Chapter 3


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ABSTRACT

Several heuristics algorithms can be employed to solve single row layout in construction site planning. Firstly, this chapter builds Tabu Search to deal with the problem. Other heuristics methods which are genetic algorithm (GA) and estimation distribution algorithm (EDA) are also developed against Tabu Search. A comparative study is performed to test the effectiveness and efficiency of the algorithms. The statistical test, ANOVA followed by the t-test, compares the results of the three algorithms. Then, the pros and cons of using the algorithms are stated.

INTRODUCTION

The arrangement of machines in construction site layout can improve in cost reduction and time savings during the construction process. In construction site planning, there is a case when the facilities need to be placed in a row. The case is also known as a single row facility layout problem. The objective is to minimize the sum of the distance between facilities for the given traffic loads of the facilities.
This problem is categorized as an NP-Complete problem and heuristics method is needed to provide a near-optimal solution (Samarghandi & Eshghi, 2010). Several heuristics methods can be used to deal with this problem. Some research use metaheuristics method like Genetic Algorithm (Datta, Amaral, & Figueira, 2011), Particle Swarm Optimization (Samarghandi, Taabayan, & Jahantigh, 2010), and Ant Colony Optimization (Solimanpur, Vrat, & Shankar, 2005), while others employed heuristics methods like Estimation Distribution Algorithm (Ou-Yang & Utamima, 2013) and Variable Neighborhood Search (Guan & Lin, 2016).

An early work on the benefits of heuristics for facility layout problem (FLP) was introduced by Kumar et al. (Kumar, Hadjinicola, & Lin, 1995). The method used is greedy heuristic to minimize the cost of material for a single-row layout. The main contribution is the two premises can be included at any step of the proposed method when generating an optimal solution. Another evolutionary-based approach, namely psychoclonal algorithm, was demonstrated to resolve the layout design in a manufacturing system (Khilwani, Shankar, & Tiwari, 2012). The main objective functions considered are activity relationship and distance from one department to other departments.

Uno and Hirabayashi (2009) suggested the correlated mutation technique as a mutation operator for evolution strategies (ES) in solving facility layout. ES is a method that similar to genetic algorithm uses a self-adaptive strategy. The experiments indicated that the correlated mutation is better than the simple mutation approach. To deal with the multi-objective case, Ripon et al. (Ripon et al., 2009) propose a genetic algorithm with a support from Pareto-optimum to get trade-off solutions from various objectives. There are two parameters considered for two objective functions, i.e. material handling cost, which based on quantitative model and closeness rating score that represents qualitative approach. Ripon et al. (2013) improve their work by employing an adaptive local search based on a variable of neighborhood search and genetic algorithm for solving a multi-objective FLP.

Genetic Algorithm (GA) simulates natural evolution process which generates a group candidate solution with selection to the best candidates, crossover, and mutation. GA become a useful optimization technique to deal with many kinds of problems since it is flexible and only need pieces of knowledge (Goldberg, 1989). Several applications of facility layout problem used many types of GA as the optimization tool. Datta et al. (2011) use permutation-based GA for several instances of single row facility layout problem and they develop customized crossover and mutation operators. Therefore, SRFLP is modeled as an unconstrained optimization case. El-Baz (2004) use GA for facility layout problem in the different manufacturing environment (El-Baz, 2004) and the author considers various aspects such as materials flow and handling costs between manufacturing machines. The machines in the manufacturing department are modeled as the grids, and these grids then become chromosomes in the proposed GA (El-Baz, 2004). Said and El Rayes (2013) build and compare GA and dynamic programming for dynamic site layout planning which deals with nonlinear constraints. The authors reported that GA is outperformed by Approximate Dynamic Programming method, but GA still has the advantage to support multi-objective problem. Said & El-Rayes (2013) consider not only construction space, but also the schedule to build the construction site.

Estimation Distribution Algorithm (EDA) is an algorithm that mimics the statistical process of the sampling technique. EDA also uses randomization technique like GA in the beginning but choose the candidate solution based on the probabilistic model that defined before (Hauschild & Pelikan, 2011). Numerous applications use EDA to deal with their problem, i.e., flow shop problem (Zhang & Li, 2011), single machine scheduling (Chen, et al., 2010), and stochastic permutation flow shop (Wang, Choi, & Lu, 2015). Regarding construction site planning, EDA is employed to solve facility layout problem (Ou-