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Framework for Role of Transportation in Estimated Resources Supplying In Construction Site

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Abstract—Engineering construction projects play an important role in national economic development. India, which contributed approximately 8.5% to the total of India's GDP. Project schedule slips, budget overruns, compromised quality, resulting claims and counter-claims problems have plagued the industry. The reasons for poor project performances abound. Previous researches have dealt much with the problems of project risk and uncertainty, variations in project outcomes, work fragmentation, complex relationships among stakeholders and activities, and excessive phase overlaps in general Construction projects are implement ting different phases., viz conception phase, definition phase, planning phase, scheduling phase, controlling phase and termination phase Many construction projects suffer from delay. Delays give rise to disruption of work and loss of productivity, late completion of project increased time related costs, and third party claims and abandonment or termination of contract Various factors affect completion periods of projects The objective of paper identifying the causes of delay delivering renewable and non renewable resource to site, and optimize transportation costs of resources for supplying to sites. To study current status problems of resource delivery procedure for construction industries and develop effective resource supply model. Construction projects are facing numerous problems related to resources supply to various construction project sites. The proposed framework is evaluated through expert interviews and literature survey, to develop the model addressing the problems are involving in distribution of various resources to supply for executing construction projects This framework also provides physical distribution of resources from different point of sources to construction project sites and mapping for the improvement of business performance in construction industries .

Keywords—Renewable and non renewable resources, transportation cost, transshipment quantity, delivery channel, construction site, replenishment quantity of resources, stores location etc.,

I. INTRODUCTION

The goals of EPC industries provide deliverable project product (facilities) to customers / owner / developers of their needs, wishes and desires are defined, quantified and qualified into clear requirements which was communicated Construction project activities are consumes resources Planning is required for supplying resources at right quantity, right time and good condition to the site. Construction industries are facing problems to supply resources physically to project sites at lower cost, at the earliest time and good condition of resources. Transshipment planning problems are more complexity in construction projects. Construction sites are geographically spread different locations. The resources storing facilities also geographically spread different locations. Construction projects sites team estimating resources quantities and quantities are vary site to site depends on owners of project requirements. Resource capacity of storage facility varies location to location. Distance between project sites and storage facilities are varying. Transportation cost and transit time varying stores in the function of time and location of site and storage facility. The transport of construction resources accounts for 20% of energy consumed by the construction industry R A Smith etc., (2003).
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II. RESEARCH METHODOLOGY:

- To identify potential the research problems focusing in the area of resource supplying to construction sites from EPC industries and vendors' of EPC industries
- Data and information of EPC industries are collected using the following methods
- To interview senior management of contractor, Construction management, consultant and owner of EPC industry project and visit construction project site to collect the research related data and information
- To collect information of EPC industry through literature survey like to referred research problems related international journals
- To develop the integrated business performance enhancement model through heuristic optimization analysis and achieve the trade-off of the transportation cost and transshipment quantities of resources
- To measure the business performance factors of EPC industries

III. FORMULATION

This paper addresses transport of resources in construction projects. The problem focuses on transshipment and transport of renewable or non renewable resources. To develop Tradeoff model between cost and time in the transport of

resources in the construction sites In this paper focuses on renewable, non renewable resources are physically supplying to construction projects.
To optimize transportation cost for transport of resources to construction sites.

3.1. Resources:

Renewable resources are available (Blazewicz et.al. (1986) on a period –by-period basis that is the amount is renewable from period to period. Renewable resources are limited at particular time. Typical examples of renewable resources included machines, tools, equipment, space, manpower etc.,

Non renewable resources are available on a total project basis, with limited consumption availability for the entire project. Typical examples of nonrenewable resources included raw materials, components, consumption materials etc.,

Doubly constrained resources are constrained per period as well as for the overall project combination of renewable and nonrenewable resources.

Partially renewable, nonrenewable resources (B□ ttcher et al. (1996), Drexl (1997) examples of manpower may work on every day from Monday through Friday and either on Saturday or on Sunday but not both. Man power is working renewably weekends and man power is nonrenewable in weekdays.

Resource is called preemptible if each of its units may be preempted, i.e. .withdrawn from currently processed tasks, allotted to another task and then returned to the previous task. Resources which do not posses the above property are called or non preemptible . (Blazewicz et.al. (1986)
Location of construction sites, location of resources storage facility.

Distance between storage and project sites. Transport cost of resources for loading, transit, toll and unloading cost from storage/construction site

3.2. Notations:

Location of resources storage = Source (k)
Location of construction site = Sink (n)

C_{ij} = Unit transportation cost of resources from source i to sink j (i=1,2,3,…..k; j=1,2,3,4….n)

A_i= No. of units of resources are available at Source (i) (i=1,2,3,4…k)
B_j= No. of units of resources are allocated at sink (j) (i=1,2,3,4…n)

X_{ij} = Quantities of resources supplying from source (i) to sink (j)
X_i = Quantities of resources inventory in sources (k) (i=1,2,3,..k)
X_j = Quantities of resources inventory in sink (n) (j=1,2,3,..n)
$-X_i$ = Quantities of resources backlog in sources (k) (i=1,2,3,..k)
$- X_j$ = Quantities of resources backlog in sink (n) (j=1,2,3,..n)
D_{ij} Distance between source i and sink j (i=1,2,3,…..k; j=1,2,3,4….n)
P_j = Penalty cost of backlog quantity of resources at the construction site
H_j = Holding cost of inventory quantity of resources at the storage
Z = Total transportation cost

3.3. Model

The objective of the problem is to determine the amount of resources to be shipped from each source to each construction site such that the total transportation cost is minimized

3.3.1.Scenario –I

When $\sum_{i=1}^{k} A_i = \sum_{j=1}^{n} B_J$ (I)

Minimize transportation cost
Objective function is

$$\mathbf{Z=} \sum_{i=1}^{k}\sum_{j=1}^{n} C_{ij} \times X_{ij} \qquad \textbf{(1)}$$

$$\textbf{Subject to } \sum_{j=1}^{n} X_{ij} = A_i \ \textbf{(i=1,2,3….k)} \qquad \textbf{(2)}$$

$$\sum_{i=1}^{k} - X_{ij} = -B_j \,(j = 1,2,3.....n) \qquad \textbf{(3)}$$

$$X_{ij} \geq 0 (i = 1,2,3....k;\ j = 1,2,3,4....n) \qquad \textbf{(4)}$$

Expression (1) represents the minimization of the total distribution cost, assuming a linear cost structure for shipping. Equation (2) states that the amount being shipped from source *i* to all possible destinations should be equal to the total availability, A_i , at that source. Equation (3) indicates that the amounts being shipped to destination *j* from all possible sources should be equal to the requirements, B_j, at that destination. Usually Eq. (3) is written with positive coefficients and right-hand sides by multiplying through by minus one.

3.3.1.1.Linear programming format

Minimize

$$Z = (C_{11}X_{11} + C_{12}X_{12} + \ldots + C_{1n}X_{1n}) + (C_{21}X_{21} + C_{22}X_{22} + \ldots + C_{2n}X_{2n}) + . \ldots + (C_{k1}X_{k1} + C_{k2}X_{k2} + \ldots + C_{kn}X_{kn})$$

Subject to

$$X_{11} + X_{12} + \ldots\ldots + X_{1n} \le A_1;$$

$$X_{21} + X_{22} + \ldots\ldots + X_{2n} \le A_2;$$

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$$X_{k1} + X_{k2} + X_{k3} + \ldots X_{kn} \le A_k$$

$$-X_{11} - X_{12} - \ldots\ldots - X_{1n} \le -B_{1;}$$

$$-X_{21} - X_{22} - \ldots\ldots - X_{2n} \le -B_2$$

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$$X_{k1} - X_{k2} - X_{k3} - \ldots - X_{kn} \le -Bn$$

$$X_{ij} \ge 0 \ (i = 1,2,3\ldots k;\ j = 1,2,3..n)$$

C_{11} **-Denotes transport cost from source destination 1 to sink destination2**

C_{ij} = f (D_{ij}, W_k, V_k)

D_{ij} Distance between source i and sink j (i=1,2,3,…..k; j=1,2,3,4….n)

W_k Weight of the resource (i= 1, 2,3,4…….k)

V_k Volume of the resource (i= 1, 2,3,4…….k)

3.3.2. Scenario –II

When $\sum_{i=1}^{k} A_i > \sum_{j=1}^{n} B_j$

Then holding cost incurs due to inventory built-up in resources storing destination

Minimize the transportation cost

$$Z = \sum_{i=1}^{k}\sum_{j=1}^{n} C_{ij} \times X_{ij} + \sum_{i=1}^{k} H_i \times X_i + \sum_{j=1}^{n} H_j \times X_j \quad \textbf{(5)}$$

Subject to

$$\sum_{j=1}^{n} X_{ij} < A_i \ \textbf{(i=1,2,3….k)} \quad \textbf{(6)}$$

$$\sum_{i=1}^{k} - X_{ij} > -B_j \,(j = 1,2,3.....n) \quad \textbf{(7)}$$

$$X_{ij} \ge 0 (i = 1,2,3....k;\ j = 1,2,3,4....n) \quad \textbf{(8)}$$

Expression (5) represents the minimization of the total distribution cost, assuming a linear cost structure for shipping. Equation (6) states that the amount being shipped from source *i* to all possible destinations should be less than the total availability, A_i , at that source. Equation (7) indicates that the amounts being shipped to destination *j* from all possible sources should be greater to the requirements, B_j, at that destination. Usually Eq. (7) is written with positive coefficients and right-hand sides by multiplying through by minus one.

3.3.2.1. Linear programming format

Minimization of transportation cost

$$Z = (C_{11}X_{11} + C_{12}X_{12} + \ldots + C_{1n}X_{1n}) + (C_{21}X_{21} + C_{22}X_{22} + \ldots + C_{2n}X_{2n}) + . \ldots + (C_{k1}X_{k1} + C_{k2}X_{k2} + \ldots + C_{kn}X_{kn}) + (H_1X_1 + H_2X_2 + H_3X_3 + \ldots + H_kX_k) + (H_1X_1 + H_2X_2 + \ldots H_nX_n$$

Subject to

$$X_{11} + X_{12} + \ldots\ldots + X_{1n} < A_1;$$
$$X_{21} + X_{22} + \ldots\ldots + X_{2n} < A_2;$$

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$$X_{k1} + X_{k2} + X_{k3} + \ldots X_{kn} < A_k$$
$$-X_{11} - X_{12} - \ldots\ldots - X_{1n} > -B_{1;}$$
$$-X_{21} - X_{22} - \ldots\ldots - X_{2n} > -B_2$$

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$$X_{k1} - X_{k2} - X_{k3} - \ldots - X_{kn} > -Bn$$
$$X_{ij} \geq 0 \ (i = 1,2,3\ldots k;\ j = 1,2,3..n)$$

3.3.3.Scenario –III

When $\sum_{i=1}^{k} A_i < \sum_{j=1}^{n} B_j$

Then Backlog cost incurs due to inventory built-up in resources storing destination
Minimize the transportation cost

Z= $\sum_{i=1}^{k}\sum_{j=1}^{n} C_{ij} \times X_{ij} + \sum_{i=1}^{k} P_i \times X_i + \sum_{j=1}^{n} P_j \times X_j$ **(9)**

Subject to

$$\sum_{j=1}^{n} X_{ij} > A_i \quad \textbf{(i=1,2,3….k)} \qquad \textbf{(10)}$$

$$\sum_{i=1}^{k} -X_{ij} < -B_j (j = 1,2,3.....n) \qquad \textbf{(11)}$$

$$X_{ij} \geq 0 (i = 1,2,3....k;\ j = 1,2,3,4....n) \qquad \textbf{(12)}$$

Expression (9) represents the minimization of the total distribution cost, assuming a linear cost structure for shipping. Equation (10) states that the amount being shipped from source *i* to all possible destinations should be less than the total availability, A_i , at that source. Equation (11) indicates that the amounts being shipped to destination *j* from all possible sources should be greater to the requirements, B_j, at that destination. Usually Eq. (11) is written with positive coefficients and right-hand sides by multiplying through by minus one.

3.3.3.1. Linear programming format

Minimization of transportation cost

$$Z = (C_{11}X_{11} + C_{12}X_{12} + \ldots. + C_{1n}X_{1n}) +$$
$$(C_{21}X_{21} + C_{22}X_{22} + \ldots + C_{2n}X_{2n}) + .$$
$$\ldots + (C_{k1}X_{k1} + C_{k2}X_{k2} + \ldots + C_{kn}X_{kn}) + (P_1X_1 +$$
$$P_2X_2 + P_3X_3 + \ldots + P_kX_k) + (P_1X_1 +$$
$$P_2X_2 + \ldots P_nX_n$$

Subject to

$$X_{11} + X_{12} + \ldots\ldots + X_{1n} > A_1;$$
$$X_{21} + X_{22} + \ldots\ldots + X_{2n} > A_2;$$

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$$X_{k1} + X_{k2} + X_{k3} + \ldots X_{kn} > A_k$$
$$-X_{11} - X_{12} - \ldots\ldots - X_{1n} < -B_{1;}$$
$$-X_{21} - X_{22} - \ldots\ldots - X_{2n} < -B_2$$

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$$X_{k1} - X_{k2} - X_{k3} - \ldots. - X_{kn} < -Bn$$
$$X_{ij} \geq 0\ (i = 1,2,3\ldots k;\ j = 1,2,3..n)$$

IV. SOLVING THE TRANSPORTATION PROBLEM

Solution of optimum resource quantity is required to deliver supply to different construction sites from different storage destination at minimum transportation cost with different working business scenarios. Transportation problems to develop an efficient algorithm for the general minimum-cost flow problem by specializing the rules of the simplex method to take advantage of the problem structure. However, before taking a somewhat formal approach to the general problem, the method will indicate the basic ideas by developing a similar algorithm for the transportation problem. The properties of this algorithm for the transportation problem will then carry over to the more general minimum-cost flow problem in a straightforward manner. Historically, the transportation problem was one of the first special structures of linear programming for which an efficient special-purpose algorithm was developed. In fact, special-purpose algorithms have been developed for all of the network structures many transportation computational algorithms are characterized by three stages

1. Obtaining an initial solution;
2. Checking an optimality criterion that indicates whether or not a termination condition has been met (i.e., in the simplex algorithm, whether the problem is infeasible, the objective is unbounded over the feasible region, or an optimal solution has been found);
3. Developing a procedure to improve the current solution if a termination condition has not been met. After an initial solution is found, the algorithm repetitively applies steps 2 and 3 so that, in most cases, after a finite number of steps, a termination condition arises. The effectiveness of an algorithm depends upon its efficiency in attaining the termination condition. Since the transportation problem is a linear program, each of the above steps can be performed by the simplex method. Initial solutions can be found very easily in this case, however, so phase I of the simplex method need not be performed. Also, when applying the simplex method in this setting, the last two steps become particularly simple.

   The transportation problem is a special network problem, and the steps of any algorithm for its solution can be interpreted in terms of network concepts. However, it also is convenient to consider the transportation problem in purely algebraic terms

Initial solutions variables of transportation cost are obtained by the following traditional methods. The basic initial solutions are determined by Northwest corner method (NW corner method) . NW corner method is easy to use and requires simple calculations (J. Reeb et.al 2002). NW corner solutions are not optimal solutions. Transport problems with

degeneracy initial basic solution is determined by with better accuracy is Vogel Approximation Method and MODI method Minimum cost (Row minimum, Colum minimum) methods are use to determine initial basic solutions.
The blocking method for finding an optimal solution to bottleneck transportation problems

4.1.The blocking method

Algorithm:
Step 1: Find the maximum of the minimum of each row and column of the given transportation table.
Step 2: Construct a reduced transportation table from the given table by blocking all .
Step 3. Check if each column demand is less than to the sum of the supplies in the reduced transportation problem obtained from the Step 2.. Also, check if each row supply is less than to sum of the column demands in the reduced transportation problem obtained from the Step 2.. If so, go to Step 6.(Such reduced transportation table is called the active transportation table). If not, go to Step 4.
Step 4: Find a time which is immediately next to the time allocated value.
Step 5: Construct a reduced transportation table from the given transportation table by blocking all cells having time more than U and then, go to the Step 3..
Step 6: Do allocation according to the following rules:
(a) allot the maximum possible to a cell which is only one cell in the row / column . Then, modify the active transportation table and then, repeat the process till it is possible or all allocations are completed.
(b) If (a) is not possible, select a row / a column having minimum number of unblocked cell and allot maximum possible to a cell which helps to reduce the large supply and/ or large demand of the cell.
Step 7: This allotment yields a solution to the given bottleneck transportation problem.
The basic solutions of allocated resource quantities from blocking method is developing further towards optimal solution is given by using Bottleneck Cost Transportation BCTP and Blocking Zero point method (R.S. Garfinkel and M.R. Rao, (1979) and Y.P. Aneja and K.P.K.Nair(1974) ,
Computer solutions for formulated transportation problems with degeneracy linear programming are solving by LINDO software the software will solve the LP problem. It will add *slack, surplus,* and *artificial variables* when necessary. (J. Reeb et.al 2002) LINDO is systems of tools. LINDO includes the following software Optimization software, integer programming, linear programming, nonlinear programming, stochastic programming and Global optimization

4.2.Combinatorial Optimization - Heuristics, and Meta-heuristics Manar Ibrahim Hosny (2010):

The importance of CO problems stems from the fact that many practical decision making issues concerning, for example, resources, machines and people, can be formulated under the combinatorial optimization framework. As such, popular optimization techniques that fit this framework can be applied to achieve optimal or best possible solutions to these problems, which should minimize cost, increase performance and enable a better usage of resources.

combinatorial optimization problem (Maniezzo et al. 1998; Kowalski 2005). These transportation problems have been solved optimally using exact algorithms such as stage ranking and branch-and-bound methods used in mixed-integer programming (MIP) (Adlakha and Kowalski 2003). However, the application of these methods has been restricted to small-scale problems because computation time dramatically increases with problem size (Kowalski 2005). For even a medium-scale problem with hundreds to thousands of edges, the computation time required by MIP
might be so large that the problem becomes unsolvable for

practical purposes (Adlakha and Kowalski 2003). Several approximation algorithms, generally called heuristics, have been developed to solve larger problems in a reasonable time (Gottlieb and Paulmann 1998; Sun et al. 1998).

Meta-heuristic Algorithms: Heuristic methods are yielding estimated resources approximate solution of resource quantity (X_{ij}) to be delivered to different storage depot to different construction sites. The variables compared with different heuristic methods in the performance factor cost, time and profit of transportation problems. Heuristic procedures based Evolution algorithms like Genetic Algorithms, Simulated Annealing, Tabu Search and Ant colony Optimization

4.3.Genetic Algorithms

were introduced by (Holland, 1975) as a method for modeling complex systems. They are a class of powerful search algorithms applicable to a wide range of problems with little prior knowledge. GAs are particularly good at global search and can deal with complex and multimodal search landscapes. They are known as effective methods that allow obtaining near-optimal solutions in adequate solution times. GAs is an evolving important component of artificial intelligence, based on fundamental principles of Darwinian evolution and genetics. GAs are robust general-purpose search program based on the mechanism of natural selection and natural genetics. Genes and chromosomes are the fundamental elements in GAs. A chromosome is a string of genes. In a real problem, genes are the variables that are considered influential in controlling the process being optimized, and chromosome is a solution to the problem. Genetic Algorithms (GAs) search for the optimal solution from populations of chromosomes. A GA may be defined as an iterative procedure that searches for the best solution of a given problem among a constant-size population, represented by a finite string of symbols, the genome. The search is made starting from an initial population of individuals often randomly generated. At each evolutionary step, individuals are evaluated using a fitness function. High-fitness individuals will have the highest probability to reproduce.
The evolution (i.e., the generation of a new population) is made by means of two operators: the crossover operator and the mutation operator. The crossover operator takes two individuals (the parents) of the old generation and exchanges parts of their genomes, producing one or more new individuals (the offspring). The mutation operator has been introduced to prevent convergence to local optima, in that it randomly modifies an individual's genome (e.g., by flipping some of its bits, if the genome is represented by a bit string). Crossover and mutation are performed on each individual of the population with

probability Pc and Pm respectively, where Pm<Pc. Further details on GA can be found in (Falkenauer 1998, Goldberg D 1989).

4.4.Procedure for evolution program

begin
t ← 0
Initialize P(X_{ij})
evaluate P(X_{ij})
while (not termination-condition) do
begin
X_{ij} ← i + 1, j+1
select P(X_{ij}) from P(X_{ij}-1)
alter P(X_{ij})
evaluate P(X_{ij})
end
end

V. CONCLUSION

In this paper Construction Industries are facing problems to supply the resources to construction sites. Formulated the transportation problem to deliver the resources quantities at the minimum transportation cost the scope of the paper is time factor of transport might be significant in several transportation problems. The proposed methods are quite simple from the computational point of view and also, easy to understand and apply. By blocking zero point method, we obtain a sequence of optimal solutions to a bottleneck-cost transportation problem for a sequence of various time in a time interval. This method provides a set of transportation schedules to bottleneck-cost transportation problems which helps the decision makers to select an appropriate transportation schedule, depending on his financial position and the extent of bottleneck that he can afford. The blocking zero point method enables the decision maker to evaluate the economical activities and make the correct managerial decisions.

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