BOTTLENECK ADJACENT MATCHING HEURISTICS FOR SCHEDULING A RE-ENTRANT FLOW SHOP WITH DOMINANT MACHINE PROBLEM

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A thesis submitted in
fulfilment of the requirement for the award of
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JULY, 2009
I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged.

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In the name of

ALLAH,

Most Gracious,
Most Merciful.

To my beloved parents Sh Ahmad bin Omar Bareduan and Maznah binti Ali Al-Qasam.

Also my loving wife Sharifah Hamidah binti Syed Hassan Al-Jahsyi.

And cheering children Nazhif, Haniff, Nadhirah, Muhammad and Ibrahim.
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ABSTRACT

The re-entrant flow shop environment has become prominent in the manufacturing industries and has recently attracted researchers attention. Typical examples of re-entrant flow shops are the printed circuit board manufacturing and furniture painting processes where components or processed parts enter some specific machines more than once. Similar with other manufacturing environment, identifying appropriate scheduling methodologies to ensure high output rate is very much desirable. The problem explored and investigated in this research is a special type of scheduling problem found in a re-entrant flow shop where two of its processes have high tendency of exhibiting bottleneck characteristics. The scheduling problem resembles a four machine permutation re-entrant flow shop with the routing of M1,M2,M3,M4,M3,M4 where M1 and M4 have high tendency of being the dominant machines. The main objective of this research is to take advantage of the bottleneck characteristics at the re-entrant flow shop and use it to develop heuristics that can be used to solve its scheduling problems. There are four major concentrations in this research. First, basic mathematical properties or conditions that explain the behaviour of the bottleneck processes were developed to give an insight and clearer understanding of the re-entrant flow shop with dominant machines. Second, four new and effective scheduling procedures which were called BAM1 (Bottleneck Adjacent Matching 1), BAM2, BAM3 and BAM4 heuristics were developed. Third, bottleneck approach was utilised in the study and the analysis using Visual Basic macro programming indicated that this method produced good results. Fourth, the Bottleneck Scheduling Performance (BSP) indexes introduced in the BAM heuristics procedure could be used to ascertain that some specific generated job arrangements are the optimum schedule. As a general conclusion, this research has achieved the objectives to develop bottleneck-based makespan algorithms and heuristics applicable for re-entrant flow shop environment. The experimental results demonstrated that the BAM heuristics generated good performances within specific P1 (first process) bottleneck dominance level and when the number of jobs increases. Within the medium to large-sized problems, BAM2 is the best at weak P1 dominance level whereas BAM4 is the best at strong P1 dominance level.
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LIST OF ABREVIATIONS

APA - Average performance advantage
API - Average percentage improvement
BAM - Bottleneck Adjacent Matching
BAM1 - Bottleneck Adjacent Matching 1
BAM2 - Bottleneck Adjacent Matching 2
BAM3 - Bottleneck Adjacent Matching 3
BAM4 - Bottleneck Adjacent Matching 4
BCF - Bottleneck correction factor
BMI - Bottleneck minimal idleness heuristic developed by Kalir and Sarin
BSP1 - Bottleneck scheduling performance 1
BSP2 - Bottleneck scheduling performance 2
BSP3 - Bottleneck scheduling performance 3
BSP4 - Bottleneck scheduling performance 4
CAD - Computer aided design
CDS - Heuristic developed by Campbell, Dudek and Smith
Ci - Completion time for each job
C max - Makespan
CMC - Cyber manufacturing centre
CNC - Computer numerical control
ddm - Decreasing dominating machines
DL - Dominance level
DM - Decomposition method
F_2/C max - 2-machine flow shop, makespan objective