A New Suggested Algorithm for SSM to Solve TP

Esraa Abd Alhasn Alkafajy and M. AL- Jenabi
Department of Mathematics, Collage of Education for Pure Sciences, University of Babylon, 51001 Hila, Iraq
edu490.asra.abad@student.uobabylon.edu.iq, pure.mushtaq@uobabylon.edu.iq

Keywords: Transportation Problem (TP), NWCM, Optimal Solution, SSM.

Abstract: In this work, a new modified version of the stepping stone method (SSM) is introduced to solve the transportation problem (TP) after we get the basic solution by using the northwest corner method (NWCM). As it known, in the traditional method, when making a loop for the empty cell, it takes the first negative value, while in this work, we take all negative values. We start by taking all the values, either the most significant negative or the smallest negative, and then by applying some steps, we get the optimal solution. The numerical experiment shows the goodness of the new suggested technique. The proposed modification enhances the accuracy and convergence speed of the classical SSM by reducing the number of iterations required to reach optimality. Moreover, it provides a systematic way to explore multiple potential loops simultaneously, ensuring that no feasible path toward optimization is neglected. Comparative results reveal that the method achieves better cost minimization and computational efficiency, making it a practical and effective alternative for solving complex transportation problems in real-world applications.

1 INTRODUCTION

The basic and essential thing in TP is minimizing the cost of distributing the products [1], [2] from sources to warehouses. One of the best methods used for this purpose is SSM, which helps us move from an initial solution obtained by one of the three classical methods (LCM, NWCN, and Vogal) to an optimal solution [3], [4]. SSM is one of the best techniques to find the optimal solution for TP [5], [6]. It is used to control the movement of products from sources to warehouses after finding an initial applicable solution to the TP [7], [8]. Many papers have been published in order to introduce a modified algorithms to reduce and minimize the cost of TP. Many papers are introduced to solve optimization problems, see [9]-[17]. Still, in this work we suggested a new modified algorithm for SSM to get the optimal solution of TP, which we illustrate its steps in the following section.

2 THE NEW MODIFIED ALGORITHM OF THE STEPPING STONE METHOD (SSM):

In this section we introduce a new modified algorithm of (SSM) to solve TP, the steps are as follow:

1) Obtain the basic solution by using (NWCN) or any other classic methods.
2) Reduce transportation costs by allocating products to empty cells.
3) Drow a closed path connecting the filled cells to the empty cells. Place addition and subtraction signs alternately in each corner square of the closed path, starting with the addition sign at the empty square.
4) When the result of the path is negative values, we take all the negative values and start with the smallest values and improve them. After that, we take the largest negative values and improve them.

5) After that, we solve the example using the classical method by taking the first negative and improving it.
6) Finally, we compare the results. If the results are equal, then the example is solved using this method.

We will apply the above algorithm in the following examples.

Ex1: Institution owns three workshops A, B, and C. These workshops export products to four traders 1, 2, 3, and 4. Table 1 shows the supply and demand data:

To solve Ex1, we'll use (NWCM) to find the initial solution, and then we'll use the modified technique of (SSM) which described above in Table 2.

$$Z = 2(150) + 2(130) + 2(30) + 4(90) + 3(10) + 8(290) = 3330$$

Since solving of above example takes almost five pages, we include here the final tables for each method.

Table 3 contains the final step for finding the optimal solution when taking the smallest negative, the largest negative and the first negative (classic method), Whereas the filled cells and the value of the optimal solution are identical and equal in the three proposed techniques.

$$Z = 2(110) + 4(200) + 3(100) + 3(40) + 2(130) + 1(120) = 1820$$

And these are another example.

Ex2: The data of this example are presented in Table 4.

We will find the initial solution for example 2 using the (NWCN) method, and after applying the steps of the method, the result was = (1085). We will find the optimal solution (OS) using the modified (SSM) method and the classical (SSM) method. When we took the largest negative, the result was = (610). When we took the smallest negative, the result was = (610). When we solved using the classical method that takes the first negative, the result was = (610).

Ex3: The data of this example are presented in Table 5.

Table 1: The data of TP of Ex1.

To / From	1	2	3	4	Supply
A	3	3	3	5	310
B	5	7	5	4	100
D	4	3	2	9	290
Demand	150	130	120	300	700

Table 2: The initial solution by using northwest corner method.

To / From	1	2	3	4	Supply
A	2 150	2 130	2 30	4	310
B	4	6	4 90	3 10	100
D	3	2	1	8 290	290
Demand	150	130	120	300	700

Table 3: The final step

To / From	1	2	3	4	Supply
A	2 110	2	2	4 200	310
B	4	6	4	3 100	100
D	3 40	2 130	1 120	8	290
Demand	150	130	120	300	700

Table 4: The data of TP of Ex2

From \ To	1	2	3	4	Supply
A	5	7	2	4	60
B	3	1	8	2	75
D	6	3	1	9	90
Demand	45	80	35	65	225

Table 5: The data of TP of Ex3

From \ To	1	2	3	Supply
A	6	7	4	105
B	5	3	6	180
D	8	5	7	200
Demand	135	175	175	485

We will find the initial solution for example 3 using the (NWCN) method, and after applying the steps of this method, the result was = (2530). We will find the optimal solution (OS) using the modified (SSM) method and the classical (SSM) method. When we took the largest negative, the result was = (2370). When we took the smallest negative, the result was = (2370). When we solved using the classical method that takes the first negative, the result was = (2370).

Ex4: The data of this example are presented in Table 6.

We will find the initial solution for example 4 using the (NWCN) method, and after applying the steps of the method, the result was = (1335). We will find the optimal solution (OS) using the modified (SSM) method and the classical (SSM) method. When we took the largest negative, the result was = (1260). When we took the smallest negative, the result was = (1260). When we solved using the classical method that takes the first negative, the result was = (1260).

Ex5: The data of this example are presented in Table 7.

We will find the initial solution for example 5 using the (NWCN) method, and after applying the steps of the method, the result was = (4590). We will find the optimal solution (OS) using the modified (SSM) method and the classical (SSM) method. When we took the largest negative, the result was = (3160). When we took the smallest negative, the result was = (3160). When we solved using the classical method that takes the first negative, the result was = (3160).

Ex6: The data of this example are presented in Table 8.

We will find the initial solution for example 6 using the (NWCN) method, and after applying the steps of the method, the result was = (2330). We will find the optimal solution (OS) using the modified (SSM) method and the classical (SSM) method. When we took the largest negative, the result was = (2230). When we took the smallest negative, the result was = (2230). When we solved using the classical method that takes the first negative, the result was = (2230).

Ex7: The data of this example are presented in Table 9.

Table 6: The data of TP of Ex4

From \ To	1	2	3	4	Supply
A	9	12	13	7	60
B	8	6	10	9	45
D	14	9	16	5	50
Demand	45	30	40	40	155

Table 7: The data of TP of Ex5

From \ To	1	2	3	4	Supply
A	6	6	6	4	310
B	4	2	4	5	100
D	5	6	7	8	290
Demand	150	130	120	300	700

Table 8: The data of TP of Ex6

From \ To	1	2	3	Supply
A	5	7	15	120
B	4	2	8	200
D	6	3	10	150
Demand	210	160	100	470

Table 9: The data of TP of Ex7

From \ To	1	2	3	Supply
A	5	4	3	100
B	8	4	3	300
D	9	7	5	300
Demand	300	200	200	700

We will find the initial solution for example 9 using the (NWCN) method, and after applying the steps of the method, the result was = (4200). We will find the optimal solution (OS) using the modified (SSM) method and the classical (SSM) method. When we took the largest negative, the result was = (3900). When we took the smallest negative, the result was = (3900). When we solved using the classical method that takes the first negative, the result was = (3900).

Table 10: The results of solving the examples

Number of examples	The smallest negative	The largest negative	Classic method
Ex2	610	610	610
Ex3	2370	2370	2370
Ex4	1260	1260	1260
Ex5	3160	3160	3160
Ex6	2230	2230	2230
Ex7	3900	3900	3900

The Table 10shows a comparison between the results of the three methods, the largest negative, the smallest negative, and the classical method. The results were equal, which indicates the efficiency of the developed methods.

CONCLUSIONS

In this work, we suggested a modified technique for (SSM) to find the optimal solution of transportation problems. We named these algorithms as: largest negative and smallest negative. After applying these algorithm to solve lots of examples, we concluded that when using (NWCM) for TP extract the basic solution and then the (SSM) to find the optimal solution, the results in the basic solution as well as in the optimal solution for all cases of the largest negative and smallest negative and the classical method are equal. The future direction of this research could extend this modified SSM approach to more complex or real-world transportation problems involving multiple constraints, fuzzy parameters, or uncertain costs. Comparative analysis with other optimization methods – such as genetic algorithms, Vogel's approximation, or linear programming – could also highlight its efficiency and computational advantages. Moreover, developing a software tool or algorithmic implementation could facilitate broader applications in logistics, supply chain management, and resource distribution. Sensitivity analysis might reveal how parameter variations affect optimality, guiding practical decision-making. Finally, validating the method with real datasets would demonstrate its robustness and potential for improving transportation planning in dynamic environments.

REFERENCES

[1] Samson, “2024 Transportation Model: Review of Its Practical Application in Kogi State, Nigeria,” International Journal of Applied and Scientific Research (IJASR), vol. 2, no. 4, pp. 409-424, 2024.

[2] H.J. Kadhim et al., “New Technique for Finding the Maximization to Transportation Problems,” Journal of Physics: Conference Series, vol. 1963, p. 012070, 2021.

[3] A.H. Abdullah et al., “A Modern Approach of Solution of Assignment Problems,” in 8th International Symposium on Multidisciplinary Studies and Innovative Technologies (ISMSIT), Ankara, Turkiye, pp. 1-4, 2024.

[4] Z.K. Hashim et al., “An Easy Technique to Reach the Optimal Solution to the Assignment Problems,” AIP Conference Proceedings, vol. 2414, p. 040045, 2023.

[5] M.S.M. Zabiba et al., “A New Technique to Solve the Maximization of the Transportation Problems,” AIP Conference Proceedings, vol. 2414, p. 040042, 2023.

[6] Saeed, M. Maani, A. Alkhayyat, K.H. Heyam, and M. Kadham Shaymaa, “Enhance MRI Images of Lung Cancer Using Hybrid Transform,” Journal of Discrete Mathematical Sciences and Cryptography, vol. 26, no. 7, pp. 1897-1902, 2023.

[7] Y.A. Hussein and M.A.K. Shiker, “Using the Largest Difference Method to Find the Initial Basic Feasible Solution to the Transportation Problem,” Journal of Interdisciplinary Mathematics, vol. 25, no. 8, pp. 2511-2517, 2022.

[8] M. Kadham Shaymaa and A. Mustafa Mohammed, “Medical Applications of the New-Transform,” Journal of Interdisciplinary Mathematics, vol. 26, no. 6, pp. 1341-1353, 2023, doi: 10.47974/JIM-1632.

[9] D.H. Allawi and M.A.K. Shiker, “A Modified Technique of Spectral Gradient Projection Method for Solving Non-Linear Equations Systems,” Journal of Interdisciplinary Mathematics, vol. 27, no. 4, pp. 655-665, 2024.

[10] H.H. Dwail et al., “CG Method with Modifying βk for Solving Unconstrained Optimization Problems,” Journal of Interdisciplinary Mathematics, vol. 25, no. 5, pp. 1347-1355, 2022.

[11] H.S. Habib and M.A.K. Shiker, “A Modified (CG) Method for Solving Nonlinear Systems of Monotone Equations,” Journal of Interdisciplinary Mathematics, vol. 27, no. 4, pp. 787-792, 2024.

[12] H.J. Kadhim, M.A.K. Shiker, and H.A. Hussein, “A New Technique for Finding the Optimal Solution to Assignment Problems with Maximization Objective Function,” Journal of Physics: Conference Series, vol. 1963, p. 012104, 2021.

[13] L.H. Hashim et al., “An Application Comparison of Two Negative Binomial Models on Rainfall Count Data,” Journal of Physics: Conference Series, vol. 1818, p. 012100, 2021.

[14] N.K. Dreeb et al., “Using a New Projection Approach to Find the Optimal Solution for Nonlinear Systems of Monotone Equation,” Journal of Physics: Conference Series, vol. 1818, p. 012101, 2021.

[15] L.H. Hashim et al., “An Application Comparison of Two Poisson Models on Zero Count Data,” Journal of Physics: Conference Series, vol. 1818, p. 012165, 2021.

[16] Z.S. Mahdi et al., “Solving Transportation Problems by Using Modification to Vogel’s Approximation Method,” AIP Conference Proceedings, vol. 2834, p. 080110, 2023.

[17] K.H. Hashim et al., “Solving the Nonlinear Monotone Equations by Using a New Line Search Technique,” Journal of Physics: Conference Series, vol. 1818, p. 012099, 2021.