ABSTRACT

Fransisca Wijaya

Undergraduate Thesis

An Improved IHDE-BPSO3 Algorithm for Order Acceptance and Scheduling Problems.

It is crucial for make-to-order manufacturers to decide which orders to accept and how to schedule them, especially when faced with limited production capacity and a high volume of orders. If the orders are poorly arranged, tardiness penalties may occur for failing to deliver specific orders by the due date. This issue is commonly referred to Order Acceptance and Scheduling (OAS) problem. Therefore, this study focuses on tackling the order acceptance and identical parallel machine scheduling problem by considering elements such as delivery deadline, order processing time, order revenue, sequence-dependent setup times, and penalty costs for late delivery. An Improved Hybrid Differential Evolution-Binary Particle Swarm Optimization 3 (IHDE-BPSO3) algorithm that was developed by Wu (2023) was chosen to solve these problems. Two variations of IHDE-BPSO3 incorporated with Variable Neighborhood Search (VNS) were developed and compared with the PSO-VNS algorithm. Results show that for mid to large-sized problems, IHDE-BPSO3 Type 1 slightly outperforms Type 2, with a total mean error of 1.449%. Additionally, IHDE-BPSO3 type 1 demonstrated competitiveness with the well-developed classical algorithm, PSO-VNS.

Keywords: make-to-order, order acceptance, parallel machines scheduling, IHDE-BPSO3, variable neighborhood search.

TABLE OF CONTENT

COVER..i
APPROVAL SHEET...ii
AGREEMENT LETTER FOR PUBLICATION OF SCIENTIFIC WORKS FOR ACADEMIC PURPOSES.......iii
FOREWORD...iv
ABSTRACT...vi
TABLE OF CONTENT..vii
LIST OF FIGURES...ix
LIST OF TABLES..x
LIST OF FORMULAS..xi
LIST OF APPENDIX...xiii
1. INTRODUCTION...1
    1.1 Background..1
    1.2 Research Question..3
    1.3 Research Objective...3
    1.4 Scope and Limitation...3
    1.5 Thesis Systematics..3
2. LITERATURE REVIEW..5
    2.1 Order Acceptance and Scheduling (OAS) Problem...5
    2.2 Order Acceptance and Scheduling (OAS) Problem Literature................................5
    2.3 Parallel Machines Scheduling...7
    2.4 Variable Neighborhood Search (VNS)...8
    2.5 Particle Swarm Optimization (PSO)...8
    2.6 Differential Evolution (DE)...9
    2.7 Improved Differential Evolution and Particle Swarm Optimization Algorithm................11
        2.7.1 Memory-Based Differential Evolution (MBDE) Algorithm.................................11
        2.7.2 Binary Particle Swarm Optimization (BPSO) Algorithm....................................12
        2.7.3 Improved Hybrid Differential Evolution (IHDE) Algorithm.................................12
        2.7.4 IHDE-BPSO Algorithm...13
3. RESEARCH METHOD...14
    3.1 Problem Identification..14
        3.1.1 Mathematical Model...15
    3.2 Scope and Objective Determination...17
    3.3 Literature Review...18
    3.4 Algorithm Design..18
        3.4.1 IHDE-BPSO3 Algorithm...18
        3.4.2 IHDE-BPSO3 Algorithm Parameters and Variables...19
        3.4.3 IHDE-BPSO3 Algorithm Encoding...19

3.4.4 Neighborhood Structure........21
3.4.5 Mutation and Crossover........24
3.4.6 Selection........24
3.5 Parameter Tuning........24
3.6 Computational Experiments........24
3.7 Result and Analysis........25
3.8 Conclusion and Recommendation........25
4. RESULT AND ANALYSIS........26
4.1 Proposed IHDE-BPSO3 Structures........26
4.1.1 IHDE-BPSO3 Type 1........26
4.1.2 IHDE-BPSO3 Type 2........29
4.2 Problem Parameters........32
4.3 IHDE-BPSO3 Parameter Tuning........33
4.3.1 This Study's Strategy........33
4.3.2 Chen's Strategy........33
4.3.2.1 IHDE-BPSO3 Type 1 Parameter Testing........34
b. Change Initial Inertia Weight () Value........35
c. Change Crossover Probability (PCR) Value........36
4.3.2.2 IHDE-BPSO3 Type 2 Parameter Testing........36
b. Change Initial Inertia Weight () Value........37
c. Change Crossover Probability (PCR) Value........38
4.3.3 Parameters Comparison........38
4.3.3.1 Comparison Based on Termination Time........38
4.3.3.2 Comparison Based on Maximum Iterations........40
4.4 Computational Experiments........42
4.5 Comparison of Two Proposed IHDE-BPSO3s........43
4.6 Comparison with PSO-VNS Algorithm........47
5. CONCLUSION........52
5.1 Conclusion........52
5.2 Recommendation........52
REFERENCES........54
APPENDIX........57

LIST OF FIGURES

Figure 3.1 Research Flowchart.. 14
Figure 3.2 Order Acceptance and Scheduling Problem with Identical Parallel Machines........... 15
Figure 3.3 IHDE-BPSO3 Algorithm Flowchart..18
Figure 3.4 Permutation Coding for Order Sequence.. 20
Figure 3.5 Permutation Coding for Assigned Machine... 20
Figure 3.6 Order Insertion Example..21
Figure 3.7 Order Insertion Example..22
Figure 3.8 Order Swap Example..22
Figure 3.9 Machine Swap Example...23
Figure 3.10 Variable Neighborhood Search Flowchart... 23
Figure 4.1 IHDE-BPSO3 Algorithm Type 1 Flowchart.. 26
Figure 4.2 IHDE-BPSO3 Algorithm Type 1 Detailed Flowchart..29
Figure 4.3 IHDE-BPSO3 Algorithm Type 2 Flowchart.. 29
Figure 4.4 IHDE-BPSO3 Algorithm Type 2 Detailed Flowchart..32
Figure 4.5 Line Chart of Average Computing Time for Two IHDEBPSO3s.................................. 44
Figure 4.6 Line Chart of Testing Mean Error for Two IHDEBPSO3s.. 46
Figure 4.7 Line Chart of Average Computing Time for Two Algorithms.....................................48
Figure 4.8 Line Chart of Testing Mean Error for Two Algorithms..50
Figure 4.9 Line Chart of Average Iterations to Reach Optimal Solutions for Two Algorithms..... 51

LIST OF TABLES

Table 2.1 Processing Times with Unrelated Parallel Machines Example....................................... 7
Table 4.1 Max Iterations Setting for This Study's Strategy...33
Table 4.2 Initial Parameters Setting for Chen's Strategy..34
Table 4.3 Percentage Error when Varying Number of Iterations for IHDE-BPSO3 Type 1............35
Table 4.4 Percentage Error when Varying Initial Inertia Weight for IHDE-BPSO3 Type 1............ 35
Table 4.5 Percentage Error when Varying Crossover Probability for IHDE-BPSO3 Type 1........... 36
Table 4.6 Percentage Error when Varying Number of Iterations for IHDE-BPSO3 Type 2............37
Table 4.7 Percentage Error when Varying Initial Inertia Weight for IHDE-BPSO3 Type 2............ 37
Table 4.8 Percentage Error when Varying Crossover Probability for IHDE-BPSO3 Type 2........... 38
Table 4.9 Parameter Settings Comparison for IHDE-BPSO3 Type 1 Based on Termination Time..39
Table 4.10 Parameter Settings Comparison for IHDE-BPSO3 Type 2 Based on Termination Time..40
Table 4.11 Parameter Settings Comparison for IHDE-BPSO3 Type 1 Based on Maximum Iterations.. 41
Table 4.12 Parameter Settings Comparison for IHDE-BPSO3 Type 2 Based on Maximum Iterations.. 42
Table 4.13 Experimental Factors.. 43
Table 4.14 IHDE-BPSO3 Parameters Setting... 43
Table 4.15 Mean Error of Two Proposed IHDE-BPSO3s for the Small Problems..........................44
Table 4.16 Mean Error of Two Proposed IHDE-BPSO3s for Mid to Large Problems................... 45
Table 4.17 Mean Error of two Algorithms for Small Problems...47
Table 4.18 Mean Error of Two Algorithms for Mid to Large Problems.......................................49

LIST OF FORMULAS

(2.1)... 6
(2.2)... 6
(2.3)... 6
(2.4)... 6
(2.5)... 6
(2.6)... 6
(2.7)... 8
(2.8)... 9
(2.9)... 9
(2.10)... 9
(2.11)... 9
(2.12)... 10
(2.13)... 10
(2.14)... 10
(2.15)... 10
(2.16)... 11
(2.17)... 11
(2.18)... 12
(2.19)... 12
(2.20)... 12
(2.21)... 13
(2.22)... 13
(2.23)... 13
(2.24)... 13
(3.1)... 16
(3.2)... 16
(3.3)... 16
(3.4)... 16
(3.5)... 16
(3.6)... 16
(3.7)... 16
(3.8)... 16
(3.9)... 16
(3.10)... 17
(3.11)... 17
(3.12)... 17
(3.13)... 17

(3.14).. 25

LIST OF APPENDIX

Appendix 1: Parameters Testing of IHDE-BPSO3 Type 1 with Chen's Strategy........................... 57
Appendix 2: Parameters Testing of IHDE-BPSO3 Type 2 with Chen's Strategy........................... 63
Appendix 3: Parameters Comparison for IHDE-BPSO3 Type 1 Based on Termination Time........71
Appendix 4: Parameters Comparison for IHDE-BPSO3 Type 1 Based on Maximum Iterations....74
Appendix 5: Parameters Comparison for IHDE-BPSO3 Type 2 Based on Termination Time........77
Appendix 6: Parameters Comparison for IHDE-BPSO3 Type 2 Based on Maximum Iterations....80
Appendix 7: IHDE-BPSO3 Type 1 Final Testing...83
Appendix 8: IHDE-BPSO3 Type 2 Final Testing...89
Appendix 9: PSO-VNS Final Testing...95
Appendix 10: Comparison of Two IHDE-BPSO3s.. 102
Appendix 11: Comparison of PSO-VNS with IHDE-BPSO3 Type 1..107