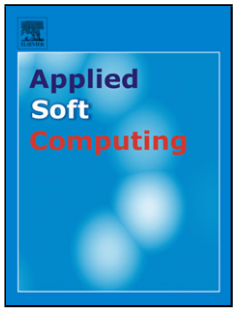

Title: A Multi-Layer Perceptron for Scheduling Cellular Manufacturing Systems in the Presence of Unreliable machines and Uncertain Cost

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<AT>A Multi-Layer Perceptron for Scheduling Cellular Manufacturing Systems in the Presence of Unreliable machines and Uncertain Cost

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<PA>*Corresponding author **Highlights►**.
<ABS-Head><ABS-HEAD>Graphical abstract
<ABS-P>
<ABS-P><xps:span class="xps_Image">fx1</xps:span><ABS-HEAD> ► Highlights ► Determine the best trading off values between in-house manufacturing and outsourcing in a restricted capacity cellular manufacturing system. ► A multi-layer perceptron is used for scheduling dynamic cellular manufacturing systems in the presence of cost uncertainty. ► Propose a new method for measuring the cell-load variation in cellular manufacturing systems. ► Develop a new method for minimizing system imbalance in dynamic cellular manufacturing systems. ► It is proved that the inflation rate can increase the system imbalance in dynamic cellular manufacturing systems.
<ABS-HEAD>Abstract
<ABS-P>In this paper, a new method is proposed for short-term period scheduling of dynamic cellular manufacturing systems in the presence of bottleneck and parallel machines. The aim of this method is to find best production strategy of in-house manufacturing and outsourcing in small and medium scale cellular manufacturing companies. For this purpose, a multi-period scheduling model has been proposed which is flexible enough to be used in real industries. To solve the proposed problem, a number of metaheuristics are developed including Branch and Bound; Simulated Annealing algorithms; Fuzzy Art Control; Ant Colony Optimization and a hybrid Multi-layer Perceptron and Simulated Annealing algorithms. Our findings indicate that the uncertain condition of system costs affects the routing of product parts and may induce machine-load variations that yield to cell-load diversity. The results showed that the proposed method can significantly reduce cell load variation while finding the best trading off values between in-house manufacturing and outsourcing.
<KWD>Keywords: Design of manufacturing; Production system optimization; Modeling and simulation

<H1>1 1 1 1 Introduction
Cellular manufacturing systems (CMS) is considered as effective way of using group technology by defining manufacturing system as a hybrid system of cells linking the advantages of both the jobbing (flexibility) and mass (efficient flow and high production rate) production approaches (Papaioannou and Wilson, 2010).
The issue system imbalance is a main concern in designing and scheduling CMS studies. Over allocating some machines during manufacturing periods can cause emerging machine load variation which will yield to cell load variation accordingly. Cell load variation imposes harms to a manufacturing system. For instance, while cell load variation emerges, some machines are under pressure of heavy allocating of work-loads. Hence, failures for these machines are supposed to be more than the other parallel machines which are less allocated or remained idle. As a conclusion, the emergency maintenance cost is expected to increase. Moreover, due to increasing in number of the loads for these machines, queues of WIP behind them become longer and longer. As a result these machines are risky to become bottleneck in a cell and decrease the production rate of the system. Hence, in the literature of