A Review Paper on Construction Site Layout Planning

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Abstract- Site space is limited resource where all temporary facilities are to be provided within boundary of construction site. In India site layout planning is mostly a neglected aspect. For site layout planning various techniques are used such as Genetic Algorithm, Simulation techniques and Ant colony. In this study Genetic Algorithm is discussed in detail. This work also focuses on the various software being used for the site layout problem. The review of literature for various aspects other than economy is presented this paper.

Keywords – Site layout planning, Genetic algorithm, Temporary facilities, Proximity weight.

I. INTRODUCTION

Site space is a resource that is as important as money, time, material, labor, and equipment .Site space is a limited where all facilities are required to be provided within the boundary of the site. Ideal site layout is one where the cost of the product is kept to minimum, with a large market share, the least risk and the maximum social gain. Generally utilization of site space is based on project managers experience and proper site planning is neglected. Good site layout, however, is important to promote safe and efficient operations, minimize travel time, decrease material handling, and avoid obstructing material and equipment movements (Tommelein et al. 1992b).

Site layout planning problem is defined as the problem of identifying the number and size of temporary facilities to be laid out, identifying constraints between facilities, and determining the relative positions of these facilities that satisfy constraints between and allow them to function efficiently (Zouein et al. 2002). Site layout planning is essential for a productive construction project because estimated profit margins are small, the relative efficiency of the construction site can influence the profitability of the project. Temporary facilities vary in different projects and may include construction equipment warehouse maintenance shops batch plants residential facilities fabrication yards , lay down areas, offices and parking lots (Tommelein 1992a ; Sebt et al. 2008)

As per FIDIC (Fédération Internationale Des Ingénieurs – Conseils) document around 10% amount of total project cost is paid by client for site mobilization. Site layout planning is one of the important part of site mobilization. Site layout planning is a main resource which allocates site space for temporary facilities which require for construction. Site layout planning will improve work efficiency and minimize the material handling cost.

II. DIFFERENT TOOLS AND TECHNIQUES

For site layout planning problem has been solved by researchers using different techniques like Genetic algorithm, Simulation techniques and Ant Colony Optimization technique (ACO).

Simulation techniques

Capabilities of simulation in modeling availability of resources as well as idleness, production rate and productivity of equipment and labors facilitate the consideration of interaction between activities. The advantage of model is the

input data to not have to be deterministic. Stochastic data can also be implemented in simulation model. In simulation model time based factors such as total project time and resource idleness can be taken into assist planners in decision making. Simulation is a suitable tool for site layout planning of projects with repetitive activities, close interactions between activities in a tight schedule, and limited number of resources. Otherwise simulation is not very beneficial.

Ant Colony Optimization (ACO)

Ant Colony Optimization algorithms are metaheuristic methods for tackling combinatorial optimization problems . The central component of an Ant Colony Optimization algorithm is the pheromone model, which is used to probabilistically sample the search space. As outlined in Blum and Dorigo (2004), the pheromone model can be derived from a model of the Com-binatorial Optimization (CO) problem under consideration

Genetic algorithm (GA)

In this paper all aspects related to Genetic Algorithm techniques are discussed in detailed. The main objective in most site layout planning by using of Genetic algorithm models is to minimize travel time and costs. There are two approaches to define the objective function for optimization a) Quantitative method and b) Qualitative method.

a) Quantitative method: Quantitative method is used to assess the facilities closeness relationship. It states that the actual transportation cost per unit distance between facilities can be used as a measure for the closeness weight.

b) Qualitative method: In the literature (Hegazy and Elbeltagi 1999) six closeness relationships are usually set in advance. The weight values used are shown in Table 1, expressing an exponential relationship with desired closeness. A high level proximity weight between two facilities means that they share high level of interaction; accordingly, the distance between them should be small. A weight value of unity also means that the two facilities have no interaction between them and the distance separating them is irrelevant.

In all optimization approaches for site layout planning, the layout goal to be attained is to minimize transportation cost. Site layout planning goal is achieved by using of one of the formula is used and that is called objective function.

$$\text{Objective Function} = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} DijRij$$

Where n = total number of temporary facilities; Dij = travel distance between facilities i and j; Rij = a relative proximity weight it depends on closeness relationship between facilities i and j.

Table 1: Closeness relationship values (Hegazy et. al.1999)

Desired relationship between facilities (1)		Proximity Weight (2)
Absolutely necessary	(A)	7,776
Especially important	(E)	1,296
Important	(I)	216
Ordinary closeness	(O)	36
Unimportant	(U)	6
Undesirable	(X)	1

III. SOFTWARE'S FOR SITE LAYOUT PLANNING

There are various software which are used for site layout planning. In each case the method of calculating closeness relationship is different. Researchers have used various software like AL-DEP, CORELAP and CRAFT.

AL-DEP: For site layout process The Automated Layout Design Program.

It starts by selecting the first facility at random and places it starting from a given point that represents the top left corner of the site (Seehof et. al. 1967). The next facility to be placed is the one that has the highest closeness relationship with the first facility. After placing all facilities one after the other. AL-DEP uses an objective function to assign a score to the layout and then repeats the process to construct a different layout until user satisfaction is reached.

CORELAP: Computerized relationship layout planning.

Select the first facility to be the one with the highest closeness relationship to all others (Lee et.al. 1967). The next facility to be placed is the one with the highest relationship with the highest relationship with first selected facility. In case of tie the facility with the higher relationship to all others is selected and the procedure continues until the layout is completed.

CRAFT: Computer relative allocation of facilities techniques.

A more detailed method of calculating the desired closeness relationship between facilities by considering distance, travel cost and material flow between facilities (Francis et. al. 1974). It then makes a pairwise location interchange of facilities that are either adjacent or have equal areas until the layout cost cannot be reduced further.

IV.SITE LAYOUT PLANNING BY USING OF GENETIC ALGORITHM:- VARIOUS ASPECTS

Site Layout Planning is not only important from economy and convenience point of view but it is also required for environment and safety aspects. In this section various aspects which are considered by researchers while study site layout planning are reviewed.

1) Safety and Environmental aspects: (Haytham M. Sanad et. al. 2008)

Safety and Environmental issues are the most important concerns in every project. In site layout planning, safety and environmental are confined to those that are intensified or lessened by distances between facilities, e.g. the potential hazard of some explosive materials is reduced by increasing the distance away from work areas.

Safety considerations and environmental aspects those are considered in this model are prohibited area, minimum distance, and safety zones.

Prohibited areas: A prespecified area in the job site must be prevented from being allocated to facilities with harmful effects. For example construction site adjacent to a hospital or school, collages etc. it is important to prevent some facilities that harmful effects (such as noise, air pollution, etc.)

Safety zones: Safety zones represent an additional area added to the physical area of the facilities to protect any person who might be injured by the fall of materials, tools, or equipment being raised or lowered. Safety zones should be specified in adequacy with respect to regulations, such as OSHA (1987) and UBC (1985).

Actual route distance between facilities: The existing method to determine the distance between facilities is a Euclidean distance. In this model the actual route distance between facilities is a network of internal routes in the site should be specified first. Internal routes are usually continuous to facilitate movement of facilities, and hence measuring distance between them.

2) EVO-SITE: Evolution Based Model for Site Layout Planning: (Tarek Hegazy et. al.1999)

In this work a facility is represented as a group of unit areas that can take any user specified shape. The model accepts any user-specified site shape and incorporates a flexible Genetic Algorithm procedure for the optimum placement of facilities.

3) Unequal size and Constrained Facilities: (P.P. Zouein et.al. 2002)

The variations stem from the assumptions made on the size and shape of facilities and on the constraints between them. Facilities may have a defined shape and size or a loose shape, in which case researcher has assume the shape of the site to which they have been assigned. The constraints can vary from simple nonoverlap constraints to other geometric constraints that describe orientation or distance constraints between facilities. In this model shape and size of facilities are fixed. Facilities have 2D geometric constraints on their relative positions along with proximity weights describing the level of interaction or flow between them.

V.CONCLUSION

Site layout planning is one of the most important aspect in construction. For site layout planning mainly three techniques are used Genetic algorithm, simulation technique and Ant colony optimization technique. To calculate objective function qualitative method is more convenient for large projects as qualitative method involves less calculations as compare to Quantitative method for which tedious mathematical calculations are required.

Among these techniques Genetic Algorithm is easy to apply as Microsoft Excel can also be used for encoding. In today's Indian scenario the use available techniques for site layout planning is very less. Large amount of research and applications in the field of site layout planning is needed.

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