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Sustainable dynamic cellular facility layout: a solution approach using simulated annealing-based meta-heuristic

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Abstract

The fiercely competitive business environment may require the manufacturing layouts to be modified across the entire planning horizon owing to addition or deletion of new/existing products, machines or processes. The existing layout may not be appropriate for the next time periods as product combination and part demand tend to vary under multi-time scenario. Also the increased awareness of environmental concerns and paucity of vital resources like electric energy has led organizations to rethink about their manufacturing strategies and design layouts which are both cost effective as well as environmentally sustainable. An

appropriately planned layout not only helps in reduction of material handling distance but can also greatly contribute to enhancement of the energy efficiency of manufacturing systems and contribute to resource productivity and sustainable value creation. To address these issues in the facility layout design, this paper models a dynamic cellular facility layout problem incorporating the sustainability aspect by considering the minimization of net electric energy consumption along with material handling and rearrangement costs. The model presented in this work is a mixed integer non-linear program. The model aims to minimize the aggregated cost of overall material handling for both the inter and intra-cell movements simultaneously. Additionally the model also minimizes the net electrical energy consumption across the entire time horizon. Twenty five data sets corresponding to varying combinations of machines, time periods and cells have been taken from extant literature to validate the proposed model. LINGO 10 optimization software has been used to solve the proposed model. However, due to NP-Hard nature of cellular facility layout problem, the proposed model is computationally difficult to be solved in reasonable time using LINGO 10, particularly, for layouts pertaining to larger dimensions. To overcome these complexities, a meta-heuristic based on simulated annealing (SA) is also employed to solve the model. It is discerned from the experimental results that LINGO is not able to optimally solve the model whereas the SA optimally solves the model for larger dimensions as well in reasonable computational time.