Site Layout of Temparory Construction Facilities using Ant Colony Optimization.

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Abstract. Site space is a resource that is as important as money, time, material, labor, and equipment. Despite its importance, site planning is often neglected, and the attitude of engineers has been that it will be done as the project progresses. 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, especially in the case of large projects . In addition, such a problem becomes far from trivial if a construction site is confined due to the lack of available space, or if the site is very large, then traveling between facilities can be considerably timeconsuming. Aim of Construction Site Layout planning is to find convenient an feasible locations for different temparory facilities.

When temparory site level facilities are required to be located on a construction site the locations of buildings to be constructed are assumed to be known. These locations are used to define available sites for temparory facilities. Then the problem can be defined as allocation of predetermined facilities like warehouses, job offices, workshops and batch plants so as to optimize an objective subject to layout constraints and requirements. Using such a definition of the problem, formulation in terms of a combinatorial optimization problem has been attempted. The vector of decision variables is the location of all the n_f facilities with the constraints being the uniquness of location and site for a particular facility. The objective is typically to minimize sum of product of resource flow(considered in a generic sense) between two *facilites* and distance between the *locations* of the two facilites. The problem is a special case of the Quadratic Assignment Problem (QAP), which is one of the most difficult $\mathcal{NP}-$complete problemS. Researchers have attempted various heuristic based techniques and approximation algorithms to solve the problem. In literature, some of the solution techniques used were Simulated Annealing, Neural Networks, Genetic Algorithms and other AI–based techiniques.

In this work a solution to the problem is attempted using Ant Colony Optimization(ACO) algorithm, inspired by the foraging behavior of real ants. When searching for food, ants initially explore the area surrounding

their nest in a random manner. As soon as an ant finds a food source, it evaluates quantity and quality of the food and carries some of the food found to the nest. During the return trip, the ant deposits a chemical pheromone trail on the ground. The quantity of pheromone deposited, which may depend on the quantity and quality of the food, will guide other ants to the food source. The indirect communication between the ants via the pheromone trails allows them to find shortest paths between their nest and food sources. This behaviour of real ant colonies is exploited in artificial ant colonies in order to solve discrete optimization problems.

Formulation of site layout problem in terms of a solution construction graph to be used by (artificial) ants has been attempted. Artificial ants perform random and guided walks on this construction graph to find feasible and high quality solutions. The allowed walks on this graph produce only feasible solutions. Previous researchers have used penalty functions and other techniques to repair infeasible solutions. In the present model no such *exterior* constraint handling technique has been used. This leads to a considerable improvement in compuational efficiency as infeasible solutions are not generated at all. Efficacy of the model has been demonstrated with a case study of a 12 facility problem.