

OSSP WITH RELEASE DATES TO MINIMIZE THE TOTAL COMPLETION TIME - A HYPOTHETICAL CASE

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ABSTRACT. Scheduling problem exists almost everywhere in real life and industrial situations. The open shop scheduling problem with release dates (OSSP-RD) is considered for the objective of minimizing total completion time (TCT) when pre-emption of the jobs is not permitted. In [6], we had developed an algorithm called DLPT - DS for the OSSP-RD for the makespan objective and now we tested the same algorithm for TCT to the hypothetical problems in which a job need not be processed on a particular machine. Numerical examples are provided which shows that DLPT - DS algorithm performs better than DSPT - DS algorithm.

1. INTRODUCTION

In modern life, everyone has their own schedule to complete the daily task while the industry situation deals the performance of the jobs over the machines called resources in the stipulated time bound. In Job shop environment, jobs must have different process sequence while same process sequence of jobs on each of the machines is the nature of the flow shop environment. The open shop situation allows the jobs to perform in any conceivable manner which is more interesting when number of jobs and machines are increased. The most common example for OSSP that we came across in our day to day life are the teacher-classes assignments, examination scheduling and railway reservation, etc., We

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split the sections of the paper as follows: section 2 provides statement of the problem; section 3 is devoted for literature review relevant to our objective; section 4 details the scope of the objective; in section 5, we gave our proposed algorithm followed by examples in section 6; concluding remarks was given in section 7.

2. STATEMENT OF THE PROBLEM

General OSSP-RD environment consists 'n' jobs and 'm' machines in which all the jobs have m operations with finite processing time. Each of m operations should be performed in different machines in any conceivable order. An operation shall be executed at any time on any machine while at most one of them has to be processed. Constrained relations between the operations are not allowed. All the jobs must have the release time $r_j \geq 0$ and is performed with respect to the availability of the jobs where as all machine are available at any time. Break down of the machines is not permitted. Processing time of job j on machine i, called $P(i,j)$ are known well in advance and $O(i,j)$ denotes operation of job j on machine i. If a job needs a machine that is occupied it can wait indefinitely until the machine becomes idle again. There are no transportation times between machines.

3. LITERATURE REVIEW

In the literature of OSSP, most of the researchers paid attention on makespan without considering release dates or due dates. But only in few papers, total completion time objective is considered. Generally, all jobs are available at time zero but we consider release dates also for our problem. Brasel and Hennes [4] presented new lower bound and heuristic to the preemptive OSSP with average completion time objective. For one machine sequencing problem along with tool changes to minimize TCT, Akturk, Ghosh and Gunes [1] focused on the performance of SPT list scheduling which provides theoretical worst -case bounds for that. Single machine scheduling with multi-operation jobs for TCT objective was studied by Cheng, Ng and Yuan [5]. It can be solved in polynomial time for few special situation which is NP-hard in nature. Scheduling tool changes to minimize TCT under controllable processing time was first considered by Akturk, Ghosh and Kayan [2]. Mastrolilli et al. [11] studied the sum of weighted completion times in a concurrent open shop. Tang and Bai [13], considered the

OSSP to minimize TCT and developed a Shortest Processing Time Block (SPTB) heuristic when the job number is the multiple of the machine number and extended it to the general problem. Naderi et al. [12] deals OSSP with parallel machines for TCT objective and found an efficient mixed integer linear programming technique and memetic algorithm. Zang and Bai [14] studied OSSP for minimizing the sum of quadratic completion time. For small scale problems, they presented a solution based on Lagrangian relaxation method.

4. OBJECTIVE AND SCOPE OF THE PROBLEM

Even though many researchers focused on makespan objective, from the industrial point of view the TCT objective plays significant role than makespan criterion. In [6], we developed DLPT - DS (Dynamic longest processing time-Dense schedule) algorithm for OSSP-RD. Then in [7] we gave attention to the general OSSP -RD as well as hypothetical case problems which gives better makespan value than DSPT - DS algorithm [3]. In [8, 9], our algorithm was tested for resource idlences objective for general and hypothetical situations. In [10], we considered the general OSSP-RD for the TCT objective and in this present work, we extended our work for the hypothetical situations and test the effectiveness of our DLPT-DS algorithm for the TCT objective by comparing its TCT value with those value obtained by DSPT-DS heuristic algorithm.

5. PROPOSED ALGORITHM

In this section, we described our DLPT - DS heuristic algorithm. Let A be the matrix consists of all operations and $R(i,j)$ denotes the starting time of operation $O(i,j)$.

5.1. DLPT-DS heuristic. Here we present our algorithm which was developed in [6].

Step 1. At time $t, t \geq 0$ execute the operation with the longest processing time, say $O(i_1, j_1)$ among all the available operations in matrix A. If tie occurs, the operation with smallest index will be executed. Update the starting times of the operations, which are at the same column and row with $O(i_1, j_1)$ to $t + P(i_1, j_1)$ in matrix A. Delete the operation from matrix A.

- Step 2. If some jobs are ready to process, go to step3; if matrix A becomes empty, go to step4.
- Step 3. Arrange the operations in matrix A, and update the starting time of each new operation to the longest starting time of its row in matrix A. Then go to Step1.
- Step 4. The machines should be kept idle until a job arrives, and go to step 3. Terminate the process if all the operations are executed.

6. EXAMPLES

This section explains our method for the general OSSP-RD and for the hypothetical case by considering 4 jobs 4 machines OSSP-RD.

6.1. EXAMPLE FOR THE GENERAL CASE. Consider four jobs four machines OSSP-RD with the release dates r_j as follows

	J1	J2	J3	J4
M1	3	5	2	6
M2	5	7	8	4
M3	7	5	3	4
M4	3	2	2	4
r_j	5	3	2	8

If we schedule the operations according to DSPT-DS, we got the completion times of J_1, J_2, J_3, J_4 are 29, 24, 24, 26 which gives the TCT value as 103 units of time (See figure 6.1.1). Meanwhile if we use DLPT - DS algorithm, the completion times of J_1, J_2, J_3, J_4 are 23, 24, 20, 27 which gives the TCT value as 93 units of time (See figure 6.1.2).

6.2. EXAMPLE FOR THE HYPOTHETICAL CASE 1. In the general OSSP-RD, a job with least processing time is chosen arbitrarily and assumed that, it need not be processed on the particular machine. This will create a hypothetical situation. We test our DLPT - DS algorithm for this special problem with TCT objective. Consider the same problem as in 6.1 which consist of the least processing time 2 in two positions. So we can choose arbitrarily as J_2 need not be processed on machine M_4 and the OSSP with hypothetical case is as follows; If we schedule the operations according to DSPT-DS, we got the completion times

	J1	J2	J3	J4
M1	3	5	2	6
M2	5	7	8	4
M3	7	5	3	4
M4	3	0	2	4
r_j	5	3	2	8

of $J1, J2, J3, J4$ are 31, 21, 22, 26 which gives the TCT value as 100 units of time (See figure 6.2.1). Meanwhile if we use DLPT - DS algorithm, the completion times of $J1, J2, J3, J4$ are 23, 24, 20, 27 which gives the TCT value as 94 units of time (See figure 6.2.2).

6.3. EXAMPLE FOR THE HYPOTHETICAL CASE 2. Here we create another hypothetical situation by choosing a job from the general OSSP-RD with largest processing time arbitrarily and assumed that, it need not be processed on the particular machine. We test our DLPT - DS algorithm for this special problem with TCT objective. Consider the same problem as in 6.1 which consist of the largest processing time 8. So we can choose $J3$ need not be processed on machine $M2$ and the OSSP-RD with hypothetical case is as follows;

	J1	J2	J3	J4
M1	3	5	2	6
M2	5	7	0	4
M3	7	5	3	4
M4	3	2	2	4
r_j	5	3	2	8

If we schedule the operations according to DSPT-DS, we got the completion times of $J1, J2, J3, J4$ are 24, 24, 9, 26 which gives the TCT value as 83 units of time (See figure 6.3.1). Meanwhile if we use DLPT - DS algorithm, the completion times of $J1, J2, J3, J4$ are 23, 25, 9, 26 which gives the TCT value as 83 units of time (See figure 6.3.2).

7. ANNEXURE

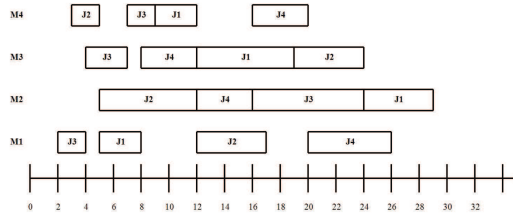


Fig. 6.1.1. DSPT-DS Schedule for general OSSP-RD

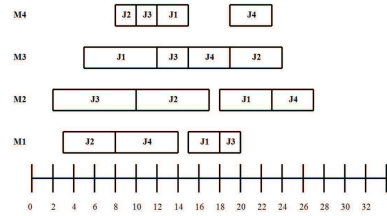


Fig. 6.1.2. DLPT-DS Schedule for general OSSP-RD

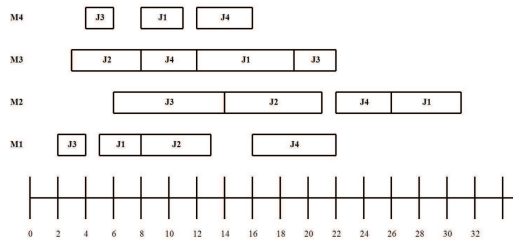


Fig. 6.2.1. DSPT-DS Schedule for hypothetical case 1

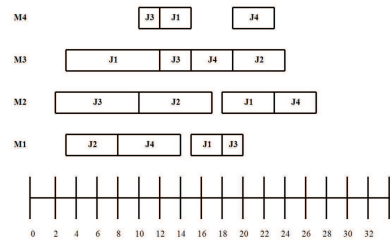


Fig. 6.2.2. DLPT-DS Schedule for hypothetical case 1

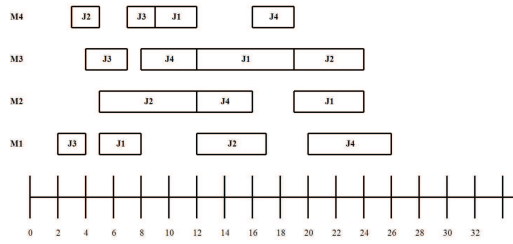


Fig. 6.3.1. DSPT-DS Schedule for hypothetical case 2

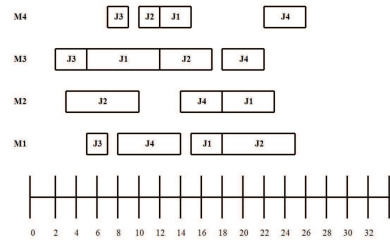


Fig. 6.3.2. DLPT-DS Schedule for hypothetical case 2

8. CONCLUSION

To test the efficiency of DLPT- DS heuristic for the TCT objective, comparison has been made between DSPT- DS and DLPT - DS for the hypothetical cases in which a job need not be processed on a particular machine. The numerical result shows that the DLPT-DS algorithm is better than DSPT-DS algorithm for both the makespan and TCT objectives.

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