

	Reliability	**Mobility**	**Service Continuity**	**User Convenience**	**Energy Efficiency**
Smart Waste Bins	0.83140	0.95822	0.92008	1.00000	0.99654
Waste Level Sensors	1.00000	1.00000	0.92454	0.97083	0.47370
AI Recycling Robots	0.95157	0.82333	0.81716	0.95946	0.85408
E-Waste Kiosks	0.70138	0.33255	1.00000	0.53938	1.00000

Table 4. Shows values represent the performance or evaluation of each technology/solution in the specified categories. For example, Smart Waste Bins have high scores in reliability, mobility, service continuity, user convenience, and energy efficiency, while Waste Level Sensors have a perfect score in reliability and mobility but a lower score in energy efficiency. AI Recycling Robots show a good performance in reliability and user convenience, and E-Waste Kiosks score well in service continuity and energy efficiency.

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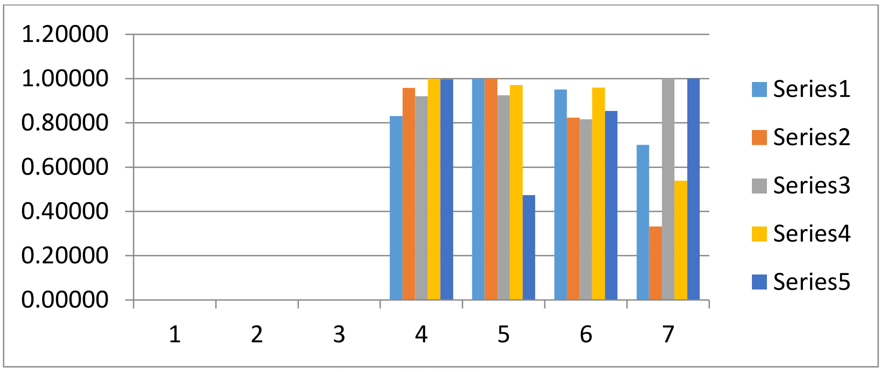

FIGURE 3. Weighted normalized decision matrix

Figure 4. Graph ofthe weighted normalized decision matrix.It's important to note that the interpretation of these scores depends on the specific criteria and weighting assigned to each category. Without additional information about the significance of these metrics or the criteria used for evaluation, it's difficult to provide a more in-depth analysis.

TABLE 5. Preference Score

Smart Waste Bins	0.73046
Waste Level Sensors	0.42518
AI Recycling Robots	0.52462
E-Waste Kiosks	0.12581

Figure 5 These preference scores indicate the relative preference or desirability of each technology. Based on the scores, Smart Waste Bins have the highest preference score, followed by AI Recycling Robots, Waste Level Sensors, and E-Waste Kiosks. However, without further information about the criteria or context of the evaluation, it is challenging to interpret the exact meaning or significance of these scores.

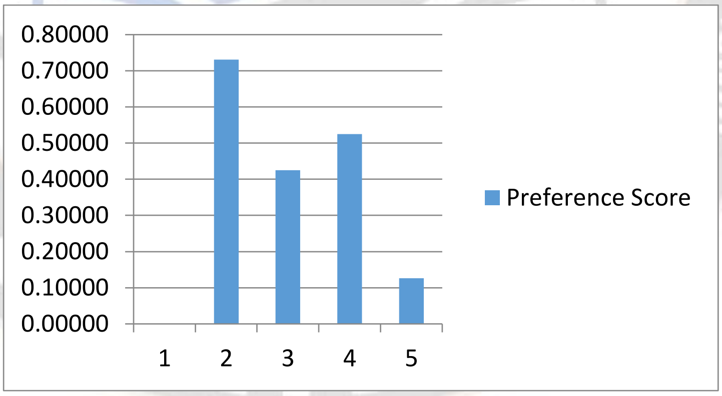

FIGURE 4 performance

Figure 5. Shows the graph ofthe performance ofgarbage management based on IOT of smart waste bins, waste level sensors, AI recycling robots , Ewaste kiosks and their reliability , mobility , service continuity , user continuity , energy efficiency.

TABLE 5. Ranking

Smart Waste Bins	**1**
Waste Level Sensors	**3**
AI Recycling Robots	**2**
E-Waste Kiosks	**4**

Smart Waste Bins is first rankings, Waste Level Sensors third ranking, AI Recycling Robots second rank, and E-Waste Kiosks fourth rank.

4. CONCLUSION

A variation of the WSM called the weighted product method (WPM) has been proposed to address some of the weaknesses of The WSM that came before it. The main distinction is that the multiplication is being used in place of additional. The terms "scoring methods" are frequently used to describe WSM and WPM. A member of the more recent creation of MCDM techniques is the weighed aggregated sum product assessment (WASPAS) put forth by 15. The weighted total model (WSM) and weighted product model (WPM) addresses are two well-known addresses that are combined in this way (26).distinct descriptions of computing in the cloud are being developed by analyst companies, academics, industry professionals, and IT firms. Table 1 lists a variety of descriptions of online computing from various analyst firms (27).The weighed product, in which matrices are combined random, in which an arbitrary unbiased is chosen to be optimised at each step. When the weights are used to aggregate numerous matrices, two approaches can be employed to determine the weights that are used at every stage of the method dynamically: fixed, in which we can give to all ants the identical weight and every goal has the same significance throughout the method run; and assigning each ant a weight that differs from the rest of the ants at each repetition (28).Our method yielded a total of three clusters. The clustering empathy calculation was subsequently performed using a weighted product model. Three values, one for each, have been calculated obtained through the use of this product model (29).This paper proposes a novel approach that utilises online computing and enhanced k-means method. The precision of the method for clustering is increased through the enhanced k-means method, and its parallel processing on the basis of the MapReduce model increases the algorithm's effectiveness (30).The interaction between both of these hierarchies must be taken into account. With this particular approach, every hierarchy is viewed as a single component, and corresponding priorities are calculated after comparisons of pairs with respect to an unique order (31).Manually choosing the best option is very time-consuming. Consequently, a scalable and computerised method of cloud buying resources is required. Although cloud vendors are not yet providing standardised services, Rochwerger et al. note that this will need to change and that the "federated cloud has enormous potential." In such a scenario, it would be feasible to combine and swap resources provided by various cloud vendors and streamline the acquisition of the aforementioned assets (32).Due to its intellect and implied concurrency, artificial intelligence techniques like evolutionary computation, particularly when used in neural networks, have gradually gained attention (33).The corresponded to model approach can have biases against new goods and quality. A matched model cannot account for the implicit cost change brought on by an improvement in the product's quality; this bias is known as excellence bias (34).The Weighted Product Method (WPM), a technique from the field of multifaceted decision-making, is recognised as a straightforward, lightweight, yet effective method of contrasting substitutes in terms of numerous criteria, not always presented in the same units (in contrast to a similar, yet less useful, approach). Method of Weighted Sums (35).In the event that there are multiple pheromone matrices that the pheromone matrix collection and a heuristic function must be used. The weighed sum, the weighted product method, and choice at random are among the most frequently used operations (36).There are only two levels of priority overall: high and low. Every node begins with a low priority. It is anticipated that traffic that is permitted to move to a higher priority will receive better service. In the following section, alternative approaches to raising a particular node's priority are provided (37).The WASPAS technique combines the weighted sum method (SAW) and the weighted product method, two multifaceted decision-making techniques. The individuals involved in the MABAC method calculate the separation between each alternative's standards operate and the border's approximation area (40). the one that is closest in weight to PM2, the ideal PM, which is PM1. However, after moving VM2 to PM2, PM2's memory usage rises to 0.51 percent, which is above the threshold. Next, TOPSIS must perform another relocation, and it decides to shift VM2 to PM1. RIAL calculates a comparable ideal PM as TOPSIS, but weights memory more heavily. As a result, it selects PM1 as the location with the most brief weighted distance (41).decision support system can perform the process of calculating employee performance appraisal with the best value results, so as to realize a fair assessment based on existing criteria calculated on this system using weighted product weighting (WP) that can produce the best employee performance appraisal system calculation from the highest value up to the lowest value. The highest score is the best employee while the lowest score is the worst employee performance (45)

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