An Efficient Implementation and Solution of Transportation Problem using Hard Computing

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Abstract— **In the area of Linear Programming Problem, modeling of Transportation Problem is fundamental in solving most real life problems as far optimization is concerned. MATLAB is used for treating programming of Linear Programming Problem, a condition referred to as M-File that can result from codes. In this synopsis we will discusses to Transportation Problem that would calculate the use of MATLAB codes using a mathematical modeling. The model develops the transportation solution for the North West Corner Rule, Least Cost Method, Vogel's Approximation Method, and Modi method for the Transportation Problem. It is clear that a lot of effort has been involved in by many researchers in inquire about of appropriate solution methods to such problem. Furthermore, analytical approach and MATLAB coding are the methods used by most researchers in the application of these efficient proposed techniques. An equivalent MATLAB coding was written that would support in the computation of such problems with easiness especially when the problem at Linear Programming Problem and Transportation Problem. For each model, we use a combination of analytical method and MATLAB coding to study the easiest way that would be efficient while find the solution of different problems. MATLAB is the powerful computational tool in operation research. The MATLAB coding method is better than analytical method for solving Transportation Problem. This model gives us good result in Transportation problem.**

Keywords—MATLAB; LP; TP; Rule;Cost

I. Introduction

Transportation problem are one of the most important and successful applications of quantitative analysis to solve business problems. Generally, the purpose of this problem is to minimize the cost of transporting goods from one location to another which can meet the needs of each arrival. But the methods of solving transportation problem sometimes create difficulties. Lot of calculations was performed to find out the optimum solution. Mistakes may be committed in manual calculations. Most of the methods are time consuming also. After converting these problems into linear programming problem and using computer based program which is discussed in this Synopsis, the difficulties have been removed. Using the computer program the desired solution can be found out easily. But the execution time was short. In a short time the solution was found with the help of computer program. It, therefore, be conclude that the computer program is the best process for finding the solution.

In the field of operations research, modeling of transportation problem is fundamental in solving most real life problems as far optimization is concerned. It is clear that a lot more effort has been put in by many researchers in seek of appropriate solution methods to such problem. Vogel's Approximation Method (VAM), among the class of algorithms provided to solve the Initial Basic Feasible Solution (IBFS) proved to be best [4]. Likewise is the Modified Distribution Method in testing the optimality of the IBFS. However, for some time now, manual calculations and MATLAB are the tools used by most researchers in the application of these efficient proposed techniques. In this work, an equivalent MATLAB program was written that would aid in the computation of such problems with ease especially when the problem at hand has a larger cost matrix. To this effect and to the best of our knowledge, no MATLAB function has been written to handle this problem, although is now obvious that more scientist in the scientific world are into the usage of MATLAB environment. Notwithstanding the fact that people is need such function to make their computations easier [2]. In this study, a MATLAB function, that is developed to implement the VAM, MODI which helps get the IBFS and Modified Distribution Method, which also test for the optimality of the IBFS based on the assumption that the problem is balanced. MATLAB is used to find easy way for the solution of the Transportation methods [3].

II. Transportation Problem Using Hard Computing

In linear programming, the transportation problem is one of the most important and successful applications of quantitative analysis for solving business problems in products distribution. Basically, the aim is to minimize the cost of shipping goods from one location to another, so that the needs of each arrival area are met and every shipping location operates within its capacity [9]. The transportation problem using hard computing is developed using a given transportation tableau. According to this mathematical model, a unified algorithm is developed, and implemented as a hardware program that computes different mathematical methods to find optimal solutions for transportation problems [12]. This is because the manual solutions incorporate many complicated calculations, which may encounter several mistakes and consume time and efforts. Economically, such a solution could provide companies and factories with the ability to transfer their goods and products from supply centers to demand centers in the lowest cost. The solution might help companies to work on increasing or decreasing production of some items according to the relationship between the demand and supply quantities. A program has been designed and tested with different cases, where its output results were accurate and justified when compared by manual calculations [11].

Finding the transportation problem solutions need an enormous effort relying on complicated calculations and require long time to reach the solutions manually. Hence, it becomes necessary to seek for modern technology assistances considering the fields of computer science and programming; specifically Matlab to find optimal solutions for the problem of transportation [13].

Now days MATLAB is widely used mathematics such as MATLAB with Numerical method, Differential Equation, Operation Research, Fuzzy Logic etc., in this article

MATLAB codin g is used to solve Assignment Problem. This gives optimal solution within fraction of seconds.
Moreover MATLAB is powerful hardware package. The name MATLAB stands for Matrix Laboratory, it deals with matrix (array) [15]. MATLAB can be used for math computations, modeling and simulations, data analysis and processing, visualization and graphics, and algorithm development, and has many built in tools for solving problems. It is also possible to write programs in MATLAB, which are essentially groups of commands that are executed sequentially [14].

III. MATHEMATICAL FORMULATION OF THE TRANSPORTATION MODEL

In its general form, the transportation problem is a mathematical model which determines the optimal program of transportation certain quantities of homogeneous goods (sources) A_1, ..., Am in the so-called demand centers (origins) B_1,..., Bn. The main criterion of optimization is the minimization of the total cost of transportation of goods, although it can be taken as a criterion the reduction of other parameters (total time of transport of goods, the degree of commitment of funds, etc.) [23]. In doing so, we assume that there is a physical separation between the sources in relation to centers of demand, and a total $m{\cdot}n$ different ways in which goods can be delivered. In that way, the transportation problem has a natural network representation, as is shown in the Fig. 1 [17].

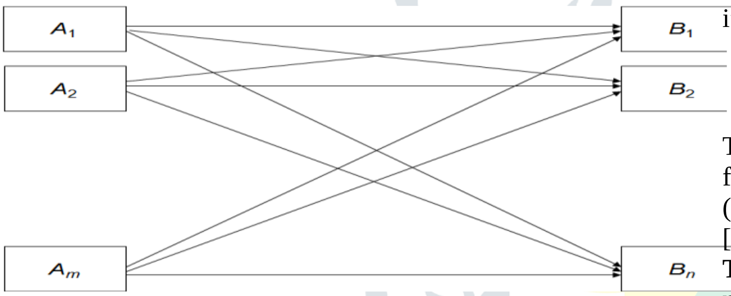

Figure 1: Diagram of all possible transportation routes of homogeneous goods

In order to formulate a general, mathematical form of transport model, here are some of its key elements [16]:
• Available quantities of manufactured goods (supply): a_1,..., am.
• The needs of the consumer centers (demand): b_1,..., bn.
• Transportation costs per unit of output from the source Ai in the origin Bj. We shall denote those costs as cij, where $i = 1,..., m$, $j = 1,..., n$.
• Quantities of goods transported from the i-th source to the j-th origin. We shall denote them as xij. The main goal of solving the transportation problem is finding the optimal values of xij, for which the total costs of transportation, defined by so called *the transportation function*

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

be the smallest. In addition, the following limiting conditions must be satisfied

$$\sum_{j=1}^{n} x_{ij} = a_i, \quad \sum_{i=1}^{m} x_{ij} = b_j. \tag{2}$$

This means that the total supply of each source must be fully allocated to the places of demand, while demand for each demand centre must be completely fulfilled. Naturally, the amount of goods that define the variables xij are nonnegative and unknown, e.g. it holds $xij \geq 0$, for any $i = 1,..., m$, $j = 1,..., n$. The transportation function (1) along with the above the constraints (2) defines a so called general (mathematical) form of the transportation problem (TP). It is a special form of linear programming (LP) problem [18].
The achievement of minimum transportation costs described transport functions (1) can be interpreted as a minimal problem in the "classical" task of LP. However, the very specificity of this model allows us a number of different, simplified procedures for its solution. First of all, the TP can be displayed in a clear manner using so called the standard transportation matrix, shown in Figure 2 [22].

Destinations / Sources	B1	B2	……………	Bn	Σ
A1	c11 x11	c12 x12	……………	c1n x1n	a1
A2	c21 x21	c22 x22	……………	c2n x2n	a2
…………..	……..	……..	……..	……..	……..
Am	cm1 xm1	cm2 xm2	……………	cmn xmn	am
Σ	b1	b2	……………	bn	S

Figure 2: Standard transportation matrix

This matrix is often used for a more user friendly presentation and efficient solving of specific problems and tasks. On the basis of the above-defined models can be prove the following statement which characterizes the necessary and sufficient conditions of solvable TP [19].
Theorem 1: The transport problem has a solution if and only if the total supply equals the total demand, i.e.

$$\sum_{j=1}^{n} a_i = \sum_{i=1}^{m} b_j = S. \tag{3}$$

The proof of the previous (and the following) theorem can be find, for instance. The TPs in which it is satisfied the equality (3) are called the closed transport problems. Also, it is valid [21].
Theorem 2: In the closed TP, the system of equations (3) has $m + n - 1$ linearly independent equations, i.e. coefficient matrix of this system has rank $m + n - 1$. Based on the previous theorems it can be concluded that any solution and TP has the same number of values of xij, exactly $m + n - 1$, which will be different from zero. We'll call this value a basic values, unlike other, non-basic values for which it is valid $xij = 0$. The main goal in solving TP is to find the optimal values xij whose provide minimum total cost of transportation of goods, i.e. values for those the transportation functions (1) reaches its minimum [20].

IV. TRANSPORTATION PROBLEM USING MATLAB

Transportation problem in the domain of operations research has been one of the aged linear programming application problems developed by Hitchcock by originality. From the nature of the problem and based on the simplex algorithm, more efficient methods were developed. Just like the simplex algorithm, an initial basic feasible solution is also required in solving the transportation problem. In this working environment, methods such as Row Minima, Matrix Minima, Column Minima, North-West Corner Rule, Least Cost or the Vogel Approximation is used [6]. In theory and practice, all transportation problems can be modeled as a standard linear programming problem implying that, simplex method as a solution technique can be employed. However, transportation problem as a special case of linear programming problem can be solved more efficiently using solution schemes such as Steeping Stone Algorithm or Modified Distribution Method (MODI) in search of an optimal solution to the problem [7].
Stepping Stone Method that was first derived was intended to serve as an alternative solution to determining the solution at

optimality [8]. However, LINDO (Linear Interactive and Discrete Optimization) package serves as a computational tool with built-in properties which handles transportation problems in its explicit form and solves the problem as a standard linear programming problem. To this effect and to the best of our knowledge, no MATLAB function has been written to handle this problem, although is now obvious that more scientist in the scientific world are into the usage of MATLAB environment. Not with standing the fact that people need such function to make their computations easier? A MATLAB function, that is, vogel and Modi method was developed to implement the Vogel Approximation Method, which helps get the IBFS and Modified Distribution Method, which also test for the optimality of the IBFS based on the assumption that the problem is balanced [10].

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