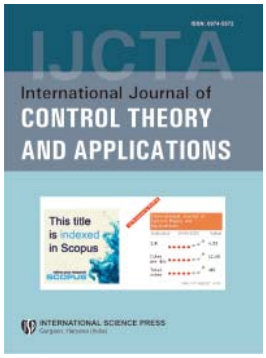

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The Dexterous Survey with a Vision Towards Waste Depletion, Garbage Ejection and Recycling Procedure

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Abstract: Solid waste management is a significant activity in large cities. Our proposed work is on wet garbage which is mainly based on the multiple objective problem. It is considered as the one of the major challenge in real world because of chemical reaction involved in biodegradation of wet garbage which produces foul odour and can spread diseases. As we are planning to work on wet garbage disposal and by-products by disposal plant we referred many papers in that some of them are used in this paper for the review. These are useful to give a good solution to construct the mathematical modelling related to maximizing the production and vehicle routing problem. Here sensors will help to detect the various gases produced at disposal plant. Also, we took other issues such as optimizing the financial issues, segregation of wet garbage and collecting revenues selling the by-product produced in the disposal plant.

Keyword: *Goal Programming (GP), Fuzzy GP, Mixed Integer GP, Vehicle routing, Sensors.*

1. INTRODUCTION

In present Scenario Waste Management is significant challenge for the growing nations like India. Even Indian government has launched the Swatch Bharat Mission to deal with the waste problem. Improper disposal of wastes is leading to many health issues, environmental pollution and many more problem. To solve this problem in technical way and to help in managing budget of garbage disposing we are planning to give the optimized solution by constructing Multi Objective Decision Model. As a First step to gain the knowledge of previous works in this field we are presenting a brief literature survey of some paper which came into our attention.

2. REVIEW OF LITERATURE

Abdulaziz SAlidi presented [1] to manage the Hazardous Waste(HW) obtained from the petrochemical industry using various methodologies such as Analytic Hierarchy Process (AHP), Goal Programming(GP). As per US environmental protection agency if the materials have the properties such as ignitable, corrosive, reactive, or toxic is considered as hazardous waste. Nowadays due to rapid growth of petrochemical industries in Saudi Arabia HW is a biggest challenge for industries. Mismanagement of HW may harm water resources, pollute the air, can cause explosion, and contaminate food etc., Thus HW from petrochemical industries must be disposed carefully.

To solve this problem Alidi [1] used GP for proper treatment. Here he designed a multi-objective model to optimize the various goal such as Removing HW from plants, Transportation cost, funds, Utilizing the available resources, Recycling, energy production etc., and objective function is fixed as per the priority to minimize the deviations.

Also, author used APH to break complex problem to various goals. Alidi [1] considered Al-Jubail Industrial city whereHW managing facility was being constructed. Here AHP is used to design the model systematically considering all the challenges and assigning the priorities. Thus, by using GP and AHP Alidiproposed aid to HW management.

As in [2] authors speak about the Solid Waste Management(SWM) under multiple uncertainties and developed the mathematical model for this problem. In this paper, they utilized the various methodologies such as Chance Constrained Programming (CCP), fuzzy goal programming. In this context authors concentrated on the Municipal Solid Waste(MSW) management problem, probabilistic uncertainties while disposing the wastes.

MSW management system mainly have four major components viz., Source of waste generation, Sorting, Waste treatment, and Disposal facilities. Animesh Biswas [2] considers this problem to minimize the system cost and maximize income for the disposal facility as objective function. In this context Animesh [2] first converts probabilistic constraints to constraints involving only fuzzy uncertainty by CCP technique. Later fuzzy constraints are defuzzified. Optimal value of each objective function is isolated. Fuzzy membership goals were constructed for each objective. At last Weighted Fuzzy Goal Programming model (WFGP) is developed to minimize the cost and maximize the income. They considered a hypothetical model as case study and developed the mathematical model for the MSW management.

To solve LINDO(11.0) software been used to minimize the cost and maximize the income for various set of data in [2]. Author says that the same methodology can also be extend to other environmental problems.

[3] explains about plastic recycling infrastructure planning problem in Thailand. The author says that energy department of Thailand was planned to construct plant in Samutprakarn which converts plastic wastes into oil using polymer energy technology.

For the proper management of plastic Thailand government is planning to build plastic recycling facilities with limited budget. To get maximum yield of oil quality of plastic place important role andthe reverse logistics to collect plastic, Mixed Integer Goal Programming (MIGP) is formulated for better decision. This model creates inter relationship between different goals for network design at different level.

The main objective of [3] is to minimize the deviation from Total cost, Recycled plastic targets, and Desired plastic waste target. Here author considered many constraints such as Flow balance between sites and between time periods for each material, Transportation and processing capacity, Maximum limit for landfill, Demand, and supply and etc.,

Wuthichai [3] collected three-year data in 2005 and worked out and constructed the model in GAMS and solved using CPLEX solver. Thus, Wuthichai [3] presented MIGP model to analyse the relationship between goals. These goals played a prominent role in finance, environmental issues, and quality aspects. Finally, author showed that increase in total cost helps to achieve good quality recyclables and recovery percentage.

In [4] authors proposed the model for recycling of paper. Main purpose of this study is to provide a Mixed Integer Goal Programming (MIGP) model for proper management of paper recycling logistics. In India consumption of paper is rapidly increasing due to the growth of population, literacy rate which is leading to scarcity of paper. But plastic and paper wastes are prominent which is causing environmental pollution. Thus, recycling of paper is best option for proper waste management.

As per the requirement of recycling facility [4], GP model has been developed consisting of the three main goals *i.e.*, minimization of reverse logistics cost, minimizing the use of low standard papers, and maximizing the wastepaper collection at the source. Subjected to reverse logistics cost constraints, relevant and non-relevant wastepaper recovery target, transportation constraints, and storage constraints. Another sub model is also developed for total reverse logistics cost for recycling for the optimization which includes all costs incurred in collection and distribution from customer to manufacturer.

The purpose of this MIGP is to analyse the Resource requirement, Impact of waste paper recovery, and effect of degree of segregation at the source. This model is used to address different types of problems and issues in management of recycling distribution system such as increasing reverse logistics cost to achieve good quality of recyclables. [4] says that this model can be extended for similar reverse logistics problems where there is an environmental issue and conservation of natural resources are involved.

In real world, due to the urbanization and improved living standards in cities Solid waste management is one of the serious issue which requires optimization technique for better decision making. Solid wastes include; Recyclable wastes, Toxic waste, and Green waste [5].

In [5] a mathematical model is developed and tested by using the data of Ilala municipal in Dar es Salaam Tanzania. In Dar es Salaam 67% of the waste is of organic matters. Thus, compost plants will play a significant role in reducing the solid waste problem. The main aim of this study is to minimize the cost of transporting wastes from the source to collection point then from collection points to composting plants or landfill.

GNU linear Programming kit solved the model. Here Mbido Kahebo took only one composting plant and landfill for study and arrived at an optimized solution by lowering the transportation cost. Further it's been observed that construction of new compost plant can increase the income which will reduce all running costs. Author also mentioned about future works which can be extended by including other conditions such as compost plant cost, landfill maintenance cost etc., to the objective function and solve as multi criteria decision analysis problem.

In waste management transportation takes an important role. In [6] author explains about the Waste Collection Vehicle Routing Problem (WCVRP). The collection of waste consists of routing of vehicle to collect garbage from customers with minimum travel cost and collection of garbage from various parts of city is generally represented as shown in the Fig 1.

Somayeh [6] designed A mixed non-linear programming model including WCVRP and the processes of unloading, balancing the distance between trashcans, types of wastes in trashcans, selection of optimal route for each vehicle. It is assumed that each VRP may have the different capacity. Thus, main objective of the WCVRP is minimize the travel cost under many constrains such as satisfying the capacity of the vehicle, collecting one types of waste from every customer at once. Here problem is solved using LINGO 9.0 and outputs of solved model is analysed.

Budgeting is a significant part of business which often requires owners to plan carefully. Budgeting is complex task helps to plan and control the financial resources which is directly related to the performance of the company. For the growth of the company an efficient and effective budgetary allocation is needed. In [7] authors explained the application of GP in budgetary allocation of garbage disposal unit. Using GP authors attempted to make GP model for profit generation within the allotted budget. The Garbage disposal plants runs on many expenditures such as Infrastructure cost, Landfill cost, Maintenance charges etc., The main objective of [7] is to maximize the personnel cost, assets of the unit, Revenue generated and Minimizing the Liabilities, Infrastructure cost, Sanitary landfill cost, maintenance charges, general expenses. To achieve maximum profit several goals were taken such as maximize the personal cost, minimize the general expenses, maximizing the assets, minimizing the liabilities, minimizing the infrastructure expenses, minimizing the scientific sanitary landfill cost, minimizing the maintenance charges, Maximizing the revenue generated. In this context authors collected the data from BBMP and developed a model to minimize the deviations. TORA software is utilized to solve the problem.

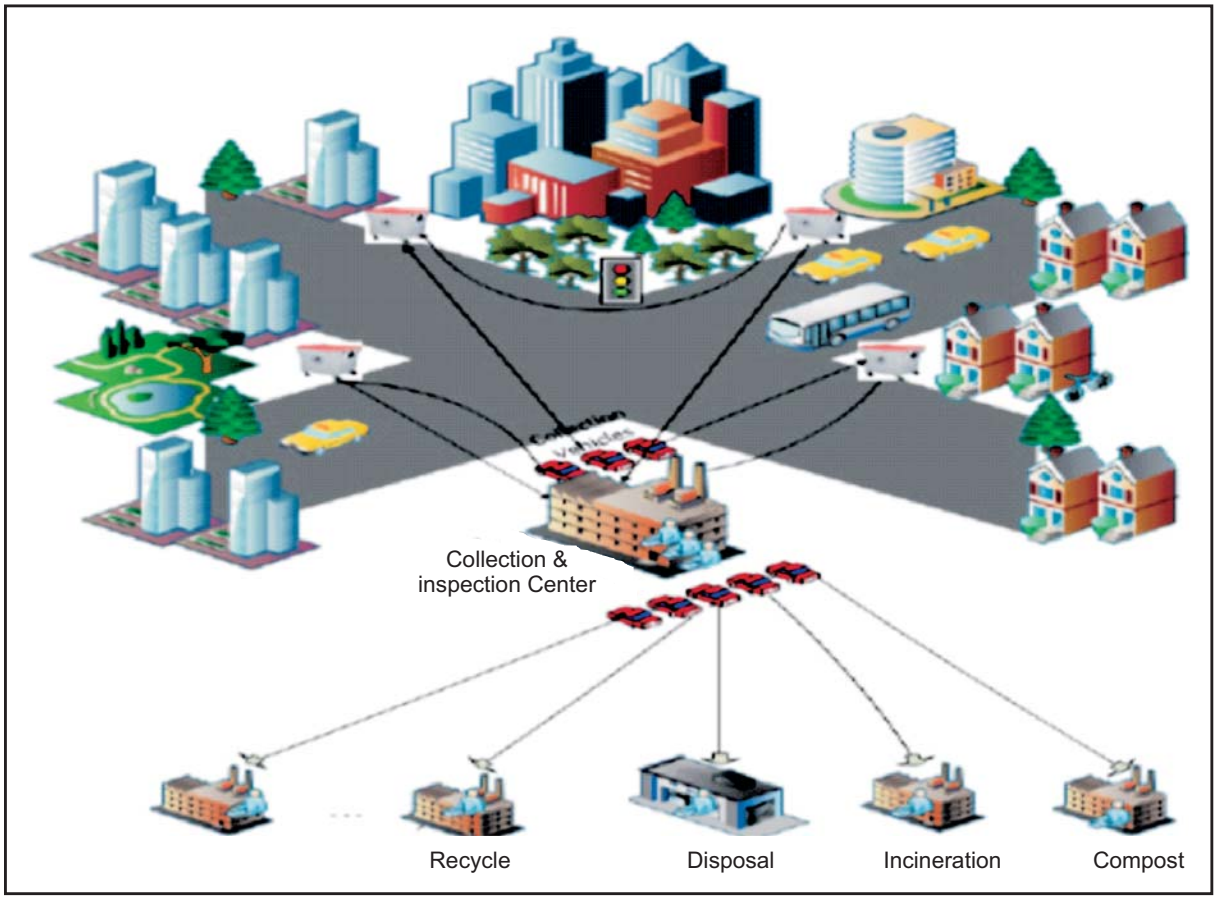

Figure 1: General diagram of the problem

Improper method of waste disposal and Unregulated dumping grounds cause serious risk to human being and environment. Solid waste, liquid waste, gaseous waste, animal by-products, chemical waste, commercial waste, biodegradable waste, biomedical waste, etc., are some of the types of waste. Improper disposal may spread many diseases like plague, jaundice, cholera etc.

While establishing new waste disposal facility business one should take care of returns on sales, storage cost, expenditure. Thus, main objective of [8] involves increase return on sales, decreasing the loss due to missed sale of wastes, minimizing the storage cost and expenditures. Authors developed a general goal programing model which involves multiple goals with multiple variables under the constraints of return on sales, missed sale of wastes, storage cost and expenditure of the unit.

Authors also explains that this model is useful in identifying the deviations while disposing the different types of wastes in one year. It is also effective for saving the processing time. Here also TORA software is used to obtain the solution by minimizing the deviations from the objective function.

Mining requires manpower and equipment to operate under the earth. Many accidents occur in coal mines because of toxic gases, inflammable gases(methane), Carbon monoxide, etc. Thus, in [13] authors explain about use of sensors to detect these odds. This paper gives the operating principle, working procedure and application od sensors. Sensors detects the varieties of gases present in the mines so that one can take the safety measures. To detect gases various method is followed as shown in the table 1. In table 2 hazardous limits of different gases and hazard caused by that gas is given so that one can take the security measures it any gas reaches hazardous limit

Table 1
Different methods of gas detection [13]

Name	*Methods of detection*
Oxygen	Electrochemical, paramagnetic, flame lamp
Methane	Catalytic oxidation, thermal conductivity, optical, acoustic, flame lamp
Carbon dioxide	Optical, infrared
Carbon monoxide	Electrochemical, catalytic oxidation, semiconductor, infra-red
Sulphur dioxide	Electrochemical, infra-red
Nitric oxide, Nitrous oxide, Nitrogen dioxide	Electrochemical
Hydrogen sulphide	Electrochemical, semiconductor
Hydrogen	Catalytic oxidation

Table 2
List of gases and their hazardous limits in underground mines [13]

Name of gas	*Flammability limits in air (%)*	*Guideline for threshold limit values*	*Hazards*
Oxygen		>19.5%	Oxygen deficiency, may cause explosive mixtures with reactive gases
Nitrogen		CL = 81,000 ppm	Inert
Methane	5 to15	At 1% isolate electricity, at 2% remove personnel.	Explosion
Carbon dioxide		TWA = 0.5%, STEL = 3.0%, CL = 1.5%	Promotes increased rate of respiration
Carbon monoxide	12.5 to 74.5	TWA = 0.005%, STEL = 0.04%, CL = 200 ppm	Highly toxic; explosive
Sulphur dioxide		TWA = 2 ppm, STEL = 5 ppm, CL = 10 ppm	Very toxic; irritant to eyes throat and lungs
Nitric oxide		TWA = 50 ppm	Oxidizes rapidly to NO2
Nitrous oxide		TWA = 50 ppm	Narcotic (laughing gas)
Nitrogen dioxide		TWA =3 ppm, CL= 5 ppm	Very toxic; throat and lung irritant; pulmonary infections
Hydrogen sulphide	4.3 to 45.5	TWA = 10 ppm, STEL = 15ppm, CL = 15ppm	Highly toxic; irritant to eyes and respiratory tracts; explosive
Hydrogen	4 to 74.2		Highly explosive

3. CONCLUSION

Regarding [1] we plan to utilize the knowledge of breaking the complex challenges into goals and sub-goals in the wet garbage management and to solve the challenges faced by the garbage disposal facilities.

In [2] fuzzy GP model been adopted for decision making under multiple uncertainties, and applied for long term planning of MSW management system which can be extended for environmental problem.

In [3] MIGP model is presented to deal with the plastics and cost reduction in maintaining the disposal unit. It also helped to collect good quality of plastic from the waste. Here author used polymer energy technology offers a method to extract the oil from recyclable plastic. This paper will be useful for us to accelerate the production of biofuel

The model proposed in [4] will assists to analyse route and flow of verities of recyclable papers in the multi-item, multi-echelon, and multi-facility format. The MIGP model can be used to solve many problems associated with the management of recycling industry.

Composting plants plays a predominant role in waste management processes as it reduces accumulation of wastes in landfill. [5] author proposed a mathematical model for Ilala municipal in Dar es Salaam Tanzania to Maximizing the profit of composting plant. Using this paper, we may utilize the similar concept for conversion of wet garbage into compost.

In [6] we can get the complete picture of reverse logistics involving in garbage management can be obtained. Here one can use this model to solve the challenges in VRP efficiently.

[7] helps in the better utilization of the resources available in disposal facility. For example, better utilization of different types of wastes, optimum returns, provides and healthy environment etc., In [7] Goal Programming technique is used to reduce the unfavourable deviations from the goals in budgeting. The same procedure can be used in our wet garbage budgeting, and [8] helps to formulate the goal programming model for multiple goals and multiple variables.

Detection of Methane gas is most important thing for miners as in [14]. By monitoring the gas levels in mining fields one can maintain the healthy atmosphere. The same technology can be used to detect gas production and odour in & around the disposal plant.

REFERENCES

[1] Abdualziz S. Alidi, *"A Multiobjective Optimization Model for the Waste Management of the Petrochemical Industry"*, King fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia. 1996

[2] Animesh Biswas, Arnab Kumar De, *"A Fuzzy Goal Programming Approach for Solid Waste Management under Multiple Uncertainties*,International Condference on solid waste management", 5IconSWM 2015. Procedia Environmental Sciences 35(2016) 245-256

[3] Wuthichai Wongthatsanekorn, "A *Goal Programming Approach for Plastic Recycling System in Thailand"*, World Academy of Science, Engineering and Technology, International Journal of Mechanical, Aerospace, Industrial, Mechatronic and Manufacturing Engineering Vol:3, No:1, 2009.

[4] Rupesh Kumar Pati, Prem Vrat, Pradeep Kumar, *"A Goal Programming Model for Paper Recycling System"*, Omega 36 (2008) 405-417.

[5] Mbido Kahebo, Egbert Mujuni, Allen Mushi, "O*ptimization of Municipal Solid Waste Management Problem with Composting Plants: The Case study of Ilala Municipality"*, International Journal of Advances in Computer Science and technology, Volume 2, No 8, August 2013.

[6] Somayeh Fooladi, Hamed Fazollahtabar, Iraj Mahdavi, "*Waste Collection Vehicle Routing Problem Considering Similarity Pattern of Trashcan and Garbage Unloading"*, International Journal of Engineering and Industrial Management 5.

[7] Jyothi P, Dr Vatsala G A, Dr Radha Gupta, *"Application of Goal Programming to Budgetary Allocation in Garbage Disposal Plant"*, Jain University, Bnagalore, India. 2015

[8] Jyothi P, Dr Vatsala G A, Dr Radha Gupta, *"Optimization of planning of disposal of waste using mathematical model"*, Jain University, Bnagalore, India. 2016

[9] Chang NB, Wang Sf. "*Solid waste management system analysis by multi-objective mixed integer programming"*. Journal of environmental management 48, 1996.

[10] A O Salami. *"Application of transportation linear programming Algorithms to cost reduction in Nigerial soft drinks Industry"*. International Journal of Social, education, economics and management Engineering 2014.

[11] Nabendu Sen, Manish Nandi, *"Goal Programming, its application its application management Sectors special Attention into Plantation Management- A review"*. International Journal of Scientific & Research Publication. 2014

[12] Vatsala G A & S D Sharama. *"Optimization of university Resources Management through"*. PAJOM 2012

[13] A Kumar, T M G Kingson, R P Varma, R Manadal, S Dutta, S K Chaulya and G M Prasad. *"Application of Gas Monitoring Sensor in the Underground Coal Mines and Hazardous Areas"*, International Journal of Computer Technology and Electronics Engineering 2013

[14] Beata Krupanek and Ryszard Bogacz. *"Dynamic Error Correction of Methane Sensor"*. Internalnational journal of Electronics and Telecommunication, 2014, VOL 60, NO 4, PP 287-289.