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A CASE STUDY ON SOLID WASTE MANAGEMENT AND DISPOSAL USING GISANDGPSOFBANGALORESOUTHAREAS

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Abstract- *The rapid increase in solid waste poses a significant challenge for developing nations, primarily driven by shifting lifestyles, urbanization, and population growth across the country. Managing the growing volume of solid waste has become increasingly difficult. Effective waste disposal and transportation are crucial aspects that demand immediate attention. The primary objective is to gain a comprehensive understanding of the present scenario of a solid waste disposal site using GIS. By analyzing spatial data, including the distribution, quantity, and characteristics of the waste, the project aims to inform effective waste management strategies. Furthermore, this study focuses on evaluating the existing procedures related to solid waste collection, transportation, and disposal within the study area. By examining current practices, strengths, and weaknesses can be identified, leading to recommendations for process optimization and improvement. By tracking and monitoring waste collection vehicles in real-time, the project aims to prevent illegal dumping by ensuring adherence to designated routes and authorized disposal sites. This measure enhances control and accountability within waste management operations, promoting a more efficient and environmentally friendly approach. As the quantity of solid waste varies across different wards, it is essential to address this issue in developing countries. Protecting the surrounding environment requires a collaborative effort involving government bodies, local authorities, and the community residing in the area. By collectively addressing the problem of solid waste and regulating human activities, we can ensure a sustainable and cleaner environment.*

Keywords:Urbanization, Population growth, SolidWaste, Global Positioning System (GPS), Geographical Information System(GIS).

Introduction

Waste materials, generated as a result of human activities, exert a severe impact on the surrounding environment and human health. Solid waste encompasses non-liquid items originating from households, municipalities, supermarkets, construction sites, and more. Irrespective of country development status, solid waste remains a pressing issue (UNEP, 2005; United Nations, 2017). Developing countries, experiencing population growth and increased human activities, witness a notable surge in solid waste quantities. Hence, it becomes crucial to identify appropriate methods for solid waste management and disposal (Ahmed and Surya Bhagavan, 2021).

The impact of solid waste on human health is a significant concern. Rapid population growth, accelerated economic development, and changing lifestyles have contributed to the increased production of solid waste worldwide (Elmira et al., 2010; Herring, 2010). The primary objective is to gain a comprehensive understanding of the present scenario of a solid waste disposal site using GIS. By analyzing spatial data, including the distribution, quantity, and characteristics of the waste, the project aims to inform effective waste management strategies. Failing to implement an effective solid waste management system can lead to numerous issues, including the transmission of diseases, pollution of ground and surface water, greenhouse gas emissions, disruption of ecosystem services, and negative effects on tourism and other business activities (Birara Endalew and Kassahun Tassie, 2018).

In recent years, Geographical Information System (GIS) has emerged as a crucial tool in decision-making processes. One significant advantage of utilizing GIS in the site selection process is its ability to save time and cost. Additionally, GIS provides a digital data inventory for long-term monitoring of the selected site (Ahmed and Suryabhagavan, 2021). Remote Sensing, in conjunction with GIS, offers valuable information on various spatial criteria such as land-use/land-cover. The disposal site for solid waste disposal must have, several factors such has: it should be located away from towns or cities to mitigate potential risks; situated at a safe distance from water bodies to prevent contamination; have adequate road infrastructure for efficient transportation of solid waste, and be free from undesirable characteristics like mud

cracks.

LiteratureReview

Duguma Erasu et. Al.,[1] Efficient municipality to be formed. New and effective strategies to be implemented. Create public awareness and importance of their involvement in cleanliness drive.

Joel R. Kinobe, et. Al.,[2] Implement efficient of waste collection methods and proper functioning of existing waste collection systems. Strict action in proper disposal of municipal wastes. Dedicated sites for disposal might avoid problems of illegal dumping in open areas.

Ajay Singh[3] Out of all the methods implemented, optimization models are proved to be effective. Ecological effects must be considered before implementing any policy for waste disposal. GIS can be used to track waste bins and proper functioning of the vehicles that collects waste.

M. Irfan Yesilnacar, et. Al.,[4] Current factors such as rapid urbanization must be considered. When considering site for landfill, the site must be suitable and take factors such as public health, hygiene, public reactions, noise, dust etc. GIS with MCDA(multi-criteria decision analysis) can produce effective results by considering the above factors.

Ahmed Musa & K. V. Surya Bhagavan[5] Identify suitable land disposal sites keeping in mind, it has to avoid environmental problems. The shifted site must be easy to dispose and travel time should be less. As these must be cost effective methods in underdeveloped /developing city. Municipality must consider awareness to public in terms of recycling and reuse.

Rajkumar Joshi & Sirajuddin Ahmed[6] Public awareness to segregate the waste into biodegradable, inert and recyclable materials. Initially composting plants will reduce the weight on the municipality for collection and transportation of wastes. Zone wise collected of waste is recommended for metro polytan cities.

Birara Endalew & Kassahun Tessie[7] Proper municipality to be formed which must also be effective. More effectiveness, more people will be satisfied with the outcome , hence the percentage of payers will increase from 22%. The municipality must strictly provide and track solid waste management services as promised. Effective monitoring and evaluation of services must be implemented.

Michel Soto Chalhoub[8] Public awareness to avoid waste to more extent created. Strict public policies must be implemented and maintained.

Kassahun Tessie & Birara Endalew [10] The pay for disposal method should not be high as it can lead to illegal dumping and it maximizes the cost recovery. Low payment and effective provision in the waste management service can increase the willingness to pay. The municipality must keep in mind, the education levels income and quantity generated per week to fix an amount so that the public will pay accordingly.

Junaid Qadir, Perminder Singh [11] Municipality must form a body to treat sewage waste from lake houses for clear water/water transparency. Proper monitoring can also reduce threat to ecosystem.

K. M. Elsheekh, et. Al.,[12] Solid waste management plans must consider and set goals to improve quality of life and health in cities. It must also be favorable by providing work by supporting industrialization and innovation.

Dipanjali Majumdar & Anjali Srivastava[13] The dumpsite emissions are particularly harmful for the health of the workers and the surrounding environment. Thus, regular health check-up must be done for the workers.

Bibi Ilmas, et. Al.,[14] This study can be useful for the baseline for policy makers to develop a waste management solution for the study area.

Taieb Waf, et. Al.,[15] It is important to point out that it is possible to use new generation bacteria for the processing of plastic waste. This is useful for the decomposition of waste from the wood industry.

Objectives

1) The primary aim of this project is to employ Geographical Information System (GIS) to know the present scenario of the solid waste disposal site.
2) This study focuses on examining the existing procedures related to solid waste collection, transportation, and disposal within the study area.
3) By leveraging Global Positioning System (GPS) the project aims to prevent unauthorized waste disposal through vehicles.

Use of GIS in Solid Waste Management

The use of GIS (Geographical Information System) in solid waste management has become increasingly prevalent

and beneficial. Here are some key uses of GIS in solid waste management:

Site Selection: GIS is utilized to identify suitable locations for waste disposal sites, considering various factors such as proximity to population centres, environmental impact, transportation accessibility, and land availability. GIS helps in analysing spatial data and making informed decisions about the optimal placement of waste disposal facilities.

Route Optimization: GIS plays a crucial role in optimizing waste collection routes. By integrating data on waste generation points, road networks, and other relevant factors, GIS can generate efficient collection routes that minimize travel time, fuel consumption, and associated costs. This helps in improving the overall effectiveness of waste collection operations.

Asset Management: GIS enables the management of waste management infrastructure assets such as landfills, recycling centres, transfer stations, and waste treatment facilities. It provides a centralized database for tracking and maintaining information about these assets, including their location, capacity,
maintenance history, and operational status. This information aids in efficient asset management and long-term planning.

Data Visualization and Analysis: GIS allows for the visual representation and analysis of various data layers related to solid waste management. It can integrate data on waste generation rates, population density, land use patterns, environmental factors, and socio-economic indicators. By overlaying and analysing these data layers, GIS helps in identifying patterns, trends, and potential areas of improvement in waste management practices.

Environmental Impact Assessment: GIS aids in assessing the environmental impact of waste disposal sites. It can integrate data on soil characteristics, hydrology, topography, and sensitive ecological areas to evaluate the potential risks and impacts associated with waste disposal activities. This information supports decision-making processes to mitigate environmental risks and protect sensitive ecosystems.

Public Engagement and Education: GIS can be used to create interactive maps and web-based platforms to engage the public and raise awareness about solid waste management. These tools provide information about waste collection schedules, recycling centres, and proper waste disposal practices. GIS-based public engagement initiatives help in promoting community participation, behaviour change, and the adoption of sustainable waste management practices.

Overall, GIS provides valuable spatial analysis capabilities, data integration, and visualization tools that enhance the efficiency, effectiveness, and sustainability of solid waste management. By leveraging GIS technology, waste management authorities can make informed decisions, optimize operations, minimize environmental impacts, and improve public engagement in the management of solid waste.

Use of GPS in Solid Waste Management

GPS (Global Positioning System) technology plays a significant role in solid waste management. Here are some key uses of GPS in solid waste management:

Vehicle Tracking and Routing: GPS enables real-time tracking of waste collection vehicles, allowing managers to monitor their location, movement, and routes. This information helps optimize collection routes, ensure timely pickups, and identify any deviations or inefficiencies in the

collection process. GPS tracking also facilitates better coordination and communication between drivers and dispatchers.

Bin and Container Management: GPS technology can be used to track the location and status of waste bins and containers. By equipping bins with GPS devices or using smart sensor technology, waste management authorities can monitor the fill level of containers, optimize collection schedules, and identify bins that need immediate attention, such as emptying or maintenance.

Asset Management: GPS helps in managing and maintaining waste management assets such as recycling centers, transfer stations, and treatment facilities. By accurately recording the location and condition of assets using GPS, authorities can effectively plan maintenance activities, track asset utilization, and ensure regulatory compliance.

Illegal Dumping Prevention: GPS technology can aid in preventing illegal dumping by monitoring and securing vulnerable areas. GPS-enabled cameras and sensors can be installed at strategic locations to capture evidence of unauthorized waste disposal activities. This data can be used for enforcement purposes, improving surveillance, and deterring illegal dumping practices.

Regulatory Compliance and Reporting: GPS data can be utilized for regulatory compliance and reporting purposes. By recording GPS coordinates during waste collection and disposal activities, authorities can maintain accurate records of waste movement, track compliance with regulations, and generate reports on waste management activities, such as volumes collected, routes taken, and disposal sites used.

Data Integration and Analysis: GPS data can be integrated with other spatial data, such as GIS layers, to provide a comprehensive view of waste management operations. By combining GPS data with demographic, environmental, and infrastructure data, authorities can perform spatial analysis to identify areas with high waste generation rates, assess the effectiveness of collection routes, and make informed decisions for resource allocation.

In summary, GPS technology enhances the efficiency, transparency, and accountability in solid waste management. It enables vehicle tracking, optimized

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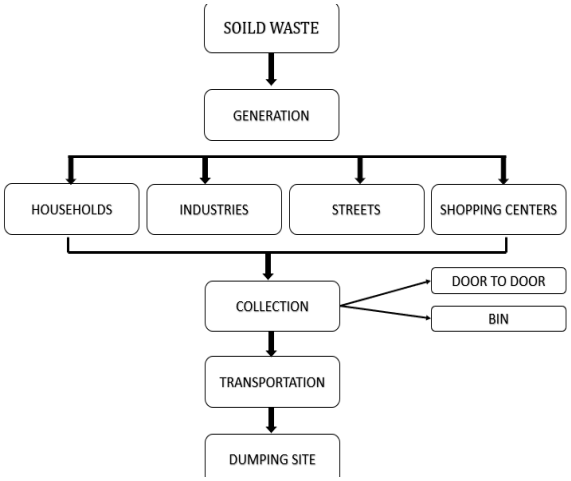
routing, asset management, illegal dumping prevention, regulatory compliance, and data analysis. By leveraging GPS technology, waste management authorities can improve operational efficiency, reduce costs, enhance service quality, and promote sustainable waste management practices.

Methodology

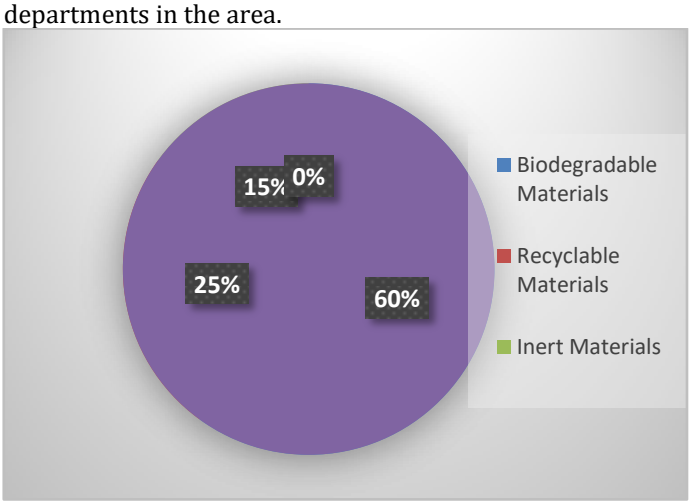


Generation: The generation of solid waste refers to the production and accumulation of discarded materials that are not liquid or gaseous in nature. It includes various forms of waste such as household garbage, industrial waste, construction debris, and agricultural residue. Solid waste is generated through human activities, consumption patterns, manufacturing processes, and natural events. The improper management of solid waste can lead to environmental pollution, health risks, and depletion of natural resources. Effective waste management strategies are essential to minimize the generation of solid waste and promote sustainable practices.

Waste Composition: In Bangalore South, the solid waste composition typically includes a mix of biodegradable waste, recyclable materials, and inert materials.

1) Biodegradable Waste: This category includes organic waste that can naturally decompose over time. It primarily consists of food waste, kitchen scraps, yard trimmings, and other organic materials.
2) Recyclable Materials: These are materials that can be processed and reused to produce new products. Common recyclable materials found in solid waste include paper, cardboard, plastic bottles, glass containers, metal cans, and certain types of packaging materials.
3) Inert Materials: This category comprises non-biodegradable and non-recyclable materials that do not undergo significant decomposition or chemical changes over time. Examples of inert materials include construction debris, ceramics, certain plastics, and other materials that are not easily recycled or biodegradable.

It's important to note that the exact composition of solid waste in Bangalore South may vary depending on factors such as waste management practices, recycling efforts, and public awareness campaigns. For the most accurate and up-to-date information on the current solid waste composition in Bangalore South, I recommend contacting the local municipal authorities or waste management departments in the area.



Collection: That's a comprehensive and accurate description of the importance of solid waste collection in the waste management process. Efficient collection systems are indeed crucial for effective waste management and environmental sustainability. By ensuring proper containment and removal of waste materials, collection systems play a significant role in preventing pollution, maintaining hygiene, and reducing the risks associated with uncontrolled waste disposal.

Curbside pickup by waste management trucks is a commonly used collection method in urban areas, where waste is collected directly from households or businesses. This system promotes convenience for residents and ensures regular waste removal. Communal collection points are often used in areas with limited access for waste management trucks, where residents bring their waste to designated locations for collection. This method can be cost-effective and efficient for areas with high population density.

Specialized collection services for hazardous or bulky waste, such as electronic waste, construction debris, or hazardous chemicals, are crucial to prevent improper disposal and potential environmental and health hazards. These services ensure that specific types of waste are handled safely and transported to appropriate facilities for treatment or disposal.

Promoting recycling and waste segregation at the source is also an important aspect of waste collection. By

encouraging residents and businesses to separate recyclable materials from general waste, collection systems can facilitate the diversion of recyclable materials, reducing the amount of waste sent to landfills or incinerators.
Overall, a well-designed and efficient waste collection system is essential for effective waste management. It ensures that waste is properly managed from its source to designated facilities for further processing or disposal, promoting environmental protection and public health.

Collection Containers: You are correct that waste collection containers are crucial in the waste management system. Here are some additional points to consider regarding the role and importance of waste collection containers:
Efficient Waste Collection: The type, size, and location of containers greatly impact the efficiency of waste collection. Properly chosen containers ensure that waste is effectively contained, reducing the risk of littering and improving the overall cleanliness of the area.
Source and Location-Based Variation: Different sources of waste generation, such as residential, commercial, institutional, and industrial areas, require containers of varying sizes and types. Residential areas with single-family households typically require smaller containers, while commercial and industrial areas need larger containers to accommodate higher waste volumes.
Manual vs. Mechanical Handling: The size of the containers determines the method of handling. Small containers can be easily handled manually by waste collection personnel. On the other hand, larger containers often require mechanical handling equipment such as cranes or forklifts for efficient loading onto collection vehicles.
Waste Segregation: Containers can also be designed for specific types of waste, such as recyclables, organic waste, or hazardous materials. Proper segregation at the source using different containers facilitates efficient sorting and recycling processes.
Location and Accessibility: Containers should be strategically placed in easily accessible locations to ensure convenient waste disposal for residents or businesses. Placing containers at appropriate intervals and in high-traffic areas reduces the distance residents or waste generators need to travel to dispose of their waste.
Durability and Longevity: Waste collection containers should be durable and able to withstand various weather conditions, as well as resist damage from misuse or vandalism. Long-lasting containers reduce maintenance and replacement costs.
Safety Considerations: Containers should be designed with safety in mind, considering factors such as sharp edges, lid mechanisms, and locking systems to prevent unauthorized access or spillage of waste.
Regular Maintenance: Proper maintenance, cleaning, and disinfection of containers are essential to ensure hygiene, prevent odor, and minimize the risk of disease transmission. Regular inspections should be conducted to identify and address any damage or issues promptly.
In conclusion, waste collection containers are critical components of an effective waste management system. Their selection, size, and placement should be carefully considered to optimize waste collection efficiency, promote proper waste segregation, ensure safety, and maintain a clean and sustainable environment.

Characteristics of Storage containers: The size and characteristics of storage container plays an essential role in waste collection. Selection of good container can save collection energy, increase the speed of collection and reduce the crew size. The characteristics to be considered while selecting a container include

- Low cost: The containers should be affordable and economical to minimize the overall cost of waste collection.
- Size and weight: Containers should be of appropriate size to avoid health hazards for the waste collectors. They should not weigh more than 20 kg to prevent muscular strain and injuries.
- Surface smoothness: Containers should have a smooth surface to prevent waste from sticking and decomposing on rough surfaces. Rough containers are also more challenging to clean.
- Absence of sharp edges: Containers should be designed without sharp edges to avoid injuries to the waste collection crew during handling.
- Inert materials: Containers should be made of inert materials to prevent any reactivity between the waste and the container. For example, avoiding iron containers that can corrode due to moisture in the waste.
- Covered containers: Containers should be covered to prevent rainwater from entering and increasing the weight and decomposition rate of the waste. Covered containers also prevent stray animals from accessing the waste.
- Strength and durability: Containers should be strong and durable to withstand rough handling during manual and mechanical unloading. This reduces the frequency of container breakage and lowers the collection cost.
- Wheels, handles, hoists, and tails: Containers should be equipped with wheels to facilitate movement, handles for easy carrying, and hoists and tails for lifting and unloading.
- Moisture resistance: Containers should not absorb moisture to avoid bacterial and fungal

growth, which can accelerate the decomposition rate of the waste. Materials like wood or bamboo should be avoided.

- Light, smooth, corrosion-resistant, inert, and recyclable materials: The container material should possess these characteristics to ensure efficient waste collection. Containers lacking these qualities may create problems, increase collection costs, and decrease collection efficiency.
- Considering these factors when selecting waste collection containers can contribute to an effective and sustainable waste management system.

Types of storage containers

Broadly, there are two principle types of collection containers: **stationary and hauled/ movable containers**.

Stationary containers: Stationary containers are fixed at specific locations for waste storage. The waste collection crew manually transfers the waste from households, commercial establishments, or other sources into these containers. However, there are instances when the waste is directly emptied from the stationary containers into the collection vehicle using mechanical means. This can be achieved through the use of cranes, hydraulic systems, or other equipment that allows for efficient transfer of waste from the stationary containers to the collection vehicle.

Fig: Stationary containers

Hauled/ movable containers: Types of Communal Containers: Communal containers are typically fixed in public places such as parks, residential colonies, shopping streets, office buildings, and institutions. They can be either stationary (fixed on the ground) or movable (equipped with wheels).

- Purpose and Usage: Communal containers are intended for public use and serve as a central point for waste disposal in high-traffic areas. They are designed to accommodate waste generated by the general public.
- Challenges in Maintenance: Communal containers, especially open ones, face challenges during rainy weather as rainwater can enter the container, increasing the weight of the waste and accelerating decomposition. This can result in obnoxious odors and attract flies, insects, rodents, and other stray animals.
- Manual Cleaning: Communal containers require manual cleaning, which adds to the cost of waste collection. Regular cleaning is necessary to maintain hygiene and prevent the accumulation of waste residue.
- Transfer and Collection Process: In cases where communal containers are built below the vehicle level, additional steps such as swiping, cleaning, and loading waste into transfer containers may be required before loading into collection vehicles. This extra process increases the collection time and effort.
- Capacity Variation: Movable communal containers typically have a capacity ranging from 1 to 4 cubic meters. However, in areas with high rates of waste generation, such as large commercial centers or wet markets, the capacity of communal containers can range from 12 to 20 cubic meters to accommodate the higher waste volume.
- Odor and Maintenance Issues: Due to limited maintenance, communal containers can emit foul odors, negatively impacting the surrounding environment. The lack of regular maintenance and cleaning can also lead to a higher rate of failure or malfunction.

- In recent times, efforts have been made to address some of the challenges associated with communal containers. For example, providing hoists and tails compatible with collection vehicles' lifting mechanisms can facilitate the emptying of these containers, improving the efficiency of waste collection operations.

It is important to continuously assess and improve communal container systems, considering factors such as container design, maintenance protocols, and waste management practices to minimize odors, ensure proper waste containment, and enhance the overall efficiency of waste collections in public areas.

Fig: Hauled/ movable containers

Transportation: Transportation of solid waste involves the movement of collected waste from the collection points to the final disposal or treatment facilities. It typically employs various modes of transportation such as waste trucks, trailers, trains, barges, and even specialized vehicles for hazardous waste. Waste is often compacted and secured during transportation to reduce volume and prevent littering or release of harmful substances. Proper handling, containment, and adherence to safety regulations are essential to prevent spills, odors, and environmental contamination during transportation. Efficient transportation systems are crucial for timely waste disposal, reducing the carbon footprint associated with waste management, and ensuring the overall effectiveness of the waste management process.

Disposal Site: A dumping site, also known as a landfill or disposal site, is a designated area where solid waste is deposited and buried. Dumping sites are carefully engineered to minimize environmental impact and public health risks. They often feature liners and leachate collection systems to prevent the contamination of soil and groundwater. The waste is compacted and covered with layers of soil to reduce odors, discourage pests, and promote decomposition. Dumping sites require proper management and monitoring to ensure compliance with regulations and prevent pollution. However, it is worth noting that modern waste management practices prioritize recycling, composting, and waste-to-energy alternatives over traditional dumping sites, as part of efforts to reduce waste and promote sustainability.

About Mittaganahalli

According to Census 2011 information the location code or village code of Mittaganahalli village is 613065. Mittaganahalli village is located in Bangalore East taluka of Bangalore district in Karnataka, India. It is situated 15km away from sub-district headquarter Bangalore East (tehsildar office) and 15km away from district headquarter Bangalore. As per 2009 stats, Kannuru is the gram panchayat of Mittaganahalli village.

The total geographical area of village is 135.24 hectares. Mittaganahalli has a total population of 1,010 peoples, out of which male population is 545 while female population is 465. Literacy rate of mittaganahalli village is 39.90% out of which 44.40% males and 34.62% females are literate. There are about 266 houses in mittaganahalli village. Pincode of mittaganahalli village locality is 562149. BBMP is nearest town to mittaganahalli for all major economic activities, which is approximately 15km away.

Conclusion

The generation of solid waste has significantly increased in recent years due to global population growth and rapid urbanization, leading to improper disposal and poor waste management practices in the Bangalore south areas. This study aims to identify a suitable site for solid waste disposal using GIS and remote sensing techniques while ensuring minimal harm to the surrounding environment and public health. Additionally, the study will assess the current condition of the landfill site and examine the environmental issues faced by the surrounding areas.

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