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Optimal Raw Material Planning To Minimize Out of Stock Costs Using The Material Requirement Planning Method

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ABSTRACT

UD. Podo Moro, a folding ironing board manufacturer in Surabaya, experienced recurring Out of Stock (OOS) conditions caused by fluctuating demand, long supplier lead times, and the absence of a structured raw material planning system. These conditions resulted in production delays, emergency purchasing activities, and increased operational costs. This study aims to optimize raw material planning and minimize inventory costs through the implementation of the Material Requirement Planning (MRP) method. Demand forecasting was conducted using three quantitative methods, namely Moving Average (MA), Weighted Moving Average (WMA), and Exponential Smoothing (ES). The selected forecasting results were then used to develop Aggregate Planning and a Master Production Schedule (MPS). Furthermore, MRP calculations were performed using three lot sizing Lot for Lot Technique, Economic Order Quantity (EOQ), and Fixed Order Quantity (FOQ). The results indicate that the Moving Average method produced the most consistent forecasting accuracy based on Mean Absolute Deviation values and tracking signal analysis. Among the evaluated lot sizing techniques, the EOQ method generated the lowest total inventory cost among the evaluated lot-sizing techniques. The implementation of MRP proved capable of improving procurement scheduling, reducing inventory shortages, minimizing emergency purchasing activities, and enhancing operational efficiency. Therefore, the EOQ-based MRP approach is recommended as the most effective strategy for minimizing OOS costs at UD. Podo Moro.

1. Introduction

Small and medium-scale manufacturing industries in Indonesia face increasingly complex challenges in managing raw material inventory systems, especially in responding to fluctuating market demand and uncertain supply chain conditions [1], [2]. The rapid growth of competition in the manufacturing sector requires companies to maintain production continuity, improve operational efficiency, and ensure product availability according to customer demand [3]. One of the most common operational problems encountered in manufacturing companies is the occurrence of Out of Stock (OOS), which refers to a condition where raw materials or finished products are unavailable when needed for production or customer fulfillment activities [4]. OOS conditions can significantly disrupt production performance because they may lead to production delays, increased procurement costs, reduced delivery reliability, and decreased customer satisfaction levels.

In manufacturing industries that implement make-to-order or pre-order systems, raw material planning becomes more critical because procurement activities highly depend on customer demand patterns and supplier responsiveness [5]. Inaccurate inventory planning may result in either excessive inventory or insufficient inventory [5], [6]. Excessive inventory increases holding costs, warehouse utilization, material handling costs, and the risk of material deterioration, while insufficient inventory may cause production stoppages, emergency purchasing activities, delayed deliveries, and loss of customer trust. Therefore, companies are required to implement an effective production planning and inventory control system capable of balancing inventory availability and operational efficiency simultaneously [5].

Inventory management is an important component in manufacturing operations because it directly influences

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production stability and company profitability. Effective inventory management enables companies to determine the optimal quantity of materials, the appropriate timing for procurement, and the efficient allocation of inventory resources [5]. Furthermore, proper inventory control systems help companies reduce uncertainty in procurement processes, improve production scheduling accuracy, and minimize total inventory costs [7]. In highly competitive manufacturing environments, the ability to maintain material availability without creating excessive stock has become one of the key success factors for sustaining operational performance and customer satisfaction.

UD. Podo Moro is a folding ironing board manufacturer located at Jl. Bulak Cumpat Timur Gg. Buntu, Surabaya, with a production capacity of 120 units per day. The company produces two main product types: Standing Folding Ironing Board (110×35×70 cm) and Sitting Folding Ironing Board (110×35×30 cm), both using a 1 mm round iron frame as the main component. The company operates using a pre-order production system in which production activities highly depend on customer orders and the availability of raw materials from suppliers [8]. This condition causes the company to face difficulties in synchronizing procurement activities with production schedules, especially when demand increases significantly within a short period.

Based on historical data for the period July–December 2025, the company experienced OOS conditions for four consecutive months (August–November 2025), with the largest deficit in October 2025 at 143 units. This situation was triggered by the uncertain pre-order ordering system, long lead times (1 month for general materials, 2 months for sengon plywood), and the absence of a structured material requirements planning system. As a result, the company often carried out emergency purchasing activities at higher costs, experienced delays in product delivery, and encountered inefficiencies in production scheduling. In the long term, these conditions may negatively affect customer satisfaction and the company's operational performance.

Method Material Requirement Planning (MRP) is a production planning and control system capable of determining the type, quantity, and timing of raw material orders in a planned manner based on the master production schedule [9]. MRP has been proven effective in various studies as an inventory control solution in the manufacturing industry [10], [11]. MRP enables companies to integrate forecasting results, inventory status, lead times, and Bill of Materials (BOM) into a comprehensive planning system, thereby minimizing the risk of material shortages and excessive inventory simultaneously.

Several previous studies have shown that the implementation of MRP can improve inventory efficiency and reduce inventory-related costs in manufacturing companies. However, many small and medium enterprises (SMEs) still rely on conventional procurement systems without structured production planning, causing frequent OOS conditions and unstable inventory levels. In addition, research related to the comparison of lot sizing techniques in SMEs producing household equipment products is still relatively limited, particularly in the context of fluctuating demand and supplier uncertainty.

Unlike previous studies that primarily focus on large-scale manufacturing environments, this study investigates the implementation of an integrated forecasting–MRP framework in a small-scale manufacturing enterprise with recurring OOS conditions. Furthermore, the study compares three lot-sizing techniques under actual operational constraints and supplier lead-time variability, providing practical evidence for inventory optimization in SMEs.

Therefore, this study is important to provide a practical and quantitative approach for optimizing raw material planning at UD. Podo Moro through the integration of forecasting, Aggregate Planning, Master Production Schedule (MPS), and Material Requirement Planning (MRP). Furthermore, this research compares three lot sizing techniques, namely Lot for Lot (LFL), Economic Order Quantity (EOQ), and Fixed Order Quantity (FOQ), to determine the most efficient method in minimizing inventory costs and preventing OOS conditions.

This study aims to: (1) identify demand patterns and select the best forecasting method; (2) develop Aggregate Planning and a Master Production Schedule; (3) calculate raw material requirements using the MRP method with three lot sizing techniques; and (4) determine the most optimal lot sizing technique to reduce OOS costs at UD. Podo Moro.

2. Literature Review

2.1 *Material Requirement Planning (MRP)*

Material Requirement Planning (MRP) is a computer-based information system designed to efficiently manage raw material ordering schedules based on planned demand (Baroto, 2002). The three main inputs of MRP are: (1) Master Production Schedule (Master Production Schedule), (2) Bill of Materials (Bill of Material/BOM), and (3) Inventory Status Records (Inventory Records). MRP outputs include: planned order release schedule (planned order release), exception reports, and performance reports. MRP implementation enables companies to anticipate material needs well before stock runs out, avoid emergency purchases, and reduce overstock that burdens working capital (Stevenson, 2021).

2.2 *Lot Sizing Technique*

Lot sizing is one of the important decisions in the Material Requirement Planning (MRP) system because it determines the quantity of materials ordered in each procurement cycle. Different lot sizing techniques produce different inventory cost characteristics depending on ordering costs, holding costs, lead times, and demand patterns. The selection of an appropriate lot sizing technique is crucial because it directly affects inventory efficiency, procurement frequency, and total operational costs. In this study, three lot sizing techniques are analyzed and compared, namely Lot for Lot (LFL), Economic Order Quantity (EOQ), and Fixed Order Quantity (FOQ).

2.2.1 *Lot for Lot (LFL)*

Lot for Lot (LFL) is a lot sizing technique in which the order quantity is exactly equal to the net material requirements for each period. This method minimizes inventory holding costs because no excess inventory is stored beyond immediate production needs. LFL is particularly suitable for materials with high holding costs, short life cycles, or unstable demand patterns. However, because procurement activities are performed frequently, the LFL method may generate relatively high ordering costs due to the large number of purchase orders. Despite this limitation, LFL is considered effective in minimizing inventory accumulation and reducing the risk of obsolete materials.

2.2.2 Economic Order Quantity (EOQ)

Economic Order Quantity (EOQ) is a lot sizing technique used to determine the optimal order quantity that minimizes the total inventory cost, which consists of ordering costs and holding costs. EOQ assumes relatively stable demand and constant lead times throughout the planning horizon. The EOQ model is mathematically expressed as:

$$EOQ = \sqrt{(2AD/H)},$$

where:

A = ordering cost,
D = demand,
H = holding cost per unit.

The EOQ method aims to balance the trade-off between ordering frequency and inventory holding costs. Larger order quantities reduce ordering frequency but increase holding costs, while smaller order quantities reduce holding costs but increase ordering costs. Therefore, EOQ is widely used to achieve optimal inventory efficiency in manufacturing systems.

2.2.3 Fixed Order Quantity (FOQ)

Fixed Order Quantity (FOQ) is a lot sizing technique that uses a predetermined fixed order quantity for every procurement cycle regardless of fluctuations in net requirements. The fixed quantity is generally determined based on supplier agreements, transportation capacity, storage considerations, or operational policies. The FOQ method simplifies procurement planning because the order quantity remains constant for each order cycle. In addition, FOQ facilitates supplier coordination and purchasing administration. However, this technique may generate higher holding costs when demand decreases because excess inventory may accumulate in the warehouse. Conversely, when demand increases significantly, additional orders may still be required to prevent shortages.

2.3 Demand Forecasting Methods

Demand forecasting is an important activity in production planning because it provides estimates of future product demand used as the basis for procurement planning, production scheduling, and inventory control. Accurate forecasting enables companies to reduce uncertainty, improve production efficiency, minimize inventory costs, and prevent stock shortages or overstock conditions. In this study, demand forecasting was conducted using three quantitative forecasting methods, namely Moving Average (MA), Weighted Moving Average (WMA), and Exponential Smoothing (ES). These methods were selected because they are widely used in manufacturing industries for short-term demand forecasting and are suitable for fluctuating demand patterns.

The accuracy of forecasting methods in this study was evaluated using Mean Absolute Deviation (MAD) and Tracking Signal analysis. MAD measures the average magnitude of forecasting errors, while Tracking Signal is used to monitor forecasting bias and determine whether forecasting results remain within acceptable control limits. According to Makridakis [12], a forecasting method is considered acceptable if the Tracking Signal values remain within the control limits of Upper Control Limit (UCL) = +4 and Lower Control Limit (LCL) = –4. The forecasting method with the smallest MAD value and stable Tracking Signal was selected as the best forecasting method for this study.

3. Research Methodology

This study employed a descriptive quantitative research method with a case study approach conducted at UD. Podo Moro, a folding ironing board manufacturing company located in Surabaya, Indonesia. The descriptive quantitative approach was selected because this research focuses on analyzing numerical data related to demand forecasting, production planning, inventory requirements, and inventory costs in order to develop an optimal raw material planning system using the Material Requirement Planning (MRP) method. The case study approach was used to obtain an in-depth understanding of the inventory management problems experienced by the company and to provide practical solutions based on actual operational conditions [13]. The object of this study is the raw material planning system for two main products produced by UD. Podo Moro, namely the Standing Folding Ironing Board and Sitting Folding Ironing Board. The research specifically focuses on identifying Out of Stock (OOS) problems, forecasting future demand, developing production planning, and determining the most efficient lot sizing technique to minimize inventory costs.

3.1 Data Collection

The data used in this study consist of primary data and secondary data. Primary data were collected through direct observation and interviews with the company owner and production personnel. The observation process was conducted to understand the actual production flow, procurement activities, inventory conditions, and raw material usage within the company. Meanwhile, interviews were carried out to obtain information related to ordering systems, supplier lead times, production capacities, inventory management practices, and operational constraints faced by the company [14]. Secondary data were obtained from company documents and historical operational records for the period July–December 2025. These secondary data include historical demand data for folding ironing boards, inventory records, Bill of Materials (BOM), raw material purchasing data, ordering costs, holding costs, lead time information, production capacity data, and production process information. Overall, the collected data were used as the basis for demand forecasting analysis, Aggregate Planning, Master Production Schedule (MPS) preparation, and Material Requirement Planning (MRP) calculations.

3.2 Research Variables

The variables analyzed in this study consist of demand data, inventory data, lead time, ordering cost, holding cost, production capacity, and lot sizing variables. Demand data refer to historical product demand used to forecast future demand patterns [15]. Inventory data include information related to current stock levels, inventory shortages, and material availability within the company [15]. Lead time represents the time required by suppliers to deliver raw materials after purchase orders are issued [16]. Ordering cost includes all expenses incurred during procurement activities, such as administration, communication, and transportation costs, while holding cost refers to costs associated with storing raw materials in the warehouse, including storage and handling costs. Production capacity describes the company's ability to produce folding ironing boards within a certain production period [17]. In addition, lot sizing variables are related to determining order quantities using the Lot for Lot (LFL), Economic Order Quantity (EOQ), and Fixed Order Quantity (FOQ) methods in the Material Requirement Planning (MRP) process.

3.3 Research Procedure

The research procedure in this study was carried out systematically through several stages. The initial stage involved identifying inventory management problems experienced by UD. Podo Moro, particularly recurring Out of Stock (OOS) conditions. At this stage, historical demand data and inventory conditions were analyzed to determine the causes and impacts of material shortages on company operations. After identifying the problems, demand forecasting was conducted using three quantitative forecasting methods, namely Moving Average (MA), Weighted Moving Average (WMA), and Exponential Smoothing (ES). The forecasting process aimed to estimate product demand for the January–June 2026 planning period. Forecasting accuracy was evaluated using Mean Absolute Deviation (MAD) and Tracking Signal analysis, where the forecasting method with the smallest MAD value and Tracking Signal within control limits (UCL = +4 and LCL = –4) was selected as the best forecasting method [18].

Based on the selected forecasting results, Aggregate Planning was developed to determine the overall production capacity required during the planning horizon. Aggregate Planning considered several factors, including regular working hours, overtime capacity, production time per unit, labor costs, and production capacity limitations. The purpose of Aggregate Planning was to ensure that production capacity could efficiently meet forecasted demand. Subsequently, the Aggregate Planning results were disaggregated into a detailed Master Production Schedule (MPS), which specifies the quantity and timing of finished products to be produced in each production period. The MPS then served as the primary input for the Material Requirement Planning (MRP) process [15].

The next stage involved the development of the Bill of Materials (BOM), in which the product structure and raw material composition for each folding ironing board product were identified and arranged systematically. The BOM contains detailed information regarding the types and quantities of materials required to produce one unit of finished product. After the BOM was completed, MRP calculations were performed to determine net material requirements, procurement schedules, and inventory planning for each raw material component. The MRP calculation process considered forecasting results, Master Production Schedule (MPS), Bill of Materials (BOM), inventory status records, and supplier lead times. In this study, three lot sizing techniques were applied and compared, namely LFL, EOQ, and FOQ. Furthermore, inventory cost analysis was conducted by calculating and comparing the total inventory costs generated by each lot sizing technique. The analyzed costs include ordering costs, holding costs, and total inventory costs. This comparison aimed to determine the most efficient lot sizing technique for minimizing inventory costs and preventing OOS conditions at UD. Podo Moro. Finally, the results obtained from forecasting, Aggregate Planning, MPS preparation, and MRP calculations were analyzed comprehensively to determine the optimal inventory planning strategy. Conclusions and recommendations were then formulated based on the research findings to support the implementation of a more effective raw material planning system at UD. Podo Moro.

3.4 Research Framework

The research framework in this study begins with the identification of inventory problems and recurring Out of Stock (OOS) conditions experienced by the company. After the problem identification stage, primary and secondary data were collected and analyzed. The collected demand data were then processed using three forecasting methods, namely Moving Average (MA), Weighted Moving Average (WMA), and Exponential Smoothing (ES), to determine the best forecasting method based on Mean Absolute Deviation (MAD) and Tracking Signal analysis. The selected forecasting results were subsequently used to develop Aggregate Planning and prepare the Master Production Schedule (MPS). Furthermore, a Bill of Materials (BOM) was developed to identify the raw material requirements for each product. The MRP calculation process was then performed using three lot sizing techniques, namely Lot for Lot (LFL), Economic Order Quantity (EOQ), and Fixed Order Quantity (FOQ). Finally, the total inventory costs generated by each technique were compared to determine the most optimal lot sizing method and formulate recommendations for improving raw material planning at UD. Podo Moro.

4. Results and Discussion

4.1 Identification of Out of Stock Issues

Historical demand and inventory data for folding ironing boards during the period July–December 2025 are presented in

Table 1. Based on the data, it can be observed that the company experienced fluctuating demand patterns throughout the observation period. The highest demand occurred in October 2025, reaching 3,263 units, while the lowest demand occurred in July 2025 at 3,038 units. Meanwhile, the company maintained a relatively constant inventory level of 3,120 units per month, indicating that the inventory planning system did not sufficiently adjust to changing market demand conditions.

Table 1.
Demand and Inventory Data for Folding Ironing Boards, Period 2025

Month	Standing Board	Sitting Board	Total Demand	Inventory	Difference
Jul	1.630	1.408	3.038	3.120	+82
August	1.677	1.480	3.157	3.120	-37
Sep	1.710	1.425	3.135	3.120	-15
Oct	1.789	1.474	3.263	3.120	-143
Nov	1.695	1.487	3.182	3.120	-62
Dec	1.618	1.455	3.073	3.120	+47

Source: UD. Podo Moro (2025)

Inventory deficits occurred consecutively from August to November 2025, indicating recurring Out of Stock (OOS) conditions. The most critical shortage occurred in October 2025 with a deficit of 143 units, followed by November 2025 with a shortage of 62 units. These results indicate that the company's existing procurement system was unable to effectively respond to fluctuating demand patterns. The primary causes of these shortages were the absence of a structured raw material planning system, dependence on a pre-order procurement mechanism, and relatively long supplier lead times, especially for sengon plywood materials requiring up to two months for procurement.

4.2 Demand Forecasting

Three forecasting methods were tested using six months of historical data. A comparison of MAD values as an accuracy measure is presented in Table 2.

Table 2.
Comparison of MAD Values for Forecasting Methods

No.	Forecasting Method	MAD Standing Board	MAD Sitting Board	Description
1	Moving Average (MA)	71,0	22,8	Selected
2	Weighted Moving Average (WMA)	66,4	30,5	Not Selected
3	Exponential Smoothing (ES)	55,24	54,9	Not Selected

Source: Processed Data (2026)

Although the Exponential Smoothing method generated the lowest MAD value for the Standing Board product, its forecasting performance for the Sitting Board product was considerably lower. Therefore, the method selection was based not only on MAD values but also on overall forecasting consistency across product categories and Tracking Signal stability. Since the MA method demonstrated acceptable forecasting accuracy and stable tracking signals for both products, it was selected as the forecasting basis for subsequent MRP analysis.

Table 2 shows that the forecasting methods produced different levels of accuracy for each product category. Although Exponential Smoothing generated the lowest MAD value for the Standing Board product, its performance for the Sitting Board product was substantially less accurate. In contrast, the Moving Average method provided more balanced forecasting performance across both product categories while maintaining stable tracking signal values within the acceptable control limits [1. This indicates that Moving Average offers a more reliable forecasting basis for integrated production and inventory planning in the context of fluctuating demand. Method Moving Average (MA) was selected because it provided the most consistently low MAD values for both product types simultaneously, the graph pattern matched actual data, and all tracking signal values were within control limits (UCL = +4, LCL = -4). Forecasting results for the January–June 2026 period are presented in Table 3.

Table 3.
Demand Forecasting Period January–June 2026

Period	Standing Board (unit)	Sitting Board (unit)	Total (units)
January	1.657	1.471	3.128
February	1.638	1.463	3.101
March	1.648	1.467	3.115
April	1.643	1.465	3.108
May	1.646	1.466	3.112
June	1.645	1.466	3.111
Total	9.877	8.798	18.675

Source: Processed Data (2026)

The forecasting results indicate relatively stable demand patterns throughout the January–June 2026 planning horizon. This stability suggests that the company can develop more structured procurement and production schedules, thereby reducing the likelihood of material shortages and improving inventory planning accuracy.

4.3 Aggregate Planning and Master Production Schedule

Aggregate Planning was developed to determine the overall production capacity required to fulfill forecasted demand during the January–June 2026 planning horizon. The planning process considered several operational factors, including regular working hours of 7 hours per day, overtime capacity of 2 hours per day, production time requirements of 0.183 hours per unit, and labor costs consisting of Rp 25,000 per hour for regular working hours and Rp 30,000 per hour for overtime activities.

Based on the forecasting results, the company's existing production capacity was considered sufficient to satisfy forecasted demand without requiring significant workforce adjustments. However, overtime utilization remained necessary during periods with relatively higher production requirements to maintain production continuity and avoid future shortages. The Aggregate Planning results generated a total production cost of Rp 87,660,000 for the six-month planning period.

The Aggregate Planning results were subsequently disaggregated into a Master Production Schedule (MPS), which specifies the quantity and timing of finished products to be produced in each production period. The MPS serves as the primary input for the Material Requirement Planning (MRP) process because it provides detailed production schedules required for determining raw material procurement quantities and timing. Through the integration of forecasting and production planning, the company can synchronize production activities with material procurement schedules more effectively.

4.4 Calculation of Material Requirement Planning (MRP)

MRP calculation was performed for both product types considering the Bill of Material (BOM) containing components: round iron, flat iron, sengon plywood, yellow foam, fabric, rubber feet, bolts, screws, and staples; along with the lead time of each material. Three lot sizing techniques were evaluated and the results are summarized as follows Before comparing the lot-sizing techniques, MRP calculations were performed by considering the Master Production Schedule (MPS), Bill of Materials (BOM), inventory status records, and lead times for each raw material component. The MRP process involved determining Gross Requirements, Scheduled Receipts, Projected Available Balance, Net Requirements, Planned Order Receipts, and Planned Order Releases for each planning period. The resulting procurement plans were then evaluated using LFL, EOQ, and FOQ techniques to identify the most cost-efficient inventory policy.

4.4.1 Example of MRP Computation

To illustrate the MRP calculation procedure, an example is provided for the Round Iron component used in the Standing Folding Ironing Board product. The calculation was performed based on the Master Production Schedule (MPS), component requirements from the Bill of Materials (BOM), current inventory status, and supplier lead times.

4.4.2 Lot for Lot Technique (LFL)

The LFL technique orders exactly according to net requirements each period. Storage costs approach zero, but the high ordering frequency results in a large total ordering cost.

Table 4.
Summary of Total MRP Costs Using LFL Method

Product	Total Raw Material Inventory Cost (6 months)
Standing Ironing Board	Rp 221.218.800
Sitting Ironing Board	Rp 195.996.910
Grand Total	Rp 417.215.710

Source: Processed Data (2026)

4.4.3 Economic Order Quantity Technique (EOQ)

The EOQ lot size was calculated from the average net requirements using the formula EOQ = $\sqrt{(2AD/H)}$ for each component. This technique produces the lowest total inventory cost.

Table 5.
Summary of Total MRP Costs Using EOQ Method

Product	Holding & Ordering Cost	Total Raw Material Cost (6 months)
Standing Ironing Board	Rp 16.655.950	Rp 172.171.150
Sitting Ironing Board	Rp 20.387.520	Rp 174.104.066
Grand Total	Rp 37.043.470	Rp 346.275.216

Source: Processed Data (2026)

The results presented in Table 5 indicate that the EOQ method achieved the most favorable balance between ordering costs and holding costs. By determining an optimal order quantity for each raw material component, EOQ was able to reduce excessive procurement frequency while avoiding unnecessary inventory accumulation [16]. Consequently, this technique generated the lowest total inventory cost among the evaluated lot-sizing methods, demonstrating its effectiveness in supporting cost-efficient inventory management.

4.4.4 Fixed Order Quantity Technique (FOQ)

The FOQ technique sets a fixed lot size based on practical operational considerations. Although it simplifies the procurement process, this technique produces the highest total inventory cost.

Table 6.
Summary of Total MRP Costs Using FOQ Method

Product	Holding & Ordering Cost	Total Raw Material Cost (6 months)
Standing Ironing Board	Rp 20.163.060	Rp 255.629.025
Sitting Ironing Board	Rp 18.103.195	Rp 232.660.834
Grand Total	Rp 38.266.255	Rp 488.289.859

Source: Processed Data (2026)

Inventory costs were evaluated by considering ordering costs and holding costs for each lot-sizing technique. Ordering costs consisted of administrative expenses, communication costs, transportation costs, and procurement processing activities incurred every time a purchase order was issued. Holding costs included warehouse utilization expenses, inventory handling costs, and storage-related expenses associated with maintaining inventory [14]. The total inventory cost was calculated as the sum of ordering costs and holding costs accumulated throughout the six-month planning horizon. The resulting costs were then compared across the LFL, EOQ, and FOQ techniques to determine the most economical inventory policy.

4.5 Comparison and Selection of the Best Lot Sizing Method

A comparison of total costs for the three lot sizing techniques for the January–June 2026 period is presented in Table 7 below.

Table 7.
Comparison of Total Costs for the Three Lot Sizing Methods

Method	Total Inventory Cost	Ranking	Description
Lot for Lot (LFL)	Rp 417.215.710	2	—
Economic Order Quantity (EOQ)	Rp 346.275.216	1	Lowest total cost
Fixed Order Quantity (FOQ)	Rp 488.289.859	3	—

Source: Processed Data (2026)

Table 7 demonstrates clear differences in inventory cost performance among the three lot-sizing techniques. The LFL method minimizes inventory holding costs by ordering materials according to exact requirements; however, frequent ordering activities increase procurement costs. Conversely, the FOQ method simplifies procurement administration but tends to generate higher inventory costs due to larger inventory holdings. The EOQ method provides a more balanced approach by optimizing the trade-off between ordering and holding costs, resulting in superior inventory cost performance compared with the alternative methods.

The EOQ method produces the lowest total inventory cost; however, its implementation requires supplier flexibility in fulfilling varying order quantities. Given that UD. Podo Moro still relies on a pre-order system with limited supply certainty, a combination of EOQ for components with stable demand and LFL for components with high holding costs (such as yellow foam and fabric) is recommended as the optimal strategy. The FOQ technique can serve as a pragmatic alternative as it facilitates negotiation and procurement scheduling with suppliers. Although EOQ generated the lowest inventory cost, the model assumes constant demand, stable lead times, and fixed ordering costs. These assumptions may not fully represent actual SME operating conditions.

4.6 Impact of MRP Implementation on Out of Stock Reduction

MRP implementation has a significant positive impact on the operations of UD. Podo Moro. With a planned raw material ordering schedule based on BOM and lead times, the company can: (1) anticipate production needs before stock runs out; (2) avoid emergency purchases at higher prices; (3) prevent excessive stock accumulation; and (4) improve distributor confidence through on-time delivery. Overall, MRP has the potential to eliminate OOS conditions and improve business profitability. Although EOQ generated the lowest inventory cost in this study, the analysis assumes relatively stable demand patterns, ordering costs, holding costs, and supplier lead times throughout the planning horizon. Variations in these parameters may affect the resulting order quantities and total inventory costs. Therefore, future studies should conduct sensitivity analysis to evaluate the robustness of EOQ recommendations under different demand levels, holding costs, ordering costs, and lead-time scenarios.

4.7 Managerial Implications of Safety Stock and Reorder Point

Although MRP significantly improves material planning accuracy, demand fluctuations and supplier lead-time variability may still create inventory risks. Therefore, implementing Safety Stock and Reorder Point (ROP) calculations is recommended to provide additional protection against unexpected demand increases and supplier delays. Future implementation of Safety Stock and ROP can further reduce the probability of OOS conditions and improve inventory responsiveness.

5. Conclusion

Based on the results of this study, the implementation of Material Requirements Planning (MRP) provides an effective approach for improving raw material planning at UD. Podo Moro, which has experienced recurring Out of Stock (OOS) conditions due to fluctuating demand and supplier lead times. The integration of demand forecasting, Aggregate Planning, Master Production Schedule (MPS), and Bill of Materials (BOM) enables the company to synchronize procurement activities with production requirements in a more systematic and efficient manner. The findings demonstrate that the application of MRP combined with an appropriate lot-sizing technique can improve inventory control performance, reduce the risk of material shortages, and support more efficient procurement planning. From a practical perspective, the proposed approach provides a structured decision-making framework that can assist small and medium-sized manufacturing enterprises (SMEs) in maintaining production continuity while improving operational efficiency. Furthermore, this study contributes to the inventory management literature by demonstrating the implementation of an integrated planning framework in an SME manufacturing environment facing recurring inventory shortages and demand uncertainty. Overall, the implementation of MRP can support better resource utilization, strengthen supply planning, and enhance the company's responsiveness to operational and market fluctuations in a sustainable manner.

Based on these findings, UD. Podo Moro is recommended to implement the MRP system consistently through digitalized inventory and production planning processes to improve data accuracy and decision-making effectiveness. The company should also develop a more reliable demand database and strengthen collaboration with suppliers to improve lead-time reliability and reduce procurement uncertainty. In addition, the company is encouraged to conduct periodic inventory reviews and supplier performance evaluations to ensure the effectiveness of the MRP system. Key indicators such as stockout frequency, inventory turnover, and supplier delivery reliability should be monitored regularly to support continuous improvement. In addition, the combination of EOQ and LFL techniques may be applied according to the inventory cost characteristics and demand patterns of each raw material component to achieve a balance between inventory efficiency and material availability. For future research, it is recommended to expand the analysis to all product variants produced by the company. Future studies should integrate Safety Stock and Reorder Point (ROP) calculations within the MRP framework to improve inventory control under uncertain demand and lead-time conditions. In addition, sensitivity analysis and simulation-based approaches can be applied to evaluate the robustness of inventory policies under different operational scenarios.

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