OPTIMUM SOLUTION FOR EFFECTIVE MEDICAL WASTE MANAGEMENT

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Abstract- *Medical wastes are highly hazardous and it lead people under risk of incurable diseases. Medical waste management is very important as medical wastes are increasing day by day. During Health care activities like treating, diagnosing, immunizing human being and animal & while during research activities wastes are generated. Mainly hospitals, clinics, diagnosis centres, healthcare institutions, dental offices, medical laboratories generate medical wastes. This paper deals with application of GP technique which is one of the optimization technique to control the expenditure of medical waste management by considering various factors like segregation, storage, transportation, treatment, by-products after recycling. This paper also helps to the systematic disposal of medical waste and environmental protection.*

Keywords: By-products, Goal programming, Optimization, Overachievement, Underachievement

1. INTRODUCTION

Clinical squanders can be named general waste, pathological waste, sharps, Infectious squanders, compound squanders and Radio-active squanders, pharmaceutical squanders, pressurized compartments, Genotoxic squanders and so forth. Risk wastes are sharps, chemical, pathological, pressurized container, infectious, pharmaceutical, Genotoxic wastes etc. Medical Wastes are generated by Government hospital, private hospitals, nursing homes, physician's office, Dental office, Dispensaries, mortuaries, blood bank and collection Centre, Animal houses, Laboratories, Research organizations. Categories of humans exposed to chance of contamination are sanitation employees, scientific and paramedical workforce, sufferers and site visitors. Standard Operating procedures of the system are Generation, segregation, collection, storage, transportation, treatment of wastes. Non-hazardous and hazardous wastes are generated in the hospitals/public authority. Non-hazardous wastes are generated in the sit of office, kitchen, administration, hostels, stores, restrooms etc. Hazardous wastes are generated by wards, treatment rooms, ICU, labor room, dressing room, dialysis room, CT scan in hospital itself. WHO estimates 85% of hospital wastes are non-hazardous and 10% is infectious, 5% are non-infectious. In health care there are two type of wastes. First variety is Non risk wastes (75%-90%) & the other variety is Risk wastes (10%-25%). Developed countries produce 1-5 kg/bed/day/with variation among countries. In India 1-2kg/bed/day with variation among government and private establishments. Estimated 506.74tons/day wastes generated, out of which 57%wastes undergoes proper disposal. Medical waste handling involves some best practices. To avoid most medical waste problems Health care workers must adhere a few key best practices. Workers should mindful of the laws, they classify and separate all loss by type into the right shading coded squander holders. Isolated squanders should be marked relying upon its classification and the correct documentation ought to go with all holders during travel. Utilize the clinical garbage removal shading code. Recruit the correct garbage removal organization

2. Review of the literature

Details of hazardous management is explained in [1]. [2] Gives the explanation of medical waste management and control. Case study of medical waste management of Korea is explained detail in [3]. Detailed process and Device for the disposal of medical waste is given in [4]. Detailed study of GP model for Rubber Wood manufacturing factory in Tripura is mentioned in [5]. GP approach for food product distribution of small and medium enterprises is mentioned in [6]. [7] Gives the explanation of how to use analytic network process and goal programming for interdependent information system project selection. [8] Explains the process of development of model based on Linear Programming to solve resource allocation task with emphasis on financial aspects.

3. Objectives of the study

a) Distinguishing deviation in the objectives
b) Boosting the benefit of reused item
c) Environmental assurance by compelling the executives of clinical garbage removal

4. Mathematical model / Goal Programming model developed in the study: Goal programming is known as one of the multi-objective programming techniques. It is an optimization technique. It is treated as an extension of linear programming that allows simultaneous satisfaction of various conflicting objectives while obtaining a solution that is optimal with respect to the decision maker's specification of goal priorities.

4.1. Minimizing the segregation cost: Segregation of wastes is done at the point of generation of waste in separate color bags. Human and animal anatomical wastes/microbiology wastes and soiled cotton/dressing/linen/bedding are collected in yellow bags. Red bag may be filled with tubing, catheters. Blue/White bags can be used for waste sharps, needles, syringes, scalpels, blades etc. Discarded medicines/cytotoxic drugs, inceration ash, chemical wastes are need to put in Black bags. Most significant advance in bio-clinical waste oversee is essential detachment of various classifications of waste produced at source and along these lines decreasing the dangers just as cost of dealing with and removal. Effective biomedical waste management depends on effective segregation. The model for segregation is

$$\sum_{i=1}^{8}\sum_{t=1}^{4} S_{it}x_{it} \le S_T$$

$$\sum_{i=1}^{8}\sum_{t=1}^{4} ST_{it}x_{it} + d_1^- - d_1^+ = ST_T$$

Where i= 1,2…..8 denotes 8 types of medical wastes, t=1,2,3,4 Quarterly calculation, ST denotes segregation cost and ST_T denotes segregation target costs, d_1^- underachievement function, d_1^+ overachievement function

4.2. Supressing the Collection cost

The assortment of biomedical waste includes utilization of various kinds of compartment from different wellsprings of biomedical squanders like Operation Theatre, research centre, wards, kitchen, hall and so on The compartments/containers should be put so that 100 % assortment is accomplished. Sharps should consistently be kept in cut verification holders to stay away from wounds and contamination to the labourers taking care of them. The model for collection is

$$\sum_{i=1}^{8}\sum_{t=1}^{4} C_{it}x_{it} \le C_T$$

$$\sum_{i=1}^{8}\sum_{t=1}^{4} C_{it}x_{it} + d_2^- - d_2^+ = C_T$$

Where i= 1, 2…..8 denotes 8 types of medical wastes, t=1, 2, 3, 4 Quarterly calculation

C denotes collection cost and C_T denotes collection target costs, d_2^- underachievement function and d_2^+ overachievement function

4.3. Controlling the Storage cost

Biomedical waste is stored in a right place once collection has been finished. Different categories Segregated wastes of essentially to be collected in identifiable containers. It is needed to be taken consideration that the term of capacity ought not to go past for 8-10 hrs. in enormous medical clinics (more than 250 bedded) and 24 hrs. in nursing homes. Every container need to be clearly labelled to show the ward or room where it is kept. The purpose behind this naming is that it could be important to follow the loss back to its source. Other than this, stockpiling region should be set apart with a posted warning.

$$\sum_{i=1}^{8}\sum_{t=1}^{4} ST_{it}x_{it} \le ST_T$$

$$\sum_{i=1}^{8}\sum_{t=1}^{4} ST_{it}x_{it} + d_3^- - d_3^+ = ST_T$$

Where i= 1,2…..8 denotes 8 types of medical wastes, t=1,2,3,4 Quarterly calculation, ST denotes storage cost and ST_T denotes collection target costs, d_3^- underachievement function, d_3^+ overachievement function

4.4. Minimizing the transportation cost:

There is a requirement of separate corridor and lift in hospital to carry and transport waste. Transport of radioactive, RCRA dangerous, and irresistible/bio hazardous squander is more controlled, costly, and unsafe. These are commonly taken from the office that produces them to a treatment, stockpiling, and removal office (TSDF) instead of directly to a landfill. The TSDF may have its own landfill or it may move the waste somewhere else for extreme removal (or for greater treatment). Transportation of BMW can be divided into internal and external transportation. Internal transportation is for yellow, red, blue and white bags. External transportation is for general waste collected in the back colored plastic bags

$$\sum_{i=1}^{8}\sum_{t=1}^{4} T_{it}x_{it} \le T_T$$

$$\sum_{i=1}^{8}\sum_{t=1}^{4} T_{it}x_{it} + d_4^- - d_4^+ = T_T$$

Where i= 1,2.....8 denotes 8 types of medical wastes, t=1,2,3,4 Quarterly calculation, T denotes transportation cost and T_T denotes transportation target cost, d_4^- underachievement function, d_4^+ overachievement function

4.5. Controlling the treating disposal cost:

Various methods of treatment and disposal technologies are Incineration, chemical disinfection, wet and dry thermal treatment, microwave irradiation, land disposal, Inertization, Autoclave, Encapsulation, Shredder etc. Treatment process involves lot of expenditure. Model for trying to minimize the treating cost of each medical waste quarterly is

$$\sum_{i=1}^{8}\sum_{t=1}^{4} TR_{it}x_{it} \le TR_T$$

$$\sum_{i=1}^{8}\sum_{t=1}^{4} TR_{it}x_{it} + d_5^- - d_5^+ = TR_T$$

Where i= 1,2.....8 denotes 8 types of medical wastes, t=1,2,3,4 Quarterly calculation, TR denotes treating cost and TR_T denotes transportation target costs, d_5^- under achievement function, d_5^+ over achievement function

4.6. Boosting the profit of recycled products:

Some materials of waste produced in hospitals may be recycled and new substance can be produced as byproducts. Recycling of sharps, syringes, needles, blades etc. gives the new product and selling of those can be increased and profit can be boosted. Model for the same is given by

$$\sum_{i=1}^{8}\sum_{t=1}^{4} PR_{it}x_{it} \ge PR_T$$

$$\sum_{i=1}^{8}\sum_{t=1}^{4} PR_{it}x_{it} + d_6^- - d_6^+ = PR_T$$

Where i= 1,2.....8 denotes 8 types of medical wastes, t=1,2,3,4 Quarterly calculation, PR denotes profit of recycled product and PR_T denotes profit target costs, d_6^- underachievement function, d_6^+ overachievement function

Priority levels

Priorities are assigned to the specified goals in the following order

Priorities	Goals
P_1	Profit
P_2	Treating cost
P_3	Storage cost
P_4	Transportation cost
P_5	Segregation cost
P_6	Collection cost

5. ACHIEVEMENT FUNCTION*:*

MinZ= $P_1d_6^- + P_2d_5^+ + P_3d_3^+ + P_4d_4^+ + P_5d_2^+ + P_6d_1^+$

6. RESULT & CONCLUSION:

After the suitable data collection, target & priorities value need to be fixed by the manager and the above equations are solved using software LINGO, which gives the deviation in the goals. By identifying the deviation in the goals, Manager can correct way of managing the particular process/ event. This helps the manager to manage the waste management system in effective way. Thus goal programming technique helps in effective waste management as a result environment protection which very much essential in present days.

REFERENCES

1.G LaGrega, M. D., Buckingham, P. L. and J. C. Evans [2001], "Hazardous Waste Management," 2nd Edition, Mc-Graw Hill

2. Zarook.M.Shareefdeen, [2012], 3, 1625-1628, Journal of Environmental protection, 'Medical waste Management and control'

3. Y.-C. Jang, C. Lee, O.-S. Yoon and H. Kim[2006], "Medical Waste Management in Korea," Journal of Environmental Management,Vol.80,No.2,pp.107-115. doi:/10.1016/j.jenvman.2005.08.018

4. W. Lersner[2007], The Process and Device for the Disposal of Medical Waste, "Canadian Patents Database," Patent Number 2079003, http://www.ecolotec.com/patents.html

[5] NabenduSen and Manish [2012] 'An optimal Model using Goal Programming for Rubber woodDoor Manufacturing Factory in Tripura, Mathematical Theory and Modelling Vol 2,No.8

[6] Nasruddin Hassan & [2012] 'A GoalProgramming Approach for food product Distribution of small and Medium Enterprises'Advances in Environmental Biology, ISSN 1995-0756, 6:2:510-13

7.Lee.J.W and Kim.S.H.[2000], "Using analytic network process and goal programming for interdependent information system project selection", Computers & Operations research, 27 ,367-382

8. Leanka Veselovska, Ing (2013). Process of development of model based on linear programming to solve resource allocation task with emphasis on financial aspects. European Scientific Journal vol. 1.

BIOGRAPHIES

Dr.Jyothi.P completed her post-graduation from Osmania University, Hyderabad in 1999. Presently working as a Professor and HOD, Department of Mathematics in City Engineering College, Bangalore, India. Completed PhD from Jain University, Bangalore. Area selected for research is 'Application of goal programming in Operation Research'. She has published 7 international papers. She is having 21 years of teaching experience in Engineering and degree colleges. Qualification is M.Sc., M.Phil, MBA, Ph.D. teaching experience in Engineering and degree colleges. Qualification is M.Sc., M.Phil, MBA, (Ph.D.)

Dr. Vatsala G A graduated from Gulbarga University, India and Received M Sc Degree in Applied Mathematics in 1997, Ph. D Degree in Mathematics CCS University, Mirut, India, with the specialization Operation Research . She is having 23 years of experience in teaching and research. Her research work is carried in the field of "A complete technical solution of garbage disposal unit in Goal programming " , "Antenna using convex optimization" and " A optimal solution in grow of crop using soil management and source of water in region" She has published more than 15 papers in National and International journals and she presented 8 papers in National and International conferences. Presently she is working as an Associate Professor in the department of Mathematics, Dayananda Sagar Academy of Technology and Management, Bangalore, India.

Dr. Radha Gupta, a faculty of Mathematics at Dayananda Sagar College of Engineering, under Visvesvaraya Technological University, Bangalore, is continuously engaged in teaching and research activities for past 25 years. Her area of specialization is Operations Research and Applied Mathematics. She has published few books, research monologue and many research papers in peer reviewed National and International Journals. She is a recipient of President's Gold Medal. from Agra University and University Gold Medal from IIT Roorkee.