Improving Material Management in Micro, Small, and Medium Enterprise (MSME) Using Material Requirement Planning (MRP)

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Abstract

Micro, Small, and Medium Enterprise (MSME) is the largest business executor to Indonesia's national gross domestic product. Due to the size of the company, it is inevitable that MSME is required to have an efficient workflow and material purchasing to minimize the costs. One of the most popular sectors of MSME is food and beverages, Glucofeel is one of them. Glucofeel is a company that sells cakes that are tasteful and attractive. Based on the company's data, it is important for Glucofeel to be able to fulfil their customer's demand. These objectives, however, were inhibited by the problem of the company's inability to make efficient material procurement in order to fulfil the customer demand in the right amount and at the right time. The purpose of this research is to increase the company efficiency by implementing MRP. The MRP will be based on the company's historical data and bill of material. The final calculations of MRP are being totalled and compared to the actual purchasing data. The result of the total calculation shows that if the company has implemented MRP from the beginning, the company can save the amount of Rp 115.746,66,- in price and make a saving of 6,22%.

Keywords
material requirement planning, material procurement, bill of material, MSME.

1. Introduction

The food production business is one of the business fields that has a lot of interest and competition (LPPM IPB 2018). This is due to the importance of the goods produced (food) in human life as a basic necessity in everyone's life. Therefore, this business field is the main focus of this research. Although this field is a major field, it also has many factors that influence the running of the business. Although it is the basic need, each customer has a different variety of tastes which causes instability in this area of business (Bech et al. 2019). The wide variety of customer tastes depends on themselves, some like Sweet tastes and some don't. In recent years, many businesses in the food sector have flourished because of their concept and great taste (Galanakis et al. 2021). Among these foods, there are many sweet food businesses, both as a side dish and as a dessert. Intense competition requires business people to be more creative in attracting customers. To solve this problem, many business people have innovated, including innovating in the taste offered (Bech et al. 2019). It is hoped that the uniqueness of the taste offered will attract the attention of new customers.

One of the businesses that is engaged in this field of business which has become our main focus is Glucofeel, this business offers a dessert in the form of Cakes with a variety of flavors that are not commonly found. This business is a Micro, Small And Medium Enterprise (MSME) business that was started in early February 2021 in Surakarta, Central Java.

Inventory control management is very important for a business, especially the MSME business (Atnafu and Balda 2018). MSME businesses that tend to have minimum funds are expected to control their inventories as best as possible to avoid any avoidable losses. With a high enough demand and limited time, inventory control is certainly needed. This problem is very fatal to business continuity if it is not handled properly. The use of MRP is expected to solve this problem.

1.1 Objectives

The objective of this paper is to seek how to improve production planning in MSME with the implementation of Master Requirement Planning (MRP) and how it will benefit them. By doing this research, it is hoped that it will be able to help the progress of these MSME businesses.

2. Literature Review

According to Arnold et al. (2007) Material Requirements Planning (MRP) is a plan for the production and purchase of the components used in making the items in the Master Production Schedule. MRP shows the number of components needed to build the certain number of end products that are needed in a certain period of time. The primary objective of MRP is to have the right materials in the right quantities available at the right time to meet the demand for the firm's products (Arnold et al. 2007). Among the benefits of MRP includes better response to customers, faster response to market change, and improved utilization of capital (Heizer and Render 2011).

In order to create MRP, certain data are required such as Master Production Schedule (MPS), Bill of Material (BOM), and Inventory Records. Master Production Schedule (MPS) is a plan for the production of individual enditems (Arnold et al. 2007). It tells us how much the quantity of each end item to be made during a certain period of time in order to satisfy customer demand. An MPS can be in a span of days, weeks, or time. Association for Operations Management (APICS) defines a bill of material (BOM) as "a listing of all the subassemblies, intermediates, parts, and raw materials that go into making the parent assembly showing the quantities of each required to make an assembly." It is needed to give the detail of every component needed to complete an end item. A single BOM could consist of several levels to be used to identify the step to create the product. In a company that has several products like glucofeel, BOM may vary from one product to another. Lastly, Inventory Records give us the information on how many sub and end items we currently have in our inventory. To make it simple, MPS gives us the information about how many end products we need, BOM shows us how many components are needed to create the end item, and finally Inventory Record tells us how many items we currently have and how much we need to buy.

In order to create MRP, we also have to know its basic knowledge such as lead time, exploding and offsetting, gross material requirement, and net material requirement. Lead time is the time required to acquire (purchase, produce, and assemble) a finished product (Heizer and Render 2011). For companies with multiple suppliers this may vary for a single item that may affect the material procurement planning. Exploding is the process of multiplying the material requirement from an end item with the production quantity.. Gross material requirements is the number of material needed for production without counting the number of inventory available at that time while the net material requirement is the amount of material needed after subsetting gross material requirements with on hand inventory. Placing the net material requirement in the proper period based on lead time is then called offsetting. The result of MRP is a Planned Order Release that will tell us what, when, and how much material is needed in order to satisfy customer demand during a certain time.

MSME is an enterprise with a relatively small capital and financial resources thus having a major interaction with the owner due to the small number of employees (Narasi Statistik 2013). MSME is a major economic contributor in Indonesia with more than 50% of Indonesia's GDP coming from it. According to Narasi Statistik (2013), there are three categories of MSME which are micro enterprise, small enterprise, and medium enterprise. The separation of each category is based on the enterprise ownership, net value (excluding land and building), and the annual sales. Micro enterprise is an enterprise owned by an individual or individual business entity with net value of at most Rp 50 Million and annual sales no more than Rp 300 Million. Small enterprise is an independent productive economic enterprise carried out by an individual or a business entity that is not a subsidiary or branch of a company that is owned, controlled, or is part of direct or indirect medium or large enterprise with the net worth of more than Rp 50 Million up to Rp 500 Million and the annual sales of Rp 300 Million up to Rp 2.5 Billion. Medium enterprise is an enterprise with individual ownership or a business entity that is not a subsidiary or branch of a company that is owned, controlled, or is part of, either directly or indirectly, with a small or large business with the amount of net assets or annual sales with the net value of more than Rp 500 Million up to Rp 10 Billion and annual sales of more than Rp 2.5 Billion up to Rp 50 Billion. According to this definition, we may conclude that glucofeel, as its capacity as an MSME company, is a micro enterprise.

Business Process is a series of activities or tasks, related to each other, that are performed to accomplish a specific goal and results. It is a set of logically related tasks performed to achieve a defined business outcome (Davenport and Short 1990). A business process diagram may be split into several sub processes that have their own attributes in order to contribute to achieving the objectives. Business process is often visualized as a Flowchart to show a series of activities with interleaving decision points. It is used to show the sequence of business process activities.

The business process from Glucofeel production is simple. To satisfy demand, Glucofeel mostly follows the Make to Order (MTO) rule while using the Make to Stock (MTS) to a certain degree. MTO systems are directly driven by customer demand and, as a result, products are directly made in response to placed customer orders while In MTS systems, customers demand is satisfied with stocked inventories of finished products (Peeters and Ooijen 2020). Most of the company demand came in the form of pre order as shown in figure below.

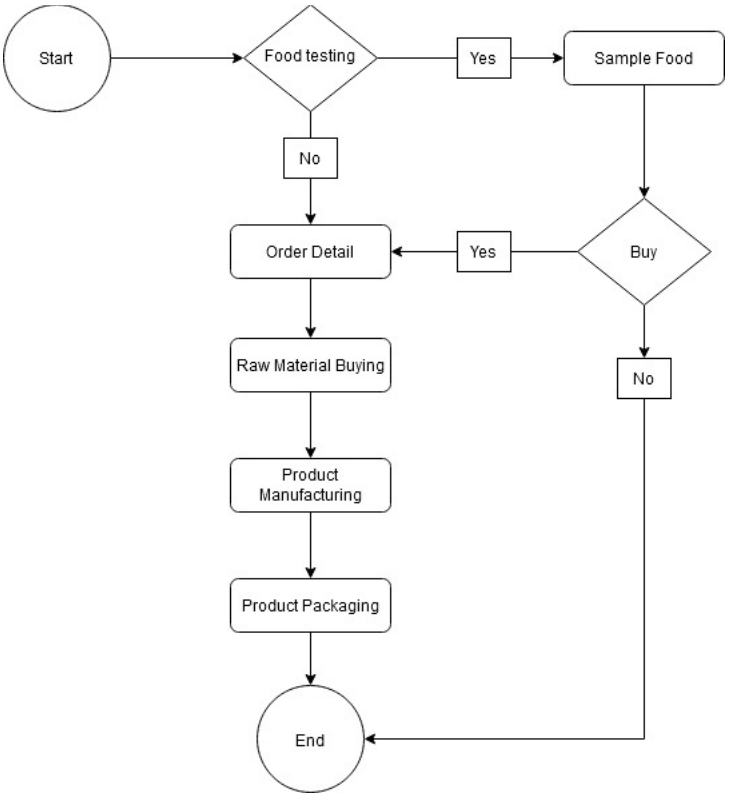

Figure 1. Flow Chart of Business Process

There is no consensus in order to measure the performance of MSME (Wu 2009) and special measurement is needed (Hudson et. al. 2001), but a company performance may be seen in its financial aspect (Mallick and Yang 2011). A research done by Iasya and Handayati in 2015 shows that the use of MRP in MSME companies may save up to 11% for material procurement. The research itself is based on an apparel outsourcing company and it might be different for other types of companies.

3. Methodology

The research methodology describes the methods used in completing the research and why this method was chosen. The method used to complete this research is the Material Requirement Planning (MRP) method. This method is considered the most appropriate method for answering research questions because it is a technique that can be used to calculate material requirements and schedule supplies to meet demand in all products and parts in a plan (Moustakis, 2000). In addition, the application of these methods will assist companies in anticipating waste, resulting in more effective production and making the business more profitable.

MRP has the advantage of better response to customer orders, faster response to market changes, and reduced inventory levels. It consists of several steps from the master production schedule to the construction of new material requirements, as described in the above literature review in relation to MRP steps. The application of MRP can actually cover the functions of both methods. The application of project scheduling to the task and the duration of the task actually has the same information as the information contained in the product Bill of Materials, which is one aspect of the MRP requirements. The scheduling function of the forecasting method can be covered by creating a master production schedule, which is also less risky than applying forecasting to a newborn company. Companies are safer to implement a material purchasing system only if there is a certain demand from customers, given the company's production situation which has many variables and the demand for products that varies from one customer to another.

4. Data Collection

There are three varieties of products provided by Glucofeel to the customer which are Milk Bath Cake, Oreo Matcha, and Regal Tiramisu. Each and every product has their own unique product structure. A single product structure is meant to create two enditem. The structure of each product is shown below.

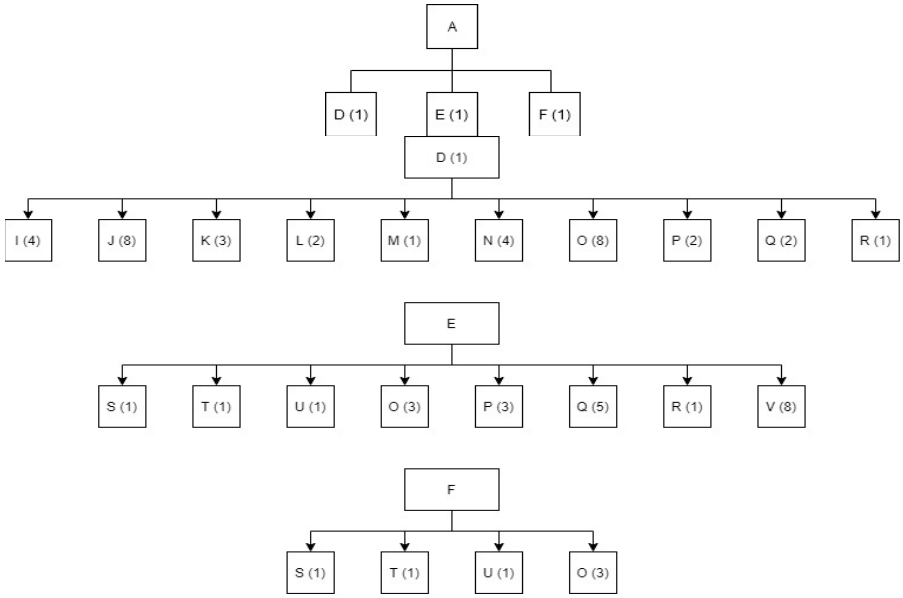

Figure 2. Product structure from Milk Bath Cake (A)

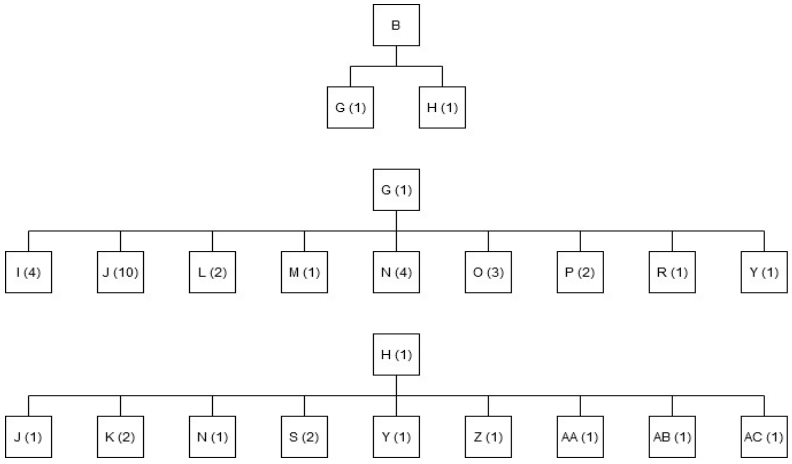

Figure 3. Product structure from Oreo Matcha (B)

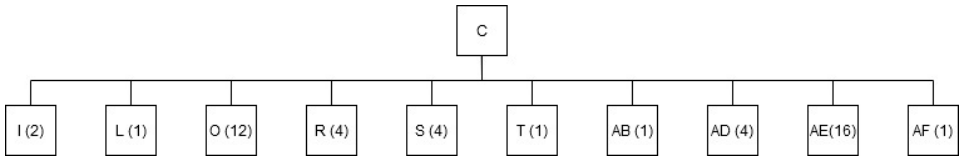

Figure 4. Product structure from Regal Tiramisu (C)

Based on the product structure, we know that some materials are used for more than one product or sub-product while others are not. We also know that product A and B have 2 levels of product structure while product C only has 1 level. Most material also has a different lot size, making it difficult to record inventory. The Bill of Material (BOM) along with the lead time and lot size will be shown in the table below.

Table 1. Bill of Material (BOM) for each product

Code	Unit	Needs			Lead Time	Lot Size	Price per Lot
		Product 1	Product 2	Product 3			
A	2 Piece	✓			1 Day	1	-
B	2 Piece		✓		1 Day	1	-
C	2 Piece			✓	1 Day	1	-
D	1 Piece	1	-	-	0 Day	1	-
E	1 Piece	1	-	-	0 Day	1	-
F	1 Piece	1	-	-	0 Day	1	-
G	1 Piece	-	1	-	0 Day	1	-
H	1 Piece	-	1	-	0 Day	1	-
I	1 Piece	4	4	2	1 Day	16	25,000
J	10 gram	8	11	-	1 Day	100	12,000
K	5 gram	3	2	-	1 Day	200	18,000
L	0.5 tsp	2	2	1	1 Day	400	12,000
M	0.5 tsp	1	1	-	1 Day	400	52,000
N	15 gram	4	5	-	1 Day	67	33,000
O	10 gram	11	3	12	1 Day	100	13,000
P	0.5 tsp	5	2	-	1 Day	28	15,000

Q	10 gram	7	-	-	1 Day	100	35,000
R	0.5 tsp	8	1	4	1 Day	40	25,000
S	50 gram	1	2	4	1 Day	20	40,000
T	400 ml	1	-	1	1 Day	48	18,000
U	200 ml	1	-	-	1 Day	5	2,000
V	10 ml	15	-	-	1 Day	56	13,000
W	70 gram	1	-	-	1 Day	15	24,000
X	400 ml	1	-	-	1 Day	48	18,000
Y	10 gram	-	2	-	1 Day	50	58,000
Z	2 gram	-	1	-	1 Day	500	20,000
AA	80 gram	-	1	-	1 Day	7	40,000
AB	200 ml	-	1	1	1 Day	48	18,000
AC	200 ml	-	1	-	1 Day	5	12,000
AD	1 sachet	-	-	4	1 Day	10	10,000
AE	1 piece	-	-	16	1 Day	120	76,000
AF	20 gram	-	-	1	1 Day	50	64,000

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

Table 2. Master Production Schedule for Five Week

No.	Product	Week 1	Week 2	Week 3	Week 4	Week 5
1	Milk Bath Cake	14	8	4	8	4
2	Oreo Matcha	7	7	6	3	3
3	Regal Tiramisu	10	10	6	7	5
TOTAL		31	25	16	18	12

Using the data found in Figure 1 (Product A structure), Figure 2 (Product B structure), Figure 3 (Product C structure), Table 1 (The Bill of Materials), and Table 2 (Master Production Schedule) we may create an MRP table for five week of demand. The MRP will be 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 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.

Table 3. Material Requirement Planning for Five Week

Part Code	MRP	Week																																		
		1							2							3							4							5						
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
A	Planned Order Release						7				3			4							2							4								2	
B	Planned Order Release						4				2			3							3							2								1	
C	Planned Order Release						5				3			5							3							3								3	
D	Planned Order Release						7				3			4							2							4								2	
E	Planned Order Release						7				3			4							2							4								2	
F	Planned Order Release						7				3			4							2							4								2	
G	Planned Order Release						4				2			3							3							2								1	
H	Planned Order Release						4				2			3							3							2								1	
I	Planned Order Release					64				16			48							16							32							16			
J	Planned Order Release					100				100			100														100										
K	Planned Order Release					200																														
L	Planned Order Release					400																														
M	Planned Order Release					400																														
N	Planned Order Release					67				67																67										
O	Planned Order Release					200				100			100							100													100			
P	Planned Order Release					56				28			28														28										
Q	Planned Order Release					100														100																	
R	Planned Order Release					80				40			80							40							40										
S	Planned Order Release					40				20			40							20							20										
T	Planned Order Release					48																														
U	Planned Order Release					10							5							5													5			
V	Planned Order Release					112				56			56							56							56										
W	Planned Order Release					15														15																	
X	Planned Order Release					48																														
Y	Planned Order Release					50																														
Z	Planned Order Release					500																														
AA	Planned Order Release					7							7																					7			
AB	Planned Order Release					48																														
AC	Planned Order Release					5				5										5																	
AD	Planned Order Release					20				20			20							10							10							10			
AE	Planned Order Release					120				120										120																	
AF	Planned Order Receipt					50																														

Based on the MRP table above, the requirements for all material are highly diverse. Some material only needed to be ordered a few times while some others material had to be ordered periodically. 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 2 (unit, lot size, and prices). The cost prices per week will be illustrated in the graph below.

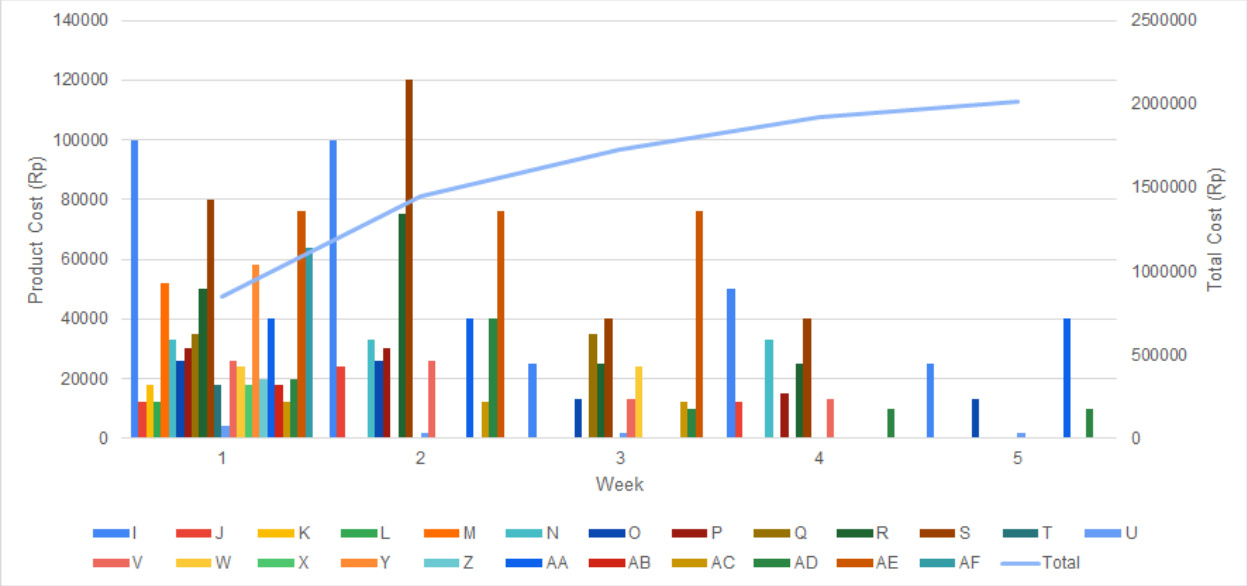

Figure 5. Production cost for each week

The data in the graphic shows the whole material procurement cost including material that hasn't been used and still in the inventory at the end of week 5. The graph also shows that spending on material purchases tends to slope with a drastic increase in the beginning. This happened due to the absence of on hand inventory for the first week of sale. The figure shows all the material purchased, including the one that havent been used in production. To compare the material procurement cost from MRP with the real one, we have to count material that was being used for the production. Thus, we will have to subtract the last inventory data from the used inventory to gain the actual material required during production as shown in the table below.

Table 4. Material procurement cost with MRP

Material Procurement with MRP	Week					On Hand Inventory at The End of Week 5
	1	2	3	4	5	
Cost	846,000.00	604,000.00	275,000.00	198,000.00	90,000.00	268,246.66
Total Cost	1,744,753.34					

Based on the table above, we found out that the material cost for five weeks of production by the company would be Rp 1,744,753.34 if the company used MRP to plan their production. However, to find out 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 finance 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.

Table 5. Actual material procurement cost

Actual Material Procurement Cost	Week				
	1	2	3	4	5
Cost	584,300.00	466,820.00	295,608.00	260,412.00	253,360.00
Total Cost	1,860,500.00				

After we have the material procurement cost for both the actual data and the MRP, we will then compare both of them to see the difference if the company chooses to use MRP for material planning from the beginning. The differences between the actual cost and MRP cost is shown in the table below.

Table 6. Material procurement cost comparison between actual and MRP

Actual Cost Material Procurement	Material Procurement Cost with MRP	Efficiency	
		In Price	Percentage
1,860,500.00	1,744,753.34	115,746.66	6.22%

Based on table 7, should the company use MRP from the beginning of their operation, they may save up to Rp 115,746.66 and increase the company's efficiency by 6,22%. These saved funds can be allocated to other sectors that can help develop this company.

6. Conclusion

Glucofeel company is a Micro, Small, and Medium Enterprises (MSME) food and beverages company which has the problem of company's inability to determine what materials should be purchased and how much the need and company's inability to make a production planning in order to fulfill the customer demand in the right amount and on the right time. This problem results in the company to experience a shortage and excess in the purchase of raw materials such as sugar, milk, margarine, etc.

To answer this problem, an implementation of Material Requirement Planning is performed in the calculation of raw materials purchasing plan. This method was chosen because it was considered appropriate to answer the problems that were faced by the Glucofeel company. Its objective to perform a better response to customer demand, more efficiency in production control, and to avoid excess in inventory (Heizer & Render, 2011) is also beneficial to fulfill the company customer demand.

In comparison, it can be figured that, in demand from February to March, the company can save costs by 6.22% if the company used MRP for their production. The company also makes savings of Rp 115,746.66 if the MRP method has been applied early February. Efficiency generated from MRP calculation is relatively small in percentage. However, in its capacity as MSME, the application of MRP in the purchasing of raw materials saves a lot of money to the company.

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