OPTIMIZATION OF TWO SIDED ASSEMBLY LINE BALANCING WITH RESOURCE CONSTRAINT

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis, and, in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Masalah pengimbangan garis pemasangan dua sisi (2S-ALB) secara praktikalnya amat berguna dalam meningkatkan pengeluaran produk dengan jumlah besar. Banyak penyelidikan telah mencadangkan pelbagai pendekatan untuk mengkaji dan mengimbangi masalah ALB yang dikenali ini. Walaupun banyak perhatian telah diberikan untuk menyelesaikan dan mengoptimumkan 2S-ALB, kebanyakan kajian menganggap stesen kerja memiliki kemampuan yang serupa. Penyelidikan ini dilaksanakan pada barisan pemasangan automotif, di mana sebahagian besar peralatan yang digunakan dalam pemasangan adalah berbeza dari satu stesen kerja ke stesen kerja yang lain. Anggapan bahawa semua stesen kerja mempunyai keupayaan yang serupa menyebabkan penggunaan sumber yang tidak cekap dalam reka bentuk barisan pemasangan. Penyelidikan ini bertujuan untuk memodelkan dan mengoptimumkan 2S-ALB dengan kekangan sumber. Selain mengoptimumkan pengimbangan barisan, model yang diusulkan juga akan meminimumkan jumlah sumber daya dalam barisan pemasangan dua sisi. Penyelidikan dimulakan dengan formulasi masalah melalui menetapkan empat objektif optimum. Pengoptimuman objektif yang dipertimbangkan adalah untuk meminimumkan bilangan stesen kerja, bilangan stesen kerja pasangan, jumlah masa terbiar dan jumlah sumber. Bagi tujuan pengoptimuman, Particle Swarm Optimization diubahsuai untuk mencari penyelesaian terbaik selain mengurangkan kebergantungan pada satu penyelesaian terbaik. Ini dilakukan dengan menggantikan penyelesaian terbaik dengan tiga penyelesaian teratas dalam proses pembiakan. Satu set masalah penanda aras untuk 2S-ALB digunakan untuk menguji cadangan Pengoptimuman melalui Modified Particle Swarm Optimization (MPSO) yang dicadangkan dalam komputasi eksperimen. Kemudian, 2S-ALB yang dicadangkan dengan model dan algoritma kekangan sumber disahkan menggunakan masalah kajian kes. Hasil eksperimen komputasi menggunakan masalah ujian penanda aras menunjukkan bahawa MPSO yang dicadangkan dapat mencari penyelesaian yang lebih baik pada 91.6%. Prestasi MPSO yang baik ini disebabkan oleh kebolehan algoritma ini mengekalkan kepelbagaian partikel disepanjang iterasi. Sementara itu, hasil kajian kes menunjukkan bahawa 2S-ALB yang dicadangkan dengan model kekangan sumber dan algoritma MPSO dapat digunakan untuk masalah yang sebenarnya. Di masa depan, masalah pengoptimuman pelbagai objektif akan dikaji untuk dioptimumkan bagi jenis barisan pemasangan umum yang lain.

ABSTRACT

Two-sided assembly line balancing (2S-ALB) problems are practically useful in improving the production of large-sized high-volume products. Many research has proposed various approaches to study and balance this well-known ALB problem. Although much attention has been given to solve and optimize 2S-ALB, the majority of the research assumed the workstation has similar capabilities. This research has been conducted in an automotive assembly line, where most of the equipment used in assembly is different from one workstation to another. The assumption that all workstation has similar capabilities lead to inefficient resource utilization in assembly line design. This research aims to model and optimize 2S-ALB with resource constraints. Besides optimizing the line balancing, the proposed model also will minimize the number of resources in the two-sided assembly line. The research begins with problem formulation by establishing four optimization objectives. The considered optimization objectives were to minimize the number of workstations, number of mated-workstation, total idle time, and number of resources. For optimization purpose, Particle Swarm Optimization is modified to find the best solution besides reducing the dependencies on a single best solution. This is conducted by replacing the best solution with the top three solutions in the reproduction process. A set of benchmark problems for 2S-ALB were used to test the proposed Modified Particle Swarm Optimization (MPSO) in the computational experiment. Later, the proposed 2S-ALB with resource constraint model and algorithm was validated using a case study problem. The computational experiment result using benchmark test problems indicated that the proposed MPSO was able to search for better solution in 91.6% of the benchmark problems. The good performance of MPSO is attributed to its ability to maintain particle diversity over the iteration. Meanwhile, the case study result indicated that the proposed 2S-ALB with resource constraint model and MPSO algorithm are able to be utilized for the real problem. In the future, the multi-objective optimization problem will be considered to be optimized for other types of general assembly lines.

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