Heuristics based hybrid approach of flow shop scheduling problem

K Lokesh¹, J Jayaprakash ²and Tibebu Alene³
¹UG Student, ²Professor, Department of Mechanical Engineering, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Chennai, India-602105.
³Faculty, Department of Industrial Engineering, University of Gondar, Ethiopia.

E-mail: ¹lokeshkannan43066@gmail.com

Abstract. In recent day’s furniture fabrication industries are one of the upcoming segments in developing countries. In the fast-developing economy and populations are substantial interest in house hold furniture and wooden games things. Almost around more than 100 medium and large furniture businesses are running in every district capital. Presently they are confronting additionally testing undertakings in adjusting of cycle arranging and assembling products based on customer requirements. In this paper, we have taken scheduling issues related with these enterprises. In the case company contain a set of tasks to be carried out and optimize make span with a set of machines available to perform those jobs. So as to lead important information writing study on past investigations, we proposed heuristics-based hybrid approach of flow shop scheduling problems to assess the make span. At last, we verify the outcomes of the hybrid approach with LEKIN programming.

1. Introduction

The Scheduling is a significant dynamic cycle that is utilized consistently in different assembling and administration companies. It deals with the optimization of various operational objectives. And also, it deals in allocating the resources to tasks over given period of time. One target might be minimization of assignments finished after their individual due dates, others may need to satisfy the interest inside a specific due date falling flat in which may prompt punishments, hardly any others may have the goal of limiting the quantity of late positions in the part and so forth.

In flow shop scheduling, condition of machines are thought to be set up in arrangement, the work in an occupation is separated into discrete assignments called tasks, and every activity is performed at an alternate machine. These operations should be sequenced to select the next task and scheduled to plan the start time and completion time.
Johnson [1] first introduced algorithm that can find ideal arrangement for a n-work and 2-machine scheduling problem. Palmer [2] presented a solitary emphasis technique to reach required result of minimizing the make span. Here the sequencing of the positions was done dependent which are then sorted in the decreasing order so as to obtain the optimum sequence by palmer’s method which are then sorted in the decreasing order so as to obtain the optimum sequence using palmer’s method. This algorithm can be applied to m-machine and n-work flow shop scheduling issues [3].

The basic Johnson's computation was expanded using Campbell [4]. In contrast to the altered Johnson's calculations, it utilizes various emphasis before arriving at the final result. This Johnson’s extended method is a heuristic approach usually known as Campbell, Dudek and Smith heuristics (CDS). Gupta [5] Introduced minimizing the completion time and the make span of the sequence. An alternate method is set up by him in getting the slop index, in light of which the sequencing of occupations is done in the flow shop.

Zakria [6] focused on a stochastic scheduling approach to get the required schedule of jobs. It uses a stochastic environment along with a single machine to carry out the target of minimizing the lateness for the completion of the job. This included a group of jobs with different due dates assigned to them, where we need to find the lateness value of each of the jobs.

Modrak [7] illustrated the comparison between the various heuristic’s algorithms based on the output value of the make span. Wu [8] acquired the concept of learning effect for the development of a model to minimize the completion time. The total completion time in various flow shop environments is minimized as required by this method by introducing the concept of learning. This paper shows some of the essential methods of solving flow shop scheduling problems focusing on finding the most efficient way of scheduling furniture manufacturing industry which is a flow shop environment that provides different types of goods (namely, bed, kitchen cabinets, drawers, dining tables, and doors.) with the help of Palmer’s heuristics algorithm with LENKIN software, Comparison was also done between those heuristics algorithms to obtain an optimal make span.

Zhang [9] reviewed job shop problems related to Inudstry4.0 Varela [10] compared different configuration of parallel scheduling problems. Toader [11] reviewed flexible scheduling problem in various production systems. Simeonovova [12], [13] and Azemi [14] focused important between planning and scheduling problems. Abide [15] discussed machine repair model. Piairo,[16], Lia [17] implemented customer centered approach in scheduling problems. May [18] increased the search efficiency by genetic algorithm in job shop problems. Duplakova,[19] proposed simulation software to optimize production scheduling problems. Coman [20], [21], Irman [22], [23] A optimized make span in job shop problems. Balog [24] proposed LENKIN simulation software to optimize time frame in manufacturing scheduling problems. Jayaprakash [25] focused Multi agent based algorithm.

2. Methodology

The Flow shop scheduling problem is evaluated for improving performance of the machines and to obtain the optimal processing time. Palmer’s Heuristic algorithms are used for analysis sample case problems and Integrate Palmer’s result as input to LENKIN software and compare the results.
2.1 Palmer’s Algorithm:

This technique will attempt to discover a weighted total for every one of these positions. In this way, we will offer loads to every one of these machines and afterward we attempt and discover the weighted whole of each positions as shown in equation 1. Pseudo code of Palmer’s algorithm is given below:

\[
t = 0, n, m; // start scheduling with m machine, n jobs //
Assign P_w (t); // Assign weights to each machine //

S(j) = - \sum_{f=1}^{k} (k - (2 * t - 1)) \cdot o(j, t) \quad \text{......... (1)}
\]

Eval \( P_j (t) = P_w (t).T_j // Evaluate weights for each job //
Sort \( P_j(t); // Sort all jobs based on weights in descending order //
Cal P_m (t) //Calculate make span based on sequence//

2.2 Lekin software system

Lekin software can be accommodating various machine scheduling environments such as single machine scheduling problem, parallel machine scheduling problem, flow shop & Job shop scheduling problems and Flexible flow shop & job shop scheduling problems.. Firstly the user has to select machine environment and enter all the machine data and job data manually. After finishing the necessary information, the user should select scheduling method from the tool bar. The two types of scheduling methods are: rule (which consist ATCS, EDD, MS, FCFS, LPT, SPT, WSPT and CR scheduling tools) and heuristic (which consists general SB routine, shifting bottleneck/ sum (wT), shifting bottleneck/ Tmax, and SB-LS (FFS decomposition)). Here for this research heuristic scheduling method is applied.

3. Results and Discussion

Scheduling is a decision-making process to assign specific job to specific machine in many manufacturing and services industries. So that we can optimize make span. The model of the furniture industry is n/m/F/M where; n = the number of jobs, T = the number of machines, F = flow shop problem, M = make span In this work, we have taken 5 jobs and 5 machines. The machines and jobs performed are listed on the following table 1.

|   | T1 | T2 | T3 | T4 | T5 |
|---|----|----|----|----|----|
| J1 | 30 | 25 | 85 | 40 | 60 |
| J2 | 20 | 150 | 165 | 60 | 480 |
| J3 | 35 | 120 | 90 | 80 | 180 |
| J4 | 60 | 180 | 240 | 240 | 340 |
| J5 | 40 | 75 | 110 | 90 | 150 |

**Table 1:** Operation time matrix for 5 jobs and 5 Machines.
J1= dressing table, J2= bed, J3=drawer, J4=kitchen cabinet, J5= door.
T1= Wood cutting machine, T2= Rotter machine, T3= Fitting machine, T4=Sander machine, T5= Painting machine.

3.1 Heuristic algorithms

3.1.1 Using Palmer’s algorithm

Implement this algorithm, we can find out a weightage sum of each job.

Step 1: In this case flow shop scheduling problem having 5 machines and 5 jobs.

Step 2: Based on important of machine utilization assign weights to each machine. weight T1 = -3, machine weight T2 = -2, machine weight (T3) = 0, machine weight (T4) = +2, machine weight (T5) = +3 as shown in table 2. Positive sign means most wanted and negative means not that much.

|       | T1  | T2  | T3  | T4  | T5  |
|-------|-----|-----|-----|-----|-----|
| J1    | 30  | 25  | 85  | 40  | 60  |
| J2    | 20  | 150 | 165 | 60  | 480 |
| J3    | 35  | 120 | 90  | 80  | 180 |
| J4    | 60  | 180 | 240 | 200 | 340 |
| J5    | 40  | 75  | 110 | 90  | 150 |

Step 3: this step we have to calculate the weight of each job, and then multiplying the weights to the processing times. The time is in minutes /some units

\[
\begin{align*}
W (J1) &= (-3*30) + (-2*25) + (0*85) + (2*40) + (3*60) = 120; \\
W (J2) &= (-3*20) + (-2*150) + (0*165) + (2*60) + (3*480) = 1200 \\
W (J3) &= (-3*35) + (-2*120) + (0*90) + (2*80) + (3*180) = 355 \\
W (J4) &= (-3*60) + (-2*180) + (0*240) + (2*200) + (3*340) = 880 \\
W (J5) &= (-3*40) + (-2*75) + (0*110) + (2*90) + (3*150) = 360 \\
\end{align*}
\]

Step 4: Sorting of calculated job weights in descending order. In decreasing order sequence, the jobs become :J2-J4-J5-J3-J1

Step 5: Formulating sequence of jobs based on the previous step done in Step 4. The sequence of the job in tabular form can be expressed in table 3.
Table 3: Optimal sequence with weight

| machine job | T1 | T2 | T3 | T4 | T5 | weight |
|--------------|----|----|----|----|----|--------|
| J2           | 20 | 150| 165| 60 | 480| 1200   |
| J4           | 60 | 180| 240| 200| 340| 880    |
| J5           | 40 | 75 | 110| 90 | 150| 360    |
| J3           | 35 | 120| 90 | 80 | 180| 355    |
| J1           | 30 | 25 | 85 | 40 | 60 | 120    |

Step 6: finally calculate make span of the given jobs with the given machines in optimal value as followed in table 4

Table 4: Final make span using Palmer’s algorithm

| Machine Job | T1 | T2 | T3 | T4 | T5 |
|-------------|----|----|----|----|----|
| J2          | 20 | 170| 335| 395| 875|
| J4          | 80 | 350| 590| 790| 1215|
| J5          | 120| 425| 700| 880| 1365|
| J3          | 155| 545| 790| 960| 1545|
| J1          | 185| 570| 875| 1000| 1605|

Make span associated with this sequence is 1605 minutes in table 4.

3.1.2. Using LEKIN software system

In order to run the LEKIN software the required data are number of machines, number of jobs and then enter processing time of each jobs in each machine.

The total processing time is displayed by default when the above data is entered to the system correctly. The following figure 1 gives detail expression for the above points.

The LEKIN software below shows the completion time total completion of each jobs using heuristics scheduling by shifting bottleneck/ T_max. The maximum completion time calculated is 1499 minutes. Total processing time 185for machine one, 550 for machine two, 690 for machine three, 510 for machine four and 1210 for machine five; 240 for job one, 875 for job two, 505 for job three, 1060 for job four and 465 for job five. Other information like beginning, ending, total and weighting time also expressed in this method. The detail optimal results using Lenkin software as shown in figure 2
**Figure 1:** Job allotment to each sequence using Lekin software

**Figure 2:** Optimal result using Lekin software
3.2 Comparison of heuristic techniques:

Table 5: comparison result with different algorithm

| Heuristic algorithm                      | Optimum value in minutes |
|------------------------------------------|--------------------------|
| Palmer’s algorithm                       | 1605                     |
| Hybrid Approach (Shifting bottleneck/Tmax)| 1499                     |

4. Conclusion

This paper we have discussed Palmer’s algorithm to minimize the make span and to enhance the performance resources. Comparison was done for the best heuristic’s algorithm for minimization. From the results of a 5 job 5 machine problems, the make span calculated is 1605 minutes for Palmer’s algorithm, and 1499 minutes by Shifting bottleneck/Tmax using Hybrid approach using LENKIN software as shown in table 5. The above sequence emphasizes that, the total completion time for the jobs to be performed on those five machines is minimized.

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