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Studying Transport Models with the Shortest Time According to the Neutrosophic Logic

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Abstract:
Time factor plays an important role in many issues, and the most important of these issues is the issue of transportation, when we need to transport perishable materials such as milk, medicines ,blood,….. etc. or develop war plans to secure the requirements of battle of ammunition - food - and soldiers …..etc., at maximum speed, we need a careful scientific study that enables us to avoid losses, so the researchers studied transport models in the shortest possible time using the values of classic logic and the best solution for such models is a specific value subject to increase or decrease because there is nothing certain in the real reality, all the results of the studies are related to the surrounding conditions of the system under study, due to the sensitivity of these issues had to be reformulated according to a science that takes into account all the cases that the system can go through so that we can take all possible precautions that help us reduce losses and secure the required in the shortest possible time, we have in This research formulates transport models with the shortest time and we presented a special way to solve such models using neutrosophic values, based on the concept of the neutrosophic linear mathematical model, a model that has something of non-determination (indeterminacy) and we reached transport models with the shortest time that are considered a generalization of the existing models because they give us optimal neutrosophic values for time, which are unspecified values $Nt^* = t^* \pm \varepsilon$ where ε is indeterminism and we will take it in the form then become the matrix of times $Nt^* = [t^* \pm \varepsilon]$, where Nt^* is any neighborhood of t^*, it should be noted that in this research when viewing the example we took some transfer times neutrosophic values of the form $Nt \in [t_1, t_2]$ to be able to clarify the main goal of the research.

Key words: Linear programming - Simplex - the problem of transportation at the lowest cost - the issue of transportation in the shortest time - Ways to solve the problem of transport .

Introduction:

Linear programming is one of the most methods of operations research that has been used to address many realistic issues and provided optimal solutions to them that helped reduce losses, and since the optimal solution to such issues depends on the data provided by those in charge of the work and this data lack stability , we are unable to study these issues and develop accurate future action plans It was necessary for a new science that provides us with a margin of freedom and helps us reduce losses, so it was a neutrosophic science, which was laid by the American scientist and mathematical philosopher Florentin Samarandche and came as a generalization of the fuzzy logic presented by Lutfizadeh [1], this science has received great attention by researchers as many researches and studies have been published in various fields of science using the basic concepts developed by the founder of this science [2-8], and since operations research is considered the applied aspect of mathematics, it was necessary to reformulate its topics using the basic concepts of neutrosophic science, where we published the feast of research on various topics such as static stock models, simulation, decision-making, dynamic programming, and in the topics of linear programming, and transport problems at the lowest cost. Waiting queues, Machine Learning...etc. [9-26], a complement to our research in which we present a study of transportation models in the shortest possible time.

Discussion:

Through our study of some topics of linear programming using neutrosophic science and due to the interest that these researches have received from researchers and those interested in the development of science, we present this research as a complementary study to what we have done in two previous researches on the issue of transport [18,19] It is dedicated to transport models with the shortest time using neutrosophic values that take into account all changes that may occur during the functioning of the systems under study and provide We have optimal transit time.

Model of transporting materials in the shortest possible time using neutrosophic values:

Based on the study contained in the research [19], we can formulate the issue as follows:

The text of the issue in general form:

Suppose we want to move a material from production centers A_i where $i = 1,2, \dots, m$,whose production capacities are respectively $Na_1, Na_2, \dots, Na_m$, to consumption centers B_j where $j = 1,2, \dots, n$ whose needs is $Nb_1, Nb_2, \dots, Nb_n$ It is in order, and let the matrix of times necessary to transfer the appropriate quantity from the center i to the center j be known and equal $NT = [Nt_{ij}]$, it is required to formulate the appropriate mathematical model to transfer all the quantities ,available in the production centers and meet the needs of all consumption centers in the shortest time. In order to build the appropriate mathematical model, we denote Nx_{ij} for the quantity transferred from the production center i where $i = 1,2,3, \dots, m$ to the consumption center j where $= 1,2,3, \dots, n$, then we can put the problem unknowns in matrix form. $NX = [Nx_{ij}]$, and we put the information in the question in a table as follows:

consumption production	B_1	B_2	B_3	…	B_n	quantities
A_1	Nt_{11} Nx_{11}	Nt_{12} Nx_{12}	Nt_{13} Nx_{13}	…	Nt_{1n} Nx_{1n}	Na_1
A_2	Nt_{21} Nx_{21}	Nt_{22} Nx_{22}	Nt_{23} Nx_{23}	…	Nt_{2n} Nx_{2n}	Na_2
A_3	Nt_{31} Nx_{31}	Nt_{32} Nx_{32}	Nt_{33} Nx_{33}	…	Nt_{3n} Nx_{3n}	Na_3
…	…	…	…	…	…	…
A_m	Nt_{m1} Nx_{m1}	Nt_{m2} Nx_{m2}	Nt_{m3} Nx_{m3}	…	Nt_{mn} Nx_{mn}	Na_m
Required quant	Nb_1	Nb_2	Nb_3	…	Nb_n	

Table No. (1) Data of the issue of transport in the shortest time

To build the appropriate mathematical model, we distinguish two cases:

First case: the model is balanced:
The model is balanced if:

$$\sum_{i=1}^{m} Na_i = \sum_{j=1}^{n} Nb_j$$

Second Case: Unbalanced Model:
The model is unbalanced if:

$$\sum_{i=1}^{m} Na_i \neq \sum_{j=1}^{n} Nb_j$$

From this case, two cases result:
Overproduction:

$$\sum_{i=1}^{m} Na_i \geq \sum_{j=1}^{n} Nb_j$$

This model is returned to a balanced model by adding an imaginary consumer center that needs it:

$$Nb_{n+1} = \sum_{i=1}^{m} Na_i - \sum_{j=1}^{n} Nb_j$$

Deficit in production:
This model is returned to a balanced model by adding a fictitious production center with a production capacity:

$$Na_{m+1} = \sum_{j=1}^{n} Nb_i - \sum_{i=1}^{m} Na_i$$

In both cases(b & a), a case of surplus production and a deficit in production, we get a balanced model.
Formulation of the mathematical model of transport models in the shortest possible time:
Our symbol for the quantity transferred from the center i to the center j with the symbol Nx_{ij} then these variables must meet the following conditions:

$$\sum_{j=1}^{n} Nx_{ij} = Na_i \qquad (i = 1,2,3,\dots,m)$$

$$\sum_{i=1}^{m} Nx_{ij} = Nb_j \qquad (j = 1,2,3,\dots,n)$$

$$Nx_{ij} \geq 0 \quad (i = 1,2,3,\dots,m), (j = 1,2,3,\dots,n)$$

In these models, the objective function cannot be formulate d with a mathematical follower, so we extract its most important qualities and properties through the following discussion:
To find the optimal solution for any transport model, we must find the values of unknowns: Nx_{ij} ; $(i = 1,2,3,\dots,m), (j = 1,2,3,\dots,n)$. In a previous research [18] we have presented ways to find the preliminary solution to the problem of neutrosophic transport at the lowest cost, taking advantage of the study contained in the research we find a primary basic solution using one of the methods, we know that any optimal solution that includes n+m-1 basic solution that are not equal to zero , and against this solution there is a set of times that we will symbolize as $[Nt_{ij}]_X$.

It represents the time required to transport all materials available in all production centers and meet the needs of all consumption centers.
The time required to finish the transfer process, which we will symbolize as corresponding to the largest element of the matrix $[Nt_{ij}]_X$ must achieve the following relationship:

$$Nt_x = Max_{i,j}[Nt_{ij}]_X$$

Since we have a large number of acceptable solutions, the optimal solution is given by the following relationship:

$$Nt_x^* = MinNt_x = Min(Max_{i,j}[Nt_{ij}]_X)$$

This means that we solve the model without a target function we get a base solution and then we determine the number set from the matrix $[Nt_{ij}]_X$ corresponding to this base solution.

Note 1:

If the issue is unbalanced and when adding an imaginary production center or an imaginary consumer center, we determine the time according to the following:
Since the time required to finish the transfer process achieves the following relationship:

$$Nt_x = Max_{i,j}[Nt_{ij}]_X$$

So we take the time required to transfer the quantities available in this imaginary production center to all consumption centers equal to zero.
And we take the time required to transport quantities from all production centers to the imaginary consumer center is equal to zero.

Note 2:

In order for the transport model to be a neutrosophic transport model, at least one of the data in Table 1 must be a neutrosophic value.
The general method used to obtain the smallest transfer time is to move from one neutrosophic base solution to another base solution using the simplex method to solve the neutrosophic linear models described in the research [12] ,and the goal is to make the largest elements Nt_x in the matrix $NT = [Nt_{ij}]_X$ as small as possible.
In this research, we will use a special method to solve neutrosophic transport models according to time, which we explain through the following example:

Example:

Four pharmaceutical plants distribute their production of one type to three pharmacies the available quantities, the quantities required and the times required to transport them are shown in the following table:

Consumption center / Production centers	B_1	B_2	B_3	Required quantities
A_1	[1 ,1.5] Nx_{11}	[2 ,2.4] Nx_{12}	6 Nx_{13}	11
A_2	[3 ,3.2] Nx_{21}	8 Nx_{22}	[1 ,1.5] Nx_{23}	9
A_3	[7 ,7.5] Nx_{31}	10 Nx_{32}	[4 ,4.6] Nx_{33}	13
A_4	12 Nx_{41}	8 Nx_{42}	[5 ,5.1] Nx_{43}	17

Available quantity	18	10	12	40 40

Table No. (2) Example data

We look for the smallest time in the rooms (i, j), we find that it is found in two rooms $(1, 1)$ and $(3, 2)$:

$$Min(Nt_{ij)} = Nt_{11} = Nt_{32} \in [1,1.5]$$

We denote b.i Ω_1 for all table stone except the two rooms $(1, 1)$ and $(2, 3)$

We saturate the two chambers opposite them $(1, 1)$ and $(2, 3)$ then we put in the other stone $(*)$ we get the following table:

consumption production				Required quantities
A_1	11	*	*	11
A_2	*	*	9	9
A_3	*	*	*	13
A_4	*	*	*	7
Available quantities	18	10	12	40 40

Table No. (3) First Step

The first solution is $x_{11}^{(1)} = 11$, $x_{23}^{(1)} = 9$ which expresses the total quantities transferred and is equal to $x_{ij} = 11 + 9 = 20$ it crosses a quantity less than the quantity required for that time solution from which we started and the author of $Nt_{11} = Nt_{23} \in [1,1.5]$ is an imperfect solution to the problem at hand.

From the elements of the sat Ω_1, where Ω_1 equal :

$$\Omega_1 = \{ [3 ,3.2], [7 ,7.5], 12, [2 ,2.4], 8,10,8,6, [4 ,4.6], [5 ,5.1] \}$$

We look for the smallest time we find:

$$\left(Nt_{ij}\right) = Min\{[3 ,3.2], [7 ,7.5], 12, [2 ,2.4], 8,10,8,6, [4 ,4.6], [5 ,5.1]\} \in [2 ,2.4]$$

Any smallest time is this $Nt_{12} \in [2 ,2.4]$ means that we must transfer the quantities available in the production center A_1 to the consumption center B_2 and this is not possible because the center A_1 no longer contains any quantity and therefore this step is not useful.

We form the sat $\Omega_2 = \{ [3 ,3.2], [7 ,7.5], 12,8,10,8,6, [4 ,4.6], [5 ,5.1] \}$ is the resulting Ω_1 after deleting $Nt_{12} \in [2 ,2.4]$ and we choose from Ω_2 the smallest time we find:

$$\left(Nt_{ij}\right) = Min\{[3 ,3.2], [7 ,7.5], 12,8,10,8,6, [4 ,4.6], [5 ,5.1]\} \in [3 ,3.2]$$

Any smaller time is this $Nt_{21} \in [3 ,3.2]$ means that we have to transfer the quantities available in the production center A_2 to the consumption center B_1 and this is not possible because the center A_2 no longer contains any quantity and therefore this step is also not useful

We form $\Omega_3 = \{[7 ,7.5], 12,8,10,8,6, [4 ,4.6], [5 ,5.1] \}$the sat which is the resulting sat Ω_2 after deleting $Nt_{21} \in [3 ,3.2]$ and choosing from the Ω_3 smallest time we find :

$$\left(Nt_{ij}\right) = Min\{[7 ,7.5], 12,8,10,8,6, [4 ,4.6], [5 ,5.1]\} \in [4 ,4.6]$$

Any smallest time is $Nt_{33} \in [4,4.6]$ this means that we must transfer the quantities available in the production center A_3 to the consumption center B_3 i.e. we put $x_{33} = 12$ and therefore we must shift the amount in the room $(2,3)$ with the same time $[1,1.5]$ to a room with a time immediately followed and located in the same line i.e. to the room $(2,1)$ with the same time $[3,3.2]$ and we put $x_{21} = 9$,then we make a balance process for the quantities that have been distributed and here we must reduce the quantity in the room $(1,1)$ becomes $x_{11} = 9$ and we put the quantity that has been reduced in the room with the lowest time immediately following the time in that room and in the same row, i.e in the room $(1,2)$ we get $x_{12} = 2$ from this step we get the following distribution:

$x_{11} = 9$ ، $x_{12} = 2$, $x_{21} = 9$, $x_{33} = 12$

But this solution is not ideal because the sum of the quantities that were distributed is not equal to the 40 total quantities available, that is, the time $Nt_{33} \in [4,4.6]$ Not the shortest time, we proceed in the same way in the eighth time to reach the distribution shown in the following table:

consumption production	B_1	B_2	B_3	Required amounts
A_1	1	10	$*$	11
A_2	9	$*$	$*$	9
A_3	8	$*$	5	13
A_4	$*$	$*$	7	7
Available quantities	18	10	12	40 40

Table No. (4) Optimal Solution

In return for $Min(Nt_{ij}) = Nt_{31} \in [7,7.5]$ this time, the entire quantities available in the production centers have been transferred and the needs of all consumer centers have been met, the ideal solution is

$$x_{11} = 1,\ x_{21} = 9,\ x_{31} = 8,\ x_{12} = 10,\ x_{33} = 5, x_{43} = 7$$

The rest of the variables is equal to zero, and the shortest time is $Nt^* = Nt_{31} \in [7,7.5]$

It should be noted that the same example was presented and solved according to classical logic in reference [20], and the data of the problem were as in the following table:

The available quantities, the quantities required and the times required for their transportation are shown in the following table:

consumption production	B_1	B_2	B_3	Required amounts
A_1	1 Nx_{11}	2 Nx_{12}	6 Nx_{13}	11
A_2	3 Nx_{21}	8 Nx_{22}	1 Nx_{23}	9
A_3	7 Nx_{31}	10 Nx_{32}	4 Nx_{33}	13
A_4	12 Nx_{41}	8 Nx_{42}	5 Nx_{43}	7

Available amounts	18	10	12	40 40

Table No. (5) Example data according to classical logic

The optimal solution was as follows:
Time $Min(t_{ij}) = t_{31} = 7$ and in exchange for this time, the entire quantities available in the production centers have been transferred and the needs of all consumer centers have been met, the best solution is

$$x_{11} = 1 \ , x_{21} = 9 \ , \ x_{31} = 8 \ , \ x_{12} = 10 \ , x_{33} = 5 \ , x_{43} = 7$$

The rest of the variables is equal to zero, and the shortest time is $t^* = t_{31} = 7$

Conclusion and results:

The solution using neutrosophic values is an undefined neutrosophic value, which can be any value belonging to the domain $Nt^* \in [7 ,7.5]$, and this value is not specified shows its impact according to one time used and according to the nature of the material transported and the need of consumption centers for it in the end The difference between it and the value $t^* = 7$ obtained when solving this problem using classical values and its impact is determined by those responsible for the work, in addition to that the method used to find the shortest time is an iterative method and in this example we repeated it eight times until we reached the required despite the number of production centers and consumption centers a small number and in Real reality is more numerous, so we recommend using computers and new technologies used in programming when applying this method to real systems from reality,

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