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Full Length Research Paper

A model for solid waste management in Anambra State, Nigeria

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Indiscriminate dumping of solid wastes along the streets and roads corners causes a lot of deadly infectious diseases which could be responsible for the large proportion of morbidity and mortality in Nigeria. A deterministic model needed for short and long term waste management and management information system in Anambra State sanitation and environmental protection agency (ANSEPA) is considered in this paper. A review of literature on model methods is presented, with brief method of the study and analysis used for the determination of the required results. Moreover, this study was aimed to determine which type of integrated solid waste management option or programme will be used to implement minimized cost and maximized benefit (benefit cost ratio) over a long period of planning period. Consequently, the model will be used by the decision makers in finding the solution to environmental, economical, sanitary, technical and social goals, through the use of equipment, routine maintenance, personal and sundry.

Key word: Minimum cost, maximum benefit, morbidity and mortality, integrated solid waste management, infectious disease, deterministic model.

INTRODUCTION

Solid waste is a system of Engineering, involving substantial engineering content, that is particularly set for actions which will best accomplish the overall objectives of the decision makers, within the constraints of law, morality, economics, resources, political and social pressure and which will govern the physical life and other natural sciences Solid waste management is defined as the discipline associated with the control of generation, storage, collection, transfer and transport, processing and disposal of solid waste in a manner that is in accord with the best principles of public health, economic, engineering, conservation, aesthetics and other environment consideration that is also responsive to public attitudes (Tchobanoglous et al., 1993).

Waste management in the three urban cities of Anamabra State, namely Awka, Onitsha and Nnewi and some few local governments is becoming an increasing problem daily and a complex task. The Anambra State sanitation and environmental protection agency (ANSEPA) are being considered as the base scenario for development of this waste management model. The State Government has a major waste management issue and has been noticeable since the 80s. The waste management which in the past times has been addressed with various methods by different administrations in tackling the waste problem yielded nothing.

However, the Board of Anambra State sanitation and environment protection agency (ANSEPA) are charged with the following responsibilities:

1. Removal, collection and disposal of domestic commercial and industrial generated waste.
2. Cleaning and maintenance of Public drainage facilities
3. Cleaning streets of Awka, Onitsha and Nnewi.
4. Removal and disposal of abandoned Scrapped vehicles
5. Streets sweeping of major roads.

In the operational period of the Waste Disposal Board, its

activities were limited to the three urban towns and just recently, due to population growth and progressive urbanization, the service areas are expanded to some few Local Government Areas.

At all times, human activities have generated waste in various forms in gaseous (abattoirs), liquid and solid. These wastes have often been discarded because they were all considered as negative value goods. The more prevalent method of disposal of these wastes have been to first collect them from their source and then burn them in a landfill site or throw them in the surrounding deep erosion gullies in the state.

However, the steady increase of landfill site, deposition in the gullies, and waste generally has caused a lot of havoc to the potable water being extracted from downstream and ground water. Currently, the emergence and development of new public environmental consciousness have created a strong negative attitude toward landfill and deposition into gullies.

The national and state regulation to protect the environment have increased the cost of developing new landfill and deposition in the gullies, also siting has become increasingly difficult because the public oppose having such facilities nearby. Solid waste management has become a major concern in industrialized developing countries, like Nigeria. The ideal way to improve the situation would be, to reduce the generation of waste. But contrarily, this goes against the people's will to preserve their life style and thus to consume more food.

Consequently, the society is searching for improved method of waste management and ways to reduce the amount of waste material which can be reused or transformed into useful material (e.g plastic and some cast iron from sites – mechanics) if managed properly. Many waste management options have been proposed previously by some committees set up by Government but has always been poorly implemented which resulted in failure, unproductiveness and corruption. The most, the implementing Agency, cannot foresee or properly forecast the out-come of such programme, and also properly and well planned scheduling processes were not included in the management system and corruption which has eaten deeply in the system.

Different waste management options must be combined intelligently in a way as to reduce the environmental and social impact at an acceptable cost for the masses in the state. This combined option is called integrated solid waste management and system approach should be used for the assessment of the competing option.

Objective

An integrated waste rearranged system of plan must place an emphasis not only on which specific waste management option are to be chosen, but on the scheduling of these location of facilities and equipment (Tippers, Pail loader and Bulldozer).

A more flexible choice and scheduling Programme for waste management options which must be, also to adapt to changing conditions need to be considered in the plan. The basic aim here is to allow decision makers to be able to determine the optimal times to implement and discontinue or close the waste management Programme and facilities. Throughout the planning period, this should include a determinist schedule plan of when and what recycling programme to implement and the landfill is to be opened or gully to be filled in a given planning period. Also the schedule option should minimize the overall cost associated with the solid system for a defined planning period. This is achieved by integrating a cost minimization, example minimizing the cost of equipment maintenance (Bulldozers, Pail loaders and Tippers).

Some operation research model is particularly well suited for the description of complex task method involving some variables as constraints (Equipment: Bulldozer, Pailoaders and Tippers). These model may be used to help understand the complexity of the system as well as assessing the long term role and impact of the new Technology option, "Gottinger 1986" in his integrated model of waste optimization proposed a network model which would help decision makers in the waste management and facility sitting decision. Also "1986 Kaila J" developed a model for the strategic evaluation of municipal solid waste management system.

METHODOLOGY

Optimization model for solid waste management system engineering approach to planning, scheduling, cost minimizing, maintenance and general management of solid waste management system, serves as a control tool for decision management makers in the areas of waste management (Mackenzie and David, 1998). The necessity for this system approach lies in the fact that waste management in recent times have developed to a complex task. The system of optimal model is focused on the Anambra State Sanitation and Environment Protection Agency, as a means of eradicating waste littering along the streets and roads and that concerns municipal and local waste management system. The optimal system represents a group of specific municipal and local system and is defined in a set of existing an optimal treatment process and flow. The input data for the system is a sum of the specific system of the category; both the municipal and local waste management systems are represented in the model. The compliance between the system model representing State Government waste transport and the mathematical representation of the model is set up from a number of standardized devices defined in the model (Sundberg, 1993); each device corresponds as described accordingly by the relations between input and output flows of material.

The material waste is modeled by a number of factions- Plastic, glasses, personnel, purchase and maintenance of equipment. The example, is that if Anambra State Environmental Protection Agency Embarks on a massive environment project called "Operation Sweep All and Clean Up" in the state using an optimization model system (Linear programme) by effective use of Pail loader, Tipper and Bulldozer in its work of Environmental sanitation, the cost of purchasing one unit of Pail loader, Tipper and Bulldozer are N20 Million, N10 million and N30 million, respectively.

Table 1. Linear programming-maximizing result

	X_1	x_2	x_3	S_1	S_2	S_3	Z
	-7	-5	-8	0	0	0	0
S_1	2	1	3	1	0	0	100
S_2	4	3	3	0	1	0	240
S_3	1	1	2	0	1	1	86
	-1/3	0	-3	0	5/3	0	400
S_1	2/3	0	2	1	-1/3	0	20
x_2	4/3	1	1	0	1/3	0	80
S_3	-1/3	0	1	0	-1/3	1	6
	0	0	-2	½	2/3	0	410
x_1	1	0	3	3/2	-1/2	0	320
x_2	0	1	-3	-2	1	0	40
s_3	0	0	-2	½	-1/2	1	16
	0	0	0	1	1	1	426
x_1	1	0	0	3/4	-1/2	-3/2	6
x_1	0	1	0	-5/4	1/4	3/2	64
x_3	0	0	1	½	-1/4	½	8

Therefore $x_1 = 6$, $x_2 = 64$, $x_3 = 8$, Z = 426. Number of Equipment and amount spent; Pail loader = 6 x 7 = ₦ 42; Tipper = 64 x 5 = ₦ 320; Bulldozer = 8 x 8 = ₦ 64; Total cost = ₦426Million = USD 2.84Million.

The routine maintenance cost for each Pail loader, Tipper, Bulldozer are N400,000, N300,000 and N300,000, respectively. Personnel and Sundry cost for running each are respectively N100, 000, N100, 000 and N200, 000. The maximum allowable budget of the Authority (Agency) for the personnel sundry, purchase and maintenance has been determined, that in relative terms the benefit (in term of clearing waste) derived from the use of each of the equipment above is in the ratio of 7:5:8. Therefore to maximize, the environmental benefit, which is the main aim of the Agency, the number of equipment; Pail loader, Tipper and Bulldozer should be determined using linear programming.

The model takes into account in the scheduling decision, benefit overtime, budget constraints and constraints on the number of equipment available to effectively implement the project. Moreover; decision making is a vital tool for the engineer, in relation to planning, design, execution or maintenance (Peavy et al., 1985).

RESULTS AND DISCUSSION

Optimal solution to sanitation problem

Maximizing the results of good environmental cleanliness

In 1979, Tomas et al stated that Linear Programming is an objective function that optimizes cost or gain as it is subjected to the constraints and involves some decisions (Table 1).

Maxi. $Z = 7x_1 + 5x_2 + 8x_3$ (Benefit point)

Subject: $2x_1 + x_2 + 3x3$ 100 (Personal and sundry)

$4x_1 + 3x_2 + 3x3$ 240 (Equipment Purchase)

$X1 + x_2 + 2x3$ 86 (Routine Maintenance)

$X1 + x_2 + x3$ 0 and integer

Standard form

$Z = 7x_1 + 5x_2 + 8x_3$

Subject to: $2x_1 + x_2 + 3x3$ 100

$4x_1 + 3x_2 + 3x3$ 240

$X1 + x_2 + 2x3$ 86

Inclusion of non- basic variable and basic variable $Z = 7x_1 + 5x_2 + 8x_3 + 0S1 + 0S_2 + 0S_3$

Subject to: $2x_1 + x_2 + 3x3 + 0S1 + 0S_2 + 0S_3$ $4x_1 + 3x_2 + 3x3 + 0S1 + 0S_2 + 0S_3$

$X1 + x_2 + 2x3 + 0S1 + 0S_2 + 0S_3$

The development of optimization model and execution process are ordered and streamlined to effectively achieve the required result, as in the determination of required result to be addressed by the model and area of focus in implementation (Kaila, 1987). This was done first to determine the scope of the design and to ensure a necessary guideline for the project work with the full aim of achieving a competitive result even both in analysis design and work.

Also, it determined planning models for project execution, which consist of planning of models and modules needed for execution of the model. Among the major purpose of this model, is the roles it plays in economics development, via high level of economics

productivity and stimulate immediate and rapid growth regards to employment under a “philosophy of more employment” will produce spectacular results, notably the young unemployed graduates migrating to three urban towns in the state.

A review of the validity of the model shows that 30 years or more may elapse between the conceptions of the needs and full utilization of the model. In addition, most component of the model involves very large investment cost. The sunk costs of the project completion are very important and make the corresponding decisions economically rigid and relatively irreversible.

Conclusion

The optimization system is an optimal solution and a feasible solution. The most favorable value of the objective function is the largest value for maximum environmental benefit (Benefit cost Ratio) and smallest value for a minimization problem of cost of maintenance.

This model presented here illustrates mix basic solution integrated planning of state and some Local Government Solid Waste Management System in Anambra State. The optimization model was developed with the objective of allowing the Board of Anambra State environmental protection agency (ANSEPA) to capture practically all aspect of waste management and it is planning problem (All integrated into, personnel sundry, equipment maintenance and purchase). It contains many innovative features and removes many limitation frequently encountered in often existing optimization modeling for waste management.

Moreover financial constraint causes delay in the models effectiveness and efficiency. As in the Nigeria factor, financial resources are usually difficult to access, in that model goals can be delayed overhead waste collection, disposal and planning management, and a whole lot could be disrupted. When the complexity of solid waste management planning increases, system engineering tools can assist municipal and local decision makers in handling the complex planning situation.

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