

Comparison Between Zero Point and Zero Suffix Methods in Fuzzy Transportation Problems

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Abstrak: Persoalan transportasi membahas tentang masalah pendistribusian suatu barang dari sejumlah sumber kepada sejumlah tujuan dengan tujuan meminimumkan biaya pengangkutan. Masalah transportasi fuzzy merupakan biaya transportasi, persediaan dan permintaan dengan kuantitas jumlah fuzzy. Tujuan dari penelitian ini adalah untuk mempelajari komparasi teoritis dan numerik antara metode zero-point dan metode zero suffix dalam menentukan solusi optimal pada biaya pengangkutan barang. Berdasarkan hasil komparasi didapatkan iterasi pada metode zero-point lebih besar dalam mencapai nilai optimal dibandingkan dengan metode zero suffix. Berdasarkan hasil perbandingan teoritis dapat disimpulkan bahwa proses menggunakan metode zero-suffix lebih pendek dalam menentukan solusi optimal yaitu 6 langkah daripada metode zero-point yaitu 11 langkah. Untuk mencapai nilai optimal menunjukkan bahwa, untuk metode zero suffix terjadi iterasi pada langkah keenam, namun untuk metode zero-point iterasi terjadi pada tahap kesembilan. Hasil perbandingan numerik, kami menyimpulkan biaya distribusi dengan menggunakan dua metode adalah sama, berdasarkan permintaan dan penawaran diperoleh 7 kali iterasi dan 7 item alokasi untuk metode zero point, sedangkan 6 kali iterasi dan 7 item alokasi untuk metode zero suffix.

Kata Kunci: Metode zero-point; Metode zero-suffix; Masalah transportasi fuzzy

Abstract: Transportation is discussing the problems of distribution items from a source to a destination with an aim to minimize transportation costs. The problem of fuzzy transport is the cost of transportation, supply, and demand with a quantity of fuzzy. The purpose of the research is a study of a comparison of theories from the zero-point method and the zero-suffix method in determining the optimal solution on cost transportation. Based on the result of the theoretical comparison, it can be concluded that the process of using the zero-suffix method is shorter in determining an optimal solution in 6 steps than that of a zero-point method in 11 steps. For achieving the optimal value shows that for zero-suffix the method of occurrence iteration in the sixth step, but for the zero-point method the iteration occurs in the ninth step. The results in the numerical comparison we conclude the distribution cost using two methods is the same, based on the demand and supply obtained 7 times iteration and 7 items allocation for zero point method, while 6 times iteration and 7 items allocation for zero suffix method.

Keywords: Zero-point method; Zero-suffix Method; Fuzzy transportation problems

1. Introduction

Many applications have in solving problems in everyday life. The parameters of the transportation problem consist of the amount of costs, supply, and demand [1]. Conditions that occur in the field of transportation problems of the value of an item often occur uncertainty and tend to change from time to time. This happens because, lack of information data related to the value of these problems [2]. Based on Zadeh introduces theory fuzzy and problems fuzzy that have been studied in relation to daily life [3]-[4]. The problem of transportation fuzzy is the amount of costs, supply, and demand of value fuzzy [5]-[6]. One method used for transportation problems fuzzy is the zero-point method and the method zero suffix to find the optimal solution for transportation costs.

Based on research conducted by Annie Christi MS and Kumari Shoba. K gives the conclusion that using the robust ranking method with the zero-suffix method gets the optimal solution of the fuzzy problem accurately and effectively [7]. In the following year research Chandrasekaran, S, et al concluded that the transportation problem fuzzy using a heptagon fuzzy number with the zero-suffix method obtained optimal solutions in solving problems fuzzy [8]. Fegade, et al about the method, zero suffix it was concluded that the optimal solution by changing the problem fuzzy to crisp using the method robust ranking so that the total fuzzy cost becomes optimal and more effective based on the example of the problem fuzzy [9]. This research was supported by Nirmala. G and Anju R in their research concluded that the zero-suffix method produces an optimal solution with few iterations in transportation problems [10].

Based on research on the zero point method by Ismail Mohideen, S and Senthil Kumar P conclude that using the method zero point in multiplication operations is better than the Vogel's Approximation method and the method modified distribution in the distribution problem fuzzy [11]. P. Pandian and G. Natarajan, it is concluded that the zero-point method provides the optimal value of the objective function with the number fuzzy trapezoid for transportation fuzzy [12]. Subsequent research carried out by Pukky Tetralian, et al concluded that the results of research on CV. Bintang Elektrik Grace associated with transportation problems fuzzy obtained optimal solutions that the zero point method and zero suffix method are the same but in terms of the number of iterations the method zero point is greater in achieving the optimal solution [13]. This is in line with Samuel's research, Edward concluded that the method was improved zero point is an efficient and better method than the VAM, SVAM, GVAM, RVAM, BVAM methods in achieving optimal solutions to the transportation problem fuzzy [14]. Sharma Gaurav et al in his research concluded that the method zero point is a symmetrical procedure for transportation problems that is easily applied and utilized for all types of transportation problems with objective functions in the form of maximum or minimum values, to make decisions when there are various types of logistical problems and provide optimal solutions to transportation problems [15]. L. Sujatha, P. Vinothini and R. Jothilakshmi conclude that the procedure developed in this paper provides the optimal fuzzy solution and the optimal fuzzy objective value which are non-negative fuzzy numbers, hence the method developed, serve as an important tool for the decision maker while handling the transportation problem under fuzzy environment [16]. P. K Senthil conclude that obtained an optimal solution to the type-2 IFTP without using the basic feasible solution and the method of testing optimality. The main advantage of this method is that the obtained solution is always optimal, and it is not required to have $(m + n - 1)$ allotted entries. In feature, the proposed method may be modified to find intuitionistic fuzzy optimal solution of solid intuitionistic fuzzy transportation problems and solid assignment problems with IFNs [17]-[18].

The purpose of this research is to study the theoretical and numerical comparisons of transportation problems fuzzy with the zero-point method and zero suffix method.

2. Methods

Following are different theoretical and numerical comparisons obtained from the zero-point method and zero suffix method.

2.1. Methods north west corner

The methods North West Corner used to calculate solution a feasible of the transportation problem. Following are the steps to get a solution feasible [19].

Step 1:

Allocate and select cells in the upper left corner on transportation issues. This cell must be allocated as many units as possible. the unit must be the same as the minimum requirements between demand and available inventory.

Step 2:

The next step is to adjust the number of requests and supplies in the allocated row and column. The first cell in the second row will only continue, if the first row's supply has run out. Likewise, the next cell in the second column will also be continued with the condition that the request for the first cell has been fulfilled.

Step 3:

For allocated cells, each supply of cells is equal to demand, the next allocation can be made in the next row or column. This procedure is repeated until the full allocation of the number of successful units according to the cells in need.

2.2. Methods zero point [20]

Step 1:

Establish a transport table fuzzy transport problem fuzzy is then converted into transport table fuzzy balanced if it is not balanced.

Step 2:

Reduce each row in the transportation table fuzzy from the minimum row.

Step 3:

Reduce each column in the transportation table results fuzzy in step 2 of the minimum column.

Step 4:

Check if each column is fuzzy demand (b_j) less than the total fuzzy inventory (a_i) resulting from cost reduction in the zero-value column. Also check if each line is fuzzy in inventory (a_i) less than the number of columns fuzzy request (b_j) where row reduction is zero ($c_{ij} = 0$). If fulfilled, continue to step 7. If it is not met, then go to step 5.

Step 5:

Closing the minimum value with horizontal lines and vertical lines that are zero from the reduction results of the transportation table fuzzy so that some rows or columns that do not meet the requirements in step 4 are not closed.

Step 6:

Form a transportation improvement table fuzzy follows:

- Find the smallest value from the reduction w_{ij} of the cost matrix fuzzy that is not covered by a line.
- Subtract the smallest reduced cost w_{ij} to all costs c_{ij} that are not covered and add costs c_{ij} covered by two intersection lines, then return to step 4.

Step 7:

Selecting the reduction cell in the transportation table fuzzy that has the largest reduced cost, is called (α, β) . If there are more than one cell, then choose just one.

Step 8:

Select cells in the row - α or column - β in the reduced transportation table fuzzy- in which the cost-reduction cell is zero $c_{ij} = 0$ and the maximum allocation to the cell. If the cell does not appear at the maximum value, find another maximum value so that the other maximum values will be met. If there is no value in the cell that appears, in the transportation table fuzzy reduced the reduction cost is zero.

Step 9:

Reform the transportation table fuzzy after it is deleted in the supply row and demand column.

Step 10:

Repeat steps 7 through 9 until inventory fuzzy and demand fuzzy are fulfilled.

Step 11:

Allocation produce solutions fuzzy on transportation fuzzy matters.

2.3. Method zero suffix [21]-[22]

Step 1:

Build a transportation table.

Step 2:

Subtract each row entry from the transportation table from the corresponding minimum row after that subtract each column entry from the transportation table to the appropriate minimum column.

Step 3:

In the cost matrix there will be at least one zero in each row and column, then look for suffix values that are denoted by S. S = Add cost from the nearest side zero which is greater than zero/ additional cost

Step 4:

Select the maximum value of S, if it has one maximum value. if you have two or more of the same value then choose one, then the cost becomes the allocation of goods with due regard to demand and supply.

Step 5:

After step 4, select the minimum $\{a_i, b_j\}$ then allocate it to the transportation table. The resulting table must have at least one cost worth 0 in each row and column, otherwise repeat step 2.

Step 6:

Repeat step 3 through step 5 until the optimal cost is obtained. optimal cost is obtained if the column or row is saturated (suffix values = 0).

3. Results and Discussions

3.1. Theoretical comparison of zero-point method and zero suffix method

Step 1 of the two methods is in the first step of the two methods forming the transportation table into a transportation fuzzy balanced, so zero suffix method and zero-point method have the same steps in step 1.

Step 2 of the two methods is to reduce rows and columns by reducing the minimum value in zero suffix method while zero point method in step 2 only reduces rows, so in step 2 method zero suffix has occurred in column and row reduction.

Next step 3 of the two methods is the zero suffix method there will be at least one zero in rows and columns to get the suffix value (S) while zero point method reduces the column, so zero suffix method in step 3 looks for the value suffix and zero point only reduces column.

Step 4 of the two methods is zero suffix method with the maximum S value being the allocation of goods by taking into account the amount of supply and demand and zero point method checks each column with the condition that demand is less than inventory and checks the row with the condition that inventory is less than demand on the row and column zero value, so zero suffix method selects the maximum S value and zero point method checks the supply and demand requirements.

While step 5 of the two methods is zero suffix method the minimum inventory or demand is selected and then allocated to the transportation table. While zero point method closes the minimum horizontal and vertical rows or columns that are not met in step 4 are not covered, so zero suffix method in step 5 will go to the iteration process and zero point method meets the requirements of step 4.

Step 6 of the two methods is zero suffix method is iterated to get the optimal value where all column or row values are zero. while zero point method still performs a transportation improvement table with several iterations until each column with the condition that demand is less than inventory and rows with the condition that inventory is less than demand on rows and columns has zero value, so that step 6 zero suffix method has occurred iterating and zero point method is still form a repair table.

Next step 7 to step 11 zero-point method is iterated to get the optimal solution value.

3.2. Numerical Comparison of the zero-point method and zero suffix method

Following is a numerical example of fuzzy transportation problem:

Table 1. Transportation Fuzzy Full

From To		Destination					Inventory
		1	2	3	4	5	
Source	1	(5,7,8,11)	(1,6,7,12)122	(2,4,5,7)	(2,5,7,9)	(7,9,10,12)	(20,35,45,60)
	2	(5,8,9,12)	(2,5,7,9)	(1,6,7,12)	(5,7,8,11)	(5,8,9,12)	(15,25,35,45)
	3	(1,6,7,12)	(5,8,9,12)	(7,9,10,12)	(1,6,7,12)	(2,5,7,9)	(10,15,25,30)
	4	(2,5,7,9)	(5,7,8,11)	(5,7,8,11)	(5,8,9,12)	(1,6,7,12)	(5,8,12,15)
Demand		(15,25,25,45)	(15,25,35,45)	(8,14,16,22)	(10,15,25,30)	(2,4,6,8)	

From transportation problems fuzzy, then changed to the transportation problem crisp using robust ranking method [23].

$$R(\tilde{A}) = \int_0^1 (0,5)(\alpha_\alpha^L, \alpha_\alpha^U) d\alpha$$

Where:

$$\alpha_\alpha^L, \alpha_\alpha^U = \{(a_2 - a_1)\alpha + a_1, a_4 - (a_4 - a_3)\alpha\}$$

$$R(\tilde{c}_{11}) = R(5, 7, 8, 11)$$

$$= \int_0^1 (0,5)(2\alpha + 5 + 11 - 3\alpha) d\alpha$$

$$= \int_0^1 (-0,5\alpha + 8) d\alpha$$

$$= 7,75$$

So that:

$$R(\tilde{c}_{12}) = 6,5, R(\tilde{c}_{13}) = 4,5,$$

$$R(\tilde{c}_{14}) = 5,75 R(\tilde{c}_{15}) = 9,5$$

$$R(\tilde{c}_{21}) = 8,5, R(\tilde{c}_{22}) = 5,75,$$

$$R(\tilde{c}_{23}) = 6,5, R(\tilde{c}_{24}) = 7,75, R(\tilde{c}_{25}) = 8,5$$

$$R(\tilde{c}_{31}) = 6,5, R(\tilde{c}_{32}) = 8,5, R(\tilde{c}_{33}) = 9,5$$

$$R(\tilde{c}_{34}) = 6,5, R(\tilde{c}_{35}) = 5,75$$

$$R(\tilde{c}_{41}) = 5,75, R(\tilde{c}_{42}) = 7,75, R(\tilde{c}_{43}) = 7,75$$

$$R(\tilde{c}_{44}) = 8,5, R(\tilde{c}_{45}) = 5,75$$

Inventory column:

$$R(\tilde{a}_{11}) = 40, R(\tilde{a}_{12}) = 30,$$

$$R(\tilde{a}_{13}) = 20, R(\tilde{a}_{14}) = 10$$

Request line:

$$R(\tilde{b}_{11}) = 30, R(\tilde{b}_{12}) = 30, R(\tilde{b}_{13}) = 15,$$

$$R(\tilde{b}_{14}) = 20, R(\tilde{b}_{15}) = 5$$

Next, enter table transportation crisp.

Table 2. Transportation Crisp

To \ From		Destination					Inventory
		1	2	3	4	5	
Source	1	7,75	6,5	4,5	5,75	9,5	40
	2	8,5	5,75	6,5	7,75	8,5	30
	3	6,5	8,5	9,5	6,5	5,75	20
	4	5,75	7,75	7,75	8,5	6,5	10
Demand		30	30	15	20	5	

From table 2, we get the total inventory and demand:

$$\sum_i^m \tilde{a} = 100$$

$$\sum_j^n \tilde{b} = 100$$

Can be concluded that $\sum_i^m \tilde{a} = \sum_j^n \tilde{b}$, So the transportation problem is balanced.

Next calculate the solution feasible using north west corner method

Table 3. Solution feasible method north west corner

To \ From		Destination					Inventory
		1	2	3	4	5	
Source	1	7,75 (30)	6,5 (10)	4,5	5,75	9,5	-
	2	8,5	5,75 (20)	6,5 (10)	7,75	8,5	-
	3	6,5	8,5	9,5 (5)	6,5 (15)	5,75	-
	4	5,75	7,75	7,75	8,5 (5)	6,5 (5)	-
		-	-	-	-	-	

Thus, transportation total costs

$$= 7,75(30) + 6,5(10) + 5,75(20) + 6,5(10) + 9,5(5) + 6,5(15) + 8,5(5) + 6,5(5)$$

$$= 697,5.$$

Then the optimal solution will be calculated using zero-point method.

Table 4. Optimal solutions for zero-point method

To \ From		Destination					Inventory
		1	2	3	4	5	
Source	1	7,75 (5)	6,5	4,5 (15)	5,75 (20)	9,5	40
	2	8,5	5,75 (30)	6,5	7,75	8,5	30
	3	6,5 (15)	8,5	9,5	6,5	5,75 (5)	20
	4	5,75 (10)	7,75	7,75	8,5	6,5	10
Request		30	30	15	20	5	

Allocation from the method is obtained zero-point,

$$x_{11} = 5, x_{13} = 15, x_{14} = 20$$

$$x_{22} = 30, x_{31} = 15, x_{35} = 5$$

$$x_{41} = 10$$

so that the minimum transportation cost is to

$$\begin{aligned}
 Z &= \sum_i^m \sum_j^n c_{ij}x_{ij} \\
 &= c_{11}(x_{11}) + c_{13}(x_{13}) + c_{14}(x_{14}) + c_{22}(x_{22}) + c_{31}(x_{31}) + c_{35}(x_{35}) + c_{41}(x_{41}) \\
 &= 7,75(5) + 4,5(15) + 5,75(20) + 5,75(30) + 6,5(15) + 5,75(5) + 5,75(10) \\
 &= 577,5
 \end{aligned}$$

Calculate the optimal solution using zero suffix method.

Table 5. Optimal solutions to zero suffix method

To \ From		Objective					Inventory
		1	2	3	4	5	
Source	1	7,75 (5)	6,5	4,5 (15)	5,75 (20)	9,5	40
	2	8,5	5,75 (30)	6,5	7,75	8,5	30
	3	6,5 (15)	8,5	9,5	6,5	5,75 (5)	20
	4	5,75 (10)	7,75	7,75	8,5	6,5	10
Requests		30	30	15	20	5	

Allocation is obtained from the method zero suffix:

$$x_{11} = 5, x_{13} = 15, x_{14} = 20$$

$$x_{22} = 30, x_{31} = 15, x_{35} = 5$$

$$x_{41} = 10$$

Thus, the minimum transportation cost is:

$$\begin{aligned}
 Z &= \sum_i^m \sum_j^n c_{ij}x_{ij} \\
 &= c_{11}(x_{11}) + c_{13}(x_{13}) + c_{14}(x_{14}) + c_{22}(x_{22}) + c_{31}(x_{31}) + c_{35}(x_{35}) + c_{41}(x_{41}) \\
 &= 7,75(5) + 4,5(15) + 5,75(20) + 5,75(30) + 6,5(15) + 5,75(5) + 5,75(10) \\
 &= 577,5
 \end{aligned}$$

From the results of the comparison of zero-point methods and zero suffix methods then arranged into a table:

Table 6. Comparison Results of Zero-Point Method and Zero Suffix Method

Method Name	The number of iterations	Allocation	Optimum Solution
Zero Point method	7	$x_{11} = 5, x_{13} = 15,$ $x_{14} = 20, x_{22} = 30,$ $x_{31} = 15, x_{35} = 5,$ $x_{41} = 10$	577,5
Zero suffix method	6	$x_{11} = 5, x_{13} = 15,$ $x_{14} = 20, x_{22} = 30,$ $x_{31} = 15, x_{35} = 5,$ $x_{41} = 10$	577,5

4. Conclusions

The results of the comparison of zero point and zero suffix methods concluded that in the sixth step the theoretical comparative zero suffix method, has happened iteration while the method in the ninth step just iterates so that zero point method is greater in achieving optimal values than zero suffix method. In numerical comparison the number of allocations and optimal solutions in both methods is equal, while the number of iterations of zero-point method is greater than the zero-suffix method.

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