International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 01, 2020
ISSN: 1475-7192

HYBRID FLOWSHOP 2 STAGE WITH HEURISTIC METHODE

Case Study: PT. XX Aircraft Manufacturing

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Abstract---*PT XX is an aircraft company. The company is currently developing a scheduling method for spare parts that are processed in the miling and lathe departments, where at each work station there are 2 machines each installed in parallel. The process is the same as the understanding of the production system of the Hybrid Flowshop model, so that one solution can use a heuristic method. The number of jobs that are in this paper is 10 jobs. The purpose of this research is how to schedule these jobs to be processed in the existing production system so as to makespan minimization. After scheduling with the heuristic method, the makespan is 995 units of time.*

Keyword---*Hybrid Flowshop, Heuristik, scheduling, Makespan minimization*

I. Introduction

The flowshop scheduling model has attracted many researchers especially after the emergence of research by Johnson (1954) which resulted in research on the completion of the flowshop model, namely Johnson's Rule. As market demand grows, many companies increase production capacity by duplicating machines to be placed in the same operation. With the addition of machines in the same operation and connected in parallel, the collection of machines is called a stage, finally the system can be said to be Hybrid Flowshop..

The object of this research is PT XX which is an aircraft manufacturing company. The company is currently producing spare parts which are part of an aircraft which consists of 2 production processes, namely Miling and Lathe. Because the number of spare parts is small, it only consists of 2 machines in each process. The purpose of this research is how to sort the production process of the spare parts on existing machines. This scheduling aims to be able to determine the sequence of processes of jobs that are processed at each stage and machine so that the overall completion time is called the Makespan.

II. Literature Review

Hybrid flowshop is the development of the flowshop scheduling system where in each or every workshop there are identical or non-identical parallel machines. The flowshop scheduling according to Baker (1974) is a production process whose flow is continuous through a series of workstations which are generally arranged based on the product process. Hybrid flowshop according to Karthik & Prabaharan (2014) is a system consisting of several stages (workstations) where

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one or all stages consist of machines arranged in parallel. According to Linn & Zhang (1999) flowshop will always be Hybrid Flowshop if at least one stage runs on more than one machine in parallel..

The research that has made a model to solve the hybrid flowshop model is Gupta (1994) where this research is used to solve the two-stage hybrid flowshop model with the aim of minimizing the makespan. The makespan model used to minimize the makespan is:

$$A_1(a_i) = A_2(a_{i-1}) + S(a_i,1) + t(a_i,1)$$
$$A_2(a_i) = A_1(a_i) + R(a_i,1)$$
$$B_1(a_i) = max\{A_1(a_i); B_2(a_k) + S(a_i,2)\} + t(a_i,2)$$
$$B_2(a_i) = B_1(a_i) + R(a_i,2)$$
$$\text{Which is, } A_1(\Phi) = A_2(\Phi) = B_1(\Phi) = B_2(\Phi) = 0$$

The heuristic method that can be used to solve the hybrid flowshop problem in accordance with Gupta's (1994) research is to use Heuristic algorithm 1-4. All heuristic methods are developed from the Sule's Rule method and The S&G algorithm. Sule's rule is the development of the model suggested in the model of Johnson's rule.

III. Problem Statement

The model that will be used in this research was adapted from Gupta (1994). This scheduling problem can use the model because the same type of production system is Flowshop Hybrid. The difference with the previous system is the research of scheduling using 2 identical machines arranged in parallel on stage 1 while on stage 2 it is the same, using 2 identical machines arranged in parallel. While the purpose of this research is how this model can minimize the makespan.

The description of the problem in this research is that there are a number of jobs (t) that will be processed on identical stage 1 and stage 2 machines installed in parallel. At each stage there is a production time which includes setup time (S) and processing time (t_a, t_b). The purpose of this research is to create a job preparation strategy so that it can be completed with the fastest time equal to the objective function of minimizing Makespan. The production process flow system of this research object as shown in Figure 1.

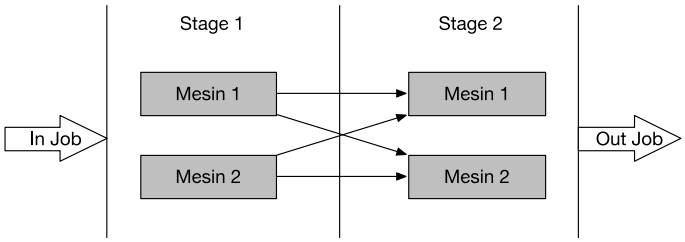

Figure 1. Real System Production Process in PT XX

This research starts by making job compilation rules that will be processed in production machines using Sule's Rule without removal time parameters:

$$p_{a,1} = S_{a,1} - S_{a,2} + t_{a,1}$$
$$p_{a,2} = t_{a,2}$$

Then all job sequences that have been arranged based on Sule's Rule will be completed by the heuristic method. The algorithm used is:

Step 1 Sort jobs based on the largest processing time at stage 2 (t_b)

Step 2 Schedule the first-order job on the machine in stage 1 that are available

Step 3 Schedule jobs that have been scheduled on stage 1 to machines on stage 2 that are available.

Step 4 Schedule all jobs to the machine on stage 1 and stage 2 until all jobs are scheduled.

IV. Result

This research data for 10 jobs that will be processed in stage 1 and stage 2. The parameter time used for this research is setup time and processing time. The data jobs are in the Table 1.

Table 1. Time Setup and Processing

No job	Stage 1		Stage 2	
	Setup Time (Minute) (S_a)	Processing Time (Minute) (t_a)	Setup Time (Minute) (S_b)	Processing Time (Minute) (t_b)
1	20	135	30	65
2	20	97	30	80
3	20	75	45	150
4	20	130	45	180
5	20	130	45	150
6	20	150	30	90
7	20	60	30	90
8	20	90	30	80
9	20	140	45	120
10	20	140	45	145

Following the scheduling algorithm above, the scheduling process will be processed as follows:

Step 1 Sort jobs based on the largest processing time at stage 2 (t_b)

Table 2. Sequencing of Jobs

No sequencing	No job	Stage 1		Stage 2	
		Setup	Processing	Setup Time	Processing

		Time (Minute) (S_a)	Time (Minute) (t_a)	(Minute) (S_b)	Time (Minute) (t_b)
1	4	20	130	45	180
2	3	20	75	45	150
3	5	20	130	45	150
4	10	20	140	45	145
5	9	20	140	45	120
6	6	20	150	30	90
7	7	20	60	30	90
8	8	20	90	30	80
9	2	20	97	30	80
10	1	135	30	65	135

Step 2 Schedule the first-order job on the machine in stage 1 that are available

Step 3 Schedule jobs that have been scheduled on stage 1 to machines on stage 2 that are available.

Step 4 Schedule all jobs to the machine on stage 1 and stage 2 until all jobs are scheduled.

Table 3. Result Scheduling Process

No seq.	No job	Stage 1				Stage 2			
		Machine 1		Machine 2		Machine 1		Machine 2	
		$A_1(a_i,1)$	$A_2(a_i,1)$	$A_1(a_i,2)$	$A_2(a_i,2)$	$B_1(a_i,1)$	$B_1(a_i,1)$	$B_2(a_i,2)$	$B_2(a_i,2)$
1	4	0	150			150	375		
2	3			0	95			95	290
3	5			95	245			290	485
4	10	150	310			375	565		
5	9			245	405			485	650
6	6	310	480			565	685		

7	7			405	485			650	770
8	8	480	590			685	795		
9	2			485	602			770	880
10	1	590	755			795	995		

From the results of calculations using a method adapted from the Gupta's heuristic algorithm 3 (1994), it was found that the makespan for the problem in this study was 995 minutes to be able to complete all jobs to be produced.

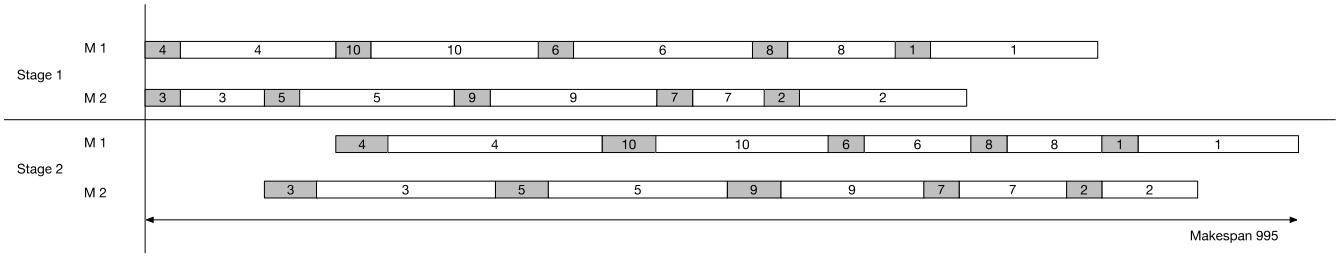

Figure 2. Ghant Chart the result

V. Conclusion

This research can solve the problem of Hybrid Flowshop 2 stage with the number of machines in each staging is 2 installed in parallel. The results of the research showed that the heuristic method that was adapted could solve the scheduling problem of the Hybrid Flowshop 2 stage model. The makespan value of the calculation is 995 units of time. These results cannot be tested to be the most optimal results, so it needs to be compared with other methods that can prove that the results of the makespan produced from this research are optimal results.

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