

An Integrated Approach for Municipal Solid Waste Management: a Model Study from Vijayawada

Rushita Tummala, S.S.Asadi, D. Satish Chandra

Abstract: Solid waste is produced from multiple sources such as households, hospitals, industries, offices and markets. In this current century, solid waste management is one of the major issues which effect health, climate, food and resources. Thus a place like India, need to have better solid waste management techniques. To overcome these waste management issues, Indian government initiated "SWATCHH BHARAT" program. Recently united A.P has been divided into two states Telangana and Andhra Pradesh due to bifurcation leading Amravathi as new capital to A.P. Due to this, there is a drastic increase of population in Vijayawada. This current study researches on solid waste management techniques and site selection for solid waste management in Vijayawada. Waste generated from Vijayawada has been dumping in Pathapadu dump yard unscientifically where it is also insufficient due to sudden growth of population. Keeping these issues in view the disposal site selection with in 10km buffer zone is taken. By using RS and GIS, different thematic layers are prepared based on the requirement from satellite imaging of Vijayawada city. By integrating and applying Analytical hierarchy process (AHP) process to these spatial and attribute data efficient landfill site is selected scientifically along with identifying solid waste transportation path with best and affordable management strategies for proper utilization of municipal solid waste and management of natural resources for sustainable development. This type of study can be applied and implemented for any study area globally.

Index terms: solid waste, thematic layers, spatial data, Analytical hierarchy process (AHP).

I. INTRODUCTION

Municipal solid waste is commonly known as garbage which includes several kinds of wastes. Solid waste management is most critical element in present developing countries and cities. Improper management of solid waste and increase of population leads stress and creates many health and environmental issues. Municipal solid waste consist different composition of waste and they will have several issues [1]. Separation of the wet and dry waste at house hold level itself is better to solve many solid waste management problems [2]. Even using biological methods are better to manage organic waste and by using these methods quantity of waste disposal can be reduced [3]. Now a day's many countries are using public private partnership for effective waste management [4, 5] and also they are involving public in waste management by involving

them waste management issues are known well and manage can be done in effective manner [6]. Even Indian solid waste management systems have several drawbacks and issues [7] mostly in urban cities it is difficult to manage the waste so waste separation should be done from house hold level itself [8]. Even townships should follow waste management in their communities like Vavuniya township following separation of plastic material and depositing in bins provided at their town ship [9].

Waste disposal is most difficult part and it should be done so carefully [10]. So the major thing required for waste disposal is landfill site it should be selected carefully and following important factors [11].

Generally every municipal solid waste management system has several components such as Collection, Transfer, and Disposal of waste.

Collection: Collection of solid waste is first and major step of solid waste management which includes collecting the heaps of waste generated by households, industries and from other different sources.

Transportation: It is second major step of solid waste management. The collected waste will be transferred to treatment points, or transfer station or disposal sites by vans, trucks etc in this step.

Disposal: It is final step and different disposal methods are used worldwide such as open dumping, landfill, composting, incineration etc. But most popular methods are dumping and land filling.

A. Description of study area

Vijayawada is under developing city which has been spread in 61.88 Sq.kms (as per 2011). This city has 59 wards and they has been divided in 3 circles each circle consists of

Circle 1: 16 wards

Circle 2: 22 wards

Circle 3: 21 wards.

Vijayawada city population rate has been increased from 8 lakh 45 thousand to 10 lakh 40 thousand in 2001 to 2011 years. Now Andhra Pradesh got new capital Amravathi. Due to this many people migrated to Vijayawada city so the population has been increased to 13 lakh approximately in recent years. This sudden increase of population creates increase of waste generation rate. As per 2011 census 550 tons of waste is generating per day consisting of 40% organic fraction and 37% combustible

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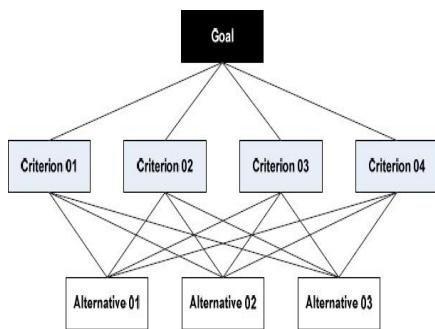


fraction and remaining 23% is inert and recyclable waste. This amount of solid waste obtained from residential area or house cluster and then it is transferred to transfer station from there the waste is transported to landfill site. The growth rate of waste from 2001 to 2011 is 101 tons of waste.

The main remedy is that people should make efforts to reduce the waste produced from their household activities. The solid waste management should be done based on two goals that is recycling & composting and reducing the waste from its sources.

B. Analytical hierarchy process

It is a process used to take complicated and difficult decisions. These decisions will be taken by disposing the task into simpler components as shown in Flow chart 1 in this paper disposal site is selected using AHP method.



Flow chart 1: Analytical hierarchy process

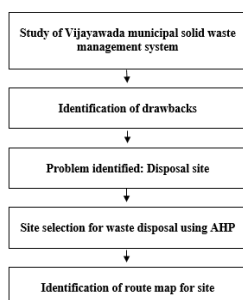
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II. RESEARCH SIGNIFICANCE

The main aim of this paper is to study the status of existing scenario of solid waste management in Vijayawada city and Identification and selection of disposal site using Analytical Hierarchy Process (AHP) and to select shortest path for solid waste transportation from collection point to the dumping site along with proper solid waste management plan and strategies to Vijayawada city.

III. DESCRIPTION OF WORK

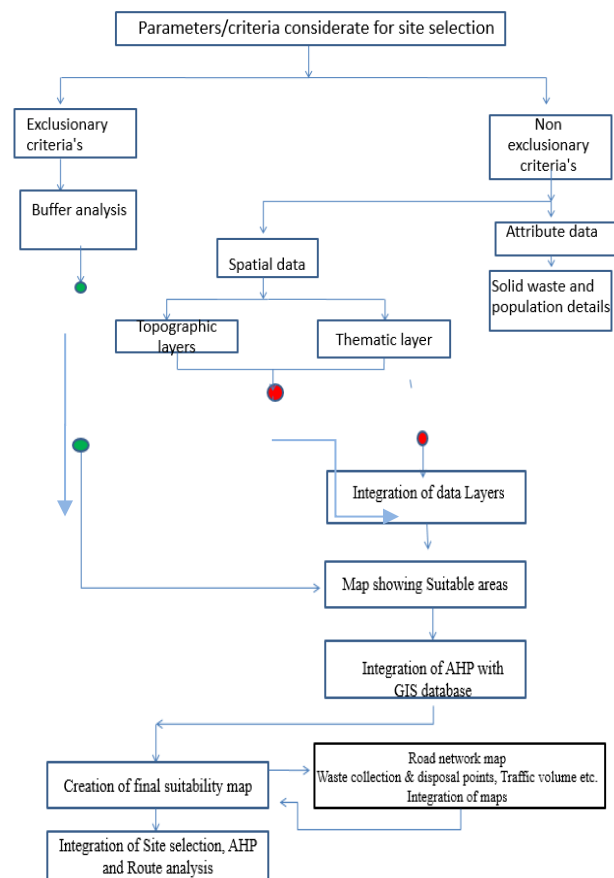
This paper focuses about Vijayawada municipal solid waste management system and drawbacks in its system. Solutions are suggested to identify drawbacks as mentioned in flow chart 2.



Flow chart 2: Study and identification of draw backs in Vijayawada solid waste management system

A. Disposal site selection

Disposal site selection has been done as shown in Flow chart 3. Selection of site and route for waste transportation to disposal site process has done based on two major steps exclusionary and non exclusionary criteria's.



Flow chart 3: Site selection process flow chart

B. Exclusionary criteria

In exclusionary criteria's buffer analysis has been taken for Vijayawada city. For that buffer zone analysis a 10km radius buffer has been created to Vijayawada city as shown in Fig. 1. With the help of this buffer analysis the disposal site will be selected with in this 10km zone. It helps in economical and time consumption ways for municipal solid waste management.



Fig. 1: 10km and 5km of buffer zone to Vijayawada city (Source: created by using Google earth)



C. Non exclusionary criteria

In non exclusionary criteria's by using spatial and attribute data disposal site will be selected.

Spatial Data:Where in spatial data first topographic layers and thematic layers are collected and prepared.

Attribute data: In this rate of solid waste generating in Vijayawada will be collected along with population details of Vijayawada city by using these details future increase rate of population and waste will be calculated.

By integrating and applying AHP process (analytical hierarchy process) to these spatial data suitable site will be selected. And final route map has been created for waste transportation by following steps shown in Flow chart. 3.

Disposal site selection:To identify disposal site few factor should be considered like land use/land cover Fig.2, geomorphology Fig.3, ground water table Fig.4, ground water potential Fig.5, ground water infiltration Fig.6 created using GIS.By integrating these all these thematic layers a disposal site is identified.

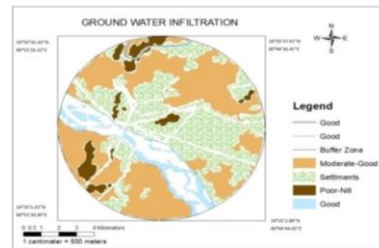


Fig. 6: Ground water infiltration

Marking collection points:Collection points are taken based on ward wise divisions map Fig.7. At every ward one collection point has been given to collect waste for further steps like transportation and dumping.



Fig. 7:Ward wise map of Vijayawada (Source VMC)

Route map: Route map is created based on collection points and road network by using GIS and traffic densities.

IV. RESULT AND DISCUSSION

A. Present municipal solid waste management system of Vijayawada

The Procedure adopted for municipal solid waste management by Vijayawada municipal corporation (VMC).

VMC adopted a 4 step method for solid waste management

Step 1:Primary collection

They will doDoor to door collection of solid waste for 275000 houses in Vijayawada city. They collect the waste by the help of tricycles and wheel barrows as shown in Fig. 8. For this collection of waste VMC is using 536 number of tricycles and 656 wheel barrows.



Fig. 8: Wheel barrow

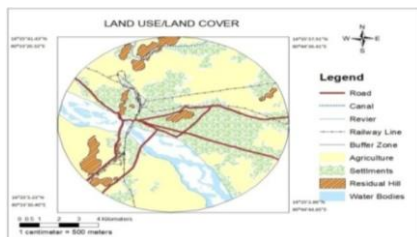


Fig. 2: Land Use/Land Cover

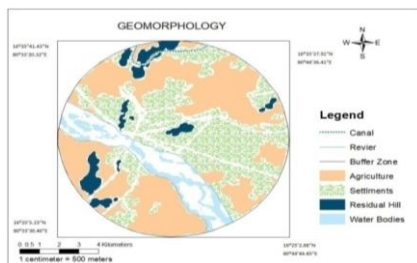


Fig. 3: Geomorphology

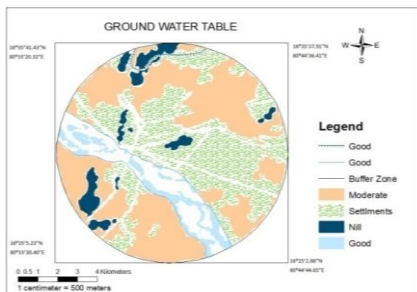


Fig. 4: Ground water table

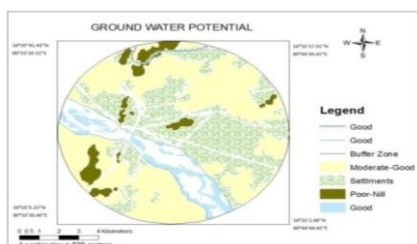


Fig. 5: Ground water potential

Step-2: Secondary collection

In this second step the waste collected from houses will be transferred or dumped into dumper bins and compactor bins as shown in Fig. 9. They are using 410 number of dumper bins in the city and they are capacity of 1 ton.



Fig. 9: Dumper bins

Step-3: Transportation waste to transfer stations

In third step the waste will be transferred to transfer stations Fig. 10 from dumper or compactor bins. There are two transfer stations in Vijayawada and they are equipped with Weigh Bridge and hook loaders and waste will be transferred to big tippers for further steps.

These transfer stations are located at

- Ajith singnagar
- Autonagar



Fig.10: Vijayawada- Autonagar transfer station

Step-4: Disposal

This is the last step of solid waste management system followed by VMC. The waste will be transported to disposal site from transfer station. The present disposal site of VMC is located at Pathapadu village Fig. 11 and Fig. 12.

But the dumping site is insufficient due to sudden increase of population.

The major issue observed during the study of municipal solid waste management system of Vijayawada is insufficient disposal site. The rapid growth of population in city drastically raised waste generation rate. This creates increase of piling waste at dump site. Where the dump site capacity cannot accommodate this suddenly raised waste quantity. So selection of dumpsite is important to reduce the waste management issue.



Fig. 11: Pathapadu dumpsite



Fig. 12: Pathapadu dump site

B. Site selected for land filling

These are the two landfill sites as represented in Fig. 13. Land fill site is selected by considering several factors mentioned in methodology.

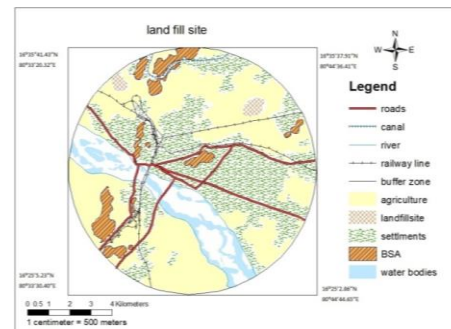


Fig. 13: Landfill site

C. Collection points

These are the finally selected points mentioned in Fig. 14 for collecting the waste for disposal or landfill. Collection points are selected based on ward divisions.

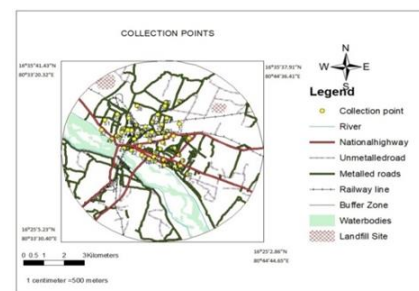


Fig. 14: Collection points of solid waste

D. Transportation route map

The transportation route map Fig. 15 has been designed based on traffic density, collection points and also based on the distance of collection points and transfer stations to landfill sites. By considering the traffic density peak hours, morning 6 to 8 and night 8 to 10 is best time for dumping or land filling. Due to this traffic density at peak hours the waste will be transferred to transfer stations located at Ajith Singnagar and Autonagar. From those transfer station the waste will be transferred to landfill sites.



This route map represents its path based on collection point numbers.

Route map 1 for disposal site 1:42-48-47-46-45-50-51-52-49-41-40-39-43-44-37-36-35-32-33-25-24-23-27-28-30-29-31-transfer station-38-disposal site.

Route map 2 for disposal site2: 22-21-19-18-17-14-11-12-10-9-13-15-27-20-5-4-2-3-7-6-16-8-transfer station-1-disposal site.

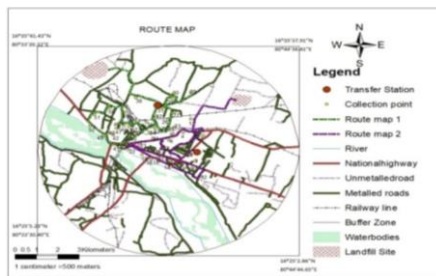


Fig. 15: Transportation route map

V. CONCLUSION

From the above study we can conclude that

1. Vijayawada municipal solid waste management system had a draw back at landfill site. It is insufficient due growth of waste rate caused by increase of population.
2. Due to the expansion of population in Vijayawada, two landfill sites has been selected based on traffic and economical issues.
3. Collection points play major role in finding the route map for economical transportation
4. This route map helps in solving the traffic issues and reduces other problems.

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