

EFFICIENT ROUTING FOR GARBAGE DISPOSAL IN NAGPUR CITY

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ABSTRACT : The paper suggests the methods for collecting and routing of garbage taking the case of Nagpur city.

INTRODUCTION :

Garbage disposal included in the waste disposal, is a public utility service in a city. The fast production of vast volume of waste is posing a formidable problem of its disposal. 'The disposal of a city's waste is no less difficult a problem --- solid waste--- presents a problem for which there is at present no economic solution'. (Pounds, 1980, p. 75). However, efficient way of garbage disposal is an urgent need of any grown and growing city.

To be efficient in garbage disposal, the service should follow the minimum-distance routing. It means the least effort or the least cost to the user. Says Cox (1972, p.21), Longer movements tend to be more costly...this is important given the tendency for people to minimise the effort involved in achieving any goal... Bhide and Sundaresan (1983, p. 78) have prepared a model for waste disposal in Nagpur which also considers minimization of route length as a prime factor.

However, efficiency in garbage disposal also requires an appropriate and equitable distribution of garbage to the dumping sites. Therefore, an efficient routing involves consideration of two parameters- the least possible distance for the trucks and the best possible distribution of the truckloads to the dumping sites. The problem, thus, requires the primal-dual solution or, in other words, the

minimum-maximum solution. An attempt has been made here to suggest the efficient routes for the trucks of garbage disposal from each collection point to the dumping site so that the dumping sites will receive equitable truckloads and at the same time, distance for the trucks to travel will be the minimum possible.

THE PROBLEM

There are 75 wards in Nagpur city, divided in five collection zones comprising of nearly 15 wards each. (Fig.1.1) Only two dumping sites are in use, in east and west corners respectively. Total per day production of garbage in Nagpur is 297.57 tonnes which is also an underestimation (Punse, 1984, P. 51). It is lifted up in trucks and carried to the dumping sites for disposals (Fig. 1.2). However, there is neither regular service nor regular routing for garbage disposal in Nagpur which is very necessary for a good and healthy city life. Adequate number of trucks is not available for carriage. Only 50 trucks run in service, while one truck per ward per day is the minimum requirement.

The problem is to find efficient route by the shortest path from each collection point to the dumping site. Supply from each ward is presumed to be one truckload and every ward is treated as one collection point with a bin in its approximate centre. For simplification, it is presumed that one truck per ward is available

for service and interior collection of the wards is not taken into consideration. Collected garbage of 75 truckloads has to be nearly equally dumped on 2 sites i.e. 37 truckloads on site A and 38 truckloads in site-B. Thus maximum demand of dumping sites is 37 and 38 truckloads respectively which must be fulfilled. In fulfilling maximum requirement, the distance may be a little more than minimum. But it is the minimum possible with maximization of service and therefore it is efficient.

The route may be considered in the cost terms. However, 'since the data on time and costs are difficult to obtain, distance can be taken as a surrogate to these factors' (Tewari, 1972, p.91). So also, there is no cost variation along the routes in Nagpur and the route length in terms of physical distance is used in computation as a parameter.

THE METHOD

Geographers are now dealing with such spatial problems in planning for development. People have a natural tendency to choose the least effort or the least-cost path. However, as Gauthier (1974, P. 173) remarks, 'This does not mean the transport user is an optimizer. He does not select necessarily the least-cost route ---'. It is the task of the

geographers to find for him the efficient path for movement.

Gauthier (1974, pp. 172-86) treated the problem of least-cost path with out-of-kilter algorithm model in a Brazilian example. Geographers are using the models of transportation problem (Yeates, 1974, P. 243) which are significant spatial allocation models of linear programme. Yeates (1974, P.258) applied a linear programming of the transportation problem in planning high school districts in Grant County, Wisconsin. Says Cox (1974, P.151), 'The solution to the transportation problem, however, provides with something more than the minimal transportation cost. The minimal transportation cost is also equal to the answer to a maximization problem for the same array of raw data---' An attempt has been made here to apply simple linear programme model to plan efficient routes for garbage disposal in Nagpur city, with the equations-

$$\sum_{i=1}^n \sum_{j=1}^m T_{ij} d_{ij} = Z = \text{minimum}; \text{ and}$$

$$\sum_{i=1}^m T_{ij} = 1 = Z = \text{maximum}$$

Where T_{ij} = Truck from i th collection point to j th dumping site

d_{ij} = distance from i to j

Table 1.2

Garbage Disposal in Nagpur City Truckloads to dumping sites by Minimum distance

From Zone	To site A	Distance (Kms)	To site B	Distance (Kms)	Total Supply (Trucks)
I	10	66.4	5	35.0	15
II	0	0.0	16	87.6	16
III	0	0.0	14	49.8	14
IV	0	0.0	15	61.3	15
V	11	51.8	4	23.9	15
Total	21	118.2	54	257.6	75
Demand	37	-	38	-	

Table 1.3**Garbage Disposal in Nagpur City : Maximum Disposal of Truckloads to Dumping Sites.**

Zone	To site A	Distance (Kms)	To site B	Distance (Kms)	Total
I	15	101.4	0	0.0	15
II	16	140.8	0	0.0	16
III	6	43.5	8	23.0	14
IV	0	0.0	15	61.3	15
V	0	0.0	15	108.2	15
Total	37	285.7	38	192.5	-

ANALYSIS

First of all, the distance from each collection point to each dumping site by the shortest path is measured which is given in table 1.1. A compilation of garbage disposal by truckloads from each zone to dumping site with minimum distance is shown in table 1.2.

The minimal solution is not efficient, since the demand is not fulfilled optimally. To meet it, the North-West corner rule (Yeates, 1974, P. 250) is applied as shown in Table 1.3.

The solution is not optimal either, as the distance increases too much. For the purpose

of minimising the distance and at the same time, fulfilling the demand, it is necessary to make a transfer of some truckloads from site B to site A even though site B is nearer to them, in such a way as to allow only minimum increase in their distance to site A. This is achieved by carefully allotting those trucks from site B to site A for which the difference in the travel distance to both the sites is the least. The resulting routing is the minimum possible in distance with maximum possible in satisfying the demand. The solution is presented in table 1.4.

Table 1.4**Garbage Disposal in Nagpur City : Maximum Disposal of Truckloads to Dumping Sites.**

Zone	To site A	Distance (Kms)	To site B	Distance (Kms)	Total
I	14	94.8	1	7.4	15
II	2	18.3	14	71.3	16
III	2	12.7	12	39.8	14
IV	4	24.7	11	41.4	15
V	15	79.4	0	0.0	15
Demand	37	229.9	38	159.9	75

Table No. 1.4 Efficient garbage Disposal Routing in Nagpur city.

In this solution, the total distance (389.8 kms.) is to be covered by the trucks increases a little over the minimum distance (375.8 Kms. in Table 1.2). But it is efficient as it also fulfills the demand maximally.

CONCLUSION

The efficient routing is recommended

to be adopted in garbage disposal in Nagpur city. The present service is inadequate and unplanned. Therefore, it is further recommended that (i) each ward should have at least one truck per day in service (ii) two more dumping sites in the north and south be created; and (iii) the regular routing by the shortest path be followed by the trucks.

Table No. 5.6

Distance for Garbage Disposal from Collection Ward to Dumping Site in Nagpur City in (Kms.)

Zone I wards	Distance to (in kms.)		Zone II wards	Distance to (in kms.)		Zone III wards	Distance to (in kms.)		Zone IV wards	Distance to (in kms.)		Zone V wards	Distance to (in kms.)	
	Site A	Site B		Site A	Site B		Site A	Site B		Site A	Site B		Site A	Site B
1	5.9	6.4	5	7.0	5.6	22	13.9	1.0	23	10.1	1.6	42	8.5	8.1
2	6.5	6.4	6	7.4	4.8	24	9.9	1.6	31	8.0	2.8	52	5.4	5.5
3	6.8	6.7	7	8.0	4.8	25	10.1	2.7	38	7.7	3.5	53	6.1	5.3
4	8.1	7.9	8	8.3	5.2	26	9.2	3.7	39	7.4	3.9	54	6.6	5.0
12	9.1	7.4	9	9.1	6.0	27	9.2	3.7	40	8.4	4.7	55	6.4	5.5
66	4.3	8.0	10	9.2	5.0	28	8.5	3.8	41	7.5	4.8	56	8.5	9.1
67	6.6	12.8	11	9.9	5.4	29	8.3	3.3	43	7.3	3.8	57	6.1	7.4
68	6.0	9.6	13	11.3	10.7	30	8.0	3.2	44	6.5	4.0	58	5.3	6.9
69	5.3	7.9	14	11.7	7.8	32	9.1	4.1	45	7.3	3.9	59	4.8	6.4
70	6.9	8.1	15	11.9	7.5	33	7.5	3.9	46	6.9	4.2	60	3.7	8.1
71	5.7	9.2	16	9.1	4.7	34	7.4	4.3	47	6.9	4.2	61	3.5	10.1
72	5.9	11.9	17	9.2	3.8	35	6.8	4.5	48	6.1	5.1	62	0.8	9.9
73	7.0	6.6	18	9.1	4.4	36	6.4	4.8	49	6.4	4.8	63	4.8	6.6
74	9.1	10.2	19	9.6	4.7	37	6.3	5.2	50	6.4	4.8	64	5.9	6.2
75	10.7	12.5	20	10.0	3.9				51	5.8	5.2	65	3.0	8.1
15			16			14			15			15		
Least Distance Wards	10	5		0	16		0	14		0	15		11	4

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