Enhanced Mixed Integer Programming Formulations for Parallel Machines Scheduling with Machine Idle Time

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ABSTRACT

This study deals with the scheduling problem of minimizing the total earliness and tardiness (ET) on unrelated parallel machines with machine idle time. Its purpose is to gain insight into the effect of machine idle time for job scheduling performances and to test the improved mathematical formulations are very competitive for the quality and efficiency of solutions. The purposes were completed gradually as follows: 1) Two models, where the use of machine idle time is allowed and prohibited, designed to gain insight into the effect of machine idle time for job scheduling performances. The models constructed by mixed integer linear programming (MIP) and compared with each other. 2) The new developed MIP formulations were proposed to obtain the optimal solution for improving solving efficiency. They ensure the quality and efficiency of solution by comparing with the formulations in previous studies. In addition, job dispatching rules also can be applied to the model with allowance machine idle time in large-sized instances. 3) Enhanced Time-Indexed Integer Linear Programming (TI) formulations were proposed for rapidly solving efficiency. At the same time, developed scheduling horizons rigorously were adopted in TI formulations, which compare with the MIP formulations.

Several experiments, which use their respective test instances, were designed to complete the purposes. Results of computational experiments show that 1) The objective function ET can be significantly reduced by allowable machine idle time between jobs. However, the improvement of ET is especially beneficial if adding the number of machines, the due date is loose and broad with range and machine idle time is inevitable. 2) The improved MIP formulations were effective and competitive, where they can reduce the constraint sizes and were capable of reforming the potential problem in the references of Zhu and Heady (2000) and Omar and Teo (2006). 3) The proposed mathematical formulations gives optimal solutions for all test instances in a reasonable time. TI formulations obtain the same solution within a short time; 4) The dispatching rules yield comparably efficient and quality solutions of MIP formulations;

5) The developed scheduling horizons were able to greatly increase the efficiency of TI formulations.