A Comparative Study Between the Methods of Finding an Initial Solution to the Transportation Problem

دراســة مقارنــة بين طرائــق إيجــاد الحــل الأولــي لمشكلــة النقــل

الباحث

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المستخلص

تعد مسألة النقل (TP) هي إحدى مسائل بحوث العمليات والتي تلخص على جدولة نقل السلع إلى المواقع من المصادر وبأقل كلفة ممكنة، ومن الممكن حلها بالطرائق الكلاسيكية والتي تتضمن (طريقة فوجل التقريبية، وطريقة اقل كلفة، و طريقة الركن الشمالي) في السنوات الاخيرة تم اقتراح عدة طرائق مختلفة لإيجاد اقل كلفة لمشاكل النقل ، في بحثنا قارنا بين طريقة فوجل التقليدية (VAM) مع بعض الطرق الجديدة طريقة الجمع المباشر (DSM) والطريقة المقترحة بواسطة Ramakrishnan.إذ أظهرت النتائج كفاءة الطريقة المقترحة بواسطة Ramakrishnan مع الطرائق المستخدمة في المقارنة.

الكلمات المفتاحية: طريقة فوجل التقريبية (VAM) ، طريقة الجمع المباشر (DSM) ، طريقة Ramakrishnan المقترحة(RPM) .

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Abstract.
One of the problems of operations research is the transportation problem (TP), which is limited to scheduling the transportation of goods from sources to sites at the lowest possible cost, and it can be solved by traditional methods, which Including North West technique, Least Cost technique, and Vogel's Approximation technique. Several methods have been proposed in recent years to locate Transportation Problems that are less costly, in our research we compared Vogel's Approximation Method (VAM), Direct Sum Method (DSM) and Ramakrishnan's proposed method. If the results show the effectiveness of the suggested Method by Ramakrishnan with the methods used in comparison
Keywords: Vogel's Approximation Method (VAM), Direct Sum Method (DSM), Ramakrishnan's Proposed Method (RPM).

Introduction
The transportation model is a major linear programming technique in the industry since it is seen as a crucial component of the process to equip a plant to meet production needs at the designated time and location.
This form seeks a speedy response from a representative for associated actors and actresses looking for jobs. The shortest amount of time possible, given that the processing can be done every source, the requirement at each location, and the cost and duration of unit transportation from every source to the individual information site, The origins of the transport model can be traced to Tolstoi, who was one of the pioneers in the 1920s A.N. to analyze the transportation problem mathematically., Hitchcock published his article. The American Society of Mechanical Engineers distributes production to many locations in (1941) from a variety of sources. When a commodity is distributed from numerous unique sources to numerous different places, Koopmans presented (1947) his studies on the Dantzig-developed "Usage Optimum Transport System" in 1963. It is possible to obtain feasible an initial solution using the

(NWCM) approach, the (LCM) approach, or (VAM) approach (Reinfeld and Vogel, 1958), Charnes and Cooper both brought up the issue of transportation difficulties (1961) Management Models and Industrial Applications of Linear Programming, is one of their books., Mackinnon & James (1975) devised a generalized transportation problem algorithm, In (1988) Ramakrishnan proposed the method to an unbalanced transportation problem, Additionally, Satir and Kirca (1990) widened the TOM heuristic for creating an initial basic feasible solution to transportation challenges. A new heuristic strategy in order to get it dependable initial solutions to transportation problems that are based on dual-based approaches, as proposed by Sharma (2000), could be adopted. In (2018) Ravi Kumar R, et al. suggested the Direct Sum Method as a novel technique in the transportation problem.

2 Methods and Materials:

2.1 TP's Mathematical Representation:

The mathematical representation of the transportation issue looks like this:

Let ′i′ stand in for one of the ′m′ sources.

Let ′j′ stand for one of the ′n′ potential destinations as a destination point.

′ai ′ stands for the number of units that are present at source ′i′.

Let ′bj′ stand in for the demand at the target ′j′.

Let "cij" represent the shipping expense between the origins i and the destinations "j".

Let 'xij' represent the quantity of units sent from origin i to destination j.

Mathematically, The problem transportation might be stated as choosing a collection of variables to minimize for i=1,2,…,m and j=1,2,…,n.

$$Z = \sum_{i=1}^{m}\sum_{j=1}^{n} x_{ij}c_{ij} \ ,$$

$$\mathrm{Z} = \textstyle\sum_{i=1}^{m}\sum_{j=١}^{n} x_{ij}c_{ij} \ ,$$

s.t:

$\sum_{j=1}^{n} x_{ij} = a_i, i = 1,2, \dots, m.$

$\sum_{i=1}^{m} x_{ij} = b_j , j = 1,2, \dots, n.$

and $x_{ij} \geq 0$, for all i and j

In a typical transportation model with m origins and n destinations, there are m + n constraint equations, one for each origin and requirement. The transportation model only requires m + n - 1 independent equation and m + n - 1 fundamental variable because the supply and demand in the model are always equal. The transportation problem has such a distinctive structure. , one of the following three techniques be able to employed to make certain a natural beginning with an initial solution:

a.Vogel approximation technique (VAM)

b. Least cost technique (LCM)

c. North west corner technique (NWCM)

The initial method is "mechanical" because it seeks to offer a first (basic, workable) response regardless of price. The end two are heuristics that look for a better-quality (beginning solution with a lower objective value) starting point. In general, the North West Corner Method is inferior to the Vogel heuristic. The North West Corner Method makes up for this drawback by requiring the fewest computations[3].

2.2 Methods of comparison:

2.2.1 Vogel's Approximation Method (VAM):

Compute the "Difference" for each column and row in step one. The penalty is calculated as the difference between the lowest and next-lowest costs.

Step 2: Identify the column or row with the biggest difference and allocate it to the cell in that column or row with the smallest cost. In the event of a tie, a random selection will determine the winner.

Step 3: Keep going until all demands and equipment have been complied with

2.2.2 Direct Sum Method (DSM):

Step 1: Determine the 'direct total cost' for each column and row. The total of each origin's transportation costs to multiple destinations and vice versa is known as the direct sum cost.

Step 2: Choose the column and row with the highest direct sum cost, and allocate the lowest cost cell in that row or column to the supply or demand minimum. Pick someone at random if there is a tie.

Step 3: retain while all equipping and request has been met.

2.2.3 Proposed Method by Ramakrishnan:

Step 1: Subtract the cost matrix's column minimum from each column.

Step 2: In the reduced matrix, Replace the dummy cost with the highest unit transportation cost.

Step 3: Now subtract the row minima.

Step 4: Subtract the dummy column's column minima.

Step 5: Then, on the reduced matrix, apply VAM.

3- Findings and Discussion:

Ex./ Let's examine the following transportation options unbalanced problem:

Destination / **Source**	D_1	D_2	D_3	Supply
S_1	6	10	14	**50**
S_2	12	19	21	**50**
S_3	15	14	17	**50**
Demand	**30**	**40**	**55**	**125≠150**

$\sum_{i=1}^{m} a_i \neq \sum_{j=1}^{n} b_j \rightarrow 150 \neq 125$, Because the preceding problem is an unbalanced transportation problem, a **dummy column** must be added to make it a balanced transportation problem. The following is the problem after adding the dummy column:

3.1 The Standard Initial Solution Using Vogel's Approximation (VAM):

Destination / Source	D_1	D_2	D_3	**D_4(Dummy)**	Supply
S_1	6	10 (40)	14 (10)	**0**	**50**
S_2	12 (30)	19	21 (20)	**0**	**50**
S_3	15	14	17 (25)	**0 (25)**	**50**
Demand	**30**	**40**	**55**	**25**	**150 = 150**

S_1 to D_2 **(x_{12})** = 40 , S_1 to D_3 **(x_{13})** =10 , S_2 to D_1 **(x_{21})** =30 , S_2 to D_3 **(x_{23})** =20, S_3 to D_3 **(x_{33})** = 25 , S_3 to D_4 **(x_{34})** =25.
Having an objective function value (Z) =**1745.**

3.2 The Standard Initial Solution Using Algorithm of Direct Sum Method (DSM):

Destination / Source	D_1	D_2	D_3	**D_4(Dummy)**	Supply
S_1	6	10	14 (50)	**0**	**50**
S_2	12 (25)	19	21	**0 (25)**	**50**
S_3	15 (5)	14 (40)	17 (5)	**0**	**50**
Demand	**30**	**40**	**55**	**25**	**150 = 150**

S_1 to D_3 **(x_{13})** =50 , S_2 to D_1 **(x_{21})** =25 , S_2 to D_4 **(x_{24})** =25 , S_3 to D_1 **(x_{31})** =5, S_3 to D_2 **(x_{32}) =** 40 , S_3 to D_3 **(x_{33})** = 5.
Having an objective function value (Z) =**1720.**

3.3 The Standard Initial Solution Using **Proposed Method**:
The cost matrix produced by the first step in the given example is as follows:

Destination / Source	D_1	D_2	D_3	Supply
S_1	0	4	8	**50**
S_2	6	13	15	**50**
S_3	9	8	11	**50**
Demand	**30**	**40**	**55**	**125≠150**

The following matrix is obtained by applying the second step to the aforementioned cost matrix:

Destination / Source	D_1	D_2	D_3	**D_4(Dummy)**	Supply
S_1	0	4	8	**15**	**50**
S_2	6	13	15	**15**	**50**

S_3	9	8	11	**15**	**50**
Demand	**30**	**40**	**55**	**25**	**150 = 150**

The above cost matrix is transformed into the following matrix using the third and fourth steps:

Destination / **Source**	D_1	D_2	D_3	**D_4(Dummy)**	Supply
S_1	0	4	5	8	**50**
S_2	0	7	6	2	**50**
S_3	1	0	0	0	**50**
Demand	**30**	**40**	**55**	**25**	**150 = 150**

Step 5 is now applied to the above-reduced cost matrix, yielding the following optimal solution to the original problem:

Destination / **Source**	D_1	D_2	D_3	**D_4(Dummy)**	Supply
S_1	6 (5)	10 (40)	14 (5)	**0**	**50**
S_2	12 (25)	19	21	**0 (25)**	**50**
S_3	15	14	17 (50)	**0**	**50**
Demand	**30**	**40**	**55**	**25**	**150 = 150**

S_1 to D_1 **(x_{11})** = 5 , S_1 to D_2 **(x_{12})** = 40 , S_1 to D_3 **(x_{13})** = 5 , S_2 to D_1 **(x_{21})** = 25 ,S_2 to D_4 **(x_{24})** = 25 , S_3 to D_3 **(x_{33})** = 50.

Having an objective function value (Z) =**1650.**

4 -Recommendations and Concluding Statements:

From the above tables, it is clear to us that there is a discrepancy in the efficiency of the methods used in our paper, as the results showed the technique proposed by Ramakrishnan (objective function value (Z) = 1650) as the best method, followed by the direct summation method as the total cost of transportation (objective function value (Z) = 1720), and finally, Vogel's approximate method, which results showed that it is less efficient compared to the methods used in our paper, as the total cost of transportation is (objective function value (Z) = 1745).

We recommended using the method suggested by Ramakrishnan to find the total cost of transportation problem.

We also recommended working on a computer software algorithm to find its solution programmatically without resorting to the classic manual solution.

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