Perspective Study on Solid Waste Management for the Forecasting Solid Waste Generation Rates Using Statistical Model

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INTRODUCTION

Urbanization continues the management of solid waste is becoming a major public health and environmental concern in urban areas of many developing countries. The concern is serious, particularly in the capital cities, which are often gateways to the countries for foreign diplomats, businessmen, and tourists. Poor visual appearance of these cities will have negative impacts on official and tourist visits and foreign investment. Central and state governments have collaboration of external support agencies, both bilateral and multilateral, in improving solid waste management in their cities in the last twenty years.

Solid waste management system in a developing country displays an array of problems, including low collection coverage and irregular collection services, crude open dumping and burning without air and water pollution control, the breeding of flies and vermin, and the handling and control of informal waste picking or scavenging activities. These public health, environmental, and management problems are caused by various factors which constrain the development of effective solid waste management systems. In most of the developing countries, there is a lack of human resources at both the national and local levels with technical expertise necessary for solid waste management planning and operation. Many officers in charge of solid waste management, particularly at the local level, have little or no technical background or training in engineering or management.

Objectives of the study

Any scientific analysis and planning for solid waste management requires solid waste generation rate. The objectives of this study are given below:

1. To study the Solid waste generation rates for the period 2014 to 2016
2. To study per capita rate of expenditure on SWM during the period 2014 to 2016.

REVIEW OF LITERATURE

Galeotti et al., (1997) developed mass balance and heavy metals distribution in Municipal Solid Waste. Incineration plants are recognized as a valid and efficient technology to treat Municipal Solid Wastes (MSW), particularly when they are part of integrated treatment plants. Waste incineration reduces the waste volume and weight, thus saving space on the landfill; also the end products are hygienized by transforming organic matter into water and carbon dioxide (CO2); it is also possible to recover steam and/or energy. The main environmental impact in an incineration plant is due to the residues of the process (solid, liquid and gaseous emissions). Consequently waste incineration can gain public acceptance only if the concentration of low volatile organic compounds and the elution stability of heavy metals can be guaranteed.

.Bruvoll (2001) Factors Influencing Solid Waste Generation and Management insight into factors influencing waste generation and management options forms an important background for waste policy planning. This paper analyzes the effect of income, waste management fees and population density on the overall amount of waste generated and of income, fees and recycling services on the choice

of waste management methods. The results show that economic incentives are effective in influencing the selection between different waste management methods. Landfill fees reduce the waste amounts land filled and increase recycling and incineration. An increased weight in recycling in the states with the highest landfill fees might undermine the effect of fees on waste generation. Thus, the total effect is substituting recycling for land filling instead of source reduction.

El-Fadel and Najm (2002) studied about the Economic and Environmental Optimization of Integrated Solid Waste Systems Increased environmental concerns and the emphasis on material and energy recovery are gradually changing the orientation of MSW management and planning. In this context, the application of optimization techniques has been introduced to design the least cost solid waste management systems, considering the variety of management processes (recycling, composting, anaerobic digestion, incineration, and land filling), and the existence of uncertainties associated with the number of system components and their interrelations. This study presents a model that was developed and applied to serve as a solid waste decision support system for MSW management taking into account both socio-economic and environmental considerations. The model accounts for solid waste generation rates, composition, collection, treatment, disposal as well as potential environmental impacts of various MSW management techniques. The model follows a linear programming formulation with the framework of dynamic optimization. The model can serve as a tool to evaluate various MSW management alternatives and obtain the optimal combination of technologies for the handling, treatment and disposal of MSW in an economic and environmentally sustainable way.

Skordilis (2003) evaluating waste management alternatives by worth— benefit—utility (WBU) analysis which allows consideration of environmental and social parameters in addition to economic and technological parameters, using a combination of statistical analysis methods, trends extrapolation and Delphi techniques. The goal structure is built by groups of stakeholders representing a variety of interests and priorities. The goal matrix is then checked for completeness and compatibility and the goals are ranked according to a grading system. Then the alternative MSW disposal methods are evaluated using WBU analysis. The method is applied for the selection of the optimal MSW disposal method in the Greater Athens Area (GAA). The analysis reveals sanitary landfill disposal to be slightly preferable to mechanical sorting - recovery - composting, and both methods to be superior to incineration.

Chang and Nishat (2005) have developed an integrated solid waste management for the city of Greensboro, NC: with a linear programming model and proved that Land filling is necessary for municipal solid waste disposal but every landfill has its own finite capacity. The most common approach to extending the life of landfills is to introduce recycling, composting, and incineration into the solid waste disposal system. Cost minimization is one of the major considerations in planning a solid waste management and disposal system. Collection, processing, operation and maintenance, and monitoring and regulatory costs for each alternative are included. The model successfully identifies the least cost solution. Separate analyses are carried out to evaluate the effect of recycling and incineration. Results show that incineration requires an additional $35.5 million, but extends the landfill life by 4.5 years (2009 to 2013). This translates into revenue of $12.22 million and the net additional cost of $23.3 million. Incineration with energy sales will reduce costs considerably. Expanding the City's current recycling and composting programs adds two years to the landfill life and saves a total of $7.8 million and $11 million, respectively. The model results indicate that it is practical and beneficial to implement incineration, and increase recycling and composting programs, even though incineration increases costs.

Miller, et al., (2009) explored the determinants of Municipal Solid Waste generation and recycling in western New York communities' accurate determination of waste quantities is essential for effective municipal solid waste management. This paper creates several statistical models that can be applied to predict residential municipal solid waste quantities. Using municipal solid waste data sourced from 38 towns and villages that were canvassed as part of the NorthEast Southtowns Regional Solid Waste Management Plan, several multiple regression based models were estimated that explored the determinants of annual municipal solid waste generated, recyclables, and compost (yard waste)

tonnages. The first group of equations was based on panel and census data for the year 2000. Climate, demographic, socio- economic, cost and distance variables were evaluated as independent variables.

MATERIALS AND METHODS

The present investigations on the topic "Perspective study on solid waste management for the Forecasting solid waste generation rates using statistical model" were carried out in Meerut Municipality Corporation. Proper selection of method for scientific treatment and disposal of solid waste requires the data of solid wastes generation (SWG) rates and finances required for solid waste management (either for a short term say five years period or for a long term say twenty years period) for any town or a city.. " The Double Exponential Smoothing model " which is to project N years (where N is 4 in this case) for forecasting solid waste management parameters, using the previous data of less than or equal to N years of the same parameters. The validity of this model is checked by Double Exponential smoothing can be extended to certain case where the process means change over time, which is accepted statistical time series modeling. This is explained as given below. The model is considered in this study are

$$Xt = b1+b2t+ \varepsilon t$$

Where = b1 & b2 are parameters and εt = Random component with mean zero & variance □2e , t is the time period.

Source	Year 2014-15		Year 2015-16	
	Number	Quantity of solid waste (tons /day)	Number	Quantity of solid waste (tons /day)
	Data		Data	
Residential Area	413400	611	415000	660
Commercial Establishments	63800	47.42	65000	51.22
Street Sweeping	3149	80.5	3312	86.9
Drain cleaning	3773	83.43	3893	90.03
Hotels	551	22.12	578	23.89
Institutions	184	5.19	193	5.6
Parks &Gardens	40	5.93	43	6.4
Markets	46	79.02	49	85.36
Temples	117	2.89	130	3.19
Meat Stalls	514	6.47	532	6.98
Slaughter Houses,	113	3.16	1600	3.41
Cinema Halls	38	0.48	40	0.56
Function Halls	12	24.5	132	26.46
Total		972		1050

Table 1: Different components of solid wastes in MMC during the period 2014 to 2016.

S. No	Category	Drain length in Km	Total waste generation in tons	Drain length in Km	Total waste generation in tons
		Year 2010-11		Year 2011-12	
1	Major Drains	1154	34.88	1217.7	36.53
2	Minor Drains	2619	48.55	2675	53.50
		Total	83.43	Total	90.03

Table 2: Waste generated in drains in MMC

RESULTS & DISCUSSION

Solid Waste Generation Rates In Meerut City (Mmc)
Solid waste generation rates for the period 2014 to 2016.
Using the data of population and solid waste generated of MMC for the years 2014 to 2016 (Table 3.1), waste generation rates have been calculated for the period 2014 to 2016 and presented in Table 4.1 and also shown in Fig.4.1, which is given below.

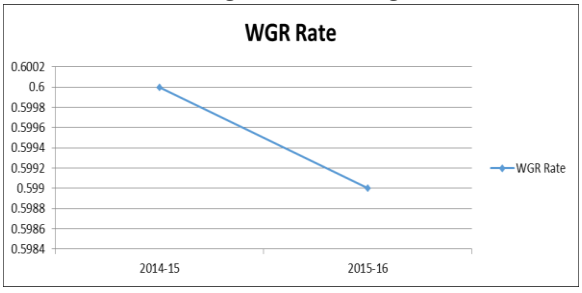

Table 4: Different components of solid wastes in MMC during the period 2014 to 2016.

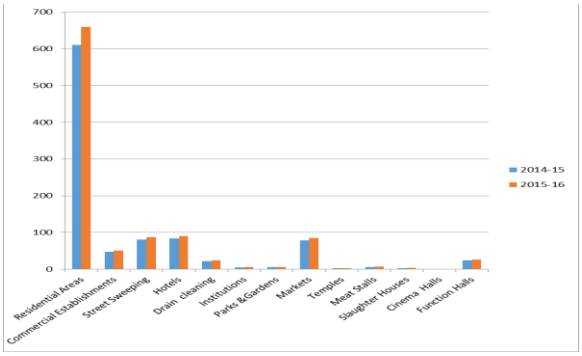

Figure 2: Different components of solid wastes in MMC during the period 2014 to 2016

All the values of SWG rates mentioned above (either minimum or average) are within the (0.40 and 0.48 kg / capita / day) national average value of SWG rate (0.2 to 0.6 kg / capita /day for Indian cities, as mentioned in the Manual of Solid Waste Management, published by the Ministry of Urban Development Government of India.

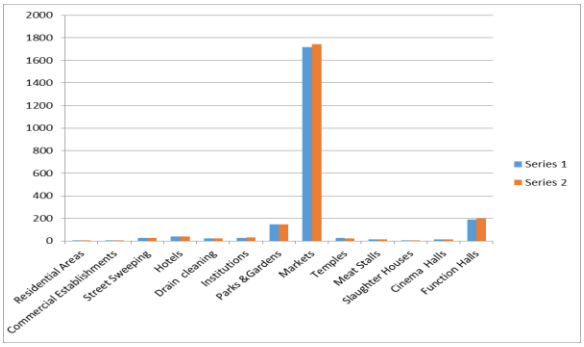

Figure 3: WGR for Different components of solid wastes in MMC during the period 2014 to 2016

SUMMARY AND CONCLUSION

It is observed that the percentage increase of expenditure of solid waste management for five years period (2007 to 2011) data as 91.11and the percentage increase of per capita expenditure as 69, whereas percentage increase of expenditure for the forecasting period (2012 to 2016) as per the DES model data is 39.58 and as per the DMA model data is 7.91 and percentage increase of per capita expenditure as per the DES model data is 27.18 and as per the DMA model data is -2.5. It can be concluded that the percentage increase per capita expenditure of solid waste management per day is considered as is a rational for scientific management of solid waste for any city.

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