Analysis of transportation model and its method to obtain the basic feasible solution: With reference of various literature

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Abstract - Transportation is one of the most crucial need for people to fulfil in order to engage in their various activities. In addition to this, it is considered to be one of the most important factors in the expansion of the economy. As they play the primary role in the process of decision-making on a scientific basis for planning productive and economic projects, the applications of operations research are interested in locating the optimal plan for transportation at the lowest costs between their production sources and their requesting bodies in order to arrive at the optimal decision. This is because they are interested in reaching the optimal decision. For this reason, the focus of this study has been on finding a solution to the issue of oil product transportation inside the Midland Oil Company, which is one of the formations that make up the Iraqi Ministry of Oil. Therefore, the purpose of this research was to examine the efficacy of employing transport models in decreasing the costs of transportation of oil products in production institutions by using fuzzy theory and a contemporary algorithm (ATM). where the method used in the Midland Oil Company for distributing its oil products from its four main warehouses to the provinces contracting with the company as the data is fuzzy and compared with using the ready programme (Win QSB) in the process of finding a solution to the problem of fuzzy transportation.

Keywords - Transportaion model, Optimum solution

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INTRODUCTION

Decision Making with multicriteria approach plays important in our daily routine life. With mathematical approach we can maximize the our objective function with given decision variables.

There are lots of techniques to get through this. In that linear programming is one of them to make a decision and with given constraints. However, there are few limitations of linear programming. Hence, there are degenerate form of linear programming. One is named as transportation model.

In this study. We are proposing transportation techniques to solve many real life situation and odder some new areas where we can apply transportation model. Then let's start with the back ground of the study.

The framing and solution of transportation issues as a linear programming problem was one of the first and most widespread uses of linear programming methods.

Frank L. Hitchcock published a research titled 'The Distribution of a Product from Several Sources to Numerous Localities' in 1941, which included the conventional form of the issue as well as a constructive solution. This study drew out the partial theory of an approach that foreshadowed the simplex method; it did not use particular features of a transportation issue except to discover initial solutions.

T.C. Koopmans, a member of the Combined Shipping Board during WWII, published a paper titled 'Optimum Utilization of the Transportation System' in 1947. This historical paper was inspired by his wartime experiences. Because of this, as well as Hitchcock's prior work, the classic example is commonly referred to as the Hitchcock Koopmans Transportation Problem.

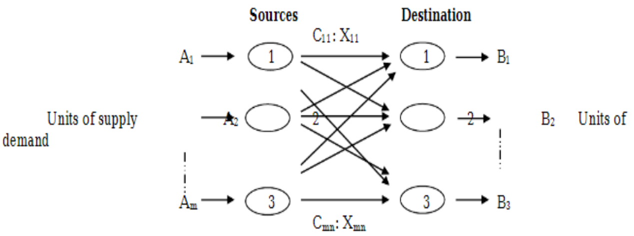
G.B. Dantzig invented the linear programming formulation and the related systematic technique of solution in 1963.

What is transportation problem:

In operational research, the transportation issue is concerned with determining the lowest cost of conveying a single product from a certain number of sources (e.g., factories) to a given number of destinations (e.g. warehouses). These issues can be tackled using normal network approaches; however, we apply a specialized transportation strategy in this case.

The transportation model is a subset of linear programming that focuses on the logistics of transporting a product from its origins (such as manufacturing plants) to its final destinations (e.g. ware houses) The goal of this exercise is to calculate the shipping schedule that will result in the lowest possible overall shipping cost while still meeting all of the required supply and demand limitations. The model operates on the presumption that the shipping cost is directly proportional to the total number of items that are transported along a certain route.

The following diagram express the transportation model:



Each of the m sources and the n destinations is represented by a node in the network. The arcs illustrate the paths that connect the various origins and destinations of the data. The information that is carried by the arc (i,j) that connects source I to destination j is the transportation cost per unit, denoted by C I j, as well as the quantity sent, denoted by X I j. The quantity of supply that is available from source I is denoted by ai, while the amount of demand that is present at destination j is denoted by bj.

The purpose of the model is to calculate the values of the unknown variables X I and j in such a way that the total transportation cost will be reduced while maintaining all of the supply and demand constraints.

The model's data comprise the following:

1. The level of supply at each source and the quantity of demand at each destination.
2. The commodity's unit transportation cost from each source to each destination.

Because there is just one commodity, a destination might get demand from several sources. The goal is to figure out how much should be delivered from each source to each destination in order to keep overall transportation costs as low as possible.

Formulation of the transportation model:

A shoe making firm has three plants located through out a state.

shoe production at each plant is as follows:

P1-------- 2 thousand/day

P2-------- 6 thousand/day

P3-------- 9 thousand/day

Each day the firm must fulfill the needs of its four distribution centers. Minimum requirements at each center is as follows:

DC 1---------- 8 thousand

DC 2---------- 4thousand

DC 3---------- 7 thousand

DC 4---------- 5 thousand

The following table provides an estimate of how much it would cost in hundreds of rupees to transport one million litres of milk from each factory to the respective distribution location.

	DC1	DC2	DC3	DC4
P1	16	8	14	10
P2	48	24	63	30
P3	72	36	63	45

REVIEW OF LITERATURE

Deshmukh's (2012) presented 'Ideal Utilization of the Transportation System' was the title of a free research which was not associated with Hitchcock's work. These two pledges contributed to the evolution of transportation plans that involve a variety of delivery sources as well as a variety of aims. The transportation problem was given this name because a considerable number of its applications involve determining the most optimal method of transporting things from point A to point B. However, it was only in 1951 that the notion of Linear Programming was coupled to the illumination of Transportation Models by George B. Dantzig that it was lit for optimal as a solution to a complicated business challenge.

Jameer (2015) employs the simplex approach on the transportation problem, referring to it as the primal simplex transportation strategy. With the help of a mechanical mechanism, Stringer and Haley have devised a method for arranging their materials.

It's possible that Efroymson and Ray's calculations were the most important in determining the optimal solution to the weaker transportation problem. They anticipated that every one of the unit generating cost capabilities would have a predetermined charge frame, and they were correct. It is noted by them, however, that they believe their branch-and-bound technique may be applied to the situation in which each of these capabilities has been submerged and is composed of just a few straight Segments. Additionally, the work on each unit's transportation costs is straightforward.

Sharma et. al.(2011) developed a three-organization strategic framework to address a true conveyance problem involving a fluid packed commodity. The structure is divided into three phases: plant-station, terminal wholesaler, and merchant. This was represented as a 0-1 whole number programming model with the target capacity of minimization of armada working costs, warehouse setup expenses, and conveyance costs, all of which were subject to supply requirements, request requirements, truck stack limit limitations, and driver hours requirements. Branch and bind, as well as Lagrangian unwinding, were the most effective approaches to solving the problem.

Nagaraj. (1980) solved the problem of how to distribute and transport foreign-made coal to every one of the power plants on time, in the needed quantities, and at the requisite quality under conditions of consistent and reliable supply with the smallest amount of delay in delivery. This was accomplished by developing an LSP that reduced shipping costs while taking into consideration supply constraints, request restrictions, vessel imperatives and taking care of port imperatives. In order to get optimal results, the model was found to provide ideal results. This model was then used as part of a decision emotionally supporting network that assisted with the coal distribution, trip booking, and armada job.

An item, for example, sugar stick, wood, or mineral metal, is carried from multiple-root supply focuses to multiple-goal request focuses or transshipment focuses using bearers that can be sent, preparations, or vehicles, as indicated by Pandian et. al. (2010). They defined an excursion as a flight in a fully loaded vehicle from one point of origin to another point of destination. They were able to detect the model in its optimal form by employing Langrangean Decomposition.

Singh et.al. (2012) considered the issue of establishing a base cost transportation design while also taking into consideration the following two sub-issues: first, the task of units accessible at a progression of beginnings to fulfil requests at a progression of goals; and second, the plan of vehicle visits to transport these units, when the vehicles must be returned to their original flight point. Building the cost minimization scientific model resulted in the transformation of the model into an unwinding all out separation minimization, which at long last degenerated into organisation concerns, a complete vehicle issue, and the avoidance of a vehicle issue. Methodologies for visit development and modification were used to illustrate the problems.

Sharma and Sharma (2000) suggested yet another heuristic strategy for obtaining excellent first-order solutions for double-based approaches that are used to address transportation-related problems. In any event, the transportation standard is only vaguely described in the sections of the document that deal with the transportation problem. Evidently, a small number of scientists have met the requirements independently of one another. In any event, the studies by Charnes and Klingman and Szwarc are cited as the foundational papers in the majority of publications on the subject.

Shi, (1995) discussed the usage of the framework of MC2 linear programming, the authors provide a transportation model with multiple criteria and multiple constraint levels (MC2) that may be implemented in real-world situations. An algorithm is being developed to address MC2 transportation issues of this kind. For a given MC2transportation issue, this method employs the conventional northwest corner rule to discover an initial basic workable solution, which is then refined further. Then, for the MC2 transportation issue, the MC2-simplex approach is used to identify the set of all feasible solutions spanning the range of possible modifications in the goal coefficient parameter, as well as the supply and demand parameters. It is shown numerically that the approach is applicable in the solution of the MC2 transportation issues by using the example given above.

MATHEMATICAL ANALYSIS OF THE METHODS

The Modelling of the Problem with Transportation

There are two ways to phrase a transportation issue that has to be addressed.

1. Representation in mathematical terms
2. Representation of the network

Clearly, the formulation of the transportation issue using mathematical approaches is the approach that is used in order to find a solution to the difficulties. However, the depiction of the network is just as vital to the readers' comprehension of the material.

Let's take each of them in turn and get a better understanding of them.

1 A Presentation in Mathematical Terms

The transportation dilemma refers to circumstances in which a single product must be moved from a number of different origins (sources of supply) to a number of different destinations (demands) (destinations).

Let there be m different sources of supply S1, S2,..................Sm, each of which has ai I = 1, 2,......m) different supply units that need to be carried to one of n different destinations D1, D2.........

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(j = 1, 2,.....n) units of requirements each and every time. Let's say that the cost of transporting one unit of the good from origin point I to final destination j is denoted by Cij for each of the possible routes. If xij indicates the number of units delivered along each route from source I to destination j, then the challenge is to figure out a transportation plan that satisfies supply and demand requirements while keeping overall transportation costs to a minimum.

The issue with transportation may be formulated mathematically as a linear programming problem, as seen in the following example:

Minimize:

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

S.T.C:

$$\sum_{j=1}^{n} x_{ij} = a_i \quad i = 1,2,\ldots..m \text{ (supply constraints)}$$

$$\sum_{i=1}^{n} x_{ij} = b_j \quad j = 1,2,\ldots..m \text{ (demand constraints)}$$

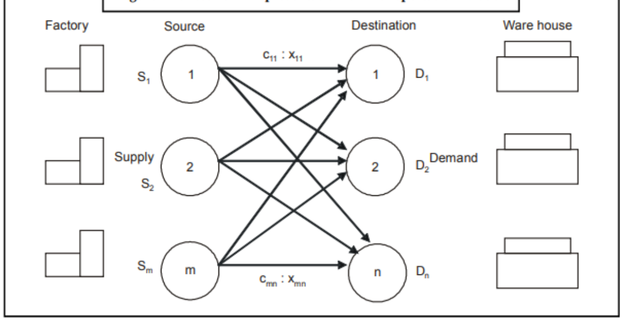
and x_{ij} ³ 0 for all $i = 1,2,\ldots..m$ and,

$$j = 1,2,\ldots..m$$

Network Representation of Transportation Model

A Model for the Representation of Networks in Transportation

Figure : Network Representation of Transportation Model



where, m = the number of sources,

n = the number of destinations,

S_m = the supply at source m,

D_n = the demand at destination n,

c_{mn}= the cost of transportation from source m to destination n, and

x_{mn} = the number of units to be shipped from source m to destination n.

The goal is to minimise the overall cost of transportation by figuring out the unknowns xmn, which refers to the number of units that need to be moved from the sources to the destinations while still meeting all of the supply and demand criteria.

An Oversimplified representation of the Transportation Model:

There is also the possibility of presenting the transportation issue in a tabular format, as seen in Table. Let's say that the price of shipping one unit of the product from its point of origin to its final destination is denoted by the letters cij.

ai is the amount of the commodity that is now available at source I bj is the quantity of the commodity that is currently required at destination j, and xij is the quantity that is being moved from source I to destination j.

Table : Tabular Representation of Transportation Model

From	To: D_1	D_2	...	D_3	Supply a_1
S_1	C_{11} X_{11}	C_{12} X_{12}	...	C_{1n}	a_1
S_2	C_{21} X_{21}	C_{22} X_{22}	...	C_{2n}	a_2
. . .	. . .	. . .	... ...	. . .	. . .
S_m	C_{m1} x_{m1}	C_{m2} x_{m2}	...	C_{mn}	a_m
Demand b_j	b_1	b_2	...	b_n	$\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j$

$$\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j$$

If the overall supply is equivalent to the total demand, then the issue with transportation that has been presented is said to be balanced.

Formulate the Problem as the First Step

Construct a solution to the issue that has been presented to you and arrange it in matrix form. Determine if the issue involves a balanced or unbalanced distribution of transportation resources. If the distribution is not balanced, add fake sources (rows) or destinations (columns), as appropriate.

Obtain the Initial Feasible Solution is the Second Step.

Any one of the three strategies that are going to be discussed may be used to achieve the first plausible answer.

1. The Method of the Northwest Corner (NWC)
2. Method of Minima in Rows and Columns (RCMM)

3. The Method of Approximation Developed by Vogel (VAM)

When compared to the other two methods, which give a value that is either closer to the optimal solution or the optimal solution itself, Vogel's approximation method, also known as VAM, will give the lowest transportation cost for the initial basic feasible solution. This is because VAM is an approximation method. The algorithms for all three different ways to discover the first fundamental answer that is possible are provided here.

1 Formulation of the North-West Corner Method Algorithm (NWC)

1. Locate the top left-hand corner cell of the table and enter the number of units that correspond to the maximum number of units that may be divided between the supply and demand needs. During the process of allocation, the cost of transportation is utterly disregarded (not taken into consideration).
2. Delete the row or column that is completely devoid of data (has reached its maximum capacity) for either supply or demand.
3. With the table now in its reduced form, choose the cell in the top-right corner that faces north-west and assign the available values to it.
4. Continue to repeat steps (2) and (3) until all of the numbers for supply and demand equal zero.
5. Acquire the original, most fundamentally viable answer.

2 The algorithm for the Row and Column Minima Method, also known as the Least Cost Method (LCM)

1. Locate the column in the table that has the lowest possible transportation cost and then divide the available supply and demand among its contents.
2. Delete the row or column that has reached its maximum capacity. It is essential that the removed row or column not be taken into consideration for any future allocation.
3. Return to the original table and distribute resources based on the column with the lowest cost. (Note: In the event that there are many cells with the lowest costs, choose the ones that allow for the most amount of allocation.)
4. Acquire the original, most fundamentally viable answer.

3. The Vogel Approximation Method's Deterministic Algorithm (VAM)

1. Determine the amount of the penalty that should be applied to each row and column by subtracting the lowest possible cost from the next highest possible cost that is available in that row or column. If there are two expenses that are comparable in size, then there will be no penalty.
2. Choose the row or column that has the most severe penalty, and then make your allocation in the cell that has the least amount of cost in the chosen row or column. If there are more than two penalties that are the same, choose the one where a row or column includes the cheapest possible unit price. In the event that there is a second tie, choose the option that allows for the greatest possible allocation.
3. Delete the row or column that satisfies both the supply and the demand at this point.
4. Continue to repeat steps 1 and 2 until both the supply and the demand have been completely met.
5. Acquire the original, most fundamentally viable answer.

Caution: Any one of the three approaches may bring about the first answer, but it must conform to the requirements listed below.

1. The solution has to be workable, which means that it has to be able to satisfy both the supply and demand restrictions (also known as rim conditions).
2. The total number of affirmative allocations, denoted by the symbol N, must be equal to m plus n minus one, where m represents the number of rows and n represents the number of columns.

Degeneracy of the Issues Regarding Transportation

There are two stages involved in degeneracy:

1. Determine whether or not the solution is degenerate. If the solution does not satisfy the requirements stated above, $N = m + n - 1$, then it is not a non-degenerate basic viable solution; rather, it is a degenerate solution. Degeneracy might take place either at the first step or during future rounds of the process.

If the number of allocations, N, is equal to m plus n minus one, then there is no such thing as degeneracy; hence, one must proceed to the following stage.

If the number of allocations, N, is equal to m plus n minus one, then there is degeneracy, and it is necessary to address it before moving on to the next phase.

2. Resolving Degeneracy: Assign a modest positive number e to one or more vacant cells that have the lowest transportation costs in order to resolve degeneracy at the first solution. Doing so will allow you to make $m + n - 1$ allocations, which will allow you to meet the constraint that $N = m + n - 1$

allocations. The selected cell to distribute e must be in a position of independence from the others. To put it another way, the process of allocating e should steer clear of creating a loop and should not have a route.

Table : Independent Allocations

*	*	*
	*	

*	*		
		*	
	*		*

The following Tables show non-independent allocations.

Table : (a) Independent Allocations, (b) and (c)

	*	*
	*	*

(a)

	*		*
	*		*

(b)

*	*		
	*		
*	*		

(c)

MODIFIED DISTRIBUTION METHOD

MODI technique, Using this approach, one has to go through a series of processes in order to arrive at the best possible answer.

CONCLUSION

In the course of this research, a novel strategy for arriving at a solution to the TP that is close to optimum was suggested. The subject of transportation has been approached from a variety of perspectives and approaches across the body of published work. In some techniques, the focus was placed on finding an initial basic answer that was practicable, while another method was used to locate the best option. Even for very large TPs, it has been shown to be possible to provide an optimum solution that satisfies certain requirements within a reasonable amount of time using computer resources. This new approach, on the other hand, is predicated on the distribution of transportation expenses throughout the transportation matrix. It is applicable to all symmetrical and asymmetrical transportation issues and makes use of a greater number of variables. In addition to this, the method is simple to comprehend and, after a limited number of iterations, produces results that are ideal.

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