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Optimality Solution of Transportation Problem in a New Method (Summation and Ratio Method)

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Abstracts: Transport problems is very important in operational research. The transport problem has been solved in several ways: north west corner, minimum cell cost and Vogel's approximation method. In this study, I discussed a new method to find an optimal solution of transportation problems in a simple step. All methods were applied in this paper to evaluate the results and compare between them with respect to a new method. Also, the researcher discussed an example on transportation problems and the results of this study indicated which one of the methods has simple steps in the solution.

Keywords: Operation Research, Transportation Problem, Optimality, Summation Method.

1. INTRODUCTION

Transportation problems have various implementations such as management and operation research. All fields are developing rapidly, and increase the aware of competency between all organizations in the world, and strive to be more successes and survival to achieve competitive advantage. Also, all organizations need to minimize the cost and time, and increase their profit margin. Recently, the methods have developed to find the solution of the transportation problem in a simple method in order to be a major idea in applied mathematical programming. For these reasons, this study aims at finding the solution of a transportation problem in a fast and simple method.

2. LITERATURE REVIEW

The first book of operation research appeared in 1946 entitle "Methods of Research Operations" for Morris and Campbell's. Some of the scientists developed a different method to solve transportation problems. The transportation problem has been studied by the French scientist (Monge, 1781), and was developed during World War II. (Hitchcock,1941), introduced the transportation problem for the first time in his research which carries the title "The Distribution of a Product from Several sources to various Localities". After that (Koopmans, 1947), displayed a free investigation and called "Ideal Utilization of the Transportation System".

The applications continued widely and intensively in a certain period in order to achieve optimal products. Later on (Dantzig, 1951) came and connected between the transportation problem and linear programming problem in a mathematical model, also (Dantzig, 1963), he used a simplex method as a method to solve transportation problem.

The solution of this method was obtained in two stages, the first stage includes Northwest Corner, Matrix Minima Method or LCM, and Vogel's Approximation Method. Then the next stage includes stepping stone and modified distribution method. The second stage was obtained to find an optimal solution.

During these years, many of scientists developed these methods and discussed the solution when the problem is unbalanced in a difference ways. But in this article I focused on the last methods that cover the period 2000 up to 2018.

Reeb, J. and S. Leavengood in (2002), they studied a special case for a linear programming problems in a transportation problem. Also, in (2006), Adlakha V, Kowalski, K. & Lev. B. Solved Transportation Problem with Mixed Constraints. In (2010a) and (2010b), Pandian P. and Natarajan G., they discussed a new method to find an optimal solution of transportation problem in general case and an optimal solution of fully interval integer transportation problems. After one year, Sharma and et. al found an optimal solution of Transportation Problem with the help of phase-II method of Simplex Method.

In (2012), Abdual Quddoos presents a New Method to find an Optimal Solution for Transportation Problems, in (2014), Reena. G. Patel developed a new approach to a transportation problems, then in (2015), Sarbjit Singh published a new method of a degeneracy case in a transportation problem. In (2016), back to presents a new a approach to optimum solution. Recently, Sushma Duraphe et. al in (2017) found a new approach to solve transportation problem by Min Max Total opportunity cost method, in (2018), Muhammad Hanif and et. al considered a new method for optimal solutions of transportation problems in LPP . In general we try to minimize total transportation cost for the commodities when transported from source to destination.

The study is organized in two sections; section 3 is devoted to the steps of the new method. In section 4, numerical example for problems are discussed. In this article we discussed a new Method for solving transportation problem in a simple and easy way. This method is very closer to the optimal solution.

3. PROBLEM FORMULATION

Transportation problems are very important in different fields as Mathematics, Engineering, management, and others. Here we will present a general table of the transportation problem and I will explain the new steps in details.

Sources	Destinations				Supply
	D_1	D_2	.....	Dn	
S_1	C_{11}	C_{12}		C_{1n}	a_1
S_2	C_{21}	C_{22}		C_{2n}	a_2
S_3	C_{31}	C_{32}		C_{3n}	a_3
⋮	⋮	⋮	⋮	⋮	⋮
S_m	C_{m1}	C_{m2}		C_{mn}	a_m
Demand	b_1	b_2		b_n	**Sum**

Where $b_1, b_2, \ldots, b_n \equiv$Demand quantities, $a_1, a_2, \ldots, a_m \equiv$ Supply quantities, $c_{ij} \equiv$ unit cost from i unit to j unit and $x_{ij} \equiv$Number of units transferred.

Now, I will present the steps of a new method by details.

Steps:

1. Check if the problem is balanced or not. If the problem is unbalanced, add a dummy row or column so the cost of all cells in a dummy row/column will be zero.

   - Add a dummy row, if $\sum_{i=1}^{m} S_i < \sum_{j=1}^{n} D_j$.
   - Add a dummy column, if $\sum_{i=1}^{m} S_i > \sum_{j=1}^{n} D_j$.

2. Find the total cost of all cells, $T_c = \sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij}$

3. Find the total cost of each row and column.

Sources	**Destinations**				**Supply**
	D_1	D_2	…..	Dn	
S_1	C_{11}	C_{12}	…..	C_{1n}	a_1
S_2	C_{21}	C_{22}	…..	C_{2n}	a_2
S_3	C_{31}	C_{32}	…..	C_{3n}	a_3
⋮	⋮	⋮	…..	⋮	⋮
S_m	C_{m1}	C_{m2}	…..	C_{mn}	a_m
Demand	b_1	b_2		b_n	**Sum**

$T_{c_{Row}}$	$Ratio_{Row}$
$\sum_{i=1}^{n} c_{1i}$	$\frac{\sum_{i=1}^{n} c_{1i}}{T_C}$
$\sum_{i=1}^{n} c_{2i}$	$\frac{\sum_{i=1}^{n} c_{2i}}{T_C}$
$\sum_{i=1}^{n} c_{2i}$	$\frac{\sum_{i=1}^{n} c_{3i}}{T_C}$
⋮	⋮
$\sum_{i=1}^{n} c_{mi}$	$\frac{\sum_{i=1}^{n} c_{mi}}{T_C}$

$T_{c_{column}}$	$\sum_{j=1}^{m} c_{j1}$	$\sum_{j=1}^{m} c_{j2}$	…..	$\sum_{j=1}^{m} c_{jn}$
$Ratio_{column}$	$\frac{\sum_{j=1}^{m} c_{j1}}{T_C}$	$\frac{\sum_{j=1}^{m} c_{j2}}{T_C}$	…..	$\frac{\sum_{j=1}^{m} c_{jn}}{T_C}$

4. Divide the total cost of each row on the sum of all cells,

$$r_{R_i} = \frac{\sum_{i=1}^{n} c_{ji}}{T_c} \ , \ j = 1,2,\dots\dots, m$$

5. Divide the total cost of each column on the sum of all cells,

$$r_{Dj} = \frac{\sum_{j=1}^{m} c_{ji}}{T_c} \ , \ i = 1,2,\dots\dots, n$$

6. Determine the cell we get through the intersection of the smallest proportion in the rows with the largest proportion in the columns.

7. From the selected row and column, we need to select the minimum of supply/demand to fill it in the cell.

8. Repeating the step 2 to step 7 to complete the solution of all cells.

4. NUMERICAL EXAMPLE

Now, I will discuss a solution of the following problem by summation and ration method, and I will compare it with other methods.

Example 1: Discuss

Sources	D_1	D_2	D_3	D_4	Supply
S_1	9	8	5	7	12
S_2	4	6	8	7	14
S_3	5	8	9	5	16
Demand	8	18	13	3	

Stage 1: Find the sum and ratio of each rows and columns

Stage 2: Determine the minimum ratio of rows and maximum ratio of columns with respect to costs.

Sources	D_1	D_2	D_3	D_4	Supply	$T_{c_{Row}}$	$Ratio_{Row}$
S_1	9	8	5	7	12	29	0.358
S_2	4	14 6	8	7	14	25	0.308
S_3	5	8	9	5	16	27	0.333
Demand	8	18	13	3			
$T_{c_{column}}$	18	22	22	19			
$Ratio_{column}$	0.222	0.271	0.271	0.234			

Stage 3: Ignore the full row or column, then repeat the first and the second stages.

Sources	D_1	D_2	D_3	D_4	Supply	$T_{c_{Row}}$	$Ratio_{Row}$
S_1	9	8	5	7	12	29	0.358
S_2	4	14 6	8	7	14	x	X
S_3	5	4 8	9	5	16	27	0.333
Demand	8	18	13	3			
$T_{c_{column}}$	14	16	14	12			
$Ratio_{column}$	0.25	0.285	0.25	0.214			

Sources	D_1	D_2	D_3	D_4	Supply	$T_{c_{Row}}$	$Ratio_{Row}$
S_1	9	8	5	7	12	21	0.525
S_2	4	14 6	8	7	14 0	x	X
S_3	8 5	4 8	9	5	16	19	0.475
Demand	8	18	13	3			
$T_{c_{column}}$	14	x	14	12			
$Ratio_{column}$	0.25	x	0.25	0.214			

Sources	

	D_1	D_2	D_3	D_4	**Supply**	$T_{c_{Row}}$	$Ratio_{Row}$
S_1	9	8	12 5	7	12	12	0.461
S_2	4	14 6	8	7	14 0	x	X
S_3	8 5	4 8	1 9	3 5	16	14	0.538
Demand	8	18	13	3			
$T_{c_{column}}$	x	x	14	12			
$Ratio_{column}$	x	x	0.538	0.461			

Total cost = 240

Example 2: Discuss

Sources	D_1	D_2	D_3	**Supply**
S_1	3	3	5	9
S_2	6	5	4	8
S_3	6	10	7	10
Demand	7	12	8	

Stage 1: Find the sum and ratio of each rows and columns

Stage 2: Determine the minimum ratio of rows and maximum ratio of columns

Sources	D_1	D_2	D_3	**Supply**	$T_{c_{Row}}$	$Ratio_{Row}$
S_1	3	9 3	5	9	11	0.224
S_2	6	5	4	8	15	0.306
S_3	6	10	7	10	23	0.469
Demand	7	12	8			
$T_{c_{column}}$	15	18	16			
$Ratio_{column}$	0.306	0.367*	0.326			

Stage 3: Ignore the full row or column, then repeat the first and the second stages.

Sources	D_1	D_2	D_3	**Supply**	$T_{c_{Row}}$	$Ratio_{Row}$
S_1	3	9 3	5	9	x	x
S_2	6	3 5	4	8	15	0.394
S_3	6	10	7	10	23	0.605
Demand	7	12	8			
$T_{c_{column}}$	12	15	11			
$Ratio_{column}$	0.315	0.394	0.289			

Sources	D_1	D_2	D_3	Supply	$T_{c_{Row}}$	$Ratio_{Row}$
S_1	3	9 3	5	9	x	x
S_2	5 6	3 5	4	8 5 0	10	0.434
S_3	6	10	7	10	13	0.565
Demand	7	12	8			
$T_{c_{column}}$	12	x	11			
$Ratio_{column}$	0.521	x	0.478			

Sources	D_1	D_2	D_3	Supply	$T_{c_{Row}}$	$Ratio_{Row}$
S_1	3	9 3	5	9	x	x
S_2	5 6	3 5	4	8 5 0	10	0.434
S_3	2 6	10	8 7	10	13	0.565
Demand	7	12	8			
$T_{c_{column}}$	12	x	11			
$Ratio_{column}$	0.521	x	0.478			

Total cost = 140

Comparing: I will compare a solution of the previous example with a solution of the same example by other methods, for more details see Sushma Duraphe and et. al, (2017).

Method	Example 1	Example 2
North west corner	320	143
Matrix Minima Method	248	159
Vogel's Approximation	248	143
MODI	240	125
Max Min Total	248	125
Current Method	240	140

CONCLUSIONS

In this study, we proposed a new method that can find solutions for some transportation problems using simple and easy steps. The results of the method are compared with the results of previous methods. It is found that they accurate and go in line with the results of MODI method. The study opens the door for using Lagrange method and other similar techniques in transportation problems.

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