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The Lean Manufacturing Design for Improving Production Scheduling Using Product Wheel Method in Chemical Manufacturing Company, Indonesia

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ABSTRACT

The current production scheduling policy at Chemical Manufacturing Company raises several problems, including the long production lead time for each product, unbalanced inventory between products, and the unavailability of goods requested by customers. Therefore, this research will focus on designing production scheduling improvements at Chemical Manufacturing Company in order to be able to overcome current problems. The product wheel method was chosen to be a proposal to improve production scheduling at Chemical Manufacturing Company Based on the calculation of Economic Production Quantity (EPQ), the product wheel's production schedule is made into three cycles in which every cycle runs for two days. Cycle 1 produces Tonsil C 1000 by 200 tons, Tonsil B 1000 150 tons, Tonsil A 1000, and Tonsil B Cylo as much as 50 tons each. Cycle 2 produces Tonsil C 1000 for 200 tons, Tonsil B 1000 150 tons, Tonsil A 1000 100 tons, and Tonsil B Cylo for 50 tons. Cycle 3 produces 200 tons of Tonsil C 1000, Tonsil B 1000, Tonsil A 1000, Tonsil B Cylo, Tonsil C 25, and Tonsil B 25, each with 50 tons. Because Tonsil C 25 and Tonsil B 25 are MTO products, they do not always have to be produced when cycle three spins. By scheduling production using the product wheel, we get a more dynamic production schedule than the production scheduling at Chemical Manufacturing Company. The previous Chemical Manufacturing Company was due to product wheel scheduling, the quantity produced, and the production sequence was made based on customer demand so that it was expected that production could run effectively and efficiently.

Keywords: *Production planning, Scheduling, Product wheel.*

1. INTRODUCTION

The development of the manufacturing industry in Indonesia is experiencing rapid progress at this time certainly creates intense competition in the manufacturing industry sector. Every company competes to gain market share by increasing company performance in all lines in order to produce quality products as expected (expected quality), offer reasonable prices, and pass on-time delivery according to the promised schedule (timeliness) of deliveries). These three factors are often used as benchmarks for customer satisfaction. The ability of company management to meet these three things can be obtained if the company carries out its production planning and control effectively.

In a manufacturing system with a high number of demands and varied products, production planning and control will be more complicated. In its application in the field, for short-term production planning, a company will make a production schedule (scheduling). Production scheduling involves the allocation of limited resources to meet demand by taking into account constraints such as capacity, priority, and start and maturity dates (Stoop and Wiers, 1996).

Chemical Company is a manufacturing company engaged in chemicals. The product produced is a solid material in the form of powder for the purification of CPO (Crude Palm Oil) oil. Based on its quality grade, the product is divided into three types, namely types A, B, and C. While based on the packaging, the product is divided into two packages, namely small bag (25 kg) and jumbo bag (1000 kg). Production scheduling that was previously running

Chemical Company is a batch flow method that is to make a production schedule for three types of products A, B, and C in one month with different duration for each type of product adjusted to the request. The batch flow system implemented by Chemical

Company is a long campaign. It is said to be a long campaign because the time span of switching from product A to product B is long. For example, in a period of one month, the process of producing product A runs 12 days, then from the 14th day to the end of week three or the 21st-day producing product B, and from the 22nd day to the 28th day it is replaced with the production of product C. Scheduling scheme with a batch flow system can be seen in Figure 1

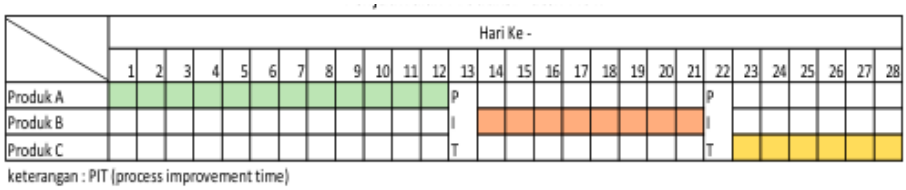

Figure 1 Batch Flow Production Scheduling Scheme

From this batch flow scheduling policy, various problems arise, such as the length of time waiting for other products, product availability, and inventory. In terms of inventory, when the production process is still running product A, then product inventory B and C will continue to decline until it reaches zero point and cause the company not to be able to meet customer demand for product B or C. Figure 2 shows the peaks and valleys in the inventory stock chart.

Figure 2 stock inventory diagram

This research will focus on improving the method of scheduling production in order to overcome the various problems mentioned in the previous paragraph. Based on the background of the problems mentioned, the problem formulation was taken, namely how to design a production scheduling using the product wheel method to be applied at Chemical Company ? The objective to be achieved in this research is to design and propose improvements to production scheduling using the product wheel method at Chemical Company.

2. LITERATURE SURVEY

Product Wheel is a visual metaphor for structured sequences, regular repetition of all materials to be made on a particular device, in a reaction vessel, in a process system, or on the entire production line (King, 2013). In short, the Product Wheel can be defined as the production sequence used by manufacturing operations when several products are made on one line or equipment.
When properly managed, Roda Products provide effective discipline to meet customer demand & service levels, while maximizing process response and minimizing inventory needed. The benefits of product wheels generally include:
• Changeover is simplified because fewer parameters have to be adjusted.
• By adjusting the ideal cycle frequency for low volume products, the total number of turns decreases.
• Overall equipment effectiveness and output capacity increase.
• Production is leveled, eliminating peaks and valleys in the schedule.
• Inventory is down and closer to the desired mix, so delivery performance to customers goes up.
• Overtime decreases.
• Overall waiting times are reduced, which makes link manufacturing operations more responsive and nimble in the supply chain.
• Repeatability and predictability enable better long-term supply chain planning.

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3. OBJECTIVE OF THE RESEARCH

Based on the background of the issues that were issued, the problem formulation was taken, namely how to design the production Scheduling using the product wheel method to be applied at Chemical Manufacturing Company?

4. RESEARCH METHODOLOGY

To design the production schedule using the product wheel, actual sales report data is needed obtained from the SAP system. This data can be considered to look at product demand variability. Then the production capacity data is also analyzed by mathematical calculations so it can determine the optimal production sequence and estimate the shortest wheel time based on the time available for product replacement with the following formula.

$$\text{Wheel cycles per period} = \frac{\text{Total available time} - \text{Total production time}}{\Sigma \text{ Changeover times per cycle}}$$

$$\text{Wheel time} = \frac{\text{Total available time}}{\text{Number of wheel cycles per period}}$$

After getting the shortest wheel time, the next step is to determine the optimal frequency for each product. The optimal frequency is obtained by calculating Economic Production Quantity (EPQ) divided by the daily demand for each product. EPQ can be calculated using the following formula.

$$EPQ = \sqrt{\frac{2 \times COC \times D}{V \times r \times \left(1 - \frac{D}{PR}\right)}}$$

Informations :

COC = Changeover cost
D = Demand per time period
V = Unit cost of the material
r = %carrying cost of inventory per time period
PR = Production rate

4. RESULT AND DISCUSSION

After calculating the optimum wheel time, EPQ, and frequency in the previous chapter, we can determine the ideal number of cycles in scheduling product wheel production at Chemical Company To meet customer demand, the absolute number of cycles needed to run wheel time for two days is three types of cycles with the number of products per cycle referring to the EPQ value of every kind of product with rounding numbers, because it is adjusted to engine capacity. The results of the production wheel scheduling design of Chemical Company can be seen in Table 1 below.

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Table 1 Product Wheel Production Scheduling

Product Description	Demand Per Week (Ton)	EPQ (Ton)	Freq. Optimum	Recommended Day	Seq.	cyle 1 (2 days)	cyle 2 (2 days)	cyle 3 (2 days)
Tonsil C 1000	597,8	190,26	0,32	1	1	200	200	200
Tonsil B 1000	330,4	125,88	0,38	1	2	150	150	50
Tonsil A 1000	163,8	166,95	1,02	1	3	50	100	50
Tonsil B Cylo	128,8	84,54	0,66	1	4	50	50	50
Tonsil C 25	49	222,31	4,54	MTO	5			50
Tonsil B 25	15,4	105,78	6,87	MTO	6			50
						450	500	450

Table 1 shows that the order of production in product wheel production scheduling at Chemical Company is sorted from the highest to lowest customer demand; this is so that the availability of goods at Chemical Company is in accordance with customer demand. From the results of product wheel production scheduling in Table 1, it can be made a visualization of product wheel cycle 1, cycle 2, and cycle three, which can be seen in Figure 3-4 below.

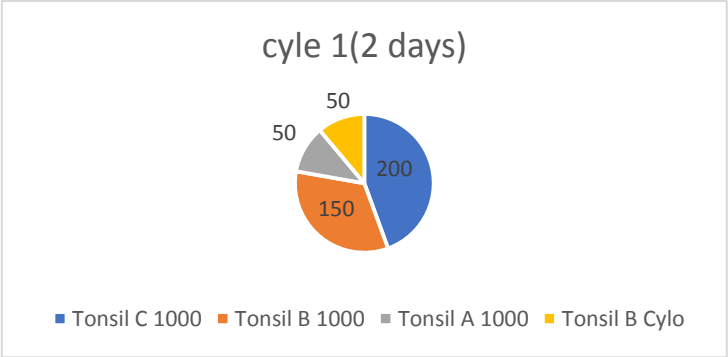

Figure 3 Cycle 1

Figure 3 shows the pie chart as a visualization of the product wheel cycle 1. In period 1, the wheel time runs for two days by producing four types of products, namely Tonsil C 1000 by 200 tons, Tonsil B 1000 150 tons, Tonsil A 1000, and Tonsil B Cylo, respectively as much as 50 tons. The total amount of product produced in cyle 1 is 450 tons. This amount is still below the engine capacity of 250 tons per day.

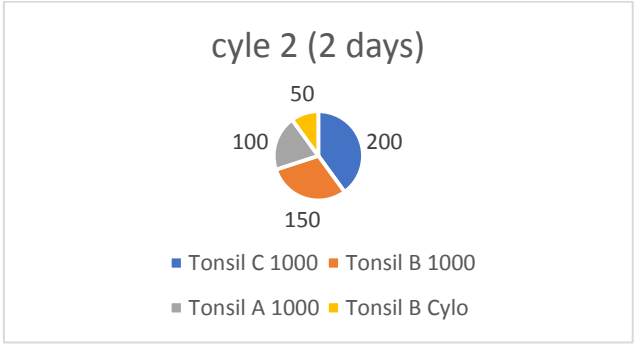

Figure 4 Cycle 2

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Figure 4 shows the pie chart as a visualization of the product wheel cycle 2. In cycle 2, the wheel time runs for two days by producing four types of products, namely Tonsil C 1000 by 200 tons, Tonsil B 1000 150 tons, Tonsil A 1000 100 tons, and Tonsil B Cylo as much as 50 tons. The total amount of product produced in cyle 2 is 500 tons. This amount is equal to the engine capacity of 250 tons per day.

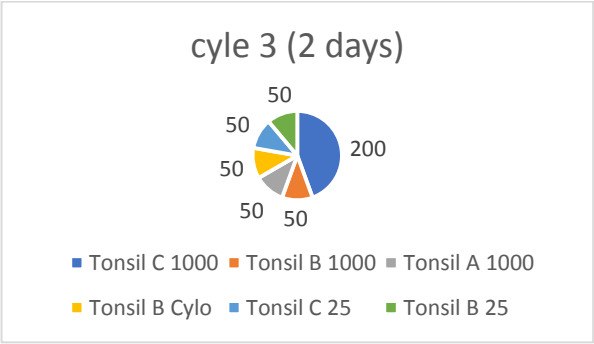

Figure 5 Cycle 3

Figure 5 shows the pie chart as a visualization of the product wheel cycle 3. In cycle 3, wheel time runs for two days by producing six types of products, namely Tonsil C 1000 by 200 tons, Tonsil B 1000, Tonsil A 1000, Tonsil B Cylo, Tonsil C 25, and Tonsil B 25 each with 50 tons. Because Tonsil C 25 and Tonsil B 25 are MTO products, they do not have always to be produced when cycle 3 rotates.

From the results of the design schedule of product wheel production that has been made, it can be seen that there are significant differences by way of production scheduling at Chemical Company before, namely regarding the order of types of products produced

and the time of changeover from the first type of product to the second type of product and so on. Comparison of production scheduling with the old method and product wheel production scheduling can be seen in Figures 5 and 6

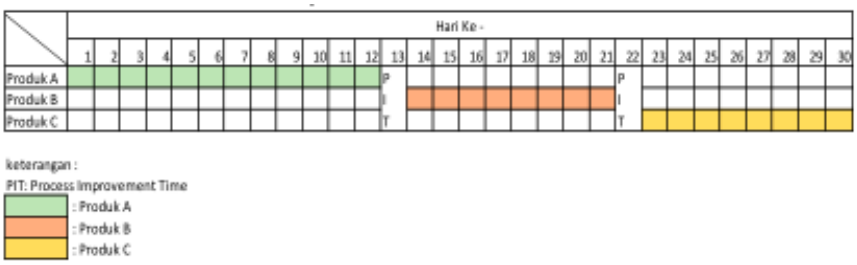

Figure 6 Batch Flow Production Scheduling Scheme

In batch flow production scheduling, the order of production starts from the type of the highest quality product to the lowest quality product. In this case, it is not seen based on EPQ values. While for product change time in the production schedule, batch production of one type of product can be produced more than five days and then replaced with another product, which makes the inventory unbalanced and results in the unavailability of other products that are not being delivered.

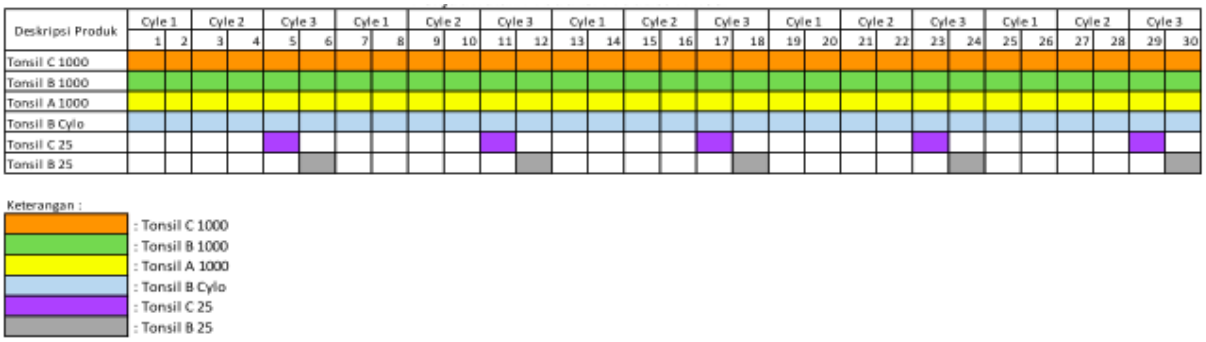

Figure 7 Product Wheel Production Scheduling Scheme

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From Figure 7, it can be seen that the changeover is carried out every day, except for products that are proposed to be MTOs, only produced when there is an order from the customer. In product wheel scheduling, customer demand is an essential point because the law of production is seen from the highest customer demand to the lowest demand. It is intended that the company can always meet customer demand. In addition, customer demand can also affect scheduling efficiency. Customer demand is used to determine the EPQ value and optimum frequency of each product. From the EPQ value, we can calculate how much quantity should be produced by considering the cost of inventory and also the cost per unit of material. Products with low demand are proposed to be MTOs, so companies can minimize inventory costs for these products.

It can also be seen in the product wheel scheduling that the product turnover cycle becomes more dynamic than the previous method. If previously the turnover from one product to another is quite long, the lead time in the product wheel in the same day can produce several different types of products because the wheel time and production capacity of each product has been calculated mathematically by considering the changeover cost and time available for the changeover.

Overall the scheduling of the product wheel is based on customer demand, and changeover between products is made dynamically to adjust customer demand so that production can run effectively and efficiently so as to achieve Chemical Company 's vision of providing excellent products and services for consumers.

5. CONCLUSION

From the production scheduling design using the product wheel method at Chemical Company that has been made, it can be concluded by scheduling production using the product wheel, so the production schedule is more dynamic than the production scheduling at Chemical Manufacturing Company was due to the scheduling of the wheels of the number of products needed and the order of products made according to customer requests so that production was expected to run effectively and efficiently. That way, Chemical Company can achieve the company's vision of providing excellent products and services for customers.

The following advice is given for Chemical Company, especially the PPIC section related to production scheduling, which is given:

1. It can be reviewed further on how to understand production scheduling using the product wheel method for all production lines.
2. It can be reviewed more now on the effect of scheduling product production with inventory when the production method has been implemented.

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