Comparison of job shop production scheduling by using the non-delay method and the Heijunka method at PT XYZ

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Abstract- The problem that often occurs in this company is the accumulation of orders at one time with a large quantity of products and human resources that are still relatively low can be one of the causes of delays in completing orders for customers. We using Non Delay Method and the Heijunka Method. Where, the Non Delay method is a method that does not let the machine idle if an operation can be started. While the Heijunka method is more concerned with equity in its production. In this study, scheduling using the Non Delay Method is better than using the Heijunka Method or using the existing scheduling method used by the company, because it can produce a faster makespan value. With this Non Delay method, to produce 3 Job 5 machines produce makespan of 3772.01 minutes smaller than using the Heijunka Method which results in makespan 3820 minutes. While the results of existing scheduling makespan only produce 3880.35 minutes.

1. Introduction
Delays in shipments often occur within a company due to the large number of requests in one unit of time with limited labor and machinery. This will have a major impact on the company, namely loss of consumer confidence which results in the company's reputation will decline or disappear altogether. A situation like this if left too long will not be good for the smooth running of a company. In an activity production, to get an optimum result, all production activities must first be planned well.

PT XYZ is a manufacturing company that specializes in General Contractor - Machining & Reconditioning Services to service users such as Industrial plants. One of the products produced by PT XYZ is nuts of different sizes. The size of the nut is M36 nut, M42 nut and M24 nut with the difference of each nut, which is in inner diameter, width and thickness. The making of this nut includes 5 processes that pass through 5 manufacturing machines, namely the process of shearing, the process of cutting, the process of perforation, the process of turning and the process of rolling. The machines used are scrap machines, cutting machines, drilling machines, lathe machines and CNC machines. The production process flow in the PT XYZ company is job shop type, that is, each product is processed through a different process in each operation and seen from the type of production, PT XYZ is made to order, for example: when there is a new order to do production activities.

The obstacles that often occur at PT XYZ are also because the human resources in the company are still relatively low, workers who chat, lack of concentration, too relaxed in work and lack of training that results in the length of the production process is completed so it is not in accordance with the time estimated by the company, so that the processing time carried out by less reliable operators will take
longer and can affect the output of the resulting product to be less than other operators. This certainly can hamper a job, causing a delay in the production process on time.

In this study used the Non Delay Method with the Heijunka Method. Non-Delay Scheduling Method is an active scheduling method that does not allow the engine to become idle if an operation can be started [3]. Heijunka method is a work schedule smoothing, namely by taking actual customer requests, determining the pattern of volume and product mix, and making a flat schedule every day. So that it is expected from the results of these methods the company PT XYZ can find out the minimum or most effective total makespan needed and can know the leveling of production every day in order to be able to produce products stably[1].

2. Research Methods

The research method begins with a literature study to find out the basics of the research, then make direct observations to get the problems found in the company so that methods can be determined in accordance with the conditions of the company to solve the problem. After that the problem is formulated and the research objectives are determined. The purpose of this study is to determine the makespan value obtained in the scheduling of proposals using the Non Delay Method and the Heijunka Method, and compare the value of the existing makespan and the selected method.

The data needed in the study are general corporate data, product demand data, number of machines and operators, set up time data, Operation Process Chart, adjustment factors and allowances

3. Results And Discussion

3.1 Scheduling Using the Non delay Method

The study was conducted in December-January 2019 with the following data. The first data processing must be done is to calculate the completion time of the entire product based on the number of products of each product and the number of machines. The results of the completion time can be seen in Table 1.

| Job  | Time for Completion of each job Job (minute) |
|------|--------------------------------------------|
|      | ST 1 | ST 2 | ST 3 | ST 4 | ST 5 |
| Job 1 | 774.06 | 706.58 | 748.17 | 188.05 | 903.24 |
| Job 2 | 361.01 | 276.05 | 318.94 | 114.84 | 359.27 |
| Job 3 | 220.08 | 185.19 | 190.85 | 24.34  | 200.98 |

In the scheduling conducted by PT XYZ for the completion time of the entire product to produce the three types of products is 3880.35 minutes.

The scheduling steps using the Non Delay Method are as follows [1]. First is determining Job, Operation and Machine at Pst starts at t = 0, because there is no scheduled process. Next we can determining the Start Time (Cj), Processing Time (tij) and calculating the completion time (rij) is used to get the time of the entire process to be scheduled on each machine. Determine the minimum start time (Cj) that will be realized to be able to determine the job, operation and engine which will then be scheduled. Entering jobs in Pst is used to find out which jobs and machines are selected. And the last is issue the job that will be scheduled to be done to find out the Schedule selected.

In scheduling using the Non Delay Method it was found that makespan for producing the three types of products was 3772.01 minutes.

3.2 Scheduling Using the Heijunka Method

The scheduling steps using the Heijunka Method: Establish the amount of production, determine the amount of production used to determine the total total product produced in daily production. Next step is calculating the ratio of the number of products. Calculate the ratio of the total daily product number. With the total time available in one working day to get the cycle time. With the formula as follows.
The ratio is used as a sequence to be able to determine the actual product to be produced. By using the formula as follows.

\[
\text{Sequencing Rules} = \frac{\text{Daily Production Amount per Product}}{\text{Minimum product total value}}
\]  

Perform repetition until it reaches the total amount until the time needed to do the daily production is reached.

### Table 2. Sequencing Rules.

| Product | Daily Qty | CT       | Rule of Sequencing | Actual |
|---------|-----------|----------|--------------------|--------|
| M36     | 7         | 1.16666667 | 1 - 2              |        |
| M42     | 8         | 20       | 1.33333333        | 1 - 2  |
| M24     | 6         | 1        |                    | 1      |
| Total   | 21        |          |                    |        |

In scheduling using the Heijunka Method, makespan to produce three types of products is 3880 minutes.

**4. Analysis**

**4.1 Analysis of Proposed Production Scheduling Using the Non Delay Method.**

The Non Delay method is a method that does not allow the machine to be idle or idle if an operation can be started [5]. In this scheduling, the selected time is the fastest time (Cj) of each operation. When there are several operations that have the same fastest start time but on different machines, the operation can be performed at the same time. But when the fastest start time for some of these operations is the same but on the same machine, one operation must be chosen to work [5].

Gantt chart on scheduling using this method illustrates a faster completion time and there is no idle time in each process of each job in the order that is done first, namely jobs that have a faster completion time, namely job 3, then job 2, then job 1. So that every job is done there is no intermediate product produced to wait for the next machine to be processed. This makes the total settlement time faster. The results of makespan obtained from scheduling using the Non Delay Method are 3772.01 minutes or 62.87 hours with 15 iterations. The iterations can be terminated if all operations have been scheduled. The results of makespan produced in this method are much smaller than the results obtained from the existing methods carried out by the company. By using this method, the company can increase production capacity more than the current actual production capacity.

**4.2 Proposed Production Scheduling Analysis Using the Heijunka Method.**

Another method that can be done to get the shortest operating time in making Mur M36, M42 and M24 is by using the Heijunka Method. Heijunka means a production system that produces various items (mix) in one production line, which means production is carried out in turns every day, every hour even every minute so that the inventory level is in the process becomes lower. States heijunka is leveling production both in terms of volume and product mix. It does not make products based on the actual order of customer orders which can rise and fall sharply, but take the total number of orders in one period and level them so that they are made in the same amount and mix every day [1].

The results of makespan obtained from scheduling using the Heijunka Method are 3820 minutes or 63.67 hours. This result is much smaller than the existing scheduling makespan. By using this method, it has several benefits including handling logistics will be balanced and evenly distributed, the workload
for workers will be balanced and evenly distributed, the resulting production for customers will also be balanced and evenly distributed and help to improve product quality by reducing defects caused by workload [1].

4.3 Analysis of Existing Scheduling Comparison with Proposed Scheduling using Non Delay Method and Heijunka Method

It can be seen from the existing scheduling that the company produces makespan of 3880.35 or 62.87 hours, then from the results of the proposed production scheduling using the Non Delay Method produces makespan of 3772.01. The results of the proposed production scheduling using the Heijunka Method produce makespan of 3820 minutes or 63.67 hours.

Based on these results it can be seen that the proposed production scheduling using the Non Delay Method and the Heijunka Method results in a faster and better makespan value compared to the existing production scheduling of the company. In scheduling proposals using the Non Delay Method can save makespan value by 108.34 minutes or as much as 3% on existing conditions. And the proposed scheduling using the Heijunka Method can save makespan by 60.35 minutes or as much as 2% on the existing condition of the company.

4.4 Analysis of Selected Scheduling Methods

Comparison of the three methods above, namely the existing production scheduling method conducted by the company, production scheduling using the Non Delay Method and production scheduling using the Heijunka Method, found that the best scheduling method is production scheduling using the Non Delay scheduling method. In this method, an operation and a machine can operate at any time if conditions permit. Certain operations do not have to wait too long to work. In essence, in this method the operation can be processed if it has the smallest start time (Cj) and allows the operation that has the same fastest start time (CJ) can be processed also if the engine is different. So that it produces a minimum makespan value that is equal to 3772.01 minutes or 62.87 hours and the earliest work done is a job with a smaller processing time which is job 3 - 2 - job 1 job.

The results show that the Non Delay Method is better at scheduling than the company method. Companies must be more careful in choosing a scheduling method. The scheduling method chosen as much as possible can accelerate the time of completion of the work and reduce the flow of work time. The faster the job can be completed, the more jobs that can be done, and the more orders received. The smaller the flow time, the smaller the time to wait for the job to process. Reducing the waiting time for jobs can reduce inventory of intermediate goods [6].

5. Conclusion

The conclusions that can be taken from the description and resolution above are as follows. The minimum makespan value obtained in scheduling using the Non Delay Method is 3772.01 minutes. The makespan value obtained in scheduling using the Heijunka Method is 3820 minutes. Based on the comparison of the results of the existing makespan calculation with the proposed method, scheduling using the Non Delay Method has a makespan value of 3% better than the existing scheduling makespan value.

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References
[1] Amran, Tiena G dan Irma Agustiningsih. 2009. *Designing a Production Schedule Using the Heijunka Method to Support the Development of Conventional Production Systems to the Toyota Production System (Case Study: Pt Adyawinsa Dinamika)* INASEA, Vol. 10 No.2, Oktober 2009: 134-147

[2] Astuti, M. 2013. *Job Shop Scheduling Study to Minimize Overall Time Using the Artificial Immune System Algorithm Approach*. Volume V, Nomor 1, Mei 2013

[3] Harto, Setyo dkk. 2016. *Production Scheduling Using a Non Delay Schedule Algorithm to Minimize Makespan Case Study in Cv. Bima Industrial Spectrum Furniture*, 2016, Vol. 14, No. 1, 1 – 108 ISSN: 1963-6590 ISSN: 2442-2630

[4] Suseno dan Bian Indrakusuma. 2014. *Job Scheduling using the Active Algorithm Method, Non Delay Algorithms and Heuristic Schedule Generation (studi case: Borobudur Knitting)*. Industrial Engineering, Faculty of Science & Technology, University of Yogyakarta.

[5] Fithri, P. 2013. *Machine scheduling using active schedule generation algorithms and non-delay scheduling algorithms for hydrotiller and hammermil products at cv. Cherry with agro facilities*. Industrial Systems Optimization Journal Vol. 12 No. 2, Oktober 2013:377-399

[6] Cahyanto, WN. 2016 *compound Machine Job Shop Scheduling Using Non Delay Algorithm To Minimize Mean Flow Time and Determine Due Date*. Industrial engineering, Universitas Muhamadiyah. Surakarta

[7] Suzaki, K. (1991) *Manufacturing Industry Challenges, Implementation of Continuous Improvement, Completion*. Adaptation Kristianto, J. Jakarta: Productivity and Quality Management Consultants.