Journal of Mathematics Technology and Education Vol. 1, No. 2, 2022 | 141 - 149

Journal of Mathematics Technology and Education

Analysis on ASM Method Perfomance in Solving Fuzzy Transportation Problems

Dini Putri Anggraini[1], Sawaluddin[2]

[1]*Student of Bachelor Degree, Department of Mathematics, Universitas Sumatera Utara*
[2]*Department of Mathematics, Faculty of Mathematics and Natural Sciences, Universitas Sumatera Utara, Medan, 20155, Indonesia*

Abstract. This study aims to show the performance of the ASM method on transportation problem. The transportation problem relates to the distribution of a product from several sources, with limited supply, to several destinations, with a certain demand, in order to obtain the minimum transportation costs. However, the amount of supply and demand cannot always be known with certainty and may change from time to time. In this paper, the coefficient of supply and demand uses fuzzy numbers and uses the ASM method to determine the optimal solution both to minimize costs and maximize profits. The result is that with the ASM method, the balanced transportation problem is always optimal, while the unbalanced transportation problem is not always optimal.

Keyword: Transportation Problem, Fuzzy, ASM Method.

Abstrak. *Penelitian ini bertujuan untuk memperlihatkan kinerja Metode ASM pada masalah transportasi. Masalah transportasi berhubungan dengan distribusi suatu produk dari beberapa sumber, dengan penawaran terbatas, menuju beberapa tujuan, dengan permintaan tertentu, untuk mendapatkan biaya transportasi minimum. Namun jumlah penawaran dan permintaan yang tidak selalu dapat diketahui dengan pasti dan dapat berubah-ubah dari waktu ke waktu. Pada penelitian ini koefisien jumlah penawaran dan permintaan menggunakan bilangan fuzzy dan menggunakan metode ASM untuk menentukan solusi optimal baik untuk meminimumkan biaya maupun memaksimalkan keuntungan. Diperoleh hasil bahwa dengan metode ASM pada masalah transportasi seimbang selalu optimal, sedangkan untuk masalah transportasi tidak seimbang tidak selalu optimal..*

Kata Kunci: *Masalah Transportasi, Fuzzy, Metode ASM*

Received 11 Nov 2021 | Revised 25 Nov 2021 | Accepted 20 Dec 2021

1. Introduction

Transportation Transportation is a special form of linear program that is used to solve problems related to transportation to minimize costs, mileage and so on so as to maximize profits.

*Corresponding author at: Department Mathematics, Faculty of Mathematics and Natural Sciences, Universitas Sumatera Utara, Medan, 20155, Indonesia

E-mail address: diniputrianggraini01@gmail.com, sawal@usu.ac.id

e-ISSN: xxxx-xxxx | DOI: 10.32734/jomte.v1i2.7618
Journal Homepage: https://talenta.usu.ac.id/jomte

Several parameters can be used in the transportation model, namely transportation costs, demand and supply values. There are cases that the coefficient of transportation costs, the quantity supplied and the quantity demanded of the transportation problem is uncertain due to several uncontrollable factors. To deal with the inaccuracy of information in making decisions, it is necessary to use fuzzy numbers on transportation costs, the amount of supply, and the number of demand.

The fuzzy transportation problem is a transportation problem where the transportation costs, the amount of supply and the amount of demand are uncertain (fuzzy)[1]. In this paper, in solving the fuzzy transportation problem using the ASM method. The ASM method is a transportation problem optimization method that directly tests the optimization of the transportation table. And ASM stands for the names of its inventors, [2] namely: Abdul Quddos, Shakeel Javaid, dan Mohd Masood Khalid.

2. Related Work

2.1. Transportation Problem

Transportation discusses the problem of distributing a commodity or product from source to destination, with the aim of minimizing the transportation costs incurred.

Transportation modeling is a problem of distributing a number of products or commodities from several distribution sources to several destinations by adhering to the principle of minimal distribution costs. In addition to finding the minimum distribution costs, transportation modeling can also be used to find the maximum gain/revenue from a commodity distribution strategy that has certain advantages.

Mathematically the transportation model can be formulated as follows ([3], [4], [5]) :

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

2.2. Fuzzy Transportation Problem

Fuzzy transportation problem is a transportation problem where the coefficient of transportation costs, supply, demand, or decision variables are fuzzy numbers [1].

2.3. Fuzzy Membership Function

The mathematical formulas of fuzzy membership functions are linear ascending and descending membership functions, Triangular membership functions, Trapezoidal membership functions, Shoulder shape membership functions, S shape membership functions, Bell Curve membership functions [1].

2.4. "New Approach" Method to Solve Problems Fuzzy Transportation to Linear Transportaion.

New Approach is a new approach method that is used to change fuzzy transportation to linear transportation. This method can be used in transportation problems with triangular and trapezoidal membership.

1. "New Approach" Method on Triangular Membership.
   Definisi:

   A fuzzy number is a triangular fuzzy number denoted by (δ, m, β) where δ, m dan β are real numbers.

   With the formula for Triangular membership [6],

$$M^{Tri}(A)=\frac{1}{4}[2m+\delta+\beta] \quad (2)$$

2. "New Approach" Method on Trapezoidal Membership
   Definisi:

   B fuzzy number is a trapezoidal fuzzy number denoted by (δ, m, n, β) where δ, m,n dan β are real numbers.

   With the formula for Trapezodial membership [6],

$$M^{Tra}(B)=\frac{1}{4}[m+n+\delta+\beta] \quad (3)$$

2.5. ASM Method to Solve Problems Fuzzy Transportation.

The ASM method is a transportation problem optimization method that directly tests the optimization of the transportation table. ASM stands for the names of its inventors, they are Abdul Quddos, Shakeel Javaid, dan Mohd Masood Khalid [2].

3. Metodology

The methodology of this research is as follows:

1. Explain about transportation problems.
2. Explain about fuzzy transportation problems.
3. Using examples of fuzzy transportation problems with triangular and trapezoidal membership functions with balanced and unbalanced transportation problems.
4. Change the fuzzy transportation equation into linear transportation with "New Approach" method to make it easier to solve fuzzy transportation problems.
5. Solving fuzzy transportation problems with the ASM method to get the minimum cost and easier because the ASM method only requires one stage of work, namely directly using the optimization stage.
6. Discuss the results.
7. Make conclusion

4. Result and Discussion

This section presents examples of balanced and unbalanced triangular and trapezoidal cases to prove the performance of the ASM method.

4.1. Case Example with Balanced Triangular Membership

An example of this case is obtained from the journal "Solution of Fuzzy Transportation Problems with Triangular Fuzzy Numbers using Rangking Function"(source: Internasional Journal of Pure and Applied Mathematics tahun 2018) [7].

$$[c_{ij}]_{4x4} = \begin{pmatrix} (5,10,15) & (5,10,20) & (5,15,20) & (5,10,15) \\ (5,10,20) & (5,15,20) & (5,10,15) & (10,15,20) \\ (5,10,20) & (10,15,20) & (10,15,20) & (5,10,15) \\ (10,15,25) & (5,10,15) & (10,20,30) & (10,15,25) \end{pmatrix}$$

With fuzzy offerings available at the source are (10, 15, 20), (5, 10, 15), (20, 30, 40), (15, 20, 25) and the fuzzy request available at the destination are (25, 30, 35), (10, 15, 20), (5, 15, 20), (10, 15, 25).

By using the ASM method to find the minimum value, the following results are obtained.

Table 1. Final Results of Fuzzy Transportation Problems with Triangular Membership**.**

Source	D_1	D_2	D_3	D_4	Penawaran
S_1	(5,10,15)	(5,10,20)	(5,15,20)	(5,10,15)	(10,15,20)
	(10,15,20)				
S_2	(5,10,20)	(5,15,20)	(5,10,15)	(10,15,20)	(5,10,15)
			(5,10,15)		
S_3	(5,10,20)	(10,15,20)	(10,15,20)	(5,10,15)	(20,30,40)
	(10,10,10)		(0,5,5)	(10,15,25)	
S_4	(10,15,25)	(5,10,15)	(10,20,30)	(10,15,25)	(15,20,25)
	(5,5,5)	(10,15,20)			
Permintaan	(25,30,35)	(10,15,20)	(5,15,20)	(10,15,25)	(50,75,100)

So, the minimum cost of the fuzzy transportation problem using the ASM method is 658

4.2. Case Example with Balanced Trapezoidal Membership

An example of this case is obtained from the journal "New Solution of Vector Fuzzy Transportation Problem in Interval Integer Form "(source: International Journal of Fuzzy Mathematics (IOSR-JM) tahun 2013) [8].

$$[c_{ij}]_{4x4}=\begin{pmatrix} (1,4,9,16) & (4,9,16,25) & (9,16,25,36) & (16,25,36,49) \\ (4,9,16,25) & (9,16,25,36) & (16,25,36,49) & (25,36,49,64) \\ (9,16,25,36) & (16,25,36,49) & (25,36,49,64) & (36,49,64,81) \\ (16,25,36,49) & (25,36,49,64) & (36,49,64,81) & (25,36,49,81) \end{pmatrix}$$

With fuzzy offerings available at the source are (36,49,64,81), (16,25,36,49), (4,16,25,36), (25,36,49,64) and the fuzzy request available at the destination are (25,36,49,64), (4,16,25,36), (16,25,36,49), (36,49,64,81).

By using the ASM method to find the minimum value, the following results are obtained.

Table 2. Final Results of Fuzzy Transportation Problems with Trapezoidal Membership

Source	D_1	D_2	D_3	D_4	Penawaran
S_1	(1,4,9,16)	(4,9,16,25)	(9,16,25,36)	(16,25,36,49)	(36,49,64,81)
	(25,46,49,64)	(1,3,4,6)			
S_2	(4,9,16,25)	(9,16,25,36)	(16,25,36,49)	(25,36,49,64)	(16,25,36,49)
		(4,6,7,8)	(23,25,26,27)		
S_3	(9,16,25,36)	(16,25,36,49)	(25,36,49,64)	(36,49,64,81)	(4,16,25,36)
			(4,6,7,8)	(1,3,4,6)	
S_4	(16,25,36,49)	(25,36,49,64)	(36,49,64,81)	(25,36,49,81)	(25,36,49,64)
				(25,46,49,64)	
Permintaan	(25,36,49,64)	(4,16,25,36)	(16,25,36,49)	(36,49,64,81)	(81,126,174,230)

So, the minimum cost of the fuzzy transportation problem using the ASM method is 4.420

4.3. Case Example with Unbalanced Triangular Membership

An example of this case is obtained from the journal "*Penyelesaian Biaya Fuzzy dalam Sistem Transportasi Fuzzy (Studi Kasus: CV. Anak Daro)*" (source: *Jurnal Sains Matematika dan Statistika tahun 2019*) [9].

$$[c_{ij}]_{3x4}=\begin{pmatrix} (300,350,400) & (400,450,500) & (350,400,450) & (350,450,500) \\ (400,500,550) & (500,550,600) & (450,550,600) & (400,450,500) \\ (450,500,600) & (550,600,650) & (500,600,650) & (500,550,650) \\ (550,600,650) & (600,700,750) & (550,650,700) & (600,700,750) \\ (0,0,0) & (0,0,0) & (0,0,0) & (0,0,0) \end{pmatrix}$$

With fuzzy offerings available at the source are (150,180,200), (200,250,300), (150,200,230), (200,230,250) and the fuzzy request available at the destination are (200,250,300), (150,180,230), (200,220,250),(1800,200,230).

By using the ASM method to find the minimum value, the following results are obtained.

Table 3. Final Results of Fuzzy Transportation Problems with Triangular Membership

Source	D_1	D_2	D_3	D_4	Penawaran
S_1	(300,350,400)	(400,450,500)	(350,400,450)	(350,450,500)	(150,180,200)
	(150,180,200)				
S_2	(400,500,550)	(500,550,600)	(450,550,600)	(400,450,500)	(200,250,300)
	(35,25,20)			(180,200,230)	
S_3	(450,500,600)	(550,600,650)	(500,600,650)	(500,550,650)	(150,200,230)
	(35,30,45)		(200,250,170)		
S_4	(550,600,650)	(600,700,750)	(550,650,700)	(600,700,750)	(200,230,250)
		(300,200,130)	(90,90,70)		
S_5	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(30,-10,30)
		(30,-10,30)			
Permintaan	(200,250,300)	(150,180,230)	(200,220,250)	(180,200,230)	(730,850,1010)

So, the minimum cost of the fuzzy transportation problem using the ASM method is 334.790

4.4. Case Example with Unbalanced Trapezoidal Membership

An example of this case is obtained from the journal "Fuzzy Transportation Problem of Trapezoidal Number with α-Cut and Ranking Technique"(source: International Journal of Fuzzy Mathematics and Systems tahun 2012) [10].

$$[c_{ij}]_{3x4} = \begin{pmatrix} (1,2,3,4) & (1,3,4,6) & (9,11,12,14) & (5,7,8,11) \\ (0,1,2,4) & (-1,0,1,2) & (5,6,7,8) & (0,1,2,3) \\ (3,5,6,8) & (5,8,9,12) & (12,15,16,19) & (7,9,10,12) \end{pmatrix}$$

With fuzzy offerings available at the source are (10, 15, 20), (5, 10, 15), (20, 30, 40), (15, 20, 25) and the fuzzy request available at the destination are (25, 30, 35), (10, 15, 20), (5, 15, 20), (10, 15, 25).

By using the ASM method to find the minimum value, the following results are obtained.

Table 4. Final Results of Fuzzy Transportation Problems with Trapezoidal Membership

Source	D_1	D_2	D_3	D_4	Penawaran
S_1	(1,2,3,4)	(1,3,4,6)	(9,11,12,14)	(5,7,8,11)	(1,6,7,12)
	(1,6,7,12)				
S_2	(0,1,2,4,)	(1,0,1,2,)	(5,6,7,8)	(0,1,2,3)	(0,1,2,3)
		(0,1,2,3)			
S_3	(3,5,6,8)	(5,8,9,12)	(12,15,16,19)	(7,9,10,12)	(5,10,12,17)
	(-2,1,2,3)	(2,3,5,6)	(1,3,4,6)	(1,2,3,4)	
S_4	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(2,0,0,-2)
Permintaan	(5,7,8,10)	(1,5,6,10)	(1,3,4,6)	(1,2,3,4)	(8,17,21,30)

So, the minimum cost of the fuzzy transportation problem using the ASM method is 134

5. Conclusion and Future Research

5.1. Conclusion

Based on the discussion in the previous chapter, it can be concluded that:

1. Balanced
   a. *Triangular* Membership
      From the journal "*Solution of Fuzzy Transportation Problems with Triangular Fuzzy Numbers using Rangking Function*" the transportation cost is ± 19% smaller than using the *Nortwest Corner Method*, *Least Cost Method*, *Vogel's Approximation Method* and MODI/*Stepping Stone*.
   b. *Trapezoidal Membership*
      From the journal "*New Solution of Vector Fuzzy Transportation Problem in Interval Integer Form*" the transportation cost is ± 44 % smaller than using the *Vogel's Approximation Method.*
2. Unbalanced
   a. *Triangular Membership*
      From the journal "Penyelesaian Biaya *Fuzzy* dalam Sistem Transportasi *Fuzzy* (Studi Kasus: CV. Anak Daro)" the transportation cost is ± 15 % smaller than using the *Least Cost Method.*
   b. *Trapezoidal Membership*

From the journal "*Fuzzy Transportation Problem of Trapezoidal Number with α-Cut and Ranking Technique*" the transportation cost is ± 9% bigger than using the *Vogel's Approximation Method.*

5.2. Future Research

The following are suggestions from the research that has been done:

1. The ASM method for unbalanced transportation does not always result in a minimum cost. Where the membership function is balanced and unbalanced.
2. "New Approach" method only applies to fuzzy transportation problems with triangular and trapezoidal membership functions. Where the fuzzy membership function is not limited to the two membership functions.

REFERENCES

[1] Kusumadewi S, Purnomo H, 2010. *Aplikasi logika Fuzzy untuk Pendukung Keputusan*. Edisi Kedua. Graha Ilmu. Yogyakarta.

[2] Quddos A, Shakeel J, Khalid MM, 2012. A New Method for Finding an Optimal Solution for Transportation Problems. *International Journal on Computer Science and Engineering*, 4: 1271-1274.

[3] Sitorus P, 1997. *Program Linier.* Universitas Trisakti. Jakarta.

[4] Siang JJ, 2014. *Riset Operasi dalam Pendekatan Algoritmis Edisi 2*. AndiOffset. Yogyakarta.

[5] Murugan P, Roohini M, 2017. Solving Transportation Problem Using Maximization Case in Vogel's Approximation Method. *International Journal of Scientific Research in Science Engineering and Technology,* 3:6.

[6] Basirzadeh H, 2011. An Approach for Solving Fuzzy Transportation Problem. *Applied Mathematical Sciences*, 5: 1549 – 1566.

[7] Kumar M, Ramesh, Subramanian S, 2018. Solution of Fuzzy Transportation Problems with Triangular Fuzzy Numbers using Ranking Function. *Internasional Journal of Pure and Applied Mathematics*, 119: 2669-2682.

[8] Jahirhussain J, Jayaraman P, 2013. New Solution of Vector Fuzzy Transportation Problem in Interveal Integer Form. *IOSR Journal of Mathematics (IOSR-JM),* 9: 47-51.

[9] Basriati S, Safitri E, Riafan R, 2019. Penyelesaian Biaya *Fuzzy* dalam Sistem Transportasi *Fuzzy* (Studi Kasus : CV. Anak Daro). *Jurnal Sains Matematika dan Statistika,* 5:2460-4542.

[10] Poonam, Shugani, Abbas, Gupta VK, 2012. Fuzzy Transportation Problem of Trapezoidal Number with α- Cut and Ranking Technique. *International Journal of Fuzzy Mathematics and Systems*, 2: 263-267.