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Optimizing Raw Material Inventory Control for Aluminum Wardrobes Using the Material Requirements Planning (MRP) Method: A Case Study on Amal Jaya SME

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ABSTRACT
This study aims to analyze the implementation of Material Requirement Planning (MRP) method in controlling raw material inventory for aluminum wardrobe production in Amal Jaya SME. The inability to accurately predict the average number of customer orders each month indicates unfulfilled consumer demand. Therefore, effective raw material control becomes crucial to ensure availability in accordance with demand. The objectives of this research are to evaluate the management of raw materials using the MRP method and identify its impact on cost efficiency of raw materials in the production process. Additionally, this study aims to optimize raw material inventory to maximize customer demand fulfillment. The MRP method was chosen as the primary approach in this research. The results of the analysis indicate that the implementation of MRP method with Lot for Lot (LFL) lot sizing is the most efficient choice in controlling raw material inventory. Based on calculations using lot-for-lot and Economic Order Quantity (EOQ) methods, the most efficient inventory expenditure incurred by the company amounts to Rp. 26,274,840. Thus, ordering raw materials with Lot for Lot lot sizing can be used as a solution to optimize the control of aluminum wardrobe inventory in Amal Jaya SME.
Keyword: Amal Jaya SME, Economic Order Quantity (EOQ), Lot for Lot (LFL) Lot Sizing, Material Requirement Planning (MRP), Wardrobe Production

ABSTRAK
Penelitian ini bertujuan untuk menganalisis implementasi metode *Material Requirement Planning* (MRP) dalam mengendalikan persediaan bahan baku untuk produksi lemari pakaian aluminium di UMKM Amal Jaya. Ketidakmampuan untuk memprediksi secara akurat jumlah rata-rata pesanan pelanggan setiap bulan menunjukkan adanya permintaan konsumen yang tidak terpenuhi. Oleh karena itu, pengendalian bahan baku yang efektif menjadi sangat penting untuk memastikan ketersediaan sesuai dengan permintaan. Tujuan dari penelitian ini adalah untuk mengevaluasi manajemen bahan baku menggunakan metode MRP dan mengidentifikasi dampaknya terhadap efisiensi biaya bahan baku dalam proses produksi. Selain itu, penelitian ini bertujuan untuk mengoptimalkan persediaan bahan baku untuk memaksimalkan pemenuhan permintaan pelanggan. Metode MRP dipilih sebagai pendekatan utama dalam penelitian ini. Hasil analisis menunjukkan bahwa implementasi metode MRP dengan ukuran lot *Lot for Lot* (LFL) adalah pilihan yang paling efisien dalam mengendalikan persediaan bahan baku. Berdasarkan perhitungan menggunakan metode *Lot for Lot* dan *Economic Order Quantity* (EOQ), pengeluaran persediaan yang paling efisien yang ditanggung oleh perusahaan sebesar Rp. 26.274.840. Dengan demikian, pemesanan bahan baku dengan ukuran lot *Lot for Lot* dapat digunakan sebagai solusi untuk mengoptimalkan pengendalian persediaan lemari pakaian aluminium di UMKM Amal Jaya.
Kata Kunci: Economic Order Quantity (EOQ), Material Requirement Planning (MRP), Produksi Lemari Pakaian, Ukuran lot Lot for Lot (LFL), UMKM Amal Jaya

1. Introduction

In the current competitive business world, inventory control of raw materials has become a crucial factor for companies to maintain smooth production processes and meet consumer demands in a timely manner [1]. Companies in the furniture and crafts industry in Indonesia, which are part of the Indonesian Furniture and Crafts Industry Association (HIMKI), have a growth target of 16% in 2021 [2]. Despite facing challenging global market conditions, the development of the furniture and crafts industry in Indonesia has been quite promising from year to year [3]. In achieving this growth, government support plays an important role in the development of the furniture and crafts industry [4], [5].

With effective control of raw material inventory [6], companies in the furniture and crafts industry can ensure an adequate supply of raw materials to meet consumer demand [7]. This will help maintain smooth production processes and provide customer satisfaction. Moreover, the growth of the furniture and crafts industry in Indonesia also presents opportunities for companies to enhance competitiveness and expand their businesses [8]. With government support that focuses on and encourages the development of this sector, it is expected that the furniture and crafts industry will continue to grow and contribute to the country's economy [9].

In this context, it is important for companies in the furniture and crafts industry to implement effective methods of raw material inventory control to optimize production processes and meet consumer demands [10], [11]. Government support is also expected to be continuously provided in the form of policies and programs that support the development of the furniture and crafts industry in Indonesia [12], [13]. One sector facing challenges in managing raw material inventory [14] is the aluminum wardrobe manufacturing industry. In this context, Amal Jaya SME is one of the businesses engaged in aluminum wardrobe production.

Raw material inventory plays a strategic role in the production process [15], [16]. Uncontrolled availability of raw materials can lead to an imbalance between demand and supply [17], which in turn can result in production delays, stock shortages, and missed business opportunities [18]. Therefore, controlling raw material inventory becomes crucial to ensure appropriate availability in accordance with demand.

Amal Jaya SME, located in Biroro village, operates in the furniture industry. Established in 2019, this SME has remained in existence until the present time. Amal Jaya SME specializes in producing customized wardrobes based on consumer demand (make-to-order). However, the SME is unable to accurately forecast the average number of customer orders each month, making it difficult to determine the required amount of raw materials for each period [19]. Consequently, to meet the monthly raw material needs, orders are placed only after receiving customer orders [20]. As a result, if orders accumulate while the raw material inventory does not align with the orders, waiting and production times increase, making it challenging to fulfill customer requirements within the desired timeframe.

Amal Jaya SME, as a company in the aluminum wardrobe manufacturing industry, faces challenges in effectively managing raw material inventory [21]. Therefore, this study will conduct a specific analysis on Amal Jaya SME to examine the implementation of the MRP method in controlling raw material inventory for aluminum wardrobes. By conducting a case study on Amal Jaya SME, this research will provide in-depth insights into the implementation of MRP in a specific context, thus offering relevant recommendations for the SME.

Several previous studies have been conducted in the context of raw material inventory control and the methods used. Previous research has shown that the implementation of the Material Requirement Planning (MRP) method can improve raw material inventory control efficiency and optimize company productivity [22], [23]. Other studies have explored the use of the Economic Order Quantity (EOQ) method in raw material inventory control and found that it can reduce unnecessary inventory costs [24], [25]. However, research specifically analyzing the use of the MRP method in controlling raw material inventory for aluminum wardrobes in SMEs is still limited. Based on this background, the objective of this research is to evaluate the management of raw materials using the MRP method and identify its influence on cost efficiency of raw materials in the production process. Additionally, this study aims to optimize raw material inventory to maximize customer demand fulfillment.

2. Methodology

This research employs a quantitative approach with a case study conducted in Amal Jaya SME, which specializes in the production of aluminum wardrobes. The implementation steps of the Material Requirement Planning (MRP) method commence with data collection concerning raw material control, production, and customer demand. Documents such as inventory policies and production reports are analyzed, along with historical data on customer demand and raw material supply. Direct observations are conducted during the production process, and interviews with production managers and warehouse staff are carried out to obtain additional information on raw material control. The collected data is then processed, starting with forecasting using multiple methods. Subsequently, MRP calculations are performed, encompassing master production scheduling, determination of material requirements within the product structure, and lot sizing calculations using the Lot for Lot (LFL) method and the Economic Order Quantity (EOQ) method. An evaluation and analysis are conducted to assess the impact of the MRP implementation on raw material cost efficiency, production timeliness, and stock availability. The results of the MRP implementation are analyzed and compared to the previous conditions. Recommendations are formulated based on the evaluation and analysis of the MRP implementation at Amal Jaya SME. Finally, practical solutions and steps are designed to optimize the control of raw material inventory for aluminum wardrobes.

3. Result and Discussion

3.1. Forecasting

The forecasting method employed is based on historical demand data obtained from Amal Jaya SME. The available methods include Moving Average (MA), Simple Moving Average, and exponential smoothing. The calculation results obtained using the POM-QM application can be observed in Table 1.

Table 1. Comparison of Smallest Error Values in Forecasting Methods

Methods	Mean Squared Error (MSE)
Moving Average	13,64
Simple Average	14,51
Exponential Smoothing	14,67

Based on Table 1 above, the calculation of the smallest Mean Squared Error (MSE) for aluminum wardrobe demand indicates that the method used is a Moving Average with an MSE value of 13.64. The forecasted values using the Moving Average method can be observed in Table 2.

Table 2. Forecast Results Using Moving Average (MA) Method

Period	Month	Demand	Forecast
1	January	17	
2	February	13	17
3	Maret	19	13
4	April	13	19
5	Mei	10	13
6	Juni	13	10
7	Juli	14	13
8	Agustus	16	14
9	September	14	16
10	Oktober	11	14
11	November	12	11
12	December	17	12
Total		169	152

In Table 2, there are forecasted results for the demand for aluminum wardrobes over a 12-month period using the Moving Average (MA) method. The data encompasses the period from January to December, with a total actual demand of 169 units during that period. Meanwhile, the total forecasted demand using the Moving Average method is 152 units.

3.2. Calculation of Material Requirement Planning

The determination of the master production schedule is based on the demand data received from Amal Jaya SME. The demand data serves as a foundation for creating a comprehensive production schedule that outlines

the required quantities and timings of production for various products. By analyzing the demand patterns and considering factors such as lead times, production capacities, and resource availability, the master production schedule aims to align production activities with customer demand. This enables the company to optimize production efficiency, minimize inventory holding costs, and ensure timely delivery of products to meet customer requirements. The accuracy and reliability of demand data from Amal Jaya SME play a crucial role in creating an effective master production schedule. This can be observed in the results of the MPS determination presented in Table 3.

Table 3. Master Production Schedule (MPS) for Products

Period	Gross Requirement	Planned Order Receipt	Net Requirement
January	17	0	17
February	17	0	17
Maret	13	0	13
April	19	0	19
Mei	13	0	13
Juni	10	0	10
July	13	0	13
Agustus	14	0	14
September	16	0	16
Oktober	14	0	14
November	11	0	11
December	12	0	12

Based on Table 3, the calculation of the master production schedule for aluminum wardrobes over 12 months is as follows: The data covers the period from January to December. The highest gross requirement occurs in April, which is 19 units. The Project on Hand (POH) or initial inventory remains unchanged at 0 units throughout the 12 months. The highest net requirement also occurs in April, amounting to 19 units. This information indicates that in April, there is a high demand for aluminum wardrobes, with a gross requirement of 19 units and a net requirement of 19 units after considering the initial inventory. This suggests that production planning and scheduling should prioritize meeting the demand in April to ensure an adequate supply of aluminum wardrobes.

Based on Figure 1, it is known that all the components are required to construct an aluminum wardrobe in Amal Jaya SME. Based on the calculations and the number of materials needed, the following components are required: Glass ribbon 203cm x 105cm - 5 materials, Special Holo 6M x 3CM - 2 pieces, Holo 1x1 - 2 pieces, 6x1/2 screws - 1 box, Hinges - 3 kg, Glass rubber - 2 kg, Handles - 3 pieces, Locks - 3 pieces, Wardrobe wheels - 1 box, Spigot (6 meters) - 2 pieces. These quantities represent the required materials and components to construct an aluminum wardrobe in Amal Jaya SME.

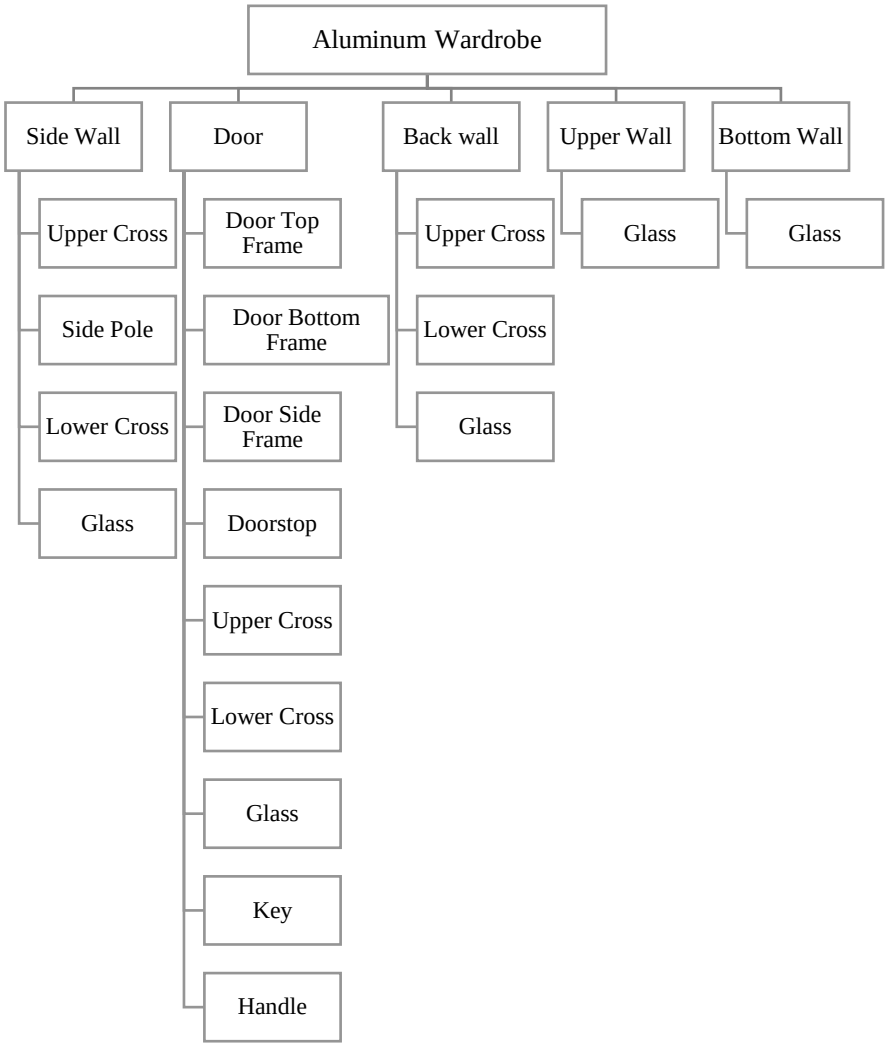

Figure 1. Structure of Aluminum Wardrobe Product

3.3. Calculation of Inventory Costs using the Lot for Lot Method

The Lot for Lot (LFL) method is a way to place orders based on the exact quantity needed. This method is one of the simplest approaches to determining order quantities. The objective of using this method is to minimize inventory costs as efficiently as possible. The results of the calculations using the LFL method can be seen in Table 4.

Table 4. Calculation of Aluminum Wardrobe Cost using the Lot for Lot Method

No	Component	Cost/Year
1	Glass Ribbon	Rp. 2.627.484
2	Special Holo	Rp. 2.627.484
3	Holo 1x1	Rp. 2.627.484
4	Screws	Rp. 2.627.484
5	Hinges	Rp. 2.627.484
6	Glass Rubber	Rp. 2.627.484
7	Handles	Rp. 2.627.484
8	Locks	Rp. 2.627.484
9	Wardrobe Wheels	Rp. 2.627.484
10	Spigot	Rp. 2.627.484
	Total	Rp. 26.274.840

Based on Table 4, the calculation of costs using the Lot for Lot (LFL) method in the production of aluminum wardrobes amounts to Rp. 26,274,840. This cost includes the demand for each material component with a cost of Rp. 2,627,484 over a 12-month production period. By using the Lot for Lot method, we can minimize cost savings without having to order more than what is needed or hold excessive inventory.

3.4. Calculation of Inventory Costs using the Economic Order Quantity (EOQ) Method

The Economic Order Quantity (EOQ) method is a way of inventory management used to determine the optimal quantity of raw materials to be purchased by Amal Jaya SME. The EOQ method is used to find the inventory quantity that minimizes the total inventory cost, determine the necessary safety stock level, and identify the appropriate time to place a reorder (reorder point). The results of the calculations using the EOQ method can be seen in Table 5.

Table 5. Calculation of Aluminum Wardrobe Cost using the EOQ Method

No	Component	Cost/Year
1	Glass ribbon	Rp. 3.475.962
2	Special Holo	Rp. 3.476.270
3	Holo 1x1	Rp. 3.476.249
4	Screws	Rp. 3.476.270
5	Hinges	Rp. 3.476.249
6	Glass rubber	Rp. 3.476.270
7	Handles	Rp. 3.476.270
8	Locks	Rp. 3.476.249
9	Wardrobe wheels	Rp. 3.476.270
10	Spigot	Rp. 3.476.249
	Total	Rp. 34.762.308

Based on Table 5, the calculation of costs using the EOQ method in the production of aluminum wardrobes amounts to Rp. 34,762,308. The highest-cost component has a cost of Rp. 3,476,270, while the lowest-cost component has a cost of Rp. 3,475,962. The difference in cost is due to considering safety stock and reorder point. By using the EOQ method, Amal Jaya SME can manage inventory more efficiently and avoid unnecessary shortages or excess inventory.

The best lot sizing method is the method that meets the criteria of having the minimum total cost in controlling raw material inventory. The results of lot sizing calculation in MRP can be seen in Table 6.

Table 6. Comparison of Costs in Lot Sizing Calculation

Method	Total Inventory Cost
EOQ	Rp. 34.762.308
LFL	Rp. 26.274.840
Company	Rp. 49.130.514

Based on the MRP calculations using lot sizing techniques, as seen in Table 6 above, the current method employed by the company results in a cost of Rp. 49,130,514. However, by using the LFL method, the total cost becomes Rp. 26,274,840, while the EOQ method yields a total cost of Rp. 34,762,308. Therefore, it can be observed that the LFL method, which incurs the lowest material ordering cost, is used as the solution for controlling the raw material inventory of Aluminum Wardrobes at Amal Jaya SME.

4. Conclusion and Future Research

Based on the results and discussions above, it can be concluded that the MRP calculation begins with forecasting using the moving average method, selected based on the Mean Squared Error (MSE). Next, the master production schedule and material requirement quantities are determined using the MRP method. In this case, lot sizing techniques are employed to determine material orders with the minimum amount of Rp. 26,274,840, specifically the Lot-for-Lot (LFL) method, which is the optimal solution for controlling the raw material inventory of aluminum wardrobes at Amal Jaya SME. A recommendation for the company is to implement this MRP method to optimize customer demand fulfillment. In future research, it is suggested to consider all aspects of the company, not just production inventory control aspects alone. One approach that can be used is the Activity-Based Costing (ABC) method, where inventory is grouped based on their relative value and importance in the production or sales process. This will direct control focus on items with the highest value. Further research is expected to explore such approaches.

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