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Three Dimensional Two-Stage Bulk Transportation Problem

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Abstract

A variant Bulk Transportation Problem with some transient nodes between Sources and Destinations and the third dimension facility is called a Two-Stage Transportation Problem. The facility makes the problem more versatile which influences the objective function. The model is expressed as zero-one programming problem. A Lexi-Search exact algorithm based on pattern recognition technique is developed to obtain an optimal solution.

Keywords: Bulk Transportation, Word, Alphabet-Table, Search-Table, Optimum Solution, Lexi-Search, Pattern Recognition Technique.

Introduction

In a Transportation Problem, the shipment of a commodity takes place from sources to destinations. But instead of direct shipments to destinations, the commodity can be transported to a particular destination through some transient points or nodes between the sources and destinations. It is sometimes convenient if the shipment passes through these transient nodes. This is called Transportation Problem with some transient Nodes between Sources and Destinations or Two-Stage Transportation Problem (Panneer Selvam). The schematic diagram of the above problem is shown below.

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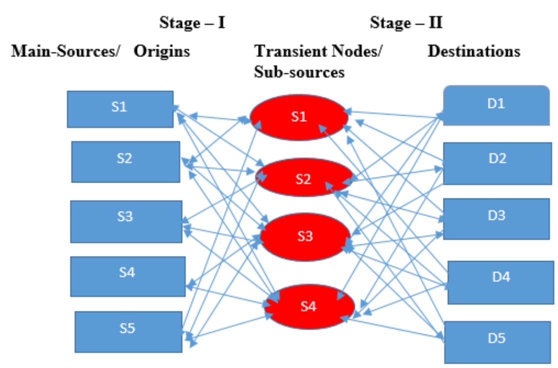

Many researchers have extensively studied this problem in different manner (Sonia and Puri – 2004, Nagoor Gani and Abdul Razak-2006 etc). In each stage, the objective is to minimize the shipment time/cost and the overall goal is to find a solution that minimizes the sum of first and second stage times/costs.

"Three Dimensional Two-Stage Bulk Transportation Problem" (TDTSBTP) presented in this paper is more generalized

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model of two-stage transportation problem and comes under combinatorial programming problems. For understanding of the problem easily, the third dimension taken into consideration is the brand of product to be transported.

In this problem a product is manufactured as main-sources/origins. The product manufactured at the origins has different brands. So the third dimension, facility is considered as the different brands of a product which increases the complexity of the problem. From the main-sources, the different brands of a product are transported to various destinations through some transient points or nodes called sub-sources only. Thus the process of transportation of a product from origins to destination is done in two stages.

The first stage involves the shipment of the product from main-sources to the transient nodes/sub-sources. And the second stage involves the transportation of product from transient nodes /sub-sources to destinations. The conditions of bulk transportation are

(i) If the origin is supplying its capacity to more than one sub-source then the shipment should be of different brands of the product.

(ii) A sub-source should get its entire requirement from exactly one origin only.
And if a sub-source is supplying its capacity to more than one destination then it should supply the same brand of a product which it has received from the origin.

(iii) A destination should get its entire requirement from exactly one sub-source.

Now the objective is to minimize the total bulk transportation cost on shipment of the products in two stages (i.e., from origins to sub-sources and from sub-sources to destinations) under the above conditions subjected to the availability and requirement constraints.

2. *Mathematical Formulation*

Let us consider *O = (1, 2… m)* of *m* origins, *S = (1, 2… n)* of *n* sub-sources and *D= (1, 2… p)* of *p* destinations. The requirement of the sub-sources *j € S* is *SA (j)* and the requirement of the destination *r € D* is *DR (r).* Let there be *K = (1, 2… l)* of *l* facilities i.e. qualities/yield varieties. *C(i, j, k)* is cost of transportation of requirement from source i to the destination j using the facility k. The availability or the capacity of the *origin i € O* is *OA (i).* The requirement of sub-source is the availability of the sub-source denoted by *SA(j).* There is a restriction that a sub-source and a destination should get its entire requirement from a single main-source. The model is expressed as zero-one programming problem as shown below.

$$\text{Minimize} \quad Z = \sum_{i \in O \cup S} \sum_{j \in S \cup D} \sum_{k \in K} C(i,j,k)\ x(i,j,k) \qquad \ldots\ldots (2.1)$$

Subjected to the constraint:

$$\sum_{j \in S} \sum_{k \in K} x(i,j,k)\ SA(j) \le OA(i) \quad i \in O \qquad \ldots\ldots (2.2)$$

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$$\sum_{j \in D} \sum_{k \in K} x(i,j,k)\, DR(j) \le SA(i) \quad i \in S \qquad \text{...... (2.3)}$$

$$\sum_{i \in O} \sum_{k \in K} x(i,j,k) = 1, \quad j \in S \qquad \text{...... (2.4)}$$

$$\sum_{i \in S} \sum_{k \in K} x(i,j,k) = 1, \quad j \in D \qquad \text{...... (2.5)}$$

$$\left.\begin{array}{l} x(i_1,j_1,k_1) = x(i_2,j_2,k_2) = 1 \; for\, i_1 = i_2, j_1 \ne j_2 \; and\, k_1 \ne k_2, \;\; i \in O, j \in S \\ x(i_1,j_1,k_1) = x(i_2,j_2,k_2) = 1 \; for\, i_1 = i_2, j_1 \ne j_2 \; and\, k_1 = k_2, \;\; i \in S, j \in D \end{array}\right\} \qquad \text{...... (2.6)}$$

$$\sum_{i=1}^{m} OA(i) \ge \sum_{j=1}^{n} SA(j) \ge \sum_{r=1}^{p} DR(r) \qquad \text{...... (2.7)}$$

$$x(i,j,k) = \begin{cases} 0 \\ 1 \end{cases} \; i \in O \cup S, \; j \in S \cup D, \; k \in K \qquad \text{...... (2.8)}$$

The constraint **(2.1)** describes the objective function of the problem i.e. to minimize the total bulk transportation cost subjected to the constraints.

The constraint **(2.2)** takes care of the restriction of availability and requirement of the product between origins and sub-sources i.e. the total requirement of the product at the sub-source is less than or equal to the availability of the product at the origin.

The constraint **(2.3)** takes care of the restriction of availability and requirement of the product between sub-sources and destinations i.e. the total requirement of the product by the destinations is less than or equal to the availability of the product at the sub-sources.

The constraint **(2.4)** describes that each sub-source should get its requirement from a single main-source.

The constraint **(2.5)** describes that each destination should get its requirement from a single sub-source.

The constraint **(2.6)** describes that a origin supplies the product to different sub-sources using different facilities and a sub-source supplies the product to different destinations using the same facility with which it has obtained the product.

The constraint **(2.7)** represents the feasibility criterion that is the total capacity available at the main-sources is greater than or equal to the total capacity of the sub-sources, and is greater than or equal to the total requirement at the destinations.

The constraint **(2.8)** describes that if a source *'i'* is supplies requirement of destination *j* availing the facility *k* then *x (i, j, k) = 1* or otherwise *0*.

A Lexi-Search algorithm based on "Pattern Recognition Technique" is developed to get the optimal solution for the proposed problem, which takes care of the simple combinatorial structure of the problem.

3. Computational Experience and Results:

A Computer program for the proposed Lexi – Search Algorithm is written in C language and is tested. The experiments are carried out on a COMPAQ (dx2280 MT) system by generating the values randomly for cost matrix *C (i. j, k)*. The values for the availability and requirement of the product are also uniformly randomly generated between [1, 1000]. We tried a set of problems by giving different values to m, n and l. The results are tabulated in the **Table-1** below. For each instance, five data sets are tested. It is seen that the time required for the search of the optimal solution is fairly less.

In the **Table-1**, SN = serial number, *m* = number of main-sources, *n* = number of sub-sources, *p* = number of destinations, *l* = number of stages, NPT= number of problems tried, AT = CPU run time for formation of the alphabet table, ST=CPU run time for searching an optimal solution. The following table shows the CPU run time taken by the proposed Lexi-Search Algorithm (LSA) to find the optimal solution of various hard instances.

Table - 1

SN	*m*	*n*	*p*	*l*	NPT	CPU Run Time in seconds with the proposed LSA		Total time Avg. (AT+ ST) in secs.
						Avg. AT	Avg. ST	
1	2	3	5	2	5	0.0549	0.0000	0.0549
2	4	5	5	2	5	0.1098	0.0000	0.1098
3	5	8	10	2	5	0.2747	0.0000	0.2747
4	5	8	10	3	5	0.3846	0.0000	0.3846
5	2	3	5	3	5	0.0540	0.0000	0.0540
6	5	7	9	3	5	0.2747	0.0000	0.2747
7	4	5	7	3	5	0.1648	0.0000	0.1648
8	10	5	8	2	5	0.1643	0.0000	0.1643
9	10	5	10	2	5	0.2197	0.0000	0.2197
10	15	10	10	2	5	0.5494	0.0000	0.5494
11	10	15	15	2	5	0.7692	0.1158	0.8850
12	20	15	15	3	5	1.6488	0.1648	1.8136
13	15	10	10	30	5	0.8240	0.3296	1.1536
14	20	20	15	2	5	1.5384	1.6483	3.2867
15	20	20	25	2	5	1.9780	1.3736	3.3516

4. Conclusion

In this paper, a model of Bulk Transportation Problem called Three Dimensional Two-Stage Bulk Transportation Problem is studied. We have developed a Lexi-Search Algorithm based on Pattern Recognition Technique for getting an optimal solution. First the model is formulated into a zero-one programming problem. The problem is discussed in detail with help of a numerical illustration. We have programmed the proposed algorithm using C-language. The computational details are reported. As an observation the CPU run time is fairly less for higher values to the parameters of the problem to obtain an optimal solution. In our study we have discussed of only two stages but the problem can be extended to any number of stages i.e. to multi-stage. Moreover, Lexi-search algorithm based on Pattern Recognition Technique has proved to be more efficient in solving this Combinatorial Programming Problem.

5. References

1. Pandit, S. N.N and Sundara Murthy, M (1975) Enumeration of all optimal Job Sequence- Opsearch, 12, pp 35-39

2. Paneerselvam, R (2006) Operations Research Second Edition, Prentice Hall of India Pvt. Ltd. New Delhi.

3. Sundara Murthy, M (1976) A Bulk Transportation Problem Opsearch, 13, pp 143-155.

4. Sonia and M. C. Puri (2004) Two Level Hierarchical Time Minimization Transportation Problem, TOP, Vol. 12 Number 2, Dec. 2004.

5. Shalini Arora and Puri, M. C (1998) A Lexi Search Algorithm for Time Minimizing Assignment Problem, 35(3), 193-213.

6. Bhavani, V, and Sundara Murthy, M (2005) Time Dependent Traveling Salesman Problem Opsearch 42, pp 199-227.

7. Balakrishna, U (2006) Truncated Time Dependent TSP, M. Phil Dissertation, SV University, Titupati, India.

8. Ahmad Murad (2010) on Bi-Criteria Two-Stage Transportation Problem: A case Study Transportation Problems: International Scientific Journal Volume 5, Issue 3, 2010.

9. Naganna, B (2007) Operations Research, Ph. D Thesis, SV University, Tirupati, India.

10. Haley, K. B (1962) The Solid Transportation Problem, Ops. Res. 10, 448-463.

11. Sangeetha Singh, Sudhir Chauhan and Kuldeep Tanwar (2017) A Survey on Bulk Transportation Problem International Journal of Advanced Research 5(5), 1240-1245.

12. G. Singh and A. Singh (2020), Solving Bulk Transportation Problem Using A Position Based Genetic Algorithm, Advances in Mathematics: Scientific Journal 9 no.6, 3887–3893