Abstract

Scheduling is one of the most important functions in almost all types of organizations, i.e. manufacturing and service organizations. Scheduling basically involves the matching of resources and activities in an effective manner in order to meet some objectives. In this research, two types of scheduling problems, which are single machine scheduling and care worker scheduling problems, are considered. Both problems can be classified as *NP*-hard scheduling problems in which finding the optimal solution is difficult. Exact algorithm and meta-heuristic algorithm are investigated to solve the problems.

The optimization technique called *Branch and Bound algorithm* (B&B) is applied to the single machine scheduling problem. The objective is to minimize the earliness/tardiness penalty and sequence-dependent setup cost. The problem is more general and more complex than many existing researches in the literature. The efficient algorithm is developed for obtaining a global optimal solution for this complex problem. To enhance the computational efficiency, a *Priority dispatching rule* with *Local improvement procedure* is used to derive an initial upper bound. The efficient lower bound based on heuristic and *Lagrangian relaxation* and two *Dominance criteria* are incorporated into basic B&B procedure to reduce number of nodes. B&B technique is applied to solve this problem since it is a very efficient technique for obtaining a global optimal solution. Although, the algorithm can optimally solve the small- to medium-sized problems in a reasonable time, the solutions can be used as benchmark for developing a heuristic techniques for larger sized problem.

In order to find an efficient procedure to solve larger problems, a meta-heuristic called *Particle Swarm Optimization* (PSO) technique is introduced. PSO is applied to the single machine scheduling problem with the objective of minimizing total tardiness where the setup time is sequence-dependent. This objective function is used in order to compare the effectiveness of PSO with other heuristics, since there are many previously proposed heuristics for this type of problem to be compared. A variety of improvement techniques such as *Local improvement procedure*, *Regroup*, *Resize* are investigated and the superior one is combined with PSO to further improve the solution quality. The performance of proposed Hybrid-PSO is compared with ant colony optimization which is the best known solution approaches for this problem in the literature.

The PSO is further applied to a more complex type of scheduling problem which is the scheduling of care workers. This problem is a genuine situation arising in a community service in the UK. The optimal routes for each care worker are determined in order to minimize the distance traveled providing that the capacity and service time window constraints are not violated. The *Heuristic assignment* scheme is specially designed to enable PSO to apply to this type of problem. The *Earliest Start Time Priority with Minimum Distance Assignment* (ESTPMDA) technique is developed for generating an initial solution which guides the search direction of the particle. *Local improvement procedures* (LIP), i.e. *insertion and swap*, are embedded in the PSO algorithm in order to further improve the solution quality. The proposed methodology is implemented, tested, and compared with existing solution methods on a variety of real problem instances.

This research contributes to the modification of the existing optimization technique (B&B) to optimally solve the complex and general single machine scheduling problem and the introduction of new effective algorithm (PSO) to compete with the best known approaches for single machine scheduling problem. Finally, this research contributes to the first application of PSO-based algorithm to the real care worker scheduling problem. It can be extended to solve all classes of similar problems.