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A modified bi-objective NSGA-II approach to sustainability in reconfiguration planning of dynamic cellular manufacturing systems

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ABSTRACT

Manufacturing plant layouts are developed to facilitate optimal process flow. Modern manufacturing systems must meet present production demands and be adaptable to changes in process flow in the future. Dynamic Cellular Manufacturing Systems (DCMS) increase the flexibility of layouts by reconfiguring cell structure and equipment distribution, to effectively adjust part routings for optimal process flow. Frequent reconfiguring of plant layout may not always be feasible or economical, however, when new product releases are planned, reconfiguring the plant layout to optimise the workflow may be extremely beneficial. This paper presents a Non-dominated Sorting Genetic Algorithm (NSGA-II) approach to solving a DCMS problem in a sustainable, and responsible manner. A bi-objective integer programming model was developed over multiple planning horizons with fluctuating product demands. This model aims to achieve sustainability by reducing the cost of production, mitigating the environmental impact of production, and minimise negative social impacts on labourers that work in such environments. A penalty function approach was used to enforce the model constraints during optimisation. This study details trade-offs between the economic factors of a DCMS, the environmental implications of reconfiguring such a system, and the social impacts of reconfigurations on the workforce.

ARTICLE INFO

Keywords:
Sustainable manufacturing;
Cellular manufacturing systems;
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Non-dominated Sorting Genetic Algorithm (NSGA-II);
Penalty approach;
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Izvirni znanstveni članek

Spremenjen dvokriterijski pristop NSGA-II za doseganje trajnosti pri načrtovanju preoblikovanja dinamičnih celičnih proizvodnih sistemov

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POVZETEK

Razporeditev proizvodnih obratov je zasnovana tako, da omogoča optimalen pretok procesov. Sodobni proizvodni sistemi morajo izpolnjevati sedanje proizvodne zahteve in se prilagajati spremembam poteka procesov v prihodnosti. Dinamični celični proizvodni sistemi (DCPS) povečujejo prilagodljivost postavitev s preoblikovanjem strukture celic in razporeditve opreme, da bi učinkovito prilagodili poti materialov za optimalni potek procesa. Pogosto preoblikovanje postavitve obrata ni vedno izvedljivo ali ekonomično, vendar pa je lahko preoblikovanje postavitve obrata za optimizacijo delovnega toka zelo koristno, kadar se načrtujejo nove serije izdelkov. V tem članku je predstavljen pristop genetskega algoritma z nedominiranim sortiranjem (NSGA-II) za trajnostno in odgovorno reševanje problema DCPS. Razvit je bil dvokriterijski model celoštevilskega programiranja za več obdobij načrtovanja s spremenljivimi povpraševanji po izdelkih. Cilj tega modela je doseči trajnost z zmanjšanjem stroškov proizvodnje, ublažitvijo vpliva proizvodnje na okolje in zmanjšanjem negativnih socialnih vplivov na delavce, ki delajo v takšnih okoljih. Za uveljavljanje omejitev modela med optimizacijo je bil uporabljen pristop kazenskih funkcij. Ta študija podrobno opisuje kompromise med ekonomskimi dejavniki sistema DCPS, okoljskimi posledicami preoblikovanja takega sistema in socialnimi vplivi preoblikovanja na delovno silo.

PODATKI O ČLANKU

Ključne besede:
Trajnostna proizvodnja;
Celični proizvodni sistemi;
Preoblikovanje postavitve obrata;
Optimizacija;
Genetski algoritem za nedominirano sortiranje (NSGA-II);
Pristop s kaznimi;
Dvokriterijsko celoštevilsko programiranje

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