UNIVERSITY OF CALGARY
SCHULICH SCHOOL OF ENGINEERING

REPORT ON

ASM Method for Finding an Optimal Solution for Transportation Problems

Based on
A New Method for Finding an Optimal Solution for Transportation Problems
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ENMF 618 Manufacturing Optimization

Research objective

The transportation problem is one of the common challenges in operations research, where the goal is to minimize transportation costs while ensuring supply and demand constraints are met. Traditional methods, like Vogel's Approximation Method (VAM) and the MODI Method, follow a two-step process where we find an Initial Basic Feasible Solution (IBFS) and then optimize it. This extra step increases computation time and doesn't guarantee an optimal solution right away. This study takes a closer look at the ASM-Method, a newer approach that claims to directly find the optimal solution without needing an IBFS. After reviewing the original research paper on the ASM-Method, it was found that the authors presented the final solution without showing the detailed steps or iterations. To understand the method better I have performed ASM method on the given problem in research paper with step by step procedure. Similarly, when comparing ASM's solution with Vogel's and MODI Methods, the paper lacked proper step-by-step calculations, making it difficult to verify whether the results were truly optimal. To clear up this uncertainty, I have validated its results using Excel Solver (Simplex LP Method). The goal is to study ASM method and to determine if ASM really delivers an optimal solution directly.

Research Methodology

The authors introduced a new method called the ASM-Method, which claims to find the optimal solution directly without first calculating an Initial Basic Feasible Solution (IBFS). This method requires fewer iterations, making it significantly more efficient in terms of computational time. In their research paper, they outlined a set of instructions for applying the ASM-Method and used these steps to solve an example problem. According to their results, the optimal transportation cost for the given problem was found to be 412.

II. ASM-Method

Step 1: Construct the transportation table from given transportation problem.
Step 2: Subtract each row entries of the transportation table from the respective row minimum and then subtract each column entries of the resulting transportation table from respective column minimum.
Step 3: Now there will be at least one zero in each row and in each column in the reduced cost matrix. Select the first zero (row-wise) occurring in the cost matrix. Suppose $(i, j)^{th}$ zero is selected, count the total number of zeros (excluding the selected one) in the i^{th} row and j^{th} column. Now select the next zero and count the total number of zeros in the corresponding row and column in the same manner. Continue it for all zeros in the cost matrix.
Step 4: Now choose a zero for which the number of zeros counted in step 3 is minimum and supply maximum possible amount to that cell. If tie occurs for some zeros in step 3 then choose a $(k,l)^{th}$ zero breaking tie such that the total sum of all the elements in the k^{th} row and l^{th} column is maximum. Allocate maximum possible amount to that cell.
Step 5: After performing step 4, delete the row or column for further calculation where the supply from a given source is depleted or the demand for a given destination is satisfied.
Step 6: Check whether the resultant matrix possesses at least one zero in each row and in each column. If not, repeat step 2, otherwise goto step 7.
Step 7: Repeat step 3 to step 6 until and unless all the demands are satisfied and all the supplies are exhausted.

III. Numerical Example

Consider the following cost minimizing transportation problem with three origins and four destinations.

	D_1	D_2	D_3	D_4	Supply
S_1	13	18	30	8	8
S_2	55	20	25	40	10
S_3	30	6	50	10	11
Demand	4	7	6	12	29 (Total)

By applying ASM-Method allocations are obtained as follows:

	D_1	D_2	D_3	D_4	Supply
S_1	13 $\boxed{4}$	18	30	8 $\boxed{4}$	8
S_2	55	20 $\boxed{4}$	25 $\boxed{6}$	40	10
S_3	30	6 $\boxed{3}$	50	10 $\boxed{8}$	11
Demand	4	7	6	12	29 (Total)

The total cost associated with these allocations is 412.

However, they did not show the iterations for the given example. To understand this method better, I have reconstructed the solution with step by step procedure. To ensure that ASM really provides the solution the authors have found, we can create step by step process and learn the method better.
Now we Apply ASM method from general instructions provided by authors in the research paper -

	D1	D2	D3	D4	Supply
S1	13	18	30	8	8
S2	55	20	25	40	10
S3	30	6	50	10	11
Demand	4	7	6	12	29 (Total)

We have three sources (S1, S2, S3) and four destinations (D1, D2, D3, D4) with the following cost matrix:

Step 1: Row Reduction

Subtract the row from the minimum value in each row which gives us the matrix :

	D1	D2	D3	D4
S1	5	10	22	0
S2	35	0	5	20
S3	24	0	44	4

Step 2 Column Reduction:

Subtract from minimum value in each column which gives the following matrix :

	D1	D2	D3	D4
S1	0	10	17	0
S2	30	0	0	20
S3	19	0	39	4

Step 3 : Assign Supplies Using the Zero Elements

Allocate supply based on zero-cost positions

	D1	D2	D3	D4	Supply
S1				8	8
S2		7	3		10
S3	4		3	4	11

Allocating supply based on **zero-cost positions:**

- Assign S1 → D4 (8 units) (S1 exhausted, D4 still requires 4 units).
- Assign S2 → D2 (7 units) (D2 satisfied, 3 units remain at S2).
- Assign S2 → D3 (3 units) (D3 still requires 3 units).
- Assign S3 → D3 (3 units) (D3 satisfied, 8 units remain at S3).
- Assign S3 → D4 (4 units) (D4 satisfied, 4 units remain at S3).
- Assign S3 → D1 (4 units) (All supply and demand constraints satisfied).

Step 4: Compute the Total Transportation Cost

Now, we calculate the cost:

$(8\times8)+(7\times20)+(3\times25)+(3\times50)+(4\times10)+(4\times30)=64+140+75+150+40+120=412$ which is same as author's result (verified).

Authors Optimality test

To validate the result obtained by ASM method is optimal or not, authors have compared the solution with Modi method (Modified distribution). They have first calculated the IBFS by Vogel's method and it was 476. After that they applied Modi method and got solution as 412. However they have directly written the results that were obtained from Modi method without even performing the method which adds Uncertainty and questions the credibility of the paper.

	D_1	D_2	D_3	D_4	Supply
S_1	13 $\boxed{4}$	18	30	8 $\boxed{4}$	8
S_2	55	20	25 $\boxed{6}$	40 $\boxed{4}$	10
S_3	30	6 $\boxed{7}$	50	10 $\boxed{4}$	11
Demand	4	7	6	12	29

The total cost associated with these allocations is 476.
To get optimal solution MODI (Modified Distribution) method is adopted and by applying MODI method the optimal solution is obtained as 412. It can be seen that the value of the objective function obtained by ASM-Method in section 3 is same as the optimal value obtained by MODI method. Thus the value obtained by ASM-Method (i.e. 412) is also optimal.

Additional optimality test

To be certain and avoid uncertainty we use Excel (simplex LP) to find the optimal solution.

Linear Programming Model

Decision Variable : Let Xij be the number of goods transported from Source i to destination j where i=1,2,3 ; j=1,2,3,4

Min. $Z = 13X_{11}+18X_{12}+30X_{13}+8X_{14}+55X_{21}+20X_{22}+25X_{23}+40X_{24}+30X_{31}+6X_{32}+50X_{33}+10X_{34}$

Supply constraints:

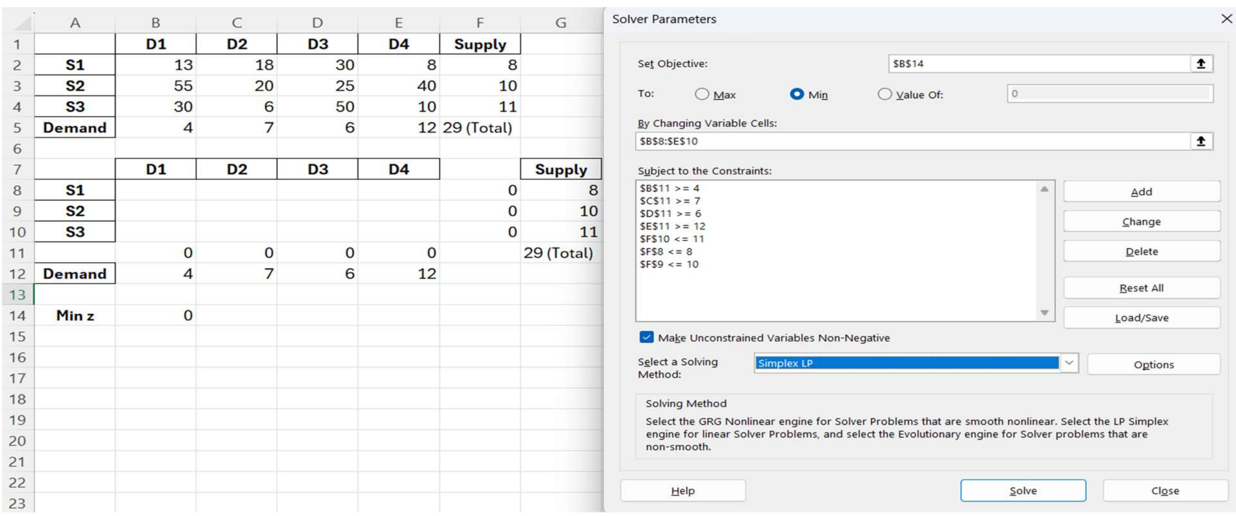
$X_{11}+X_{12}+X_{13}+X_{14}\leq 8$; $X_{21}+X_{22}+X_{23}+X_{24}\leq 10$; $X_{31}+X_{32}+X_{33}+X_{34}\leq 11$

Demand Constraints:

$X_{11}+X_{21}+X_{31}\geq 4$; $X_{12}+X_{22}+X_{32}\geq 7$; $X_{13}+X_{23}+X_{33}\geq 6$; $X_{14}+X_{24}+X_{34}\geq 12$

Non negative constraints: $X_{ij}\geq 0$, where i=1,2,3 and j= 1,2,3,4

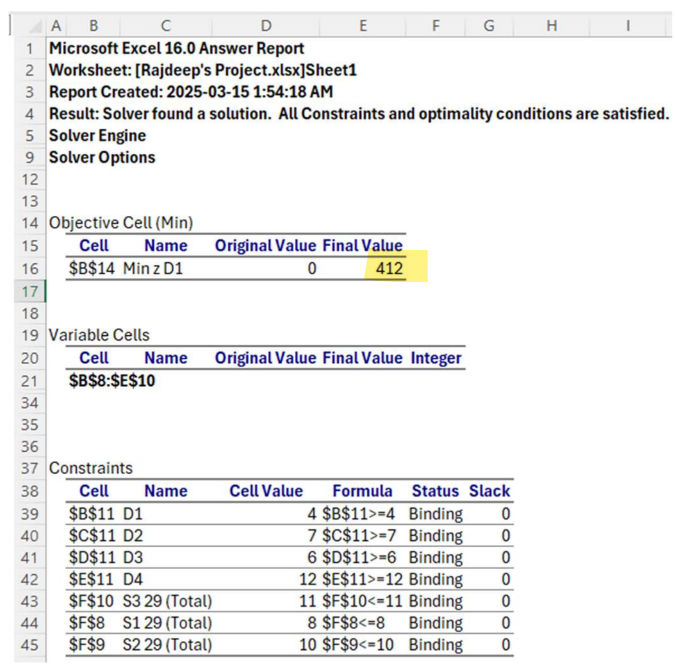
Solver with parameters-



	A	B	C	D	E	F	G
1		D1	D2	D3	D4	Supply	
2	S1	13	18	30	8	8	
3	S2	55	20	25	40	10	
4	S3	30	6	50	10	11	
5	Demand	4	7	6	12	29 (Total)	
6							
7		D1	D2	D3	D4		Supply
8	S1					0	8
9	S2					0	10
10	S3					0	11
11		0	0	0	0		29 (Total)
12	Demand	4	7	6	12		
13							
14	Min z	0					

WE obtain the results as below from the Excel Solver:

From this answer report we can see that minimum cost for transportation is 412 which is same as ASM method. Thus we can say that ASM gives us direct optimal result without having to find initial best feasible solution. The ASM-Method is faster because it bypasses the IBFS step, reduces matrix complexity early, and directly optimizes allocations, leading to significantly fewer iterations than traditional methods. Thus it can really provide industries a great algorithm to calculate an optimal solution.



Microsoft Excel 16.0 Answer Report
Worksheet: [Rajdeep's Project.xlsx]Sheet1
Report Created: 2025-03-15 1:54:18 AM
Result: Solver found a solution. All Constraints and optimality conditions are satisfied.
Solver Engine
Solver Options

Objective Cell (Min)

Cell	Name	Original Value	Final Value
$B$14	Min z D1	0	412

Variable Cells

Cell	Name	Original Value	Final Value	Integer
$B$8:$E$10				

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
$B$11	D1	4	$B$11>=4	Binding	0
$C$11	D2	7	$C$11>=7	Binding	0
$D$11	D3	6	$D$11>=6	Binding	0
$E$11	D4	12	$E$11>=12	Binding	0
$F$10	S3 29 (Total)	11	$F$10<=11	Binding	0
$F$8	S1 29 (Total)	8	$F$8<=8	Binding	0
$F$9	S2 29 (Total)	10	$F$9<=10	Binding	0

Computational Complexity Comparison

Method	Steps Required	Computational Time (Relative)
VAM + MODI	IBFS + Iterative Optimization	High
MODI Method	Iterative Optimization	Medium
ASM-Method	Direct Optimal Solution	Low

Comments and Suggestions for Improvement

The credibility of the research paper can be further improved by including detailed step-by-step iterations for Vogel's Approximation Method and the MODI Method as well. This will allow for a more transparent and comprehensive comparison which can increase the credibility of the paper.

The ASM-Method shows promise in cutting down computation time however more research is needed to test how well it works in real world scenarios. One key area for improvement is scalability like how does it performs when applied to large, complex datasets? Testing it on real transportation and logistics problems would help determine its practical value.

Also, the theoretical reasoning behind ASM's efficiency needs further research. Understanding Why exactly is it faster and understanding its computational complexity could help refine and improve the method further which in turn can make the method more robust, precise and accurate when finding optimal solution.

Finally, instead of only testing it in controlled settings, applying ASM to real-world datasets would make the research more practical and applicable to industries like supply chain management.

Conclusion and Future Work

This study carefully analyzed the ASM Method and validated its effectiveness in solving transportation problems. The method successfully produced an optimal transportation cost of 412, matching the results obtained through the MODI Method and Excel Solver (Simplex LP) while significantly reducing computational steps. By skipping the Initial Basic Feasible Solution (IBFS) and going directly to optimization, ASM proves to be a time-saving alternative to traditional methods like Vogel's and MODI.

Future Work :

- We can test ASM on bigger, more complex transportation problems to test its scalability.
- We can present detailed iterations for Vogel's and MODI Methods alongside ASM to improve transparency and strengthen the credibility of the research paper.
- We can create a software interface to make ASM more accessible for real-world logistics and supply chain management.
- Compare the ASM-Method with other methods like, North-West Corner Method, and stepping stone method to analyze it's efficiency in solving transportation problems, especially in cases where supply does not equal demand.

By following these steps, the research will not only validate ASM thoroughly but will also make a stronger case for its use in large-scale transportation optimization.

A New Method for Finding an Optimal Solution for Transportation Problems

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Abstract— **In this paper a new method named ASM-Method is proposed for finding an optimal solution for a wide range of transportation problems, directly. A numerical illustration is established and the optimality of the result yielded by this method is also checked. The most attractive feature of this method is that it requires very simple arithmetical and logical calculation, that's why it is very easy even for layman to understand and use. This method will be very lucrative for those decision makers who are dealing with logistics and supply chain related issues. Because of the simplicity of this method one can easily adopt it among the existing methods.**

Keywords- Transportation problem, Optimal Solution and ASM-Method.

Mathematics Subject Classification: 90C08, 90C90

I. INTRODUCTION

A Transportation problem is one of the earliest and most important applications of linear programming problem. Description of a classical transportation problem can be given as follows. A certain amount of homogeneous commodity is available at number of sources and a fixed amount is required to meet the demand at each number of destinations. A balanced condition (*i.e.* Total demand is equal to total supply) is assumed. Then finding an optimal schedule of shipment of the commodity with the satisfaction of demands at each destination is the main goal of the problem. In 1941 Hitchcock [2] developed the basic transportation problem along with the constructive method of solution and later in 1949 Koopmans [11] discussed the problem in detail. Again in 1951 Dantzig [3] formulated the transportation problem as linear programming problem and also provided the solution method. Now a day's transportation problem has become a standard application for industrial organizations having several manufacturing units, warehouses and distribution centers.

For obtaining an optimal solution for transportation problems it was required to solve the problem into two stages. In first stage the initial basic feasible solution (IBFS) was obtained by opting any of the available methods such as "North West Corner", "Matrix Minima", "Least Cost Method", "Row Minima ", "Column Minima" and "Vogel's Approximation Method " etc. Then in the next and last stage MODI (Modified Distribution) method was adopted to get an optimal solution. Charnes and Cooper [1] also developed a method for finding an optimal solution from IBFS named as "Stepping Stone Method".

Recently, P.Pandian *et al.* [12] and Sudhakar *et al.* [6] proposed two different methods in 2010 and 2012 respectively for finding an optimal solution directly. Here a much easier heuristic approach is proposed for finding an optimal solution directly with lesser number of iterations and very easy computations. The stepwise procedure of proposed method is carried out as follows.

II. ASM-Method

Step 1: Construct the transportation table from given transportation problem.
Step 2: Subtract each row entries of the transportation table from the respective row minimum and then subtract each column entries of the resulting transportation table from respective column minimum.
Step 3: Now there will be at least one zero in each row and in each column in the reduced cost matrix. Select the first zero (row-wise) occurring in the cost matrix. Suppose $(i, j)^{th}$ zero is selected, count the total number of zeros (excluding the selected one) in the i^{th} row and j^{th} column. Now select the next zero and count the total number of zeros in the corresponding row and column in the same manner. Continue it for all zeros in the cost matrix.
Step 4: Now choose a zero for which the number of zeros counted in step 3 is minimum and supply maximum possible amount to that cell. If tie occurs for some zeros in step 3 then choose a $(k,l)^{th}$ zero breaking tie such that the total sum of all the elements in the k^{th} row and l^{th} column is maximum. Allocate maximum possible amount to that cell.
Step 5: After performing step 4, delete the row or column for further calculation where the supply from a given source is depleted or the demand for a given destination is satisfied.
Step 6: Check whether the resultant matrix possesses at least one zero in each row and in each column. If not, repeat step 2, otherwise goto step 7.
Step 7: Repeat step 3 to step 6 until and unless all the demands are satisfied and all the supplies are exhausted.

III. Numerical Example

Consider the following cost minimizing transportation problem with three origins and four destinations.

	D_1	D_2	D_3	D_4	Supply
S_1	13	18	30	8	8
S_2	55	20	25	40	10
S_3	30	6	50	10	11
Demand	4	7	6	12	29 (Total)

By applying ASM-Method allocations are obtained as follows:

	D_1	D_2	D_3	D_4	Supply
S_1	13 [4]	18	30	8 [4]	8
S_2	55	20 [4]	25 [6]	40	10
S_3	30	6 [3]	50	10 [8]	11
Demand	4	7	6	12	29 (Total)

The total cost associated with these allocations is 412.

IV. Optimality Check

To find initial basic feasible solution for the above example Vogel's Approximation Method is used and allocations are obtained as follows:

	D_1	D_2	D_3	D_4	Supply
S_1	13 (4)	18	30	8 (4)	8
S_2	55	20	25 (6)	40 (4)	10
S_3	30	6 (7)	50	10 (4)	11
Demand	4	7	6	12	29

The total cost associated with these allocations is 476.
To get optimal solution MODI (Modified Distribution) method is adopted and by applying MODI method the optimal solution is obtained as 412. It can be seen that the value of the objective function obtained by ASM-Method in section 3 is same as the optimal value obtained by MODI method. Thus the value obtained by ASM-Method (i.e. 412) is also optimal.

V. CONCLUSION

Thus it can be concluded that ASM-Method provides an optimal solution directly, in fewer iterations, for the transportation problems. As this method consumes less time and is very easy to understand and apply, so it will be very helpful for decision makers who are dealing with logistic and supply chain problems.

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