Optimization of two-sided assembly line balancing with resource constraints using modified particle swarm optimisation

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Abstract. Two-Sided Assembly Line Balancing (2S-ALB) is essential to the production of large-sized high-volume products, including automotive production, at assembly plants. The 2S-ALB problem involves different assembly resources such as worker skills, tools, and machines required for the assembly. This research modeled and optimized the 2S-ALB with resource constraints. In the end, besides favorable workload balance, the number of resources can be optimized. For optimization purpose, particle swarm optimization was modified to reduce dependence on a single best solution. This was conducted by replacing the best solution with the top three solutions in the reproduction process. Computational experiment results using 12 benchmark test problems indicated that the 2S-ALB with a resource-constrained model was able to reduce the number of resources for use in an assembly line. Furthermore, the proposed Modified Particle Swarm Optimization (MPSO) was capable of searching for minimum solutions to 11 out of 12 test problems. The good performance of MPSO was attributed to its ability to maintain particle diversity over iterations. The proposed 2S-ALB model and MPSO algorithm were validated later using an industrial case study. This research makes a two-fold contribution: (a) Proposition of a novel 2S-ALB with resource-constrained model and (b) a modified PSO algorithm with enhanced performance.

1. Introduction

Assembly line is a system that considers arrangement of workstations, workers, tools, or machines, and it successively outlines operations so as to reach completion. It is widely used in many manufacturing industries to cope with growing demands in manufacturing. The assembly line is set up for the most optimum design to meet production demands. The assembly line system was introduced around 1900 by Henry Ford for his automobile plants [1]. Since then, various evolutions and progresses in the assembly line were reported. Derived from the above idea, the balancing approach has been developed for the assembly line, known as Assembly Line Balancing (ALB). Balancing an assembly line can be difficult for most industries. It refers to not only assigning a task to a respective workstation but also enhancing production rate with the desired performance level [2]. Nowadays, ALB has become instrumental in coping with global competitiveness in the industry. It classically started in 1955 when Salveson firstly described the typical ALB problem that focused on an efficient and fast solution approach to solving the line balancing problem [3].

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