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Research Article

Parallel Machine Scheduling with Shortest Processing Time (SPT) and Longest Processing Time (LPT) TO Minimize MAKESPAN at PT.ABC

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Abstract
PT. ABC is a manufacturing company in the Garment sector. The problem faced by the company is to determine the production strategy to be able to fulfill orders from consumers. The production process that is the object of research is the production process on a washing machine. The washing process has two identical machines installed in parallel that will do 10 jobs. Scheduling by the company currently uses the First Come First Served method with a makespan of 2255.7 hours. The research provides an alternative method for scheduling with the Shortest Processing Time and Longest Processing Time methods. The scheduling process using the SPT method produces a makespan of 2070.06 hours, while scheduling using the LPT method produces a makespan of 2039.34 hours. The proposed method in this research results that the LPT method produces a better makespan than other methods. The makespan efficiency of this research shows a saving of 9.59%, which is 216.36 hours.

Keywords
Scheduling, Parallel Machine, Shortest Processing Time, Longest Processing Time

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Introduction

Determining the resources used to complete a job is a problem that can be solved by scheduling. Limited resources are the main reason why many activities have difficulty in determining the completion time. This is the background of the scheduling method used by various operationsto solve the problem. Scheduling involves more detailed and short-term decisions to determinewhen and how to do something right (when, and how to do what). In general, the basic concept of scheduling is coordinating the process, determining the resources used and determining the time to use resources to complete all assigned work with the constraints of the resources and tasks given. According to Alimian, Saidi-Mehrabad, and Jabbarzadeh (2019) stated the purpose of scheduling is:

1. Increase the use of resources so that the time needed to complete the work is minimal.
2. Reduction of inventory, especially inventory in the work process flow.
3. Avoiding penalty fees caused by delays in completing work.
4. Can determine the decision making in determining the capacity of the process so as to minimize the costs incurred.

With a clear goal, the scheduling method will be needed in almost all processes due to resource constraints. Wu, Zhao, Feng, Niu, and Xu (2021) have conducted research on scheduling for parallel machines using the optimization method, but the optimization method is carried out using the LINGO application. PT. ABC is one of the companies engaged in manufacturing with the resulting product is clothing. PT. ABC is a company that has been established since 1982 in Bandung. One of the goals of this company is to provide the right lead time for orders to consumers. Currently, thescheduling carried out in this company is by placing according to consumer priorities, namelyFCFS (First Come First Served). Until now the company is still not able to meet the needs of all consumers in a timely manner so that a more precise production planning is needed. So, thisresearch will aim to provide an alternative scheduling method that can be used to help the company PT. ABC meets production needs in a timely manner.

Literature ReviewDefinition of Scheduling

Scheduling Management is one of the functions in planning production which has a very important role because scheduling will greatly affect the success and objectives of production. Pinedo (2012) states that scheduling is a decision-making process that is used regularly in various manufacturing and service businesses. This will relate to the allocation of resources forwork over a certain time with the aim of optimizing one or more of the objectives. Accordingto Baker (1974) scheduling is a method used to allocate limited resources to complete a set ofjobs with a predetermined time. In other words, the function of scheduling is to make adjustments between the number of jobs and the limited number of resources owned by the company.

Machine Parallel Scheduling

Parallel machine system is a development of a single machine system which is intended to make the flow more flexible. In practice, parallel machine systems have been widely used as amulti-stage process. According to Pinedo (2012), three goals in a parallel machine schedulingsystem are minimizing makespan, total completion time, and maximum delay. In determining the scheduling of parallel machines, completion steps are needed, namely determining the allocation of work to each machine and then the sequence of work on each machine.

Method

The research method used is to develop a model. The purpose of this method is to conduct research that aims to improve the application of the process to the scheduling model that has been previously modeled. The systematics of this research is with several stages according to the picture.

5. Observation, carried out to find out real problems related to scheduling problems.
6. Literature Review, conducted to determine the theoretical method that will be adjustedto be able to solve the problems found as a result of observation.
7. Data collection, carried out to collect the data needed in solving problems according tothe method to be used.
8. Data processing, carried out after all data from data collection are complete with theaim of being able to solve problems found previously.
9. Analysis, conducted to see the interpretation of the results of data processing.

Problem Statement

Company PT. ABC is a garment production company. The process carried out to produce the final product consists of several processes. The problem that often occurs is the implementationof the process in identical washing machines (m) which are arranged in parallel and the numberof machines is limited, so there is often a buildup in this washing process. In this research, scheduling for two wahing machines in the company is carried out.
In its implementation there are 10 jobs (j) that must go through a washing machine. Each job has a different processing time (p) according to the length of the product ordered by the consumer.

Figure 1 Parallel Machine Problem

The objective function of this research is to minimize makespan. Minimization of makespan will be related to the timeliness of completion in accordance with consumer orders.

Result and Discussion

The results of the first data collection are to identify the 10 jobs that will be the object of research.Job identification includes the processing time of each job, shown in the table

Table 1
Data Collection Results

No.	No. Order	Length	Processing Time
1	21010015	50	378,36
2	21010016	50	380,49
3	21010024	100	736,11
4	21020030	50	212,19
5	21020040	35	184,5
6	21020041	100	745,05
7	21020050	100	545,79
8	21030027	22	117,63
9	21030030	35	185,64
10	21030040	100	547,83

In solving the scheduling problem in this case, the SPT (Shortest Processing Time) and LPT (Longest Processing Time) methods will be compared, then the processes will be compared with each other to find the best solution.

Shortest Processing Time (SPT) Method

The steps in scheduling the SPT are:

10. Arrange the work according to the smallest processing time to the largest.

From the results of the job arrangement in Step 1, schedule the machine that is idle or has the smallest completion time. Do this Step until all jobs are scheduled on the machine? The result of scheduling for each machine is Machine 1 =(8,9,1,7,3) and Machine 2=(5,4,2,10,6) with makespan is 2070.06.

Table 2
Sorting Jobs based on the shortest processing time

No.	Processing Time
8	117,63
5	184,5
9	185,64
4	212,19
1	378,36
2	380,49
7	545,79
10	547,83
3	736,11
6	745,05

Longest Processing Time (LPT) Method

The steps in the LPT scheduling are:

1. Arrange the work according to the smallest processing time to the largest.

Table 3
Sorting Jobs based on the longest processing time

No.	Processing Time
6	745,05
3	736,11
10	547,83
7	545,79
2	380,49
1	378,36
4	212,19
9	185,64
5	184,5
8	117,63

From the results of the job arrangement in Step 1, schedule the machine that is idle or has the smallest completion time. Do this Step until all jobs are scheduled on the machine? The result of scheduling for each machine is Machine 1 = (6,7,1,9,5) andMachine 2=(3,10,2,4,8) with makespan is 2039,34.

Conclusion

The method that can be used in PT ABC is the LPT scheduling method to produce the shortest turnaround time. The use of PT. FCFS scheduling method. ABC takes 2255.7 to complete thetime to process 10 jobs. But by using the LPT method, it is found that the completion time is 2039.34. Comparison of completion times using the FCFS, SPT and LPT methods is shown inthe table.

Table 4 Makepan comparison for each method

Method	Makespan
FCFS (Existing)	2255,7 hours
SPT	2070,06 hours
LPT	2039,34 hours

So, if PT. ABC performs its production scheduling using the LPT method, it will save 216 hours to be able to complete the 10 jobs about 9.59% of the total completion time using the FCFS method.

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