Solve the Fuzzy Transport Problems (FTP) to Reduce Transport Costs Using a Modern Method (An Empirical Study)

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Abstract- Transport models are operational research applications that are interested in finding an optimal transport plan with the lowest costs for a group of its production centres and a range of demand or consumption centres. Being play an essential role "in the process of optimal decision-making in the enterprise resource planning on a scientific basis, that based on analysis and research, the utility of quantitative and operational research considers a valuable tool to attain optimal decisions to transport goods from their sources to those who request them at the lowest possible cost of transport,[1] In order to make the right decision, we will use the fuzzy logic theory to deal with the fuzzy transport models using the (Al Rank) method, as well as a proposed recent algorithm then compare this method by using the Winqsb program to solve the fuzzy transport problem. And this method has been applied by the Middle Refineries Company, one of the companies of the Ministry of Oil that the data signifies of a fuzzy nature, which is an easy method to understand the application to solve the problems of fuzzy transport and contribute in making decisions to decision makers.
Keywords: Fuzzy Transportation, Al Rank Method, Winqsb.

Research problem

Actually, the oil sector is one of the most important sectors in the country and the region, and it has considered one of the most essential resources of the country in economic terms for its great role in achieving an important financial resource for the State of Iraq, the choice of dealing with this aspect has a significant impact on the Iraqi economy and efforts are made to develop production, transport and refining of oil derivatives. Therefore, the problem of research is find an optimal solution to transfer oil products from the main refineries to the provinces which requesting the product because the General Company for the distribution of oil products suffer from this problem in general. Consequently, data acquisition encountered the problem of fuzzy data because the actual cost of transport in the company was not determined due to many circumstances and because of the urgent need for the product, so that the percentage of demand varied by the consumer. And to adopt the transfer of the product on trucks (tanks) And the accompanying process of transport problems of high costs, in addition to traffic accidents and fire and the inability to determine the real cost of transport of the products, so it was used to manage the fuzzy logic in the transport model to achieve the objective of this research.

The importance of research is shown by the importance of decision-making in various sectors and establishments, especially those characterized by the huge and complexity of its internal system, which affects the decision-making process of decision-makers, in particular, which provides operational research and decision-making to reach the facility to the optimal decision at the lowest cost.

Research object

The aim of the research is to solve a fuzzy transport model that meets the following objectives:

1- Decreasing the cost of transportation of the Central Refinery Company / Ministry of Oil.

2- Determine the optimum quantities transferred from the main warehouses of the Central Refineries Company to the governorates requesting the product.

Research limits

The research limits are divided into the following:

a. Spatial limitations: are those related to the company in subject research, the Central Refineries Company, one of the Ministry of Oil formations.

B. Time Limits: The duration of the data obtained from the company and processing and then obtain and analyse the results starting from 1/1/2018 until 1/6/2018.

1. Introduction

The applications of linear programming in the practical and substantive aspects are limited to the application of Assuming the state of certainty, but under the technological development there are several uncertain and non-specific cases, so the fuzzy programming has become more effective to address and represent the scientific

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Article History: Received: Aug 15, 2018, Revised: Sep 10, 2018, Accepted: Oct 04, 2018

reality. So the concept of Fuzzy sets and models of decision making was proposed by Bellman and Zadeh. The concept was adopted in Tanaka's linear programming problems in the fuzzy model of multi-purpose linear programming problems. While the formulation of the problem of linear fuzzy programming was formulated by Nagoita with ambiguous coefficients called Robust Programming [2]. Therefore, the research looking for giving a comprehensive picture of the fuzzy linear programming because of the lack of Arab research and resources. Where the fuzzy programming was used to solve the problem of transporting the black oil product (fuel oil) from the main warehouses of the Central Refineries Company to the product requesters (governorates) and using the Al Rank method to handle fuzzy data.

The research methodology is as follows

First: "The theoretical side contains the theoretical concept of the fuzzy set.

second: The problem of the fuzzy transport of the central refinery company, one of the formations of the Ministry of Oil using the fuzzy set has been the process of processing data in the Al Ranks method, while the section includes the treatment of the problem of fuzzy transport and solve it to get the optimal solution.

Third: The most important conclusions and recommendations have been obtained by research for the purpose of benefiting from it by researchers and specialists in this field in the future.

2. Theoretical Side

1. The Logic and Fuzzy theory

Fuzzy logic is one of the forms of logic that has been used in systems and application artificial intelligence, which is a profoundly efficient technology to find solutions to the problems of application and has a clear influence in decision-making in solving the various problems facing decision-makers, including researchers due to inaccuracies, which leads to mistakes in determining the objectives inquired by decision makers , And through applying this logic, specific conclusions are obtained from ambiguous data in contrary to "classical logic Which requires the determination of the numerical values of the system and thus the fuzzy logic is a type of multi-value logic and a system of concepts used in the methods of accurate conclusion. This logic was created in 1965 by the Iranian scientist Lutfi Zadeh. Where he developed it as the best method of data processing, that aims to present mathematical functions which at the beginning were used at mathematical rules and statistical methods, after that the mathematical rules and statistical methods were combined together. There are several reasons that inspired scientists to develop this logic furthermore with the evolution of modern technology the fuzzy logic has become one of the theories that the modern theories have been built on [3] Fuzzy logic has been used in all types of applications such as neural networks, manufacturing processes, etc. because of its great importance in decision making to choose the optimal solution to the problem [4], And in order to have more flexibility to reach the optimal solution, it was necessary to resort to the use of some mathematical models with a fuzzy shape that is the optimal method in addressing such type of problems [3].

2. The fuzzy set

The classical or traditional set a (crisp set), it is a set with clear milestones of elements, i.e. a countable set and specific, it takes one of the two variable (0,1). When the element belongs to the set, it takes (1), but when the element doesn't belong to the set it takes (0) as shown in the following figure:

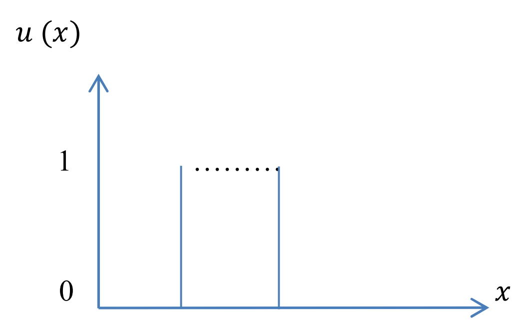

Fig. 1. classical (traditional) set

The fuzzy set allows partial affiliation, so the traditional set is a special case or a partial set of the fuzzy set. This can be represented as follows: [6]

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Article History: Received: Aug 15, 2018, Revised: Sep 10, 2018, Accepted: Oct 04, 2018

Fig. 2 .the partial affiliation to the fuzzy set

The fuzzy set was defined as a set of arranged pairs and it is ($A^{\sim}$) with the grade of membership $u_{A^{\sim}}$ the grade of membership function ranging between [0, 1]. And it's been varying values between (0) and (1). If the element associates to the set with high grade so its belonging equal to (1) and when its grade belonging equal to (0) this means that the element doesn't belong to the set, when the grade of membership to the set is equal to (0.9) or (0.8) this means the grade of element membership is high where the grade of membership of the element equal to (0.5) this is meant that the grade of belonging or not belonging to the set is equivalent. While if the grade of element membership is less that (0.5) this refers that the elements belonging to the set is weak [7]. In 1988 Zimmerman defined the fuzzy sets accurately, if x contributes a set of elements and symbolized with x, where the (A) is a fuzzy set in X which represents pair of ordered sets , when the fuzzy set is defined as $A^{\sim}$ so that :

$$A^{\sim} = \{(u_{A^{\sim}}(xi), (xi))\} \qquad i=1,2,\ldots\ldots,n \qquad (1)$$

where $\mu_{\tilde{A}}(xi) \in [0, 1]$

It could be performed the fuzzy set with the following figure:

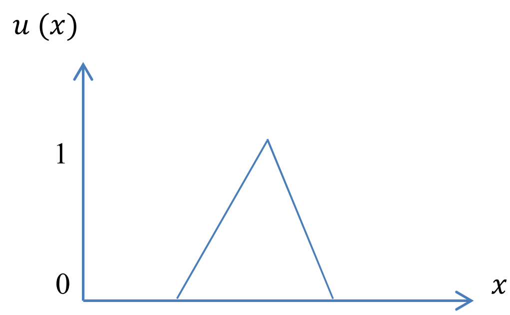

Fig. 3. a fuzzy set

3. Types of function membership liner

A. Triangular membership function

It's a function member ship liner with three figures with a line shape, when it be (8):

$$A^{\sim} = (a, b, c)$$

It could be said that $A^{\sim}$: represents a tringle fuzzy number and we can express the function above by the following equation

$$\mu_A(x) = \begin{cases} \frac{x-a}{b-a} & if \quad a \le x < b \\ 1 & if \quad x = b \\ \frac{c-x}{c-b} & if \quad b < x \le c \\ 0 & if \quad otherwise \end{cases} \qquad \ldots\ldots \quad (2)$$

Where:

A: represents the minimum edge

B: represents the centre value

C: represents the maximum edge

$\mu_A(x)$ the grade of (x) membership which is ranging between [0,1]

It can be explained the function by the following figure:

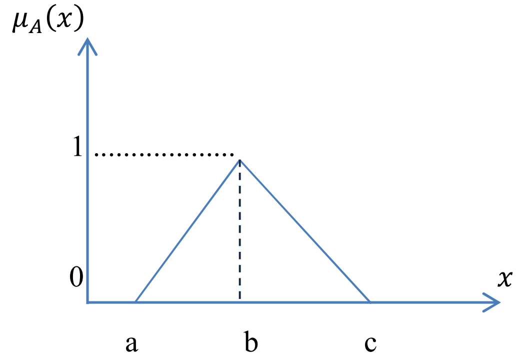

Fig. 4. Triangular membership function

B. Trapezoidal Function It's a function member ship liner with four figures $A^{\sim}$ *represents four shapes to the fuzzy number*, where (9) :

$$A^{\sim} = (a, b, c, d)$$

$$\mu_A(x) = \begin{cases} \frac{x-\mathrm{a}}{\mathrm{b}-\mathrm{a}} & if \quad \mathrm{a} \le x < \mathrm{b} \\ 1 & if \quad \mathrm{b} \le x \le \mathrm{c} \\ \frac{\mathrm{d}-x}{\mathrm{d}-\mathrm{c}} & if \quad \mathrm{b} \le x < \mathrm{c} \\ 0 & if \quad otherwise \end{cases} \quad \dots (3)$$

It can be performed by the following figure

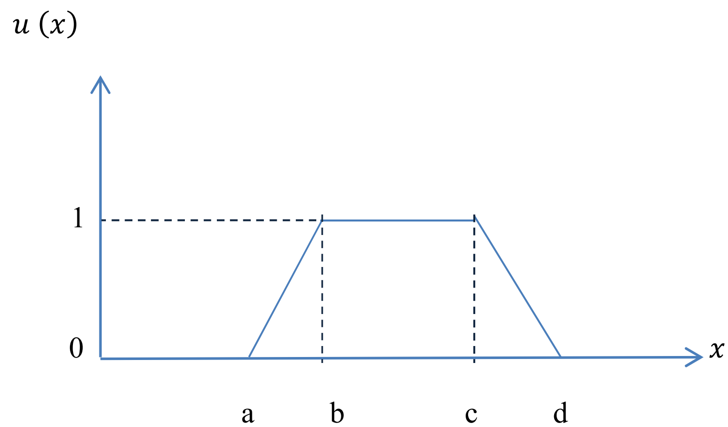

Fig. 5. is show Trapezoidal Function

4. operations on triangular intuitionistic fuzzy number [10]

We have two sets of fuzzy numbers $A^{\sim}$, $B^{\sim}$ where are described respectively :

$$A^{\sim} = (a_1, a_2, a_3, a_4)$$
$$B^{\sim} = (b_1, b_2, b_3, b_4)$$

Therefore, it can do the essential mathematical operations on the fuzzy numbers (addition, subtraction, multiplication) and what follows of procedures as in (11) :

1.Addition

$A^{\sim} + B^{\sim} = (a_1, a_2, a_3, a_4) + (b_1, b_2, b_3, b_4)$

$= [\ a_1 + b_1, a_2 + b_2, a_3 + b_3,\ a_4 + b_4]$

2. subtraction

$A^{\sim} - B^{\sim} = (a_1, a_2, a_3, a_4) - (b_1, b_2, b_3, b_4)$

$= [\ a_1 - b_4, a_2 - b_3, a_3 - b_3,\ a_4 - b_1]$

3. multiplication

$A^{\sim} * B^{\sim} = (a_1, a_2, a_3, a_4) * (b_1, b_2, b_3, b_4)$

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Article History: Received: Aug 15, 2018, Revised: Sep 10, 2018, Accepted: Oct 04, 2018

$= [\ a_1 * b_4, a_2 * b_3, a_3 * b_3,\ a_4 * b_1\ ]$

4. Scalar multiplication (12)

$$k\ (a_1, a_2, a_3, a_4\ ) \quad = \quad (ka_1, ka_2, ka_3, k\, a_4\ )$$

5. the fuzzy number is called not negative if $\boldsymbol{A^{\sim} > 0}$

, zero if $A^{\sim} = 0$

, equivalence if $A^{\sim} = B^{\sim}$

Where is (12) :

a_1 :represents the first number in the first set

a_2 : represents the second number in the first set

a_3 : represents the third number in the first set

a_4 : represents the fourth number in the first set

b_1 : represents the first number in the second set

b_2 : represents the second number in the second set

b_3 : represents the third number in the second set

b_4 : represents the fourth number in the second set

5. The method of solving the problem of fuzzy transport (9)

There are various methods have proved its efficiency in solving the fuzzy transport problem, most researches and articles attempt to develop a model of solution to the fuzzy transport problem. The Rank Function One of the most important techniques that have been used in finding the solutions to the complex transport problems, because it is characterized by a specific criterion aims to find the optimal solution by transforming the problem from fuzzy to non-fuzzy, that most of the realistic world problems happen in ambiguity circumstances , and this make the task of decision maker difficult most of time , especially during determining the main goal in miss obvious states, for that the Rank method contributed in dealing with these circumstances to get to the optimal solution for this problem because it consider one of the important tools to deal with [13].

Rank Function Method

It's a method used to manipulate the fuzzy number and transfer them to ordinary numbers through the equation that have used the Rank function to get the following result [14]

That the set of fuzzy number is F(R)

$$(a, b, c, d) \quad \in \quad F(R)$$

$$R: F(R) \longrightarrow R$$

Whereas F (R) a Rank function represent a set of all fuzzy numbers on a true line number

$(R^{\sim}) = (a + b + c + d)/4$

Two sets with a fuzzy number $A^{\sim}$, $B^{\sim}$ (10):

$A^{\sim} = (a_1, a_2, a_3, a_4)$

$B^{\sim} = (b_1, b_2, b_3, b_4)$

i) $A^{\sim} \leq B^{\sim} \iff R(A^{\sim}) \leq R(B^{\sim})$

(ii) $A^{\sim} \geq B^{\sim} \iff R(A^{\sim}) \geq R(B^{\sim})$

(iii) $A^{\sim} = B^{\sim} \iff R(A^{\sim}) = R(B^{\sim})$

6. Fuzzy Transport Problem (FTP)

It's a liner programming problem(FTP). It the same in structure to the ordinary transport problem but its variables take the fuzzy description (the factors of target function, the quantity of demand, the quantity of supply, the transportation cost, and it's possible to be the only fuzzy costs, or fuzzy costs, demands and supply all together). it could be able to write the mathematical model to the fuzzy transport problem as follow:

Minimize $(Z) = \sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij}\ x_{ij}$ ..... (1)

Subject to

$$\sum_{j=1}^{n} x_{ij} = a_i^{\sim} \qquad j = 1,2, \ldots, n \qquad \ldots. (2)$$

$$\sum_{i=1}^{m} x_{ij} = b_j^{\sim} \qquad i = 1,2, \ldots, m \qquad \ldots\ldots (3)$$

$$x_{ij} \geq 0 \qquad i = 1,2, \ldots m \quad , j = 1,2, \ldots, n \qquad \ldots.(4)$$

Whereas

$c_{ij}^{\sim}$: represents the cost of fuzzy transport to transfer one unit from the supplier resource to demand side for transport problem.

a_i : represent the fuzzy supplying quantities in the transport table.
$b_j^{\sim}$: represents the fuzzy demands quantities in the transport table.

7. Algorithm the proposed method to the fuzzy transport problem in order to find the optimal solution (17)

In order to apply the proposed method to solve the transport problem and after making a transfer table to the problem we should follow the procedures after ensure of the balance of transport table:
First step – Balance the transport table by adding an column dummy or row dummy the cost of its cells equal to zero according to documented data.
Second step – Processing the fuzzy data by rank function method to transfer it to limited data.
Third step – Establishing a table consists of two columns, the first include the supplying resources (warehouses) and the second column includes less cost to every side of demand every according to its supplying resource which opposite to it.
The fourth step – It has been chosen the lowest cost of the al transport costs within the second column, then begin to specify within supply and demand in specific table for them.
Fifth step – After determining the cell which will be specify in transport matrix in the following step we will delete the row or column after exhausting it or specify it within the limits of specified supply and demand
The Sixth step – we choose the lowest cost in the second column for the transport table and begin in specifying in the column number (2) according to the limits of supply and demand which were specified in the transport table.
The Seventh step – we notice when the two lowest transport costs are equal, we choose the cost which achieve the biggest supply or demand quantity within the transport table.
The eighth step – If there is one demand side for two resources out of supplying resources we should subtract lowest cost out of the lowest cost which comes after within the source of one supply and for two sides of demand that achieve the biggest cost through the processing of abstract the cost to specify.
The ninth step – we repeat the steps above from (1) to step (5) up to exhausting all the quantities of supply and demands in the transport table.
The Tenth step – it should be accounted the total transport cost to the transport table.

3. Problem Application Side

In order to apply the theoretical side in the research we had to apply a modern algorithm to show that it is a modern method and important to get to the optimal edge that has a great impact in reducing the cost of transport for national and productive institutions, and it has been chosen the Central Refineries Company one of the formations of the Ministry of Oil Which contains four refineries (Al Doura Refinery, Najaf Refinery, Samawa Refinery, Diwaniyah Refinery) for the period from (1/1/2018 to 1/6/2018) supplying the governorates of the country with black oil (fuel oil) Bricks and generators, as well as increasing the cost of a transition has an impact (1) approved by calculating the cost of transportation of black oil in the Central Refineries Company Calculates the cost of transport according to table (1-3) After documenting the fuzzy data.
Cost of transportation = Load (ton) * Distance (Km) * Transport price (dinars per ton) .... (1)

Table 1-3. shows the fuzzy transport problem to black oil (oil fuel)

Provincez / Warehouse	Baghdad	Basra	Karbala	Babylon	Kuot	Najaf	Diwanyia	Samawa	Supply
Al-Doura refinery warehouse	8,10, 12,14	50,60, 77, 80	10,20, 30,40	10,20, 33,45	30,33, 40,55	32,50, 54,56	20,28, 35,40	40,45, 50,55	4000,4500, 4600,5000
Najaf refinery warehouse	28,30, 38,50	50,55, 59,63	10,16, 25,35	16,20, 30,45	20,28 ,33,40	10,14, 20,33	15,20, 25,35	33,40, 45,49	2100,2500, 2550,2555

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Article History: Received: Aug 15, 2018, Revised: Sep 10, 2018, Accepted: Oct 04, 2018

Diwaniyah refinery warehouse	33,35,, 45,50	48,50, 56,65	20,28, 35,40	15,18, 24,34	18,20, 28,32	15,20, 29,35	15,20, 25,30	30,33, 39,42	1250,1500, 1550,1600
Samawa refinery warehouse	40,49, 52,59	40,42, 48,53	30,36, 38,40	29,30, 36,42	30,34, 36,45	32,35, 40,46	20,21, 30,39	9,15, 20,25	2000,2250, 2500,2550
Demand	3100,3500 ,3900,400 0	3800,3999, 4500,4398	1500,2000, 2500,2900	800,850, 900,955	600,700, 750,950	500,555 650,700	445,800, 910, 500	400,480 550,600	

After the formulation the table of fuzzy transport problem to the black oil material mathematically "and by using the method of rank function according to the mathematical equation below:

Min(Z) = R (8,10,12,14) X11+R (50,60,77,80) X12+R (10,20,30,40) X13+ R (10,20, 33,45) X14+R (30,33,40,55) X15+R (32,50 ,54,56) X16+R (20,28,35,40) X17+R (40,45,50,55) X18+R (28,30,38,50) X21+R (50,55,59,63) X22+R(10,16,25,35)X23+R(16,20,30,45) X24+R (20,28,33,40)X25+R (10,14,20,33) X26+R (15,20,25,35) X27+R (33,40,45,49) X28+R (33,35,45,50) X31+R (48,50,56,65) X32+R(20,28,35,40) X33+R (15,18,24,34) X34+R (18,20,28,32) X35+R (15,20,29,35) X36+R (15,20,25,30) X37+R (30,33,39,42) X38+R (40,49,52,59) X41+R (40,42,48,53) X42+R (30,36,38,40) X43+R (29,30,36,42) X44+R (30,34,36,45) X45+R (32,35,40,46) X46+R (20,21,30,39) X47+R (9,15,20,25) X48

After applying Rank function, we get the cost of fuzzy transport as follow:

R (8,10,12,14) = (8,10,12,14) / 4 = 11
R (50,60,77,80) = (50,60,77,80) / 4 = 66.75
R (10,20,30,40) = (10,20,30,40) / 4 = 25
R (10,20, 33,45) = (10,20, 33,45) / 4 = 27
R (30,33,40,55) = (30,33,40,55) / 4 = 39.5
R (32,50 ,54,56) = (32,50 ,54,56) / 4 = 48
R (20,28,35,40 Z) = (20,28,35,40) / 4 = 30.75
R (40,45,50,55) = (40,45,50,55) / 4 = 47.5
R (28,30,38,50) = (28,30,38,50) / 4 = 36.5
R (50,55,59,63) = (50,55,59,63) /4 = 56.75
R (10,16,25,35) = (10,16,25,35) / 4= 21.5
R (16,20,30,45) = (16,20,30,45) / 4= 27.75
R (20,28,33,40) = (20,28,33,40) / 4= 30.25
R (10,14,20,33) = (10,14,20,33)/4=19.25
R (15,20,25,35) = (15,20,25,35) /4 = 23.75
R (33,40,45,49) = (33,40,45,49) /4 =41.75
R (33,35,45,50) = (33,35,45,50) /4 = 40.75
R (48,50,56,65) = (48,50,56,65) 4/ = 54.75
R (20,28,35,40) = (20,28,35,40) /4 = 30.75
R (15,18,24,34) = (15,18,24,34) /4 = 22.75
R (18,20,28,32) = (18,20,28,32) /4 = 24.5
R (15,20,29,35) = (15,20,29,35) /4 = 24.75
R (15,20,25,30) = (15,20,25,30) /4 = 22.5
R (30,33,39,42) = (30,33,39,42) /4 = 36
R (40,49,52,59) = (40,49,52,59) /4 = 50
R (40,42,48,53) = (40,42,48,53)/ 4 = 45.75
R (30,36,38,40) = (30,36,38,40) /4 = 36
R (29,30,36,42) = (29,30,36,42) /4 = 34.25
R (30,34,36,45) = (30,34,36,45) /4 = 36.25
R (32,35,40,46) = (32,35,40,46) / 4 = 38.25
R (20,21,30,39) = (20,21,30,39) /4 = 27.5
R (9,15,20,25) = (9,15,20,25) / 4 = 17.25

(After that the method of Rank function is applied to the processing sources of the product represented by the main warehouses of the company of the central refineries we get:

R(4000,4500,4600,5000) = (4000,4500,4600,5000)/4= 4525/ Doura refinery warehouse
R (2100,2500,2550,2555) = (2100,2500,2550,2555)/4= 2426.25 / Najaf refinery warehouse
R (1250,1500,1550,1600) = (1250,1500,1550,1600)/4= 1475 /Diwaniyah refinery warehouse

R (2000,2250,2500,2550) = (2000,2250,2500,2550)/ 4= 2325 / Samawa refinery warehouse
Then we apply the Rank function to the requesting parties for the black oil (governorates), so we get the following:
R (3100,3500,3900,4000) = (3100,3500,3900,4000) / 4 =3625/ Baghdad province
R (3800,3999,4500,4398) = (3800,3999,4500,4398) / 4= 4174.25 / Basra province
R (1500,2000,2500,2900) = (1500,2000,2500,2900) /4 = 2225 /Karbala province
R (800,850,900,955) = (1500,2000,2500,2900) / 4 = 876.25 / Babylon province
R (600,700,750,950) = (600,700,750,950) / 4 = 750 /Kut province
R (500,555,650,700) = (500,555,650,700) / 4 = 601.25 / Najaf province
R (445,800,910,500) = (445,800,910,500) / 4 = 663.75 / Diwaniyah province
R (400,480,550,600) = (445,800,910,500) / 4 = 507.5 / Samawa province

For each of the above we document the data according to the table of the cost of fuzzy transport in Table (2-3), which shows the transportation costs of the fuzzy transport problem of black oil (fuel oil)

Table 2-3. shows the transport costs of the fuzzy transport problem of black oil (fuel oil)

Province / Warehouse	Baghdad	Basra	Karbala	Babylon	Kut	Najaf	Diwaniyah	Samawa	supply
Doura refinery warehouse	11	66.75	25	27	39.5	48	30.75	47.5	4525
Najaf refinery warehouse	36.5	56.75	21.5	27.75	30.25	19.25	23.75	41.75	2426.25
Diwaniyah refinery warehouse	40.75	54.75	30.75	22.75	24.5	24.75	22.5	36	1475
Samawa refinery warehouse	50	45.75	63	34.25	36.25	38.25	27.5	17.25	2325
Demand	3625	4174.25	2225	876.25	750	601.25	663.75	507.5	

1. Apply the modern method to solve the problem of transporting black oil

After constructing a transport schedule for the problem of transporting fuel oil according to Equation (1) in order to extract the cost of transportation. Therefore, to apply the modern mathematical method, we follow the following steps: The first step: balancing the transport table by adding a fifth processing point (row dummy) whose cells cost the row dummy equal to zero and the quantity of the supply in it is (2671, 75) according to table (3-3).

Table 3-3. shows the transport table after balancing transport table

Province / Warehouse	Baghdad	Basra	Karbala	Babylon	Kut	Najaf	Diwaniyah	Samawa	Supply
Doura refinery warehouse	11	66.75	25	27	39.5	48	30.75	47.5	4525
Diwaniyah refinery warehouse	40.75	54.75	30.75	22.75	24.5	24.75	22.5	36	1475
Samawa refinery warehouse	50	45.75	63	34.25	36.25	38.25	27.5	17.25	2325
dummy row	0	0	0	0	0	0	0	0	2671,75
Demand	3625	4174.25	2225	876.25	750	601.25	663.75	507.5	

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The second step: establishing two columns the first one represent supplying the black oil and the second column represents the lowest cost of transport in each source of supply (provinces) represented by the main warehouses within the request bodies for this subject (governorates) as in Table (4-3).

Table No. 3-4

Main warehouses	Supply body (governorate)	Transport cost
Doura warehouse	Baghdad	11
Najaf warehouse	Najaf	19.25
Diwaniyah warehouse	Diwaniyah	22.5
Samawa warehouse	Samawa	17.25
Imaginary warehouse	*	0

The third step:
Determining the minimum cost of transport in all the main warehouses i.e. the dummy warehouse to be customize to the second request in Basra province and subtracting the quantity within the specified supply and demand limits. The allocation is as in Table (3-3),the body of dummy supplying (row dummy)
The fourth step:
The following step is then prepared according to the table below to determine the following lowest cost:

Table No. 3-5

Main warehouses	Supply body (governorate)	Transport cost
Doura warehouse	Baghdad	*11
Najaf warehouse	Najaf	19.25
Diwaniyah warehouse	Diwaniyah	22.5
Samawa warehouse	Samawa	17.25

clearly, that the less e source of the existing cost in the first supplying resource first (Doura warehouse) is allocated within Doura refinery warehouse and subtracting off the amount quantity (3625) tons of warehouse of Doura refinery and delete the body demand for the province of Baghdad after exhausting all the required quantity for the province.
Step Five: After the previous step, repeat the same procedure as shown below

Table No. 3-6

Main warehouses	Supply body (governorate)	Transport cost
Doura warehouse	Baghdad	25
Najaf warehouse	Najaf	19.25
Diwaniyah warehouse	Diwaniyah	22.5
Samawa warehouse	Samawa	* 17.25

We determine the demand body represented by the Province of Samawa at the lowest cost and quantity of demand (507,5) and deducting it from the quantity offered to the Samawa refinery warehouse within the limits of the request and supply allocated. Thus, the applicant for the province of Samawa is deleted for exhausting by the province [18].
Step six:
Return to the previous steps according to the table below after determining the lowest possible transfer cost in all warehouses

Table No. 3-7

Main warehouses	Supply body (governorate)	Transport cost
Doura warehouse	Baghdad	25
Najaf warehouse	Najaf	* 19.25
Diwaniyah warehouse	Diwaniyah	22.5
Samawa warehouse	Diwaniyah	27. 5

Therefore, the cell containing the transportation cost is allocated (19,25) and the request body of Najaf province is deleted after being allocated by Najaf Refinery and the allocated quantity should be subtracted off the quantity of supply of Najaf warehouse.

Step Seven: We proceed to the next step according to the table below

Table No. 3-8

Main warehouses	Supply body (governorate)	Transport cost
Doura warehouse	Karbala	25
Najaf warehouse	Karbala	21. 5
Diwaniyah warehouse	Diwaniyah	22.5
Samawa warehouse	Diwaniyah	27. 5

We note that there is one body demand for each of the two sources, that is, the warehouse of Doura and Najaf have the same demand (Karbala governorate). While The Diwaniyah and Samawa warehouses are the same as the demand side (Diwaniyah governorate), which requires the implementation of the eighth step to achieve the privatization process we should follow:

Table No. 3-9

Doura warehouse	Karbala	27-25=2
Najaf warehouse	Karbala	23.75-21. 5=2.25 *
Diwaniyah warehouse	Diwaniyah	22.5- 22.5=0.25
Samawa warehouse	Diwaniyah	* 34.25-27.5=6.75

* Indicates the selected cost for customization

I.e., each cost is subtracted from the next lowest cost in the same source of supply (the warehouse) and we choose the highest low cost of transport after the process of subtraction and application of the allocation process is deleted the source of processing for the warehouse of Samawa refinery.

In order to allocate the cells, the processing source of Najaf Refinery is deleted in relation to the request of Karbala governorate. As for the allocation of Diwaniyah Governorate, the allocated amount of Diwaniyah province is removed after depleting the quantities required.

Step 8:

For the previous steps we follow the same procedures so the current step is as follows:

Table No. 3-10

Main warehouses	Supply body (province)	Transport cost
Doura warehouse	Karbala	25
Diwaniyah warehouse	Babylon	22.75
Samawa warehouse	Babylon	34. 25

By Following the previous context with regard to the demand body for the province of Babylon where it has two exporters for processing are Diwaniyah warehouse and the Samawa warehouse and after subtracting the least cost of the next lowest cost we find the following:

Table No. 3-11

Doura warehouse	Karbala	25
Diwaniyah warehouse	Babylon	24.5-22.75=1.75 *
Samawa warehouse	Babylon	36-34.25 = 1.75

Because of the subtract process is equal between the two costs, so we select the source that own the least transport cost out of the two costs for the same source i.e. we choose the cost (22, 75) , because it is less cost and the cell is allocated within the specified supply and demand. within that the all requested quantity for Babylon province has been exhausted from Diwaniyah refinery warehouse.

Ninth step: by repeating the same previous step we get on the following:

Table No. 3-12

Main warehouses	Supply body (governorate)	Transport cost
Doura warehouse	Karbala	25
Diwaniyah warehouse	Kut	24.5
Samawa warehouse	Karbala	36

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Article History: Received: Aug 15, 2018, Revised: Sep 10, 2018, Accepted: Oct 04, 2018

The quantity supplied shall be allocated from the Diwaniyah warehouse as it is the lowest transport cost, thus eliminating the source of the processing of the Diwaniyah refinery warehouse and the exhausting of its quantities supplied from the material.

Tenth step :

W turn to the current step as follow:

Table No. 3-13

Main warehouses	Supply body (governorate)	Transport cost
Doura warehouse	Karbala	39.5-25 =14.5
Samawa warehouse	Karbala	36.25- 36 = 0.25

It has been select the highest cost of transport after subtracting, and it has allocated within the supplying and demanding limits, the after allocation, the provinceof Karbala has been taken its sufficiency with all its requested quantity.

Eleventh step:

We get the following of this step

Table No. 3-14

Main warehouses	Supply body (governorate)	Transport cost
Doura warehouse	Kut	66.75- 39.5= 27.25
Samawa warehouse	Kut	45.75 – 36.25 = 9.5

By following the previous procedures, we get on specifying all still quantities and exhausting all still quantities within the limits d specifics supply and demand.

By excluding the solution results we obtain on the fuzzy transport table which has allocated within the specifying of supply and demand limits

According to the table No. 3-15

Province / Warehouse	Baghdad	Basra	Karbala	Babylon	Kut	Najaf	Diwaniyah	Samawa	Supply
Doura refinery warehouse	11 3625	75 66. 348.75	25 400	27	39.5 151.25	48	30.75	47.5	4525
Najaf refinery warehouse	36.5	56.75	21.5 1825	27.75	30.25	19.25 601.25	23.75	41.75	2426.25
Diwaniyah refinery warehouse	40.75	54.75	30.75	22.75 876.2	24.5 598.75	24.75	22.5	36	1475
Samawa refinery warehouse	50	45.75 1153.7	36	34.25	36.25	38.25	27.5 663.75	25 17. 507.5	2325
Imaginary row	0	0 2671.7	0	0	0	0	0	0	, 75 2671
Demand	3625	4174.25	2225	876.25	750	601.25	663.75	507.5	

After the process of customizing the cell in transport matrix and by using the modern method the optimal quantities are being which will transfer from the main warehouse to the requested provinces as follow:

$x_{1,1} = 3625$

$x_{1,2} = 348.75$

$x_{1,3} = 400$

$x_{2,3} = 1825$

$x_{2,6} = 601.25$

$x_{3,4} = 876.25$

$x_{3,5} = 598.75$

x 4,2 = 1153.75
x 4,7 = 663.75
x 4,8 = 507.5
The twelfth step:
After excluding the decision variables for the fuzzy transport table we count the totel cost for transport as a follow:
Min(Z) = 11* 3625 + 66.75*348.75+ 25*400+ 39.5* 151.25+ 21.5* 1825+ 19.25*601.25+ 22.75*876.25+24.75*598.75+ 45.75*1153.75+ 27.5*663.75+ 17.25*507.5+ 0* 2671.75= 244335.625
So, the final cost to transport the black oil is (244335 625) million IRD
It's clear of the optimal solution table above, that the total of transport cost to transfer the product in the company is (244335625) with an optimal transferred quantities amount (10600) ton of the black oil material in which achieve the least total cost for transporting.
2. Application of the liner programming method (simplex) to find solution to the optimal sample for the fuzzy transport problem:
In order to get benefits of the ready-made programs in processing the problems of the liner program it has been used (WINQSB) program to solve the problem above as follow:
The value of the target function equal to: Min(Z) = 235,124,4000
And the result of applying the problem will be show them as a follow:

	23:40:16		Thursday	September	20	2018		
1	x11	3,625.0000	11.0000	39,875.0000	0	basic	-M	40.0000
2	x12	0	66.7500	0	21.7500	at bound	45.0000	M
3	x13	400.0000	25.0000	10,000.0000	0	basic	24.5000	31.2500
4	x14	500.0000	27.0000	13,500.0000	0	basic	20.7500	27.5000
5	x15	0	39.5000	0	10.7500	at bound	28.7500	M
6	x16	0	48.0000	0	25.2500	at bound	22.7500	M
7	x17	0	30.7500	0	4.0000	at bound	26.7500	M
8	x18	0	47.5000	0	31.0000	at bound	16.5000	M
9	x21	0	36.5000	0	29.0000	at bound	7.5000	M
10	x22	0	56.7500	0	15.2500	at bound	41.5000	M
11	x23	1,825.0000	21.5000	39,237.5000	0	basic	15.2500	22.0000
12	x24	0	27.7500	0	4.2500	at bound	23.5000	M
13	x25	0	30.2500	0	5.0000	at bound	25.2500	M
14	x26	601.2500	19.2500	11,574.0600	0	basic	-M	25.5000
15	x27	0	23.7500	0	0.5000	at bound	23.2500	M
16	x28	0	41.7500	0	28.7500	at bound	13.0000	M
17	x31	0	40.7500	0	34.0000	at bound	6.7500	M
18	x32	0	54.7500	0	14.0000	at bound	40.7500	M
19	x33	0	30.7500	0	10.0000	at bound	20.7500	M
20	x34	376.2500	22.7500	8,559.6880	0	basic	22.2500	29.0000
21	x35	750.0000	24.5000	18,375.0000	0	basic	-M	29.5000
22	x36	0	24.7500	0	6.2500	at bound	18.5000	M
23	x37	348.7500	22.5000	7,846.8750	0	basic	16.0000	23.0000
24	x38	0	36.0000	0	23.7500	at bound	12.2500	M
25	x41	0	50.0000	0	38.2500	at bound	11.7500	M
26	x42	1,502.5000	45.7500	68,739.3800	0	basic	29.5000	59.7500
27	x43	0	36.0000	0	10.2500	at bound	25.7500	M
28	x44	0	34.2500	0	6.5000	at bound	27.7500	M
29	x45	0	36.2500	0	6.7500	at bound	29.5000	M
30	x46	0	38.2500	0	14.7500	at bound	23.5000	M
31	x47	315.0000	27.5000	8,662.5000	0	basic	13.5000	34.0000
32	x48	507.5000	17.2500	8,754.3750	0	basic	-M	41.0000
	Objective	Function	(Min.) =	235,124.4000				

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Article History: Received: Aug 15, 2018, Revised: Sep 10, 2018, Accepted: Oct 04, 2018

4. Results of Analysis of Results

We note that the proposed method in this research gave the best economic solution (the least cost)

1. The aim of the research is to find a solution to the problem of transport provided by the available methods, but also aims to develop a logical methodology of scientific methods of obtaining this situation.
2. The methods currently adopted to solve the transport problem can be improved through the development of a comparison based on concluding all scientific methods to reach the objectives.
3. Despite the simplicity of the proposed method, the goal is to develop a methodology to develop the scientific method to formulate the issue in a scientific manner consistent with the main objective of solving the problem.

Conclusion

The researcher reached through the results of the research to the most important conclusions, which are:

1. The total transport cost of the black oil (fuel oil) in modern mathematical method is (244335625), and in optimum quantities transferred (10600) tons of sources of processing to the requesting parties of the product.
2. When using the general linear programming method (Simplex) the total cost of transportation was (2351244000), and in quantities transported ( ) tons.
3. 3 - through the current method we will be able to plan for the future company plans, this will contribute to give the appropriate decision to determine the quantities required to be transferred in the future.
4. Adopting the ready-made software to arrive at the optimal solution of the problem because it is efficient, accurate and speed in addition to ease of use such as (Winqsb).

Recommendations

The researcher recommends a number of recommendations based on the research conclusions which are:

1- generalization the method on the models of fuzzy transport problems by the company of the center refineries because it provides a solution that contributes to the decision makers of administrative decision makers to determine the policy of the company and the development of future plans.

2- it’s necessary to provide a database to the company in order to documenting the data on the limits of quantities required, quantities displayed, and the cost of transport, so that the academic researcher will be able to apply modern methods contributing in the process of reducing the cost of transport in institutions and production facilities.

3- Due to the importance of the proposed method, and the method of rank function, we recommend training the responsible parties in the company on how to use the software and methods in this area for the purpose of benefiting from them in practical applications in the transport sectors and economic institutions.

4- Giving importance to the issue of the fuzzy transport models because they are models being flexible and closer to the representation of reality of traditional transport models.

5- Developing new methods depending on the method used in the research to find the optimal solution to the fuzzy transport problem quickly and easily.

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Article History: Received: Aug 15, 2018, Revised: Sep 10, 2018, Accepted: Oct 04, 2018