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A bi-objective Genetic Algorithm for flexible flow shop scheduling: A real-world application in the electrical industry

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ABSTRACT

The electrical sector forces manufacturing companies of electrical solutions to continually innovate and implement new processes for greater efficiency. The growing demand for electrical energy, as well as the need to adapt to hybrid operations that combine multi-project operation models with continuous production models, requires efficient workflow management. Accordingly, this article proposes a Genetic Algorithm (GA) approach for solving the scheduling problem in a Flexible Hybrid Flow Shop (FHFS) environment considering a transfer batch approach to minimize makespan and total tardiness. The approach is inspired by a real-world application in the electrical industry and also accounts for unrelated parallel machines, precedence, release times, and due dates for jobs at each production center as key constraints. Three real-data scenarios were generated and evaluated. In the first scenario, a 7 % improvement in makespan was observed compared to real execution times. In Scenario 2, the makespan improved significantly by 33 %, and only 17.4 % of jobs were delayed, compared to 96 % in the real data. Likewise, GA showed a lightly better performance over Tabu Search (TS) in 3.01 % for makespan while the delayed jobs found by GA were 25 % below those obtained by TS. These results highlight the potential of the proposed method to improve overall production efficiency, not only in the electrical sector but also in similar industries.

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