Solving Transportation Problem with Four Different Proposed Mean Method and Comparison with Existing Methods for Optimum Solution

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ABSTRACT-In this article, finding an optimal solution is the prime requirement for the transportation problems. We compared a four different proposed mean (PAM, PHM, PGM, PQM) to find out the optimum solution of a TP. The most attractive feature of this method is that requires very simple statistical and rational calculation, that’s why it is very easy even for layman to understand and use. This method will be very beneficial for those decision makers who are dealing with logistics and supply chain related issues. A Numerical illustration is established and the optimality of the result received by this method is also verified.

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Keywords: Transportation problems (TP), Initial Basic Feasible Solution (IBFS), PAM, PHM, PGM, PQM, NWC, LCM, VAM, MODI, Optimal Solution (OS), (PMM).

1. Introduction

Now a day, transportation problem is famous in operation research for its wide application in real life. This is a special kind of the network optimization problems in which goods are transported from a set of sources to a set of destinations subject to the supply and demand of the source and destination, respectively, such that the total cost of transportation is minimized. The basic transportation problem was originally developed by Hitchcock in 1941 [1]. Efficient methods for finding solution were developed, primarily by Dantzig in 1951 [2] and then by Charnes, Cooper and Henderson in 1953 [3].

Basically, the solution procedure for the transportation problem consists of the following stages:

• Stage 1: Arithmetic formulation of the transportation problem.
• Stage 2: Finding an initial basic feasible solution.
• Stage 3: Optimize the optimal solution which is obtained in Stage 3.

In this paper, Stage 3 has been focused in order to obtain a better optimal solution for the transportation problems.

In the past few year Abdual Quddoos et.al [4] and Sudhaker et.al [5] implemented two different methods in 2012 respectively, for finding an optimal solution. In 1954 charnes and copper [5] was developed Stepping Stone method on “The Simplex method is not suitable for the Transportation problem especially for large scale transportation problem due to its special structure of model”.

Now days the researchers recently focus on many different methods that provide a betterment for transportation problem. Urvashikumari D.Patel et.al. [6] established “Transportation Problem using Stepping Stone Method and its Application. And also Neetu M.Sharma et.al [7] cope with “An alternative method to north west corner method for solving transportation problem which is totally new concept. A.Amaravathy et.al [8], Reena G.Patel et.al [9, 10] and Sushma Duraphe et.al [11] implemented the method is very helpful by solving less iterations and also required minimum time period for getting optimal solution.
In this article we proposed a new concept for solving TP in easiest manner.

(i) Arithmetic Mean AM = \( \frac{\sum_{i=1}^{n} x_i}{n} \).

(ii) Harmonic Mean, HM = \( \frac{\sum_{i=1}^{n} \frac{1}{x_i}}{n} \).

(iii) Geometric Mean, GM = \( (X_1 \cdot X_2 \cdots \cdots X_n)^{1/n} = (\prod_{i=1}^{n} X_i)^{1/n} \).

(iv) Quadratic Mean, QM = \( \sqrt[2]{\frac{x_1^2 + x_2^2 + \cdots + x_n^2}{n}} \).

2. Procedure for Proposed Approach to Find an optimal Solution

In the proposed approach, different mean is formed to find the optimum solution for the transportation problem.

- **Step-1:** Construct a Transportation Table (TT) from the given transportation problem.
- **Step-2:** Ensure whether the TP is balanced or not, if not, make it balanced.
- **Step-3:** Obtain the PAM / PHM / PGM / PQM for each row and column by using the corresponding principle.
- **Step-4:** Choose the maximum mean value from step2 and assign the min (supply or demand) at the place of lowest value of corresponding row or column.
- **Step-5:** Reiterate step2 and step3 till the demand and supply are exhausted.
- **Step-6:** Now transfer this allocation to the original TP.
- **Step-7:** Finally calculate the total transportation cost of the TP.

3. Numerical Illustrations

*Example 3.1.*

(i) **Illustrate Solution:**

|       | \( D_1 \) | \( D_2 \) | \( D_3 \) | \( D_4 \) | Supply |
|-------|-----------|-----------|-----------|-----------|--------|
| \( S_1 \) | 4         | 6         | 8         | 8         | 40     |
| \( S_2 \) | 6         | 8         | 6         | 7         | 60     |
| \( S_3 \) | 5         | 7         | 6         | 8         | 50     |
| **Demand** | 20        | 30        | 50        | 50        | 150    |

The above mentioned transportation table is balanced, therefore it exist a IBFS to PGM method.

(ii) **Arithmetic Mean**

|       | \( D_1 \) | \( D_2 \) | \( D_3 \) | \( D_4 \) | Supply |
|-------|-----------|-----------|-----------|-----------|--------|
| \( S_1 \) | 4         | 10        | 8         | 8         | (6, 50) |
| \( S_2 \) | 6         | 30        | 8         | 8         | (6)    |
| \( S_3 \) | 8         | 8         | 40, 10    | (6)       | (6)    |
| \( S_4 \) |           |           |           |           | (6)    |
The Transportation cost is

\[ Z = 4 \times 10 + 6 \times 30 + 6 \times 10 + 7 \times 50 + 5 \times 10 + 6 \times 40 = 920/- \]

(ii) Harmonic Mean

|      | D₁  | D₂  | D₃  | D₄  | Supply |
|------|-----|-----|-----|-----|--------|
| S₁   | 4   | 10  | 6   | 30  | 8      | 8      | 40, 10 | (6)  | (5.54) | (5.33) | (5.33) |
| S₂   | 6   | 8   | 6   | 10  | 7      | 50     | 60, 10 | (6.65)| (6.55) | (6)   | **     |
| S₃   | 5   | 10  | 7   | 6   | 40     | 8      | 50, 10 | (6.30)| (5.89) | (5.45) | (5.45) |
| Demand | 20,10 | 30  | 50, 40 | 50  | **     |

The Transportation cost is

\[ Z = 4 \times 10 + 6 \times 30 + 6 \times 10 + 7 \times 50 + 5 \times 10 + 6 \times 40 = 920/- \]

(iii) Geometric mean

|      | D₁  | D₂  | D₃  | D₄  | Supply |
|------|-----|-----|-----|-----|--------|

The Transportation cost is

\[ Z = 4 \times 10 + 6 \times 30 + 6 \times 10 + 7 \times 50 + 5 \times 10 + 6 \times 40 = 920/- \]
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\[ Z = 4 \times 10 + 6 \times 30 + 6 \times 10 + 7 \times 50 + 5 \times 10 + 6 \times 40 = 920/- \]

(iv) **Quadratic mean**

The Transportation cost is

\[ Z = 4 \times 10 + 6 \times 30 + 6 \times 10 + 7 \times 50 + 5 \times 10 + 6 \times 40 = 920/- \]

Example 3.2.

*Illustrate*
### Solution:

The above mentioned transportation table is balanced, therefore it exist a **IBFS** to **PGM** method.

|     | $D_1$ | $D_2$ | $D_3$ | $D_4$ | $D_5$ | Supply |
|-----|-------|-------|-------|-------|-------|--------|
| $S_1$ | 12    | 8     | 11    | 18    | 11    | 6      |
| $S_2$ | 14    | 22    | 8     | 12    | 14    | 2      |
| $S_3$ | 14    | 14    | 16    | 14    | 15    | 4      |
| $S_4$ | 19    | 11    | 14    | 17    | 15    | 10     |
| $S_5$ | 13    | 9     | 17    | 20    | 11    | 9      |
| Demand | 2     | 8     | 7     | 10    | 4     | 31     |

|     | $D_1$ | $D_2$ | $D_3$ | $D_4$ | $D_5$ | Supp ly |
|-----|-------|-------|-------|-------|-------|---------|
| $S_1$ | 12    | 8     | 11    | 18    | 11    | 6       |
| $S_2$ | 14    | 22    | 8     | 12    | 14    | 2       |
| $S_3$ | 14    | 14    | 16    | 14    | 15    | 4       |
| $S_4$ | 19    | 11    | 14    | 17    | 15    | 10      |
| $S_5$ | 13    | 9     | 17    | 20    | 11    | 9       |
| Demand | 2     | 8     | 7     | 10    | 4     | 31      |

|     | $D_1$ | $D_2$ | $D_3$ | $D_4$ | $D_5$ | Supply |
|-----|-------|-------|-------|-------|-------|--------|
| $S_1$ | 12    | 8     | 11    | 18    | 11    | 6       |
| $S_2$ | 14    | 22    | 8     | 12    | 14    | 2       |
| $S_3$ | 14    | 14    | 16    | 14    | 15    | 4       |
| $S_4$ | 19    | 11    | 14    | 17    | 15    | 10      |
| $S_5$ | 13    | 9     | 17    | 20    | 11    | 9       |
| Demand | 2     | 8     | 7     | 10    | 4     | 31      |
(i) **Arithmetic Mean**

The Transportation cost is

\[
Z = 11 \times 6 + 12 \times 2 + 14 \times 4 + 11 \times 6 + 17 \times 4 + 11 \times 4 + 13 \times 2 + 9 \times 2 + 17 \times 1 = 385/-
\]

(ii) **Harmonic Mean**

(iii) **Geometric Mean**

**Table: Supply and Demand**

| Supply | Demand  |
|--------|---------|
| S₁     | D₁, D₂ |
| S₂     | D₂, D₃ |
| S₃     | D₃, D₄ |
| S₄     | D₄, S₅ |
| S₅     | D₅, S₆ |
| S₆     | D₆, S₇ |
| S₇     | D₇, S₈ |
| S₈     | D₈, S₉ |
| S₉     | D₉, S₁₀|

**Table: Cost Calculation**

| Supply | Demand  |
|--------|---------|
| S₁     | D₁, D₂ |
| S₂     | D₂, D₃ |
| S₃     | D₃, D₄ |
| S₄     | D₄, S₅ |
| S₅     | D₅, S₆ |
| S₆     | D₆, S₇ |
| S₇     | D₇, S₈ |
| S₈     | D₈, S₉ |
| S₉     | D₉, S₁₀|

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6
Quadratic Mean

The Transportation cost is

\[ Z = 11 \cdot 6 + 12 \cdot 2 + 14 \cdot 4 + 11 \cdot 6 + 17 \cdot 4 + 11 \cdot 4 + 13 \cdot 2 + 9 \cdot 2 + 17 \cdot 1 = 385/- \]

4. Result Analysis

After obtaining an optimum by the “proposed Mean Method”, the obtained result is compared with the results obtained by other existing methods shown below

Table 1: Result Analysis

| Method               | Example 3.1 | Example 3.2 |
|----------------------|-------------|-------------|
| Proposed Arithmetic  | 920         | 385         |
5. RESULTS AND DISCUSSION

In this article, we implemented the algorithm for less iterations and getting minimum optimal solution. And also we have described the comparison results for various methods of TPM and (PAM, PHM, PGM, PQM) is same as MODI's method in Table 4. Finally, we conclude that the (PAM, PHM, PGM, PQM) is an important Geometrical tool for the decision makers when they are handling the variety of logistic problems.

6. CONCLUSION

In this article, we implemented the algorithm for less iterations and getting minimum optimal solution. And also we have described the comparison results for (PAM, PHM, PGM, PQM) which is same as MODI method. The Four different mean methods (PAM, PHM, PGM, PQM) are important statistical tool for the decision makers when they are handling the variety of logistic problems.

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The authors are very much gratifying to the editors and the reviewers for their constructive observations to progress this article. In this article, we implemented the algorithm for less iterations and getting minimum optimal solution. And also we have described the comparison results for TPM and PGM is same as that MODI’s method. The PGM is important Geometrical tool for the decision makers when they are handling the variety of logistic problems.

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