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Due date optimization in multi-objective scheduling of flexible job shop production

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ABSTRACT

The manuscript presents the importance of integrating mathematical methods for the determination of due date optimization parameter for maturity optimization in evolutionary computation (EC) methods in multi-objective flexible job shop scheduling problem (FJSSP). The use of mathematical modelling methods of due date optimization with slack (SLK) for low and total work content (TWK) for medium and high dimensional problems was presented with the integration into the multi-objective heuristic Kalman algorithm (MOHKA). The multi-objective optimization results of makespan, machine utilization and due date scheduling with the MOHKA algorithm were compared with two comparative multi-objective algorithms. The high capability and dominance of the EC method results in scheduling jobs for FJSSP production was demonstrated by comparing the optimization results with the results of scheduling according to conventional priority rules. The obtained results of randomly generated datasets proved the high level of job scheduling importance with respect to the interdependence of the optimization parameters. The ability to apply the presented method to the real-world environment was demonstrated by using a real-world manufacturing system dataset applied in Simio simulation and scheduling software. The optimization results prove the importance of the due date optimization parameter in highly dynamic FJSSP when it comes to achieving low numbers of tardy jobs, short job tardiness and potentially lower tardy jobs costs in relation to short makespan of orders with highly utilized production capacities. The main findings prove that multi-objective optimization of FJSSP planning and scheduling, taking into account the optimization parameter due date, is the key to achieving a financially and timely sustainable production system that is competitive in the global market.

ARTICLE INFO

Keywords:
Flexible job shop scheduling problem (FJSSP);
Due date;
Makespan;
Capacities utilization;
Multi-objective optimization;
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Multi-objective heuristic Kalman algorithm;
Simio simulation and scheduling software

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Izvirni znanstveni članek

Optimizacija roka izdelave pri večkriterijskem prilagodljivem terminiranju proizvodnje po naročilu

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POVZETEK

Članek predstavlja pomen vključitve matematičnih metod v evolucijsko optimizacijo roka izdelave pri večkriterijskem problemu prilagodljivega terminiranja proizvodnje po naročilu (FJSSP). Za optimizacijo roka izdelave smo za primer nizke in polne zasedenosti strojev predlagali večkriterijski hevristični Kalmanov algoritem (MOHKA). Predlagan pristop je primeren za reševanje srednje težkih do zelo težkih problemov. Sposobnost algoritma MOHKA smo preverili s primerjavo z dvema primerljivima algoritmoma. Primerjali smo tri spremenljivke, čas izdelave, izkoriščenost strojev in razporeditev rokov izdelave. Na podlagi rezultatov smo za terminiranje delovnih nalogov v okviru FJSSP ugotovili večjo zmogljivost MOHKA v primerjavi z običajnim terminiranjem delovnih nalogov po prednostnih pravilih. Na podlagi rezultatov, pridobljenih z naključno ustvarjenimi podatki, smo potrdili pomembnost terminiranja delovnih nalogov v primeru soodvisnosti parametrov optimizacije. Z uporabo realnih podatkov in simulacijskega programa Simio smo potrdili uporabnost predstavljene metode za realno proizvodnjo. Poudarili smo pomen optimizacije roka izdelave v dinamičnem FJSSP, kadar so pomembni dejavniki majhno število zamudnih opravil, kratke zamude pri opravilih in nižji stroški zamudnih opravil glede na kratek čas izdelave in visoko izkoriščenost proizvodnih zmogljivosti. Ugotovili smo, da je večkriterijska optimizacija načrtovanja in razporejanja FJSSP, ob upoštevanju roka izdelave, ključ do doseganja finančno vzdržnega in odzivnega proizvodnega sistema, ki je konkurenčen na svetovnem trgu.

PODATKI O ČLANKU

Ključne besede:
Prilagodljivo terminiranje proizvodnje po naročilu (FJSSP);
Rok izdelave;
Čas izdelave;
Izkoriščenost zmogljivosti;
Večkriterijska optimizacija;
Evolucijsko računanje;
Večkriterijski hevristični Kalmanov algoritem;
Programska oprema za simulacijo in terminiranje Simio

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