Material Requirements Planning for PT Petrokimia Gresik's Fertilizer Production to Reach Production Cost Efficiency

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Abstract

Fertilizer is one of the most important things in agriculture. One of the biggest companies that produce fertilizer in Indonesia is PT. Petrokimia Gresik that is located in Gresik. In the last two years, Indonesia is facing a lack of fertilizer stock to meet the needs of Indonesian farmers. One of the root causes is the high production cost needed for making urea fertilizer. This paper discusses the use of Material Requirements Planning (MRP) to improve production cost efficiency in the PT. Petrokimia Gresik. The right MRP will minimize the product cost, so PT. Petrokimia Gresik can produce more products with efficient costs.

Keywords
Material Requirements Planning, fertilizer, urea, cost efficiency

1. Introduction
Indonesia is an agricultural country. As an agricultural country, the agricultural sector is an important sector for Indonesia. Based on records from the Central Statistics Agency (BPS, 2022), in 2020 there are around 33.4 million farmers engaged in all commodities in the agricultural sector. The gross domestic product (GDP) of the agricultural sector at current prices (ADHB) will reach IDR 2.25 quadrillion throughout 2021 (BPS, 2022). This value contributes 13.28% to the national GDP (BPS, 2022).

Fertilizer is one of the important production factors for agriculture because the proper use of fertilizer will determine the quantity and quality of agricultural products produced. The Ministry of Agriculture has said that until 2021, Indonesia's fertilizer needs have reached 22.57 million tons to 26.18 million tons per year (Susanto, 2021). But on another side, Indonesia's fertilizer production actually decreased slightly in 2021. It was a decrease of 0.2% compared to 2020 which was 12.26 million tons. One of the root causes of this problem is the high cost needed for fertilizer production. As one of the fertilizer producers in Indonesia, PT Petrokimia Gresik needs to pay more attention due to the gap between production and demand concerning the cost efficiency of production.

In order to maximize certain strategies and policies, a company needs to have a well-designed production planning and forecasting, including a well-planned material stock schedule which is MRP. Material requirements planning will help the company to maximize production while minimizing cost. A poor material supply and storage system will have a negative impact on production, such as delays in product completion or even stopping production, which can lead to a decrease in customer satisfaction, lowering the company's competitiveness (Rahmat et al., 2020)

This paper discusses the use of Material Requirements Planning (MRP) to improve production cost efficiency in the fertilizer industry. By arranging the precise MRP, PT. Petrokimia Gresik could minimize its production cost and reach efficiency.

1.1 Objectives

The objective of this research is to reach production cost efficiency in PT. Petrokimia Gresik's fertilizer. By doing this, PT. Petrokimia Gresik could reach more profit by reducing the margin, minimizing production cost, and maximizing production efficiency.

2. Literature Review

2.1 Material Requirement Planning

MRP defines as "a set of techniques that uses BOM data, inventory data, and the Master Production Schedule (MPS) to calculate requirements for materials. It makes recommendations to release replenishment orders for material. The system will produce output in the form of raw materials on the booking schedule, using Material Requirement Planning (MRP) per week (period), and not using safety stock with the assumption that goods arrive on time. Materials Requirement Planning (MRP) is a technique for determining the quantity and the time to purchase dependent demand items necessary to meet the needs of the Master Production Schedule (MPS) [3]. Materials Requirement Planning (MRP) as a technique that uses a list of bill of material, inventory, receipts were estimated, and the master production schedule to determine material requirements [4]. The implementation of MRP would create competition and efficiency, which would lead to a better quality of life for customers at lower costs [5]. MRP systems are subject to diverse forms of uncertainty: demand, lead times, production yield, production capacity, among others (Dolgui and Prodhon 2007, Guide and Srivastava 2000). The implementation of MRP system starts with customer order and ends with the production of the corresponding product (Ramya et al, 2019). The major components of the MRP are the Master Production Schedules (MPS) and the Bill of Materials (BOM), which is discussed in this section (Drexl & Kimms, 1998).

3. Methods

This research follows several steps in order to reach a conclusion. The first is data collection. The data collection process is conducted by collecting the product structure, which is PT Petromkimia Gresik's urea structure, from their official website. Then, based on the product structure, we build the bill of material (BOM) with a single lot size. From that data, we calculate the Master Production Schedule (MPS) as a base data for making the MRP.

4. Data Collection

PT Petrokimia Gresik is producing Urea fertilizer which has its unique product structure. The structure of the product is shown below:

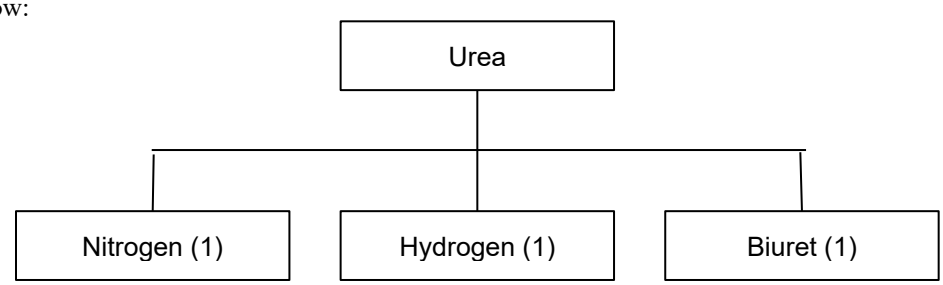

Figure 1. Product Structure from Urea

Based on the product structure, the urea is built by Nitrogen, Hydrogen, and Biuret. Therefore, these compositions have a single lot size to record inventory. The Bill of Material with its lead time and lot size are described below:

Material	Unit	Needs	Lead Time	Lot Size	Price per lot
		Urea Fertilizer			
Nitrogen	1 kg	✓	1 Day	22	Rp20.000,00
Hydrogen	1 kg	✓	1 Day	27	Rp17.500,00
Biuret	500 gram	✓	1 Day	1	Rp65.000,00

Table 1. Bill of Material for Urea

Based on the data, we earned the number of sales for five weeks. The data is the number of demands of the company has to fulfill. The data will be served as an input for MPS as it provides us with the number of end items needed at the end of each week.

No	Product	Week 1	Week 2	Week 3	Week 4	Week 5
1	Urea Fertilizer	19.000	19.837	20.943	18.750	19.560
TOTAL		19.000	19.837	20.943	18.750	19.560

Table 2. Master Production Schedule for Five Weeks

Using the data found in Figure 1 (Product Structure from Urea), Table 1 (Bill of Material for Urea) and Table 2 (Master Production Schedule for Five Weeks), we may create an MRP for five weeks of demand. Based on the assumption that on hand inventory at the beginning of week 1 is 0 for all material, sub-assembly, and enditem as the company has just started their business, we can create the precisely MRP. We will also assume that there is no storage fee as the company does not provide the storage cost data. The MRP table will be shown in the table below.

MRP	1	2	3	4	5
Planned order release	180	172	157	150	130
Planned order release	250	290	283	275	250
Planned order release	86	73	68	60	50

Table 3. Master Resource Planning for 5 Weeks

Based on the MRP table above, the requirements for all material are highly diverse. All materials have stock at the end of the 5th week which will be on hand inventory the following week.

5. Results and Discussion

Based on the MRP table we can calculate the cost of material procurement from week 1 to week 5. The calculation of material cost will also use the data found in table 1 and 2 (unit, lot size, and prices). The cost prices per week will be illustrated in the graph below.

5.1 Numerical Results

Based on the table below, we found out that the material cost for five weeks of production by the company would be 977.997.912,12, if the company using MRP to plan their production. In order to find how well the use of MRP is compared to the company's current material calculations, a comparison of the five weeks of material procurement data is required. The actual procurement cost is based on the company financial report that covers the material being used during week 1, week 2, week 3, week 4, and week 5. The data of actual material procurement cost is stated in the table below.

Material Procurement with MRP	Week					On Hand Inventory at The End of Week 5
	1	2	3	4	5	
Cost	232.210.000	217.450.000	207.217.500	199.837.500	121.432.200	149.087,88
Total Cost	977.997.912,12					

Table 4. Material procurement cost with MRP

5.2 Graphical Results

We calculate the material procurement cost with MRP table. As we have started the production from week 1, we will start the material cost calculation from that week also (referred from the data in table 2). The price per week is being illustrated in the graph below

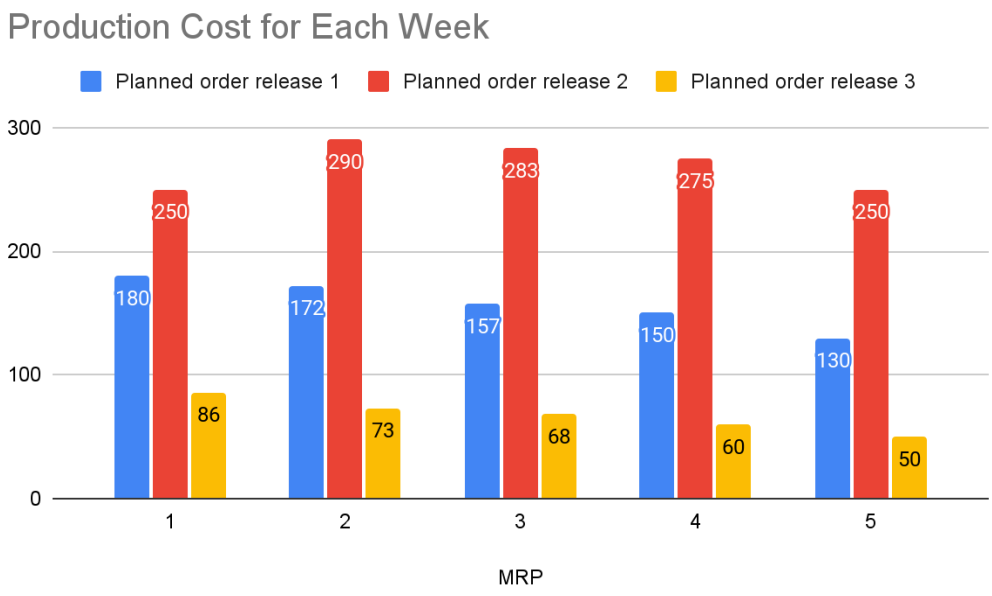

Figure 2. Production cost for each week

The graphic shows the material procurement cost data including the unused material, which are still available at the inventory at the end of week 5. The graph also shows that the material spending is mostly sloping (referred to the planned order release 1 and 3). But, if we referred to the planned order release 2, there is a slight increase on week 2, then sloping withing the following weeks until week 5. We will count the used material in the production to compare

MRP material procurement cost with the actual data. Finally, we will substract the last inventory data from the used inventory to gain the precise required material as shown in the table below during the production.

5.3 Proposed Improvements

Actual Material Procurement Cost	Week				
	1	2	3	4	5
Cost	240.200.000	215.500.000	206.880.000	199.700.000	143.550.000
Total Cost	1.005.630.000				

Table 5. Actual material procurement cost

After knowing the material procurement cost for both actual data and MRP. Then, we will compare both of them to see the difference between choosing the MRP and Actual Material Procurement for material planning from the beginning. The differences between the actual cost and MRP will be shown on the table below.

5.4 Validation

Based on the MRP calculation, we will calculate and compare the actual data to see whether the company is in the right track to choose MRP to improve their operation. The differences between each efficiency is shown below:

Actual Cost Material Procurement	Material Procurement Cost with MRP	Efficiency	
		In Price	In Percentage
1.005.630.000	977.997.912,12	27.632.087,88	2.75%

Table 6. Material procurement cost comparison between actual and MRP

Based on the table 7, the company is in the right track to choose to use MRP to increase the operation efficiency. The company may save up to Rp27.632.087,88 or 2,75% from the while material procurement cost. The differences in the fund can be saved to develop the company and make improvement.

6. Conclusion

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From this discussion, there are two options of reaching the most efficient cost of production, actual data and . It can be concluded that the right option is to use MRP to increase the operation efficiency by looking the graphic results of material procurement cost with MR,, and company save up to Rp27.632.087,88 or 2,75% from the while material procurement cost. Therefore, the company can develop by choosing MRP to improve their operation.

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Biography

Aldyth Ardiyanto is an undergraduate student in Industrial Engineering at the Universitas Indonesia. He actively participates in various academic and student activities. currently he is an expert staff in the academic and profession of IMTI FTUI. His field of interest is manufacturing systems.

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