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A STUDY ON GLOBAL WARMING POTENTIAL CAUSED BY MSW STORAGE IN ERODE DISTRICT BY USING MATLAB

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Abstract - *On the outset however the design of temporary storage systems are Important to look into. Due to the current lack of sufficient operating capacity in the corresponding facilities, waste stream must be held in interim storage until treated or further utilization becomes possible. So, we consider Temporary storage of municipal Solid Waste. Temporary storage for collection of municipal solid waste is composed with various parameters, such as size of bin, collection frequency, average filling rate, and number of bins, volume of material needed for bin production, bin density, and catchment area. The environmental impact of temp array storage is estimated with emissions generated due to the production of net material used for bin production. An artificial neural network (ANN) is a computational model based on the structure and functions of biological neural networks. An artificial neural network-back propagation method is proposed for modeling the temporary storage. Thus, a set of different structures of artificial neural network-back propagation are investigated and then the best model is developed for temporary storage of municipal solid waste. The artificial neural network-back propagation model is trained using various parameters, such as number of neurons in the hidden layers, training tolerance, momentum, and learning rate. This model is helpful for the decision makers in choosing the environmentally sound options in the design of temporary storage for municipal solid waste management. Further ANN-BP can be successfully used to predict number of bins, GWP from waste generation rate of the city.*

Key Words: *Environmental Impact, Global Warming, Mat Lab, Erode, Solid Waste….*

1. INTRODUCTION

The collection bins serves as temporary storage in managing municipal solid waste (MSW), for the wastes generated from households. The term temporary storage acts as contact point between waste generators and waste management; that is how it slams its importance which should be carefully designed and managed. The city of Erode, India has a population of 5, 68,000 as per the municipal administration records, spread over an area of 109.5 km2, generating 564 tons of MSW per day. In most of the places of the city, an adequate number of bins is not placed for the disposal of wastes for the residents. The wastes are directly thrown and heaped in streets by considering that as dumping point. In present era, only mixed wastes are collected from the city. Old types of bins which are more damaged are in concrete and used widely. The Erode Municipal Corporation (EMC) has planned to provide high density polyethylene (HDPE)/steel containers for temporary storage of MSW, which are placed at specific intervals for the residents to dispose their wastes. The bin has top lids for covering the wastes and bottom wheels for moving the bins. The design of temporary storage for collection can be proposed for promotion of economically efficient and environmentally sound design options for MSW management. Hence, in this project, the temporary storage for collection of MSW is designed with various parameters, such as size of bin, collection frequency, average filling rate, and number of bins, volume of material needed for bin production, bin density, and catchment area. The environmental impact of temporary storage is evaluated with emissions generated due to the production of net material used for bin production. An artificial neural network-back propagation (ANN-BP) network is developed to predict the number of bins and global warming potential (GWP) based on the quantity of waste generated. This model is trained using various parameters such as number of hidden layers, number of neurons in the hidden layers, training tolerance, RMS (Root Mean square), error and learning rate. This model is helpful for the decision makers in choosing the environmentally sound options in the design of temporary storage for MSW management.

1. Sustainable Management of MSW

The sustainable management of collection, transportation and final disposal of MSW in terms of environmental, economic and social aspects should be properly evaluated for the implementation of Integrated Solid Waste Management (ISWM). Thus, ISWM encompasses the functions of collection, transfer, resource recovery, recycling and treatment. In order to implement ISWM a state regionalization of MSW systems continue to require increasing attention (SWANA 2001).associated with the entire cycle of MSW. With this in mind, Life Cycle Analysis (LCA) has been used by industry and the public sector to identify where real environmental improvements can be made. LCA concepts and techniques provide solid waste planners and decision makers with an excellent frame work to evaluate MSW management strategies because of its holistic approach to system. For sustainable management of MSW, environmental issues are the prime concern of environmentalists and decision makers of governmental agencies. MSW management needs to be environmentally effective to reduce overall environmental burdens. One way of reducing emission of GHGs, from the MSW management is to understand and choose environmentally sound MSW options. Hence, MSW management sector is to be concentrated considering the environmental indicators in the differential functional elements of temporary storage system, collection and transportation of MSW and disposal. Hence, in the research work, environmental issues are analysed, with various approaches for the management of MSW.

2. LITRATURE REVIEW

Weitz et.al. Attempted to give a brief account of different aspects of the methodology in managing the environment effectively using meteorological air quality data, the need for standardizing the air quality models. They described the air quality management system and its components through a flow diagram. Although the emission control technology developed for gasoline engines is very successful in reducing emissions of CO, NO_X and Hydro Carbon (HC) per distance driven, the increasing number of vehicles and the distances traveled by these vehicles eliminate a significant part of these benefits with the result that motor vehicle emissions continue to be of concern from a human health perspective. The quantification of the emission rates of individual species from motor vehicles and a difference in these emission rates with different fuels has therefore become a key objective in dealing with motor vehicle emissions.

Beede et.al. Reported that the collection of MSW is the first major step towards the clean environment. The collection bins act as temporary storage for MSW generated from households. The temporary storage is the first point where waste leaves the house and enters collection bins. This is an initial and essential part designed in the waste management system. Bin collection system is generally practiced in India. It is observed, that the bins are designed with inadequate size and number and are not installed at appropriate locations. This has resulted in diminishing collection efficiency. The doorstep collection of wastes from households, shops and establishments is insignificant. In most of the areas, the MSW collection disorganized that less than 25% of the MSW produced is actually collected for disposal and the remaining 75% is allowed to remain, causing health hazards and pollution to the environment. Hotels and Restaurants may make their own arrangements for collection of wastes. Vegetables, fruits, meat and market wastes should be removed on a daily basis either by the corporation or by the contractors. The wastes stored in parks, gardens, lawns are to be collected on a weekly basis.

Chang et.al. Reported the waste composition of most countries in the world is containing mainly organic matter followed by paper and plastics. Waste composition in Asian countries other than Japan is known for organic waste, comprising approximately 75% of the total waste stream. Average organic waste composition in the years 1980s and 1990s was approximately 50%. Current waste composition indicates a very high percentage of putrescible waste, which mainly consists of processed kitchen waste and food waste.

Siva Kumar et.al. Discussed different methodologies available for estimation of pollution load for Indian vehicles, which can be used as input data for highway pollution Simulation models. The results indicated that air pollution levels are increasing significantly causing health problems. They also highlighted that the methodology adopted in aiming at the vehicular pollution load is an essential step in predicting air pollution connections through mathematical models.

Singh et.al. Monitored the concentration levels of Sulphur Dioxide (SO_2), Nitrogen oxides (NO_X), Ozone (O_3), and Carbon monoxide (CO) in Delhi during winter months of 1993. A positive condition was observed between NO_X and O_3. The CO concentrate was found to exceed the respective ambient air quality standards. The ambient levels of pollutants were found to be in the decreasing order of central/Middle East and suburban areas.

3. METHODOLOGY

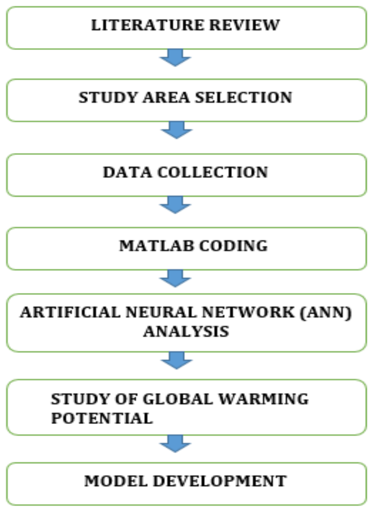

Fig -1: Methodology

4. STUDY AREA CHARACTERISTICS: ERODE CITY

In the design of temporary storage, municipalities have different options for the selection of number of bins, bin size, and collection frequency. The different sizes of bins are considered for degradable and recyclable wastes, which mainly depend on the quantity of waste generated and bulk density of the waste fractions. Generally, not all the bins are fully filled every time. The filling of bins should be over 50% and under 100% to account for seasonal influences. This value is assumed equal for both waste fractions in the city. The average filling rates of both the bins are assumed as 80%.

Table -1: Details of infrastructure in the town

Area (Sq.km)	109.52 Sq.km
No. of Wards	60
No .of Houses	102516
No of Commercial Establishments	21870 (Commercial and Industrial Establishment

No. of Streets	1252
Population (As per 2011 census)	498121
Population as on 2015	535000
Floating Population	50000
Total Length Of Road	806.70 Km
Total Length of Storm Wa Drain	540.81 m

4.1Quantity of Bin Material

For calculating the material required for production of bins, the partial recycling of bins is considered. The amount of bin material required is calculated by considering the amount of recycled material used in bin production. The following parameters are needed to calculate the total amount of bin material required per year,

Number of bins required;
Weight of the bins;
Recycling rate (default values between 25 and 80%); and
Lifetime of bins (10 years).
Therefore, the quantity of material for bin production per year is calculated

Qtm= (N*(1+EN)*W*(100-Rr))/LT

Qtm = total quantity of bin material required in kg/year;
EN = extra bins needed in stock for smooth operation in %;
W = weight of bins in kg;
Rr = recycling rate of used bins material in %; and LT = lifetime for bins in years

4.2 Impact Analysis

The production of galvanized steel MSW collection bins leads to higher impact on global warming and human toxicity. Hence, in this study, a High Density Polyethylene collection bin is considered. The direct environmental impacts of temporary storage are determined by the production of net used material used for the bin production. The use of recycled material along with virgin material for bin production reduces the lower net material consumption. The emissions from the manufacturing of temporary storage are accounted by environmental impact factor GWP.

4.3 Network Parameters

There are a number of different parameters that must be decided upon when designing a neural network. Among these parameters are the number of layers, the number of neurons per layer, the number of training set, the number of training iterations and so on. This model is trained by using one input set data and two target data. This dataset contains input parameters as quantity of wastes generated. The target parameter contains a number of collection bins and global warming potential. The data are divided into a training and testing set. With the total number of 564 sets of data, 60% of the data are used for training and 40% are considered for testing the proposed ANN-BP model.

4.4 Processing Elements

In an artificial neural network, neurons can take many forms and are typically referred to as processing elements. The processing elements are connected into network pattern, with different pattern serving different functional purposed. Unlike biological neurons with chemical interconnections, the processing elements are in artificial systems that are electrical only and may be either analog, digital or hybrid. However to reproduce the effect of the synapse, the connections between processing elements are assigned multiplicative weights, which can be calibrated or trained to produce the proper system output.

4.5 Optimization of Neural Network Parameters

Neural networks have been widely used in manufacturing industry, but they suffer from a lack of structured method to determine the settings of NN design and training parameters, which are usually set by trial and error. A case study of a complex forming process is used to demonstrate implementation of the approach in manufacturing, and the issues arising from the case are discussed. The training tolerance is varied to optimize the RMS error which is least and epoch for optimized neuron. The learning rate is also optimized for a chosen number of neurons and training tolerance. The learning rate parameter also plays an important role in the convergence of the network depending on the application and network architecture. Then, the momentum is optimized for the chosen number of hidden layers, number of neurons, training tolerances, and learning rate. The momentum factor is varied between 0.1 and 0.9 for optimized learning rate. In addition, momentum allows the network to respond, not only to the local gradient, but also to recent trends in the error surface.

5. RESULTS AND DISCUSSION

The design of the temporary storage for Erode is environmentally assessed using the Global warming potential. Also, GWP decreases as size of the bin increases. Global warming potential reduces as the collection frequency increases, which is due to use of a lesser number of bins with the increasing collection frequency and bin size. The collection frequencies suggested for the degradable wastes are collected either once in a week or twice a week due to the formation of the decomposed waste at a shorter interval of time, which leads to problems in waste handling and also results in a bad odour. The recommended size of bins for the degradable waste is 1,100 and 2,500L because of more generation of degradable waste.

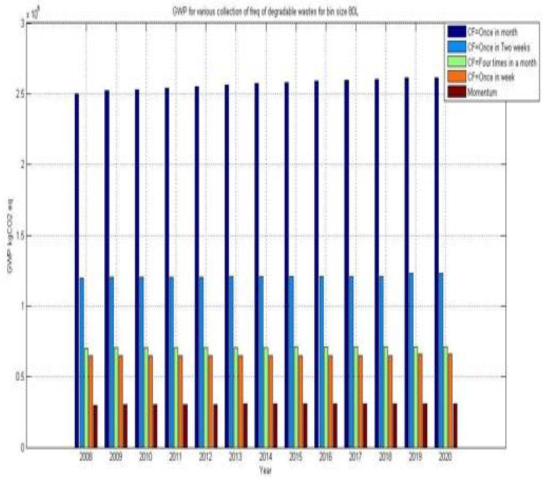

Chart -1: GWP for various collection frequencies of degradable wastes for bin size 80L.

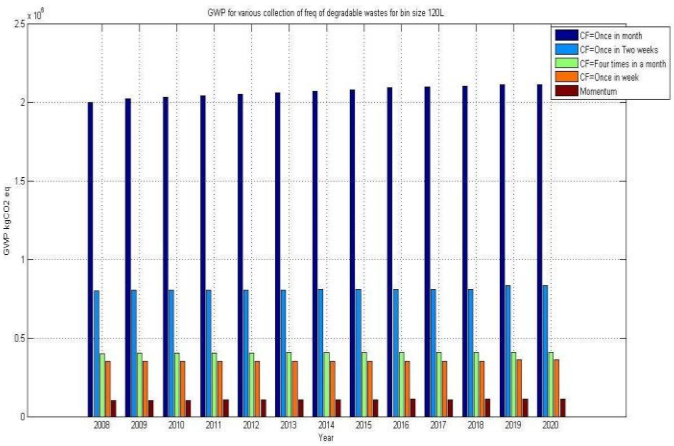

Chart -2: GWP for various collection frequencies of degradable wastes for bin size 120 L.

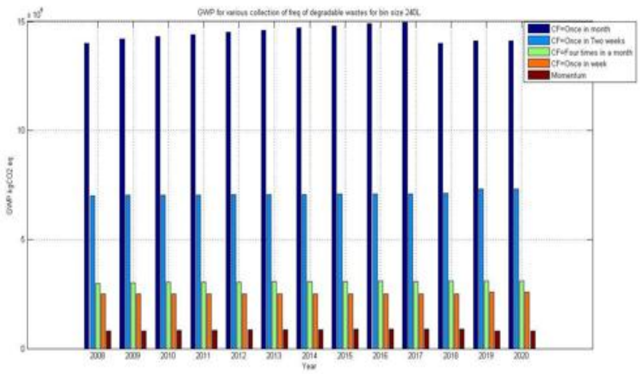

Chart -3: GWP for various collection frequencies of degradable wastes for bin size 240 L

6.1Optimization of Number of Neurons in ANNs Parameter

A deterministic approach has to be done in narrowing down the parameters properly so that the maximum range or sound for a given input parameter can be set to map them with corresponding output. The network is trained with one hidden layer initially and the simulation is carried out by increasing the number of hidden layers using Neutralist software. To optimize the neuron number in the hidden layer, neuron numbers from 1 to 10 are run with the increment of 1. Thereafter, the RMS error and number of epochs are evaluated for the neuron number. Figures show RMS error and number of epochs for increasing the neuron number from 1 to 10. However, increasing neuron numbers for more than 10 causes an unrealistic result. it is observed that the number of epochs is minimal, i.e., 13, when the number of neuron is 10. At the same time, data is to be trained for minimum RMS error. From Figures 9 and 10 it is observed that neuron number 3 corresponds to the minimum number of epochs, with a slightly higher RMS error. When the number of neuron is 10, both RMS error and number of epochs is less. Thus, it is reasonable to choose the number of neuron as 10. Once the number of neuron is fixed as 10, further experiments are carried out by varying other training parameters.

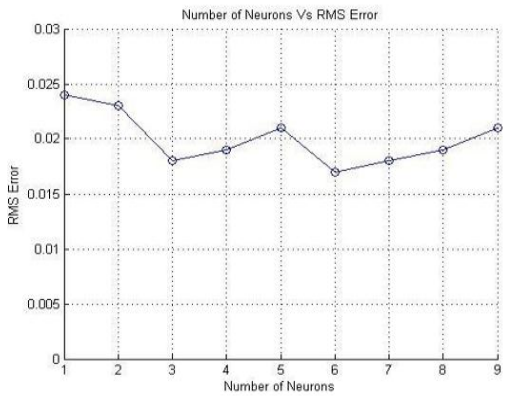

Chart -4: Number of neurons vs. RMS error

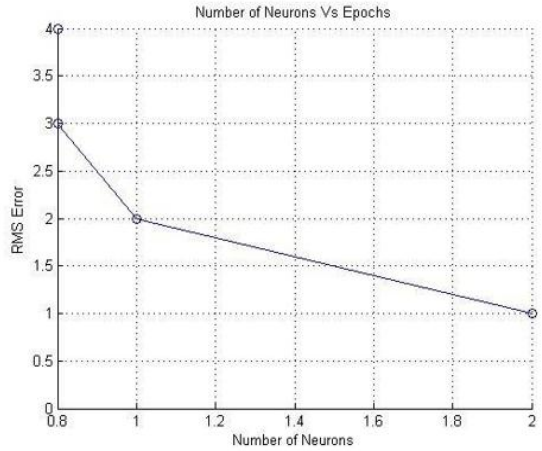

Chart -5: Number of neurons vs. Epoch

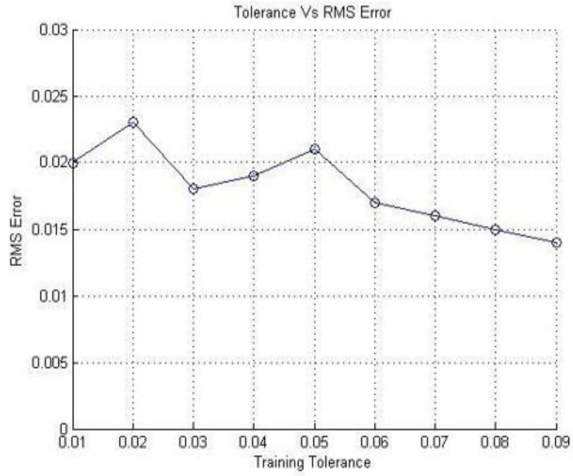

Chart -6: Training tolerance vs. RMS error

6.2 Optimization of Training Tolerance in ANNs Parameter

If the training tolerance is looser, then the RMS error in predicted values is high. The value of the training tolerance is as least as possible. The lesser value of training tolerance provides least RMS error and epochs. The corresponding RMS error, number of epochs, and % training with training tolerance. It is evident that the training tolerance is 0.08 with the minimum RMS error. . A study has been carried out with the range of training tolerance from 0.01 to 0.1 with an increment value of 0.01. The number of epochs required is also minimal when the training tolerance is0.08. The percentage of learning does not reach 100% at all for further values of tolerance less than 0.05. The minimum RMS error and number of epochs is obtained with 100% training for the training tolerance of 0.08. Thus, the training tolerance of 0.08 is chosen for further training.

6.3 Optimization of Learning Rate in ANNs Parameter

The learning rate is set after setting the minimum number of neurons and training tolerance. Generally learning rate varies from 0.1 to 1 with an increment of 0.1. The corresponding RMS error, number of epochs, and % of training for different learning rates are plotted. The RMS error is low for learning rate values of 0.6 to 1. The number of epochs required is also low for those values. A 100% training is achieved for the learning rate of 0.7 to 1. When the learning rate is 1, 100% training is achieved with a lesser number of epochs and RMS error. Hence, the learning rate is fixed as 1 for further optimized parameters. Once the learning rate is fixed, all other parameters have to be optimized to find a momentum value.

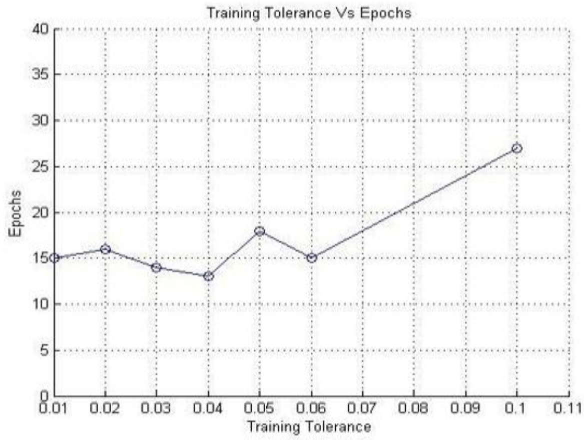

Chart -7: Training tolerance vs. Epochs

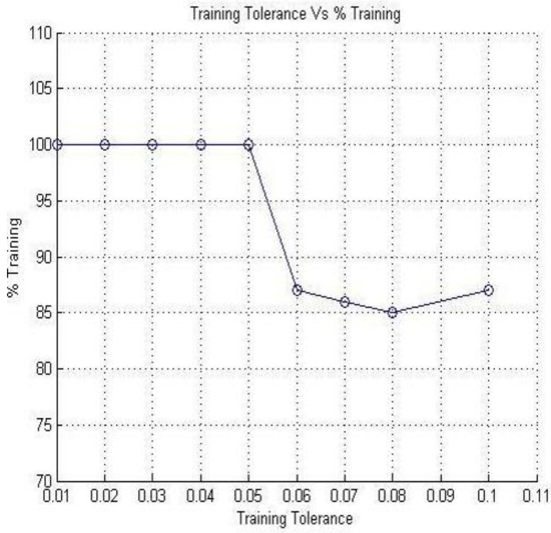

Chart -8: Training tolerance vs. % training

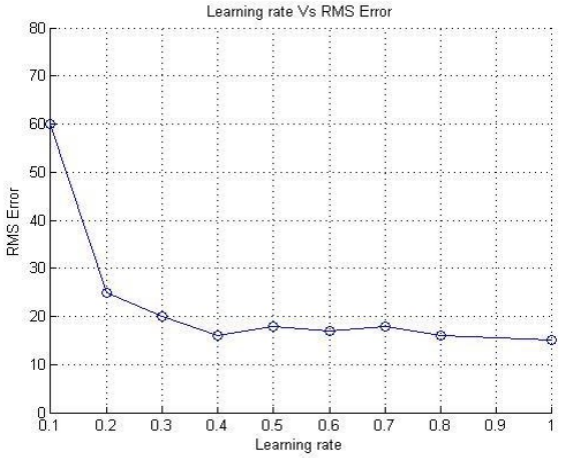

Chart -9: Learning rate vs. RMS error

6.4 Learning Curve and Optimal Neural Network Structure

First, the best fitting back propagation algorithm minimizing the error between neural network output and target value, is calculated. This result is reasonable, since the test set error and the validation set error have similar characteristics, and it does not appear any significant change over fitting has occurred. With optimized values of varying parameters for the data, ANNs are trained and tested.

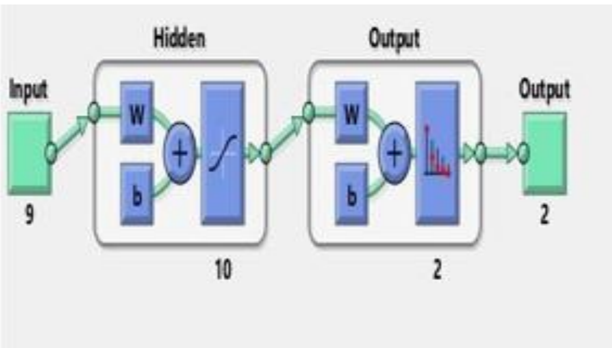

Chart -10: Optimal neural network structure for the waste generation method using ANN-BP

The process of training is repeated as discussed earlier to ascertain optimal architecture and other training parameters and the learning curve for the waste generation method using ANN-BP is derived. The optimal neural network structure for the ANN-BP, the waste generation method, is given in Figure .a two- layer network with a tan sigmoid transfer function at a hidden layer with six neurons and a linear transfer function at the output layer.

7. CONCLUSION

For various collection frequencies the size and number of bins are determined and evaluated using GWP for the city of Erode. This model which is proposed based on ANN technique gives an overview about the GWP that is used for the design of temporary storage for MSW. An Artificial Neutral Network Back Propagation model is dictated based on data from the design components of temporary storage for Municipal Solid Waste. Artificial Neutral Network Back Propagation structure is optimized with ten neurons in one hidden layer, and with a training tolerance of 0.08, momentum of 0.9, and learning rate of 1 gives 100% training accuracy for the proposed model in the waste generation studies. This systematic approach of Artificial Neutral Network Back Propagation can be positively used to determine number of bins and Global Warming Potential from waste generation rate in the city. Further this model can be reliably applied in the design parameters of temporary storage for Municipal Solid Waste. Finally the identified model will be much more helpful for the decision makers to choose the economically viable environmentally sustainable option in the design of temporary storage for MSW management. Hence the works aims to denote the possible modeling options for designing proper municipal solid waste management bins with more efficiency.

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BIOGRAPHIES

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