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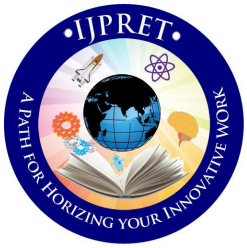

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OPTIMIZATION OF MUNICIPAL SOLID WASTE MANAGEMENT- A LITERATURE REVIEW

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Abstract

Environmental policy formulation can prove complicated when the various system components contain considerable degrees of stochastic uncertainty. In addition, there are invariably unmodelled issues, not apparent at the time a model is constructed, and that can greatly impact the acceptability of its solutions. While a mathematically optimal solution may be the best solution for the modelled problem, it is frequently not the best solution for the real problem. Consequently, it is generally preferable to create several good alternatives that provide different approaches and perspectives to the same problem. This study shows how a computationally efficient simulation-optimization (SO) approach that combines evolutionary optimization with simulation can be used to generate multiple policy alternatives that satisfy required system criteria and are maximally different in decision space. The efficacy of this stochastic modelling-to-generate-alternatives approach is demonstrated on a waste management planning case. Since SO techniques can be adapted to model a wide variety of problem types in which system components are stochastic, the practicality of this approach can be extended into many other operational and strategic planning applications containing significant sources of uncertainty.

Introduction

Policy formulation often proves to be an extremely complicated and challenging process. Because of the complexities involved, numerous optimization and mathematical modelling methods have been proposed to support this policy formulation endeavour. For environmental policy determination, numerous deterministic mathematical programming techniques have been introduced. While optimization-based techniques generally create single best solutions to problems, the presence of unmodelled issues, considerable system uncertainty and opposition from dominant stakeholders can actually eliminate any single (even an optimal) solution from further consideration. Furthermore, although a mathematically optimal solution may be the best result for the modelled problem, it is frequently not the best solution for the real problem as there are invariably unmodelled issues and unquantified objectives, not apparent at the time the model is constructed, that can greatly impact the acceptability of its solutions.

In addition, in the environmental decision-making arena, there are frequently numerous stakeholders with incompatible standpoints with reality dictating that policy-makers must establish a framework that simultaneously balances numerous incongruent points of view. Consequently, from a policy formulation standpoint it is often preferable to generate several alternatives that provide multiple different perspectives to the particular problem. Preferably these alternatives would all possess good (i.e. near-optimal) objective measures with respect to the modelled objective(s), but would differ from each other in terms of the system structures characterized by their decision variables. The policy-makers would then be required to perform a subsequent comparison of these alternatives to determine which option most closely satisfies their specific circumstances.

Literature Review

Riccardo Minciardiet. al (2008),proposed an iterative procedure based on the repeated application of the RPmethodology introduced by Wierzbicki.

A real case study has been considered in the paper, inorder to validate the effectiveness of the proposed approach.This case study refers to a major city in Italy, and has beenexamined from the viewpoint of two different decision makerswith different expertise and attitudes. The procedure providestwo different solutions (actually, not too different) thatare accepted by the two decision makers. The method iscapable of identifying, under the control of the decisionmaker, a satisfactory solution even when starting from quitedifferent initial reference points. It is really possible to structurean interactive and iterative procedure allowing the progressiveacquisition of information from the decision maker,at the price of limited computational effort.

YavuzGunalayet. al (2011),summarised that environmental policy formulation is a very complicated process that can be impacted upon by amultitude of uncertain factors, unquantified issues and unmodelled objectives. Any ancillary technique to supportpolicy generation must simultaneously account for all of these features and must be flexible enough to encapsulatethe impacts from the inherent planning uncertainty. In this paper, a computational procedure was presented thatshowed how SO could be used to efficiently generate multiple near-best policy alternatives for difficult, stochastic,environmental problems and the effectiveness of this MGA approach was illustrated using a case study of wastemanagement facility expansion. In its stochastic MGA capacity, SO can produce numerous solutions possessingthe requisite characteristics of the system, with each alternative providing a different planning perspective. SinceSO techniques can easily be adapted to many different stochastic problems, the practicality of this approach canclearly be extended into many other planning applications containing significant sources of uncertainty.

V.R. Sumathiet. al (2008), examines an approach for identifying the optimum site for the construction of a landfill in a typically urbanizing city. A multi-criteria approach was employed in conjunction with GIS-based overlay analysis to identify the

most suitable site for landfill development in the Pondicherry region.

The study was based upon a set of key criteria, which were selected based upon the already available knowledge from research literature as well as the pre-existing local level factors of the area.

Table 1 Identified sites for landfill

Site no.	Rank	Description of the site	Area in km^2
1	1	Waste land, large area and soil suitability	0.36
2	2	Area located in the path of HT power lines	0.19
3	3	Land located in the dip zone of main water source of Pondicherry	0.14
4	4	Land situated around the new habitation area	0.12
5	5	Waste land and soil suitability	0.11
6	6	Site not recommended by the geologists due to sandy soil	0.09
7	7	Land situated around the new school zone	0.08
8	8	Land located in the dip zone of main water source of Pondicherry	0.08
9	9	Located 10 km or more away from the municipal boundary	0.08
10	10	Land situated around the new habitation area	0.07
11	11	Located 10 km or more away from the municipal boundary	0.06
12	12	Land located in the dip zone of main water source of Pondicherry	0.06
13	13	Waste land and soil suitability	0.06
14	14	Small single site	0.05
15	15	Land located in the dip zone of main water source of Pondicherry	0.05
16	16	Land situated around the new habitation area	0.04
17	17	Located 10 km or more away from the municipal boundary	0.04

A set of 17 potential sites were identified (Table 1) in the first level of analysis while subsequent screening and refinement on the basis of existing microscopic factors led to optimized selection of the 3 most suitable sites for landfill construction. The sites were ranked on the basis of area availability. Sites 1, 5, and 13 covering areas of 0.36 km2, 0.11 km2 and 0.06 km2, respectively, were chosen as the most suitable for landfill construction.

Amar Katkar(2012),focuses on the collection and transport of solid waste from waste bins in the area under study. The minimal spanning tree is introduced and implemented, for monitoring, simulation, testing, and route optimization of alternative scenarios for a solid waste management system. The first experiments have shown that applying the optimization technique for the solution of this every day problem – the collection of urban solid waste – can greatly minimize the collection tour length and eventually the total cost in time and money. However, as it was reported above, the particular problem is much more complicated than presented in the current work. The proposed methodology was applied in a region of the Kolhapur city which contains a quantity of solid waste generation equal to the capacity of the waste truck used in this particular area. Although the case study covers an area of Kolhapur having about 15,000

citizens. Such problem of uneven growth and generation of heaps is common in surrounding areas of city. This method ensures the reliability of the results, a future prospect of this work is that the proposed method of collection can be implemented at places where collection problem is severe.

Juin-I Liu et. al (1996),analysed multiple regression analysis was used to develop predictive models of the energy content of municipal solid waste (MSW). The scope of work included collecting waste samples in Kaohsiung City, Taiwan, characterizing the waste, and performing a stepwise forward selection procedure for isolating variables.

The various conclusions found to be are,

• The multiple regression models derived from physical composition analysis and from ultimate analysis accurately predicted the energy content of MSW from Kaohsiung City.

• The regression model based on physical composition was superior to the conventional equation (also based on physical composition) developed by other researchers. The conventional equation had poor accuracy and substantially over predicted the energy content.

• The model developed in this work based on ultimate analysis was also more accurate than equations/models developed by other researchers.

• Modeling efforts on the proximate analysis database were not successful.

BehzadNadi et.al (2011), presented that the amount that the municipality of Sari spent for workers salary, fuel and vehicles for transporting waste was US$71,680 in fall 2009. In addition, the value of machinery used in this section is equivalent to US$197,050. According to prediction done, generation of solid waste will be 25,147 ton in spring 2011. Using response surface 2FI model, the costs of labor, machinery, and fuel consumption can be decreased to US$55,606 and the capital value of machinery used in this section will be US$136,615.

Salah R. Agha (2006),studied that public environmental policy formulation is a very complicated process that can be impacted by many uncertain factors, unquantifiedissues and unmodelled objectives. This combination of

uncertainties and unknowns together with the competing interests of various stakeholders obligates public policy-makers to integrate many conflicting sources of input into their decision process prior to final policy adoption. In this paper, a computational procedure was presented that showed how SO could be used to efficiently generate multiple, maximally different, near-best policy alternatives for difficult, stochastic, environmental problems and the effectiveness of this MGA approach was illustrated using a case study of municipal solid waste management planning.

In its stochastic MGA capacity, SO was shown to efficiently produce numerous solutions possessing the requisite characteristics of the system, with each generated alternative providing a very different planning perspective.Because an evolutionary method guides the search, SO actually provides a formalized, population-based mechanismfor considering many more solution options than would be created by other MGA approaches.

However, unlike the deterministic MGA methods, SO incorporates system uncertainties directly into the generation of these alternatives. MSW systems provide an ideal testing environment for illustrating the wide variety of modelling techniques used to support public policy formulation, since they possess all of the prevalent incongruencies and system uncertainties that so often exist in complex public planning processes. Since SO techniques can be adapted to model a wide variety of problem types which system components are stochastic, the practicality of this MGA approach can clearly be extended into numerous disparate operational and strategic planning applications containing significant sources of uncertainty.

SarikaRathi (2007), developed a linear programming model to design an integrated waste management strategy for Mumbai taking into account different economic and environmental costs of the waste management system. In order to integrate the role of different stakeholders, different options considered for an integrated waste management strategy are community compost plant, aerobic compost plant and sanitary landfill. The optimal solution of the model indicates community compost

plantsare the best option whereas sanitary landfills are indispensable for waste management in Mumbai. Further, three scenarios are constructed to test the optimal solution under various situations. The optimal solution is based on the assumptions of no cost of segregation of waste at the household level, revenue recovery from compost and considerations of environmental costs.

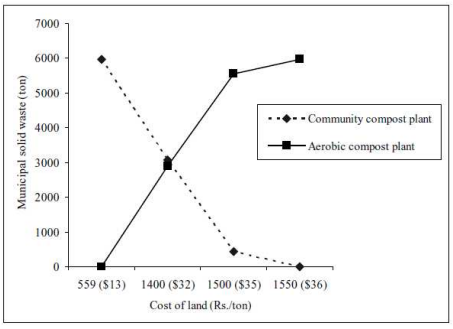

Figure 1.Change in waste management strategy with an increasing cost of land

However, in reality segregation of waste at the household level requires time and involvement from households. Further, the MCGM does not take into consideration the economic value of organic materials and environmental costs associated with different options of waste management. Scenario three is developed under the assumptions that there is a cost associated with segregation of waste at the household level, no revenue recovery from compost and neglect of environmental costs. As the model correctly predicts, under this situation sanitary landfill becomes the optimum solution.

Elmira Shamshiryet. al (2011),developed a model for the 3D response surface at 2FI to better imagine the significant ($p < 0.05$) interaction effects of independent variables on theoptimization cost of collection and transportation of solid waste. The plots are drawn as a function of four factors at a time, holding the fifth factor at fixed levels (at the mid level). Those plots are helpful in understanding both the main and the interaction effects of these four factors.

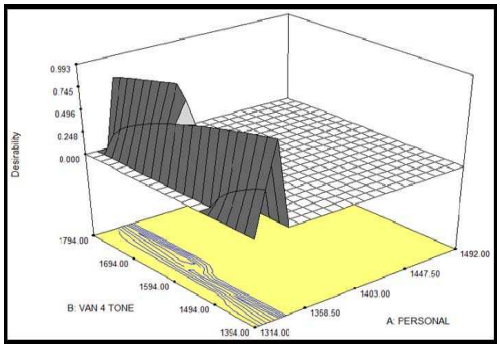

Figure 2 Design-expert plot of 3D surface desirability

Figure 2 present the best optimization cost in the management of number of personnel and kind and the number of trucks which are used in collection and transport of solid waste in the city of Sari.

The most significant and unique part of this model is that for the first time cost optimization of solid waste management has been done by the statistical analysis of response surface two-factor integration model and also combining the amount of generated waste, fuel consumption, total labor force and quantity and quality of transport as inputdata.

According to statistics presented, the amount that the municipality of Sari spent for workers salary, fuel and vehicles for transporting waste was US$71,680 in fall 2009. In addition, the value of machinery used in this section is equivalent to US$197,050. According to prediction done, generation of solid waste will be 25,147 ton in spring 2011.

Using response surface 2FI model, the costs of labor, machinery, and fuel consumption can be decreased to US$55,606 and the capital value of machinery used in this section will be US$136,615.

AshtashilVrushketuBhambulkarsuggested some essential restrictions, such as the streets' directions, no U-Turns rules(with the exception of the dead-ends) and also, the fact that the truck should follow true-shape route. Moreover, Network Analyst was asked to show the results in meters, as the distance criterion was selected, and to reorder the stop-points in order to find the shortest route. It is worth mentioning that, in the special case where some piece of refuse causes traffic problems, Network Analyst can be asked to find the shortest route starting from this certain point, so as to relieve the traffic. Finally, pushing the "solve" button of Network Analyst, the closest route for the solid waste collection was produced. In this work optimize the solid waste route for vehicle in Laxmi Nagar by using Arc map Network Analyst.

With the GIS technique, optimum route was identified which found to be cost effective and less time consuming when compared with the existing run route. The route is to be obtain by Arc GIS is 5.1 km. and time are 8 Hr. 35 min. The cost for these operation are 965 rupees per day 28,950 rupees per month 3,52,225 rupees per year. The cost is

save up to 14 % per month. The software based analyses is quickly / fast and easy to understand as compared to manual analyses. So software analyses also the good option for these type of study.

Conclusion

One of the most complicated problems of human society is the production of solid waste materials in different quantities and of varied quality. Establishing a management system of collecting and disposing the solid waste materials is of remarkable importance for the purpose of control of production and consumption, and the process of garbage collection and disposal. The collection and transportation of solid waste in urban areas is a very hard and complicated problem. Collection and transportation of solid waste often accounts for a substantial percentage of the total waste management budget (including labor costs). Therefore, even a small improvement in the collection operation can result in an important saving in the overall cost. The total cost of the solid waste management system included the transportation cost of the waste to different facilities such as transfer stations, landfills, and incinerators and also the operational and fixed costs of these facilities.

REFERENCES

1. Riccardo Minciardi, Massimo Paolucci, Michelarobba, Roberto Sacile, "Multi-Objective Optimization Of Solid Waste Flows: Environmentally Sustainable Strategies For Municipalities" Waste Management 28 (2008) 2202–2212.

2. Yavuzgunalay And Julian Scott Yeomans, "Simulation-Optimization Techniques For Modelling To Generate Alternatives In Waste Management Planning" Journal Of Applied Operational Research (2011) 3(1), 23–35 ISSN 1735-8523.

3. V.R. Sumathi ,Ushanatesan , Chinmoysarkar, "GIS-Based Approach For Optimized Siting Of Municipal Solid Waste Landfill", Waste Management 28 (2008) 2146–2160.

4. AMAR A. KATKAR, " Improvement Of Solid Waste Collection By Using Optimization Technique" International Journal Of Multidisciplinary Research Vol.2 Issue 4, April 2012, ISSN 2231 5780.

5. Juin-I Liu, Rajendra D. Paode, Thomas M. Holsen, "Modeling The Energy Content Of Municipal Solid Waste Using Multiple Regression Analysis" ISSN 1047-3289 /. Air & Waste Manage. Assoc. 46: 650-656.

6. Behzadnadi, Elmira Shamshiry, Ahmad Rodzi Bin Mahmud, "Response Surfaces Model For Optimization Of Solid Waste", International Journal Of Chemical Engineering And Applications, Vol. 2, No. 1, February 2011 ISSN: 2010-0221.

7. Salah R. Agha, "Optimizing Routing Of Municipal Solid Waste Collection Vehicles In Deir El-Balah – Gaza Strip", The Islamic University Journal (Series Of Natural Studies And Engineering) Vol.14, No.2, P.75-89, 2006, ISSN 1726-6807.

8. Sarikarathi, "Optimization Model for Integrated Municipal Solid Waste Management in Mumbai, India", Environment and Development Economics 12: 105–121.

9. Elmira Shamshiry, Behzadnadi, Ahmad Rodzi Mahmud, "Optimization of Municipal Solid Waste Management", 2010 International Conference on Biology, Environment And Chemistryipcbee Vol.1 (2011).

10. Ashtashilvrushketubhambulkar, " Municipal Solid Waste Collection Routes Optimized With Arc Gis Network Analyst" International Journal Of Advanced Engineering Sciences And Technologies Vol No. 11, Issue No. 1, 202 – 207.