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Optimum Integrated Municipal Solid Waste Management for Sanand Town and Surrounding Villages

Arti Pamnani[1], Meka Srinivasarao[2]

[1]*Civil Engineering Department, B. & B. Institute o Technology, Vallabh Vidyanagar, Gujarat, artnitnan@yahoo.com*
[2]*Chemical Engineering Department, Dharmsinh Desai University, Nadiad, Gujarat*

Abstract — *Municipal solid waste management of urban areas is one of the active areas of research in the recent past. However due attention is not paid to MSWM from small towns and their nearby villages. Significant portion of population in developing country like India resides in small towns and their nearby villages. The primary objective of the present work is to study technological aspect of MSWM for small-scale towns and their surrounding villages located in the state of Gujarat. We propose an optimization model to identify suitable collection, segregation and disposal methods based on the solid waste quality and quantity of the study area under consideration. Analysis of the results has shown that formation of clusters for segregation is more economical compared to segregation at each source town/village in absence of segregation at each household.*

***Keywords**- Small towns, Villages, Technological aspect, segregation and Cluster*

I. INTRODUCTION

Municipal solid waste management is one of the prime responsibilities of all municipalities/ administrative bodies (MSW rule 2000). Municipal solid waste management includes things like planning, engineering, administration and legal matter of solid waste from collection to disposal. It includes collection, transportation, and proper disposal of solid waste. MSWM should be done adopting principal of economy, energy and conservation [11]

Generally, MSW dumped at unsanitary landfill sites, which leads to pollution of waste source, foul smell and odors. It can be major source of epidemic like plague, malaria etc [3]

It is recorded by studies carried out by National Environmental Engineering Research Institute (NEERI) indicated that the per capita generation rate increases with the size of the city and varies between 0.3 to 0.6 kg/d. In the metropolitan areas, values up to 0.5 kg / capita / day The estimated annual increase in per capita waste quantity is about 1.33% per year [12]

Study shows that municipal agencies spend about 5-25% of their budget on MSWM. At present situation very low level of service is found in MSWM and it has became threat to public health [8].

Constant increase in quantity of MSW due to rapid urbanization and changing life style and variation in quantity of MSW makes it difficult and complicated work for management. The existing waste dumping sites are full beyond capacity and under unsanitary conditions leading to pollution of water sources, proliferation of vectors of communicable diseases, foul smell and odors, release of toxic metabolites, unaesthetic ambiance etc. It is difficult to get new dumping yards and law prohibits open dumping [6]

According to report by society of participatory research in India, Municipalities, in the current scenario, have been facing tremendous challenge of planning, developing and managing the solid waste due to lack of technical knowledge, human resource, and scarce resources remittance from state agencies and most importantly a integrated plan to deal with the issue of SWM. These challenges are compounded for numerous small and medium towns (smts) in India [1][4][5][7][10]

Social engineering and technological aspects are to be considered for effective implementation of MSWM. Social engineering deals with waste management as reduce, recover and reuse. Technological aspect of MSWM gives economical and scientific methods for collection to disposal of MSW [6][8]. Hence, technological aspect gives waste management application to improve the system and supportive to environment. The primary objective of the present work is to study technological aspect of MSWM for small-scale towns and their surrounding villages located in the state of Gujarat.

II. CLASSIFICATIION OF TOWN AND VILLAGES

In India according to state law for classification of town habitants or settlement, need to cross population of 20,000. Municipal committee or Municipal Corporation administrates these towns.

According to census of India e with population one million and above are known as class I city/ metros, town with population between 50,000 to less than one million are known as class II cities and population less than 50,00 are class III towns. The number of towns and cities have increased to 4378 of which 393 are Class-I towns, 401 are class-II towns, 1151 are class-III towns and remaining are classified as small towns with population ranging between 20,000 to less than 5000. The number of metropolitan cities having million plus population has increased to 35 as per 2001 Census, and this has seen growing public concern with exponential increase in sanitation and environmental issues.

In state of Gujarat classification of town according to population given by Urban development and housing department different municipalities are given as Class A Municipality - Population of 100000 and above , Class B Municipality - Population of 50000 – 99999,Class C Municipality - Population of 25000 – 49999, Class D Municipality - Population of 15000 – 24999.

III. MSW SCENARIO OF CLASS IV TOWNS AND THEIR SURROUNDING VILLAGES

In India, major occupation of population in small-scale town and surrounding village is farming. Major economy of the area is dominated by agriculture. MSW generation in these towns and nearby villages is varying with urbanization and population growth. Population of villages surrounding small-scale town varies from less than 5000 to 10000. Due to low population and economical variation, MSW generated varies in quantity. We have studied municipal solid waste management in small-scale towns along with their surrounding villages located in the state of Gujarat- India. We found that average waste generation is 0.41Kg/capita/day from small-scale towns while 0.08kg/Capita/day waste is generated from villages. In rural area, people generally do not use plastic or metal containers to keep segregated waste as biodegradable and non-biodegradable [2] The total quantity of waste generated on day to day basis in each of the villages is considerably low.

The composition of waste for small-scale towns was found to be 48% decomposable, 30% recyclable and 22% inert material. In the surrounding villages waste has approximately 73% decomposable, 20% recyclable and 7% inert materials. MSW for villages contain more of biodegradable. The general practice is to decompose this waste along with farm waste and reuse the same as fertilizer. The major problem in handling SW in these villages is collection transportation and disposal due to very low quantity of waste generated on daily basis.

Due to financial constrain, management inefficiency, manpower deficiency and less political will are found to be major difficulties with respect to MSWM in small scale towns and villages. Integrated waste management is to be explored to deal with waste generated from small-scale towns and surrounding villages. MSWM of these small semi urban areas have not received their due attention from the researchers. Optimal integrated management of solid waste is an interesting area to be explored in future.

IV. OPTIMAL INTEGRATED MANAGEMENT FOR SMALL-SCALE TOWN AND SURROUNDING VILLAGES

Author develops optimization model using GAMS results are obtained by MNILP for integrated MSWM for small-scale town and surrounding villages. Detail study, is conducted for development of model for small-scale town and surrounding village of Gujarat state. Study for Quality and quantity of MSW is done for research area.

There is lack of data at all levels from the ward, district and municipality for solid waste, and where available, is generally unreliable, scattered and unorganized, this hampers solid waste management (World Bank 2002, 2003).

In large or medium scale cities, sufficient number of trained personnel for solid waste management, sufficient financial support from government and public for cleanness, public awareness for solid waste is more as compare to small-scale town/villages. Due to less awareness in public, infrastructure development and other amenities like solid waste disposal site, sanitary facilities etc are less in small-scale town and villages. Generally open dumping at low line area or area outside town or villages. This creates nuisances of flies, mosquitoes and other insects, which can lead to major health hazards in the area. It causes ground water pollution due to leached. Due to availability of funds and proper data at large/metro cities proper planning and study, have been done with MSWM while almost negligible work is done for small-scale towns and villages.

The study of municipal solid waste for its collection to disposal in metro and large cities done is more than in small-scale town/villages. This is due to insufficient funds government policy and willing to pay capacity of people in these areas. For development of any country, it is necessary to look at problem generated at small-scale towns and villages with priory as for developing countries these are the development hubs. As large population, lives in small-scale towns/ villages it becomes important to know about solid waste generated by this population and manage it to reduce environmental degradation.

These municipalities have villages having low population, which leads to an average generation of solid waste 0.05 to 0.1 Kg/person/day, which is a low generation of MSW. Compositions of solid waste of Small-scale town and village around have high organic matter, as agriculture is major occupation of people. Composition of MSW from small-scale town and villages are different it is found that small-scale town produces more recyclable and inert waste as compared to villages. Organic waste can be done by composting at side of the farms which is generally done it is converted into manure and is useful for agriculture. For inert waste disposal can be either done by Incernatiion, land filling, reduction of waste etc as these villages have very less population and thus waste generation is low collection, segregation and disposal of waste becomes a major issue. Due to low quantity of waste construction cost of collection and segregation site increases. For proper and scientific method, collection of waste from village should be transfer to a common place for segregation and disposal.

Optimized integrated municipal solid waste management system is developed for Sanand sub district of Ahmedabad is having total population of 237845 the entire district has 141955 rural population while 95890 population lives in urban area. Three segregation sites are selected in Sanand sub district of Ahmedabad district optimization in MINL programming by GAMS Table(1). Total cost consists of land cost, segregation cost and transportation cost is optimizing to obtain segregation sites so that minimum cost of segregation is obtained. Optimization is done by variable of total cost

Optimization of total cost gives three segregation sites are selected for Sanand municipality area with optimization of total cost. Three segregation site are selected Sanand, Rethal and Zolapur villages require to bring waste for segregation at these sites are given in Table 1 and Figure 1

Table 1: Segregation Site And Source Villages

Town	Segregation site	Source town/villages
Sanand	Sanand	Lekhamba, Goraj, Kunwar, Hirapur, Vasodara, Rupavali, Khoda, Iyava, Chekhla, Rampur, Anaderi, Bayanpur, Nidhrad, Godhavi, lanipurm Shela, Telav, Sanahal, Kolat, Navapura, Tajpur, Maraiya, Sari, Modasar, Pipanm Falgdo, Sanand
	Rethal	Daduka, Melasana, Makhiyav, Vinchhiya, Mankol, Junval, Dayan, Ariyali, Zamp, Upandal, Rethal
	Zolapur	Bakrana, Lhoraj, Umachanagar, Dodar, Naranpura, Kalana, Bol, Charal, Makhiyva, Zolapur

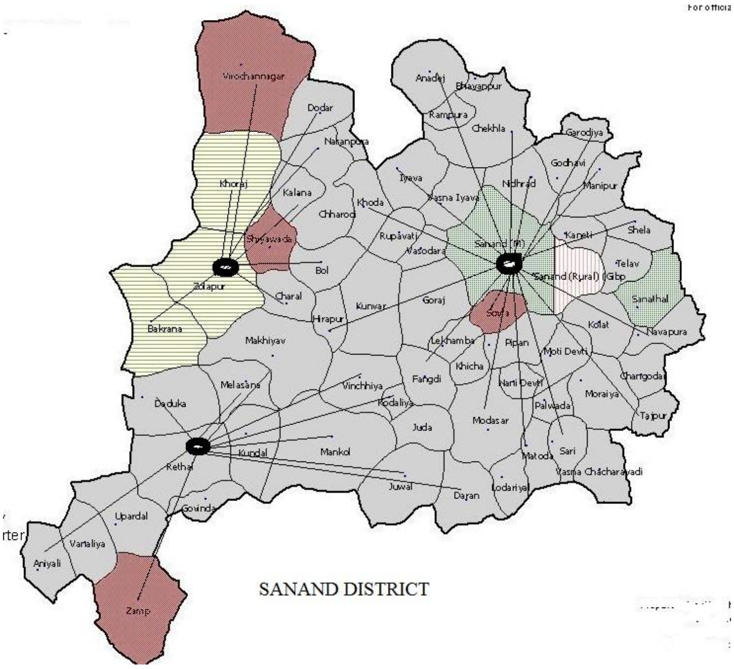

Figure 1: Purposed segregation site for Sanad Municipality

According to program result the total area, divided into three clusters Sanand, Rethal and Zolapur. Table (2) shows cost comparison of selected site and segregation at source. Site selected having optimum total cost that includes transportation cost, segregation cost and land cost. It is found that area nearby are selected in a cluster which makes it more feasible.

Table 2: Cost Analysis of Segregation MSW at Source and at Selected Segregation Site of Sanand Sub District at Ahmedabad District

Sanand Site	At segregation site	At source
Land cost	3507500	6723765
Segregation cost	98000	98000

Construction cost	1403000	4482511
Transportation cost form source to segregation site	78424	-
Total	5086924	11304276
Rethal Site	**At segregation site**	**At source**
Land cost	552000	1329129
Segregation cost	56000	56000
Construction cost	220800	886087
Transportation cost form source to segregation site	34262	-
Total	863062	2271216
Zolapur Site	**At segregation site**	**At source**
Land cost	232000	517032
Segregation cost	43000	43000
Construction cost	92800	344688
Transportation cost form source to segregation site	39324	-
Total	407124	904720

It is concluded that three cluster are found for sanand town and village around. Total cost for segregation at cluster site is 25 to 55% less than segregation at source .
According to preliminary study done by the authors for the state of Gujarat, India found optimization of collection of waste for small-scale towns and village around by formation of clusters reduces MSWM cost up to 30 to 40%. It is also found that fixed costs like land and construction cost is very high when segregation sites are constructed at each source village while operating cost increases when cluster is formed. Operate one segregation site for a small town and cluster of villages is observed to be technically feasible and convenient from management view point

V. CONCLUSIONS

It is found from study that composition of waste for small-scale towns and villages consists of 40 – 70% as organic waste, 20-30% as recyclable waste and 10 – 20% inert waste. It is found that rate of generation of waste ranges from 0.5 to 1.0 Kg /person/Day. Optimized Integrated waste management by formation of cluster for segregation and disposal is suggesting for this type of situation. Total cost includes fixed cost like land cost, equipment cost and operating cost like transportation cost labor cost etc. optimization is done for total cost. Transfer of waste to cluster reduces the cost of segregation and disposal at each village. Fixed cost like construction cost and land cost at each source sites increases while transportation cost for cluster site is more. It is found that there is a reduction in total cost of segregation up to 30 to 40% by formation of clusters compared to segregation at each source. The management of cluster site is much easier than segregation at source as less number of trained personal will be required. Inert waste after segregation should be send to selected land filling site for further disposal.

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