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Employing the arithmetic mean to find the IBFS for transportation problems

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***Abstract*---**Transportation Problem (TP) cost is a term that refers to the operating costs associated with transportation. The cost of transportation is critical in order to optimize profit. In recent time, competitive global market and enterprises must carefully organize their transportation systems in order to keep transportation costs low. Modeling this transport channel is a management choice that entails determining the most cost-effective distribution strategy for a single homogenous item. This is referred to as a transportation issue, which may be expressed mathematically as a linear programming problem. A fundamental practicable solution is always necessary in the solution method of a transportation issue in order to reach the best solution. There several classic methods to find initial basic feasible solution (IBFS). In this work, a novel strategy for obtaining (IBFS) to (TP) is presented. Numerical examples are used to explain the suggested technique.

***Keywords*---**initial basic feasible solution, optimal solution, transportation cost.

Introduction

The transportation problem is a subset of the linear programming problem, which is studied in operations research. In general, the transportation problem is concerned with the distribution of high-quality sources (e.g. manufactories) to a large number of different destinations (e.g. warehouses). According to the model, the goal is to discover the delivery plan that reduces total transportation costs

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while still fulfilling supply and demand limitations. In this model, the cost of shipping is assumed to be proportional to the number of units that are sent over a certain route. It is often possible to apply aspects of the transportation model to other aspects of a company's operations like inventory management, task scheduling, and personnel assignment. In 1941, Hitchcock identified the underlying transportation problem and proposed a constructive solution [1]. In 1949, Koopman distinguished the transportation problem in further depth [2]. In recent days, and for good reason, transportation challenges are often mentioned across a broad spectrum of organizations and businesses. Transportation issues are often tackled utilizing well-known methodologies such as North West corner method (NWCM), least coast method (LCM), and Vogel approximation method (VAM). For discovering the simplest potential answer, (VAM) technique is more efficient than other methods. The arithmetic mean is the most frequently used and intuitive measure of a data set's central tendency, it is defined as the sum of each observation's numerical values divided by the total number of observations. Symbolically, if we have a data set with the values $a_1, a_2 \ldots a_n$, then the arithmetic mean A is defined by:

$$A = \sum_{1}^{n} \frac{a_i}{n} \;\; ; ; \text{ i} = \text{ } 1,2, \ldots, \text{n}$$

Transportation Problems

The classical transportation problem examines a collection of nodes or places referred to as plants $(S_1, S_2, S_3, \ldots, S_m)$ that have a ready-to-ship product and another set of sites referred to as destinations $(D_1, D_2, D_3, \ldots, D_n)$ that need this commodity. The data set contains information on the commodity's availability at each plant, the commodity's demand at each destination, and the cost of shipping the commodity per unit from each plant to each destination is C_{ij}. The purpose is to determine the quantity of material that must be transported from each facility to each destination, X_{ij}, in order to meet requirements while incurring the fewest shipping costs feasible. A tableau (Table 1) and a network diagram (Figure 1) of the transportation issue are presented.

Table 1
Transportation Tableau

Destination / Plants	D_1	D_2	D_3		D_{n-1}	D_n	Supply quantity
S_1	x_{11}	x_{12}	x_{13}	…	$x_{1,m-1}$	$x_{1,n}$	s_1
S_2	x_{21}	x_{22}	x_{23}	…	$x_{2,m-1}$	$x_{2,n}$	s_2
S_3	x_{31}	x_{32}	x_{33}	…	$x_{3,m-1}$	$x_{3,n}$	s_3
.	.	.	.	. .	.	.	
.	.	.	.	. .	.	.	
.	.	.	.	. .	.	.	
S_{m-1}	$x_{m-1,1}$	$x_{m-1,2}$	$x_{m-1,3}$	…	$x_{m-1,n-1}$	$x_{m-1,n}$	s_{m-1}
S_m	$x_{n,1}$	$x_{n,2}$	$x_{n,3}$	…	$x_{m,n-1}$	$x_{m,n}$	s_m

Demand quantity	d 1	d 2	d 3	…	d n-1	d n

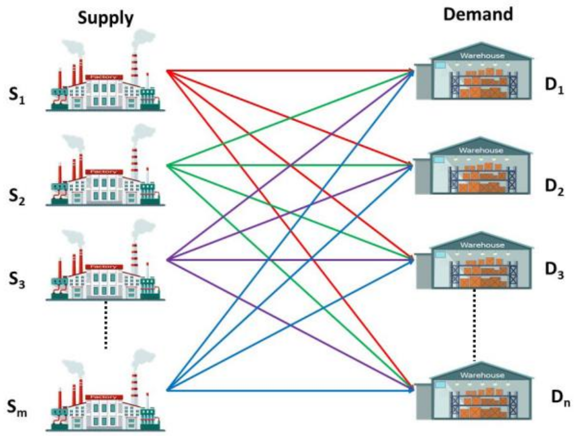

Figure 1. Network representation of general transportation problem

Take note that the dummy destination has no cost and that the fundamental solution must be acceptable to the transport model. There are various distinct approaches to the first solution that vary in terms of time and effort needed. Three of the most often utilized techniques for obtaining an appropriate fundamental solution are as follows [3]:

- **NWCM:** This is the easiest method, since you do not take into account costs using any scientific logic in the distribution process (distribution of available quantities).
- **LCM:** It is better than NWCM, that is, LCM gives a solution with less value than NWCM in most cases.
- **VAM:** It is the best method to find IBFS among the classical methods, its solution value is near the optimal solution value.

Transportation Model Problem

The TP can be described in the following optimization problem:

Minimized (Z) $\sum_{i=1}^{m} \sum_{j-1}^{n} C_{ij}X_{ij}$ (1)
Subject to $\sum_{j-1}^{n} X_{ij} = a_{ij}$ (2)
$\sum_{j-1}^{n} X_{ij} = b_{ij}$ (3)
$X_{ij} \geq 0$ (4)

Proposed Method (Arithmetic Mean Method)

The researcher's approaches tried to give the fundamental answer to the issue of balanced and unbalanced transportation in order to get an effective solution (optimal or near-optimal). The authors introduced many papers to solve the problems in various fields of sciences such as optimization [4- 26], reliability [27- 36], and operations research [37- 43]. The following are the fundamental phases in this method:

- The transfer schedule must be balanced.
- We apply the mathematical formula { $A = \sum_1^n \frac{a_i}{n}$; i= 1,2,...,n } to each column separately .
- Determine the highest value resulting from Step (2) in all columns and then choose the cell with the lowest cost to give the proper supply to meet the needs (demand).
- If there are more than one column, we choose to allocate the cell with the lowest cost.
- The row filled in the application does not enter into the following calculation.
- Repeat steps (2-4) and after completing the filling of cells we calculate the total ost.

To make the proposed method clear and easy to understand, here are some **Examples**

In this section we give some examples to show the efficiency of the new algorithm.

Example 1: Consider the following data:

	S1	S2	S3	S4	supply
D1	7	3	8	2 100	100
D2	5 80	6 120	11	12	200
D3	10	4 50	7 190	6 60	300
demand	80	170	190	160	600
	7.3	4.3	8.6	6.6	
	7.3	4.3	-	6.6	
	-	4.3	-	6.6	
	-	5	-	9	

Cost =(2*100) + (5*80) + (6*120) + (4*50) + (7*190) + (6*60) = 3210
Co**st** (**VAM**) = 3210

Example 2: Consider the following data

	S1	S2	S3	S4	supply
D1	3 100	4	6	0	100
D2	7	3 80	8	0	80
D3	6 10	4 30	5	0 50	90

D4	7	5	2 60	0 60	120
demand	110	110	60	110	390
	5.75	4	5.25	0	
	6.6	4	5	0	
	-	4	5	0	
	-	4	-	0	
	-	4.5	-	0	

Cost = (3*100) + (3*80) + (6*10) + (4*30) + (0*50) + (2*60) + (0*60) = 840
Cost (**VAM**) = 880

While the suggested technique outperformed the Vogel approximation method in the majority of situations, there are certain unusual or few circumstances where the proposed method outperforms the Vogel approximation method, as seen below:

Example 3

	S1	S2	S3	S4	supply
D1	20 4	16	14 5	20	9
D2	9 1	15 5	16	10 2	8
D3	8	13	5	9 7	7
D4	9	6 5	5	11	5
demand	5	10	5	9	29
	11.5	12.5	10	12.5	
	12.3	14.6	11.6	13	
	14.5	15.5	15	15	
	14.5	-	15	15	
	14.5	-	15	-	

Cost = (20*4) + (14*5) + (9*1) + (15*5) + (10*2) + (9*7) + (6*5) = 347
Cost (**VAM**) = 308

Conclusion

In this paper, we use the new suggested strategy in order to offer a workable initial basic solution to transportation difficulties that is practical. The proposed technique will eventually aid industry managers in choosing their own supply lines. The effectiveness of the newly offered strategy is shown in the study's result and assessment section, where the overall performance of the recommended method is assessed. Also, the new technique is more computationally efficient and requires less time to acquire, indicating that it might be the first basic solution to transportation problems. Once again, the good optimal solution requires fewer repetitions in exchange for a better starting response. Taking all of this into consideration, we believe that our proposed approach may be used to develop the (IBFS) to (TP) and can be included into any operation research project.

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