Mathematics and Statistics 10(4): 741-746, 2022 http://www.hrpub.org
DOI: 10.13189/ms.2022.100404

Analysis of IBFS for Transportation Problem by Using Various Methods

S. K. Sharma, Keshav Goel*

Department of Mathematics, Chandigarh University, Gharuan, Mohali, 140413, Punjab, India

Received November 17, 2021; Revised February 15, 2022; Accepted March 16, 2022

Cite This Paper in the following Citation Styles

(a): *[1] S. K. Sharma, Keshav Goel, "Analysis of IBFS for Transportation Problem by Using Various Methods," Mathematics and Statistics, Vol. 10, No. 4, pp. 741 - 746, 2022. DOI: 10.13189/ms.2022.100404.*

(b): *S. K. Sharma, Keshav Goel (2022). Analysis of IBFS for Transportation Problem by Using Various Methods. Mathematics and Statistics, 10(4), 741 - 746. DOI: 10.13189/ms.2022.100404.*

Abstract The supply, demand and transportation cost in transportation problem cannot be obtained by all existing methods directly. In the existing literature, various methods have been proposed for calculating transportation cost. In this paper, we are comparing various methods for measuring the optimal cost. The objective of this paper is obtaining IBFS of real-life problems by various methods. In this paper, we include various methods such as AMM (Arithmetic Mean Method), ASM (Assigning Shortest Minimax Method) etc. The Initial Basic Feasible solution is one of the most important parts for analyzing the optimal cost of transportation Problem. For many applications of transportation problem such as image registration and wrapping, reflector design seismic tomography and reflection seismology etc, we analyze the transportation cost. TP is used to find the best solution in such a way in which product produced at several sources (origins) are supply to the various destinations. To fulfil all requirement of destination at lowest cost possible is the main objective of a transportation problem. All transport companies are looking forward to adopting a new approach for minimizing the cost. Along these lines, it is essential just as an adequate condition for the transportation problem to have an attainable arrangement. A numerical example is solved by different approaches for obtaining IBFS.

Keywords TP, LPP, IBFS, LCM, Optimization Problem

1. Introduction

TP is the important type of LPP for solving routing problems. It gives the supply of any object from the various supply sources to the diverse sink of mandate in a manner that the entire transportation charge would be minimum. In operation research, transportation problem is most essential application in the field of LPP. There are lots of development in different areas of transportation such as shipping, networking etc. The transport problem is to transport a single homogeneous good, which is mainly stored in different places of origin to different destinations, so the total transport costs are minimal. There is a challenge to introduce a new method for IBFS. Due to traffic and hike of fuel prices in day-to-day life is very challenging to all humans. TP was firstly expressed as supply of a product from various sources to numerous destinations by Hitchcock and Koopmans [1], [2], found Optimum consumption of the transportation classification. For the development of various methods, these papers are the milestones for solving transportation problem. Simplex method is given by G.B. Danzing in 1995 to solve the transportation problem for LPP then it takes a big number of variables, constraints, and take some time for solving the problem. Some researchers developed different methods for finding an IBFS which takes costs into account. There are some methods namely, (LCM) Least cost Method, (VAM) Vogel's Approximation Method, NW Corner Method, Row Minima Method, Column Minima Method for obtaining the IBFS of a transportation problem. There are many applications of transportation problem such as image registration and wrapping, reflector design seismic tomography and reflection seismology etc. Advancements in data and correspondence innovations also, expanding rivalry, especially in the assembling area, have prompted the requirement for viable and modest conveyance of crude materials, work in progress, completed items or related data from starting place to end of utilization. This need can be met specifically with the assistance of ideas for everything identified with coordination. Now, coordination as an answer for assembling organizations turns out to be more significant. However, control of administrations and activities, organization additionally offers a solid and prudent vehicle limit. Organization things might differ by time and industry. Separation in necessities and innovation has prompted the way that organization related parts have changed over the long run. However, transportation costs have consistently been for most logistic companies. Linear programming is a method to complete the best result (such as supreme profit or minimum price). A transportation problem is concerned with calculating the lowest cost of transporting of a single product from a given quantity of initial point to a specified quantity of destinations.

A feasible solution is called to be optimum solution if it reduces the transport price. The feasible solution is supposed to be elementary if the number of allocations like to m+n-1; that is one less than the number of rows and columns in a transportation problem. When the number of belongings obtainable for shipment to the origins equals the request for belongings to the terminuses, the transportation problem is titled as the balanced transportation problem otherwise unbalanced transportation problem. The constraint is a condition of an optimization problem that the solution must satisfy.

2. Formulation of Transportation Problem

Let us consider the number of sources and destinations are m and n respectively. Let the number of items for supply existing at source i (i=1,2, 3, ……., m) be Ai and let the demand of number of units necessary at destination j (j=1, 2, 3, ……, n) be Bj. Transporting the units available from sources to destination has some cost known as transportation cost represented by cij. The intention of transported the number of items from source i to destination j so that the total cost of transportation should be minimum. In accumulation, the limits of supply at the origin and the demand at the destination required must be fulfill exactly.

If r_{ij} ($r_{ij} \geq 0$) is the numeral of shipping items from basis i to the end point j, the corresponding LPP is

Calculate r_{ij} (i=1,2, 3, ………, m; j=1, 2, 3, ……., n) in sequence to

Minimize $z = \sum \sum c_{ij} r_{ij}$,

subject to $\sum r_{ij} = P_i$, i=1,2,3,⋯⋯⋯⋯,m,

and $\sum r_{ij} = Q_j$, j=1,2,3,⋯⋯⋯⋯.,n,

where $x_{ij} \geq 0$.

The two sets of restrictions will be reliable i.e. the structure will be in steadiness if

$$\sum Pi = \sum Qj$$

In the event that this condition is satisfied, then we have an achievable arrangement of the given transportation problem. At that point we state that a transportation problem will have a possible arrangement if and just if $\sum P_i = \sum Q_j$ will be fulfilled. The issue which fulfils this condition is called balanced transportation problem. Furthermore, the issue which do not fulfill this condition is called unbalanced transportation problem. We can't locate the feasible solution of transportation problem if

$$\sum P_i \neq \sum Q_j$$

Note that a transportation problem will have a doable arrangement just if the above limitation is fulfilled. Along these lines, it is essential just as an adequate condition for the transportation problem to have an attainable arrangement.

Problem that fulfills this condition are called adjusted transportation problem. Where D_{ij} is the shipping cost, R_{ij} is the shipping quantity, P_{ij} is the supply available, and Q_{ij} is the destination demand.

Table 1. Formulation of TP

	DESTINATION						
SOURCES		1	2	3	……j….	n	SUPPLY
	1	D_{11} r_{11}	D_{12} r_{12}	D_{13} r_{13}	D_{1j} r_{1j}	D_{1n} r_{1n}	P_1
	2	D_{21} r_{21}	D_{22} r_{22}	D_{23} r_{23}	D_{2j} r_{2j}	D_{2n} r_{2n}	P_2
	3	D_{31} r_{31}	D_{32} r_{32}	D_{33} r_{33}	D_{3j} r_{3j}	D_{3n} r_{3n}	P_3
	…i	…	…	…	…	…	P_i
	M	D_{m1} r_{m1}	D_{m2} r_{m2}	D_{m3} r_{m3}	D_{mj} r_{mj}	D_{mn} r_{mn}	P_m
	Demand	Q_1	Q_2	Q_3	Q_j	Q_n	$\sum P_i = \sum Q_j$

TP is used to find the best solution in such a way in which product produced at several sources (origins) are supply to the various destinations. To fulfil all requirement of destination at lowest cost possible is the main objective of a transportation problem. For determining an optimum result of a transport problem firstly find the IBFS and the IBFS can us find out by any of the methods like as NWCR, LCM – Method and VAM-Method etc. Quddoos [3] gave a new algorithm for solving transportation problems named the method as ASM-Method. A numerical is taken and the result efficiency of this method is also verified. The importance of this method is that it is very easy to recognize and also have less number of iterations. Das et al.[4] talked about the drawbacks of VAM and introduced a new method for explaining the transportation problem. When biggest cost looks in two or more than two columns or rows then the VAM Method doesn't give a logical solution. Then he gives a new method name as Logical Development of VAM- Method for the solution of highest cost appearing in rows and columns. Kumar [5] provided the relative analysis of ASM Method and North West Corner Method for solving transport problem and then checked the efficiency for lowest shipping cost. An innovative process for solving the transportation problem has discussed in [6]. The intention of this method is to minimize the shipping cost. This method is solved by using the statistical tool called arithmetic Mean. The main advantage of this method it is very easy to use but finding the solution by this method takes some time. Kumar et al. [7] suggested the transportation problem have many objectives such as minimize the transportation cost, with respect to time we minimize the distance, find the past having lowest cost etc. Sharma [8] also suggested an analysis for solving the different types of problems in real. Kizolli [9] suggested the transportation demand management through physical improvement as application in real life. There is a standard way to solve any problems. For this we can find the IBFS of the given problem firstly by any of the method such as NWCR-Method, least cost method, VAM-Method etc and also there are some other methods to solve such type of problems. In this paper, we developed a new mathematical method named as DSM-Method for finding an IBFS of the transportation problem and the effectiveness by this method is also compared with the other methods.

3. Numerical Example

A farm has three utility companies that manufacture 7, 9, and 18 vehicles. The farm stores four customers whose company constraints are 5, 8, 7, and 14. Consider the following cost minimization problem for linear programming with 3 farms and 4 plants given in table 2.

Table 2. Specific data of Column/Row

	P_1	P_2	P_3	P_4	*Farm Capability*
R_1	***19***	***30***	***50***	***10***	***7***
R_2	***70***	***30***	***40***	***60***	***9***
R3	***40***	***8***	***70***	***20***	***18***
Plant Constraint	***5***	***8***	***7***	***14***	***34***

Solution: Since we see that the transportation problem is balanced, we can find solutions to this transportation problem by various methods to minimize costs.

ASM-Method:

Table 3. IBFS by ASM Method

	P_1	P_2	P_3	P_4	*Farm Capacity*
F_1	***19 (5)***	***30***	***50***	***10 (2)***	***7/2/0***
F_2	***70***	***30 (2)***	***40 (7)***	***60***	***9/2/0***
F_3	***40***	***8 (6)***	***70***	***20 (12)***	***18/12/0***
Plant Requirement	***5/0***	***8/6/0***	***7/0***	***14/12/0***	***34***

Z=19*5+10*2+30*2+40*7+8*6+20*12=743

Row-Minima Method:

Table 4. IBFS by Row Minima Method

	P_1	P_2	P_3	P_4	*Farm Capacity*
F_1	***19***	***30***	***50***	***10 (7)***	***7/0***
F_2	***70***	***30 (8)***	***40 (1)***	***60***	***9/1/0***
F_3	***40 (5)***	***8***	***70 (6)***	***20 (7)***	***18/11/6/0***
Plant Requirement	***5/0***	***8/0***	***7/6/0***	***14/7/0***	***34***

Z=10*7+30*8+40*1+70*6+20*7=1110.

Column-Minima Method:

Table 5. IBFS by Column Minima Method

	P_1	P_2	P_3	P_4	*Farm Capacity*
F_1	***19 (5)***	***30***	***50***	***10 (2)***	***7/2***
F_2	***70***	***30***	***40 (7)***	***60 (2)***	***9/2/0***
F_3	***40***	***8 (8)***	***70***	***20 (10)***	***18/10/0***
Plant Requirement	***5/0***	***8/0***	***7/0***	***14/12/2/0***	***34***

Z=19*5+10*2+40*7+60*2+8*8+20*10=779

LCM- Method:

Table 6. IBFS by LCM Method

	P_1	**P_2**	**P_3**	**P_4**	**Farm Capacity**
F_1	19	30	50	10 (7)	7/0
F_2	70 (2)	30	40 (7)	60	9/2/0
F_3	40 (3)	8 (8)	70	20 (7)	18/10/3/0
Plant Requirement	5/2/0	8/0	7/0	14/7/0	34

Z=10*7+70*2+40*7+40*3+8*8+20*7=814

NWCR-Method:

Table 7. IBFS by NWCR Method

	P_1	**P_2**	**P_3**	**P_4**	**Farm Capacity**
F_1	19 (5)	30 (2)	50	10	7/2/0
F_2	70	30 (6)	40 (3)	60	9/3/0
F_3	40	8	70 (4)	20 (14)	18/14/0
Plant Requirement	5/0	8/6/0	7/4/0	14/0	34

Z=19*5+30*2+30*6+40*3+70*4+20*14=1015

VAM-Method:

Table 8. IBFS by Vogel's Approximation Method

	P_1	P_2	P_3	P_4	Farm Capacity
F_1	19 (5)	30	50	10 (2)	7/2/0
F_2	70	30	40 (7)	60 (2)	9/0
F_3	40	8 (8)	70	20 (10)	18/10/0
Plant Requirement	5/0	8/0	7/0	14/4/0	34

Z=19*5+10*2+40*7+60*2+8*8+20*10=779

Arithmetic-Mean Method:

Table 9. IBFS by Arithmetic Mean Method

	P_1	P_2	P_3	P_4	Farm Capacity
F_1	19 (5)	30	50	10 (2)	7/2/0
F_2	70	30 (2)	40 (7)	60	9/2/0
F_3	40	8 (6)	70	20 (12)	18/6/0
Plant Requirement	5/0	8/6/0	7/0	14/12/0	34

Z=19*5+10*2+30*2+40*7+8*6+20*12=743

DSM-Method:

Table 10. IBFS by DSM Method

	P_1	**P_2**	**P_3**	**P_4**	**Farm Capacity**
F_1	19 (1)	30	50 (6)	10	7/1/0
F_2	70	30 (8)	40 (1)	60	9/1/0
F_3	40 (4)	8	70	20 (14)	18/4/0
Plant Requirement	5/4/0	8/0	7/6/0	14/0	34

Z=19*1+50*6+30*8+40*1+40*4+20*14=1039

Table 11. Comparison of IBFS with all Method

Methods	**Cost**
ASM Method	743
Row-Minima Method	1110
Column-Minima Method	779
LCM-Method	814
NWCR Method	1015
VAM Method	779
Arithmetic Mean Method	743
DSM Method	1039

By using above desired obtained values construct a diagram which shown below.

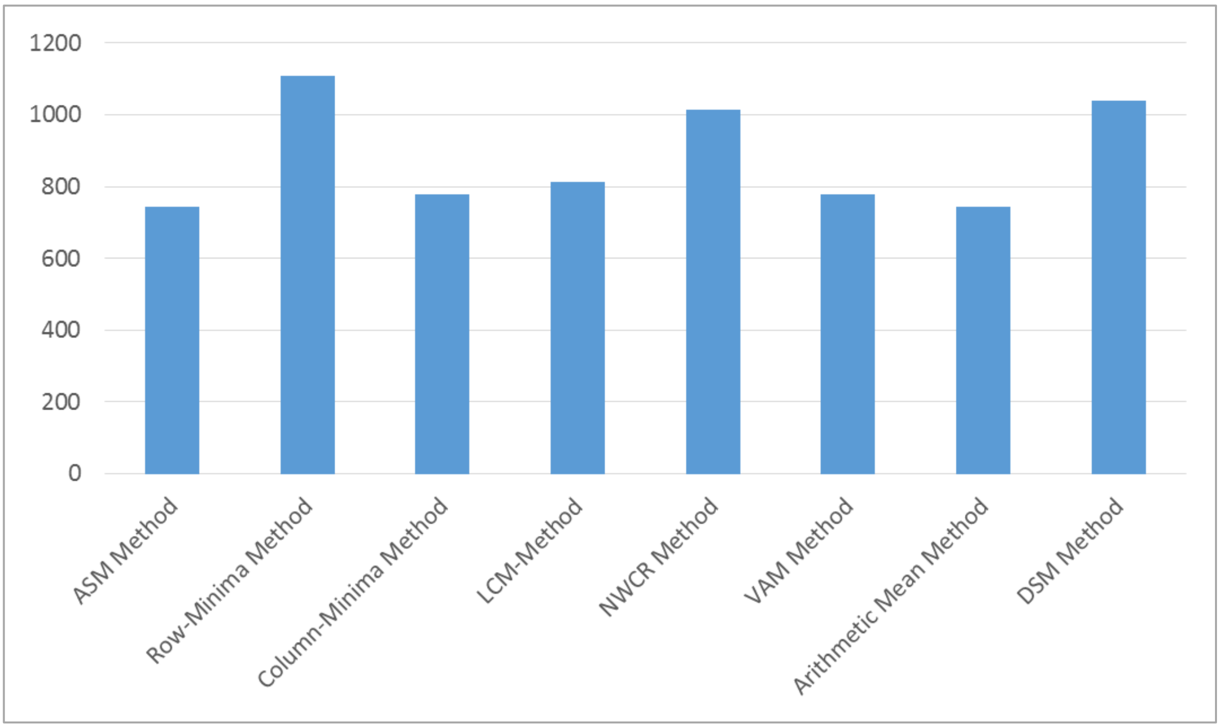

Figure 1. Shows Comparison of used methods

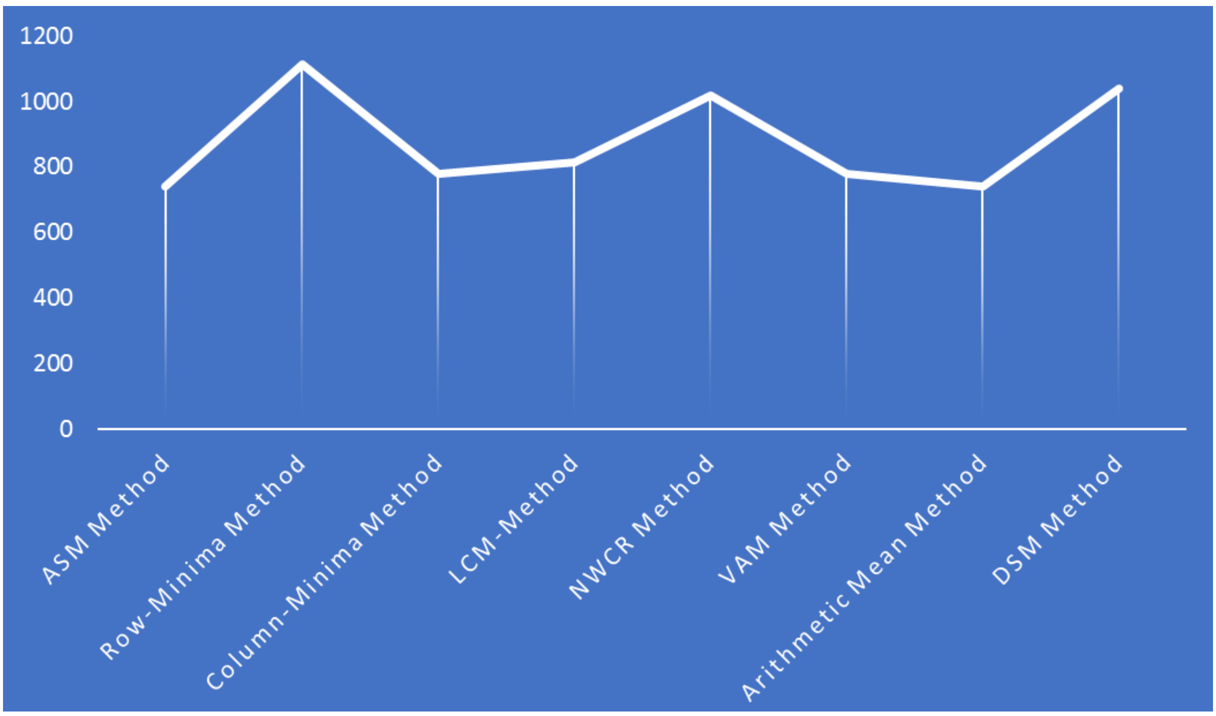

Figure 2. Analytical representation

The solutions of this transportation problem by different methods are discussed are tabulated above.

4. Conclusions

IBFS is one of the most essential steps to obtain optimal solution. From above table 9 and figure 1, we conclude that the solution of minimization of cost for the transportation problem is same in ASM Method and Arithmetic Mean Method. We can see the solution through Arithmetic Mean Method is easy to use but it takes some time for determining the solution of a TP in comparative to ASM Method. Then we conclude that

ASM-Method is more suitable for calculating the solution of transportation problem.

REFERENCES

[1] F. L. Hitchcock, “The Distribution of a Product from Several Sources to Numerous Localities,” *Journal of Mathematics and Physics*, vol. 20, no. 1–4, Apr. 1941, doi: 10.1002/sapm1941201224.

[2] T. Koopmans, “Optimum Utilization of the transportation system,” *Proceeding of the international statistical conference*, vol. 8, no. 1–6, pp. 136–146, 1947.

[3] A. Quddoos, S. Javaid, and M. Khalid, “A new method for finding an optimal solution for transportation problems,” *International Journal on Computer Science and Engineering*, vol. 4, no. 7, pp. 1271–1274, 2012.

[4] U. et al. Das, “Logical development of Vogel’s approximation method (LD-VAM) an approach to find basic feasible solution of transportation problem,” *International Journal of Scientific & Technology Research* , vol. 3, no. 2, pp. 43–48, 2014.

[5] S. B. Kumar, R. Nandhini, and T. Nanthini, “A comparative study of ASM and NWCR method in transportation problem,” *Malaya Journal of Matematik*, vol. 5, no. 2, pp. 321–327, 2017.

[6] S. Duraphe, G. Modi, and S. Raigar, “A New Method for the Optimum Solution of a Transportation Problem,” *International Journal of Mathematics And its Applications*, vol. 5, no. 3–C, pp. 309–312, 2017.

[7] R. Kumar R, R. Gupta, and K. O, “A NEW APPROACH TO FIND THE INITIAL BASIC FEASIBLE SOLUTION OF A TRANSPORTATION PROBLEM,” *International Journal of Research -GRANTHAALAYAH*, vol. 6, no. 5, May 2018, doi: 10.29121/granthaalayah.v6.i5.2018.1457.

[8] S. K. Sharma and H. Nazki, “COMPARISON OF VARIOUS METHODS FOR SOLVING REAL LIFE PROBLEMS RELATED TRANSPORTATION SCHEDULING,” *Advances in Mathematics: Scientific Journal*, vol. 9, no. 8, Aug. 2020, doi: 10.37418/amsj.9.8.10.

[9] B. Kizolli and S. Hatipoğlu, “Transportation Demand Management through Physical Improvements: The Case of Pristina,” *Civil Engineering and Architecture*, vol. 8, no. 6, pp. 1296–1312, Dec. 2020, doi: 10.13189/cea.2020.080614.