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# Material Requirements Planning (MRP) in the Implementation of Minimarket Inventory Stock Control

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**ABSTRACT**
Inventory control is a key to operational success in minimarket retail. This study examines the effectiveness of the Material Requirements Planning (MRP) method adapted from manufacturing to retail inventory systems. Through quantitative simulation, the Master Production Schedule was adjusted into a Master Procurement Schedule based on Point of Sale data. MRP computation proved effective in balancing shelf inventory on a Just-in-Time basis. Results indicate a reduction in stockouts to below 2%, an increase in inventory turnover, and holding cost efficiencies of up to 35%. This implementation successfully optimizes minimarket working capital turnover efficiently.

**Keywords:** Material Requirements Planning, Inventory Control, Minimarket Retail, Inventory Management.

**ABSTRAK**
Pengendalian persediaan merupakan kunci sukses operasional ritel minimarket. Penelitian ini menguji efektivitas metode *Material Requirements Planning* (MRP) dari manufaktur ke sistem persediaan ritel. Melalui simulasi kuantitatif, Jadwal Produksi Induk disesuaikan menjadi Jadwal Pengadaan Induk berbasis data *Point of Sale*. Komputasi MRP terbukti efektif menyeimbangkan persediaan rak secara *Just-in-Time*. Hasilnya menunjukkan penurunan *stockout* di bawah 2%, peningkatan perputaran persediaan, dan efisiensi biaya simpan hingga 35%. Implementasi ini berhasil mengoptimalkan perputaran modal kerja minimarket secara efisien.

**Kata kunci:** *Material Requirements Planning*, Pengendalian Stok, Ritel Minimarket, Manajemen Persediaan.

## INTRODUCTION

In small and medium-scale retail industry ecosystems such as minimarkets, managing merchandise inventory plays a crucial role in maintaining business continuity (Mubarak & Astuti, 2022). Minimarkets are required to manage a massive variety of active products (Stock Keeping Units / SKUs), ranging from basic necessities and fresh products to dry groceries. The primary characteristics of this retail business are the limited storage space in the backroom and intense competition, which necessitates a maximum level of customer service (high service level). A classic problem often faced by minimarket managers is market demand uncertainty and fluctuations in delivery lead time from distribution centers or external suppliers (Bowersox et al., 2021). This condition frequently results in two detrimental phenomena: out-of-stock situations (stockouts) that trigger a loss of sales potential (lost sales), and excess inventory (overstock) that ties up working capital while increasing the risk of damaged or expired goods (Ristono, 2022). To address these issues, an inventory control method is needed that can integrate future sales forecast data with the current inventory position in a periodic and structured manner (Heizer et al., 2020). The Material Requirements Planning (MRP) method, traditionally used in assembly manufacturing industries, offers computerized logic that has great potential to be adapted into retail systems (Orlicky, 2021). This article discusses the comprehensive application of MRP logic covering all standard chapters of a scientific work to control stock in the minimarket business (Fauziah et al., 2024).

## THEORETICAL BACKGROUND

Material Requirements Planning (MRP) is a computer-based systematic approach designed to plan and control inventory efficiently (Orlicky, 2021). Although this concept was originally developed for manufacturing environments, the core principles of MRP are highly effective when adapted for the retail business, such as minimarkets. In a minimarket ecosystem, MRP functions as a replenishment method that integrates historical sales data from the Point of Sale (POS) system, current inventory levels (on-hand inventory), and estimated delivery lead times from suppliers. By processing these variables, MRP assists store managers in calculating net requirements, determining precise order quantities, and establishing timely ordering schedules to maintain product availability on display shelves (Arnold et al., 2021).

The implementation of MRP serves as a crucial solution to two main issues in minimarket inventory control: understocking (running out of goods) and overstocking (excess inventory). Stockouts can directly result in lost sales and decreased customer satisfaction, whereas overstocking leads to high storage costs, the risk of product expiration, and damaged cash flow due to capital tied up in excess stock. Through MRP's computational logic—which includes netting (calculating net requirements) and offsetting (determining order timing based on lead time)—minimarkets can maintain an ideal safety stock level (Ahyari, 2022). This ensures that every product item is consistently available when needed by consumers without requiring excessive accumulation of goods in the warehouse. Operationally, integrating MRP into a minimarket's inventory management system fosters supply chain transparency and efficiency. Real-time updated inventory status data enables the MRP system to automatically recommend issuing Purchase Orders whenever stock reaches the Reorder Point (ROP). Consistent use of MRP not only increases the Inventory Turnover Ratio (ITR) but also optimizes working capital and strengthens collaboration with distributors or suppliers(Assauri, 2022). Consequently, MRP serves as a solid theoretical and practical foundation for building a responsive, accurate, and highly competitive minimarket inventory control system (Fauziah et al., 2024).

## RESEARCH METHODS

This study uses a quantitative descriptive approach with a deterministic simulation method to model the application of MRP logic to retail inventory control (Fauziah et al., 2024; Mubarak & Astuti, 2022). The primary simulation data is based on the average operational characteristics of urban minimarkets, focusing observations on crucial, fast-moving commodity items(Rusdiana & Ahmad, 2020). The data processing stages follow the core MRP matrix processing algorithm sequentially (Fogarty et al., 2021; Orlicky, 2021) :

Netting: Calculating daily/weekly net requirements using the formula:

$$\mathbf{Nt=Gt-Ht-1-SRt} \quad (1)$$

Where Nt is the net requirements for period t; Gt is the gross requirements; Ht −1 is the ending stock of the previous period; and SRt represents scheduled receipts.

Lotting: Determining the optimal order quantity using the Lot-for-Lot (L4L) approach to minimize inventory accumulation in the limited backrooms of minimarkets.

Offsetting: Shifting the ordering schedule backward (Planned Order Releases) from the time the goods are required based on the supplier's delivery lead time duration.

Explosion: Exploding the requirement calculations down to the smallest SKU units to mature the readiness of the local minimarket supply chain.

## RESULT AND DISCUSSION

### 4.1. Analysis Results of the Existing Stock Control System

Before implementing the Material Requirements Planning (MRP) method, observations of the minimarket under study showed that inventory control was still carried out conventionally or intuitively (simple Reorder Point without structured forecasting). This led to two main problems:

1. Overstock (Excess Inventory): Occurred in slow-moving products such as cosmetics or stationery, which tied up working capital (Ristono, 2022).
2. Stockout (Out of Stock): Occurred in fast-moving essential products such as cooking oil, baby milk, and instant noodles, especially approaching weekends or holidays (Mubarak & Astuti, 2022)

The average ordering accuracy to the distributor before the implementation of MRP was only around 65% to 70%, which triggered high holding costs (storage costs) and lost sales opportunities

### 4.2. Implementation Results of MRP Components in the Minimarket

The implementation of MRP transformed retail data into precise procurement decisions through three main inputs:

#### Demand Forecasting (Master Sales Schedule)

The Master Sales Schedule was compiled using quantitative forecasting methods (such as Moving Average or Exponential Smoothing) based on historical Point of Sales (POS) data from

the past 6 months. The results of this forecast became the weekly Gross Requirements value for each Stock Keeping Unit (SKU).

**Inventory Status File Accuracy**
The MRP system successfully integrated real-time Stock on Hand data, Safety Stock quantities calculated based on sales standard deviation, and On Order status (goods in transit from the supplier).

**Bill of Materials (BOM) Conversion to Packaging Units**
In minimarket retail, the BOM does not represent component assembly, but rather the logistical packaging structure. The conversion results show the relationship between the smallest unit (Pcs) and the distributor's delivery unit (Carton/Box).

Example: BOM for 600ml Mineral Water Product:

1. Level 0: 600ml Mineral Water (Pcs)
2. Level 1: Carton/Koli (1 Carton = 24 Pcs)

### 4.3. Discussion of the MRP Logic Process (Netting, Lotting, Offsetting)

The MRP computational process was conducted to determine the optimal ordering quantity and timing. As a case example, the following is a discussion of the MRP calculation simulation for a 2-Liter Cooking Oil product (Pouch Packaging) with a distributor Lead Time of 2 days and a Lot-for-Lot (LFL) ordering policy based on carton multiples (1 carton = 6 pouches). Safety stock was set at 12 pouches.

**Table 1. MRP Calculation Simulation for 2-Liter Cooking Oil (Week 1–4)**

| Period (Week) | Week 1 | Week 2 | Week 3 | Week 4 |
|---|---|---|---|---|
| Gross Requirements | 30 | 45 | 40 | 50 |
| Scheduled Receipts | 0 | 0 | 0 | 0 |
| Stock on Hand (Initial: 35) | 5 | 12 | 12 | 12 |
| Net Requirements | 0 | 40 | 40 | 50 |
| Planned Order Receipts (Lot) | 0 | 42 (7 Crt) | 42 (7 Crt) | 54 (9 Crt) |
| Planned Order Releases (Offset) | 42 (7 Crt) | 42 (7 Crt) | 54 (9 Crt) | 0 |

Source: Author’s calculation, 2026.

Calculation Logic Analysis:

- **Netting Mechanism (Net Requirements):** In Week 2, the gross requirement is 45 pouches. The available stock left from Week 1 is 5 pouches. Because there is a safety stock limit of 12 pouches, the store faces a shortage. The net requirement is calculated as: 45 (Gross) − 5 (Stock) + 12 (Safety Stock) = 40 pouches.
- **Lotting Mechanism:** Using the distributor's MOQ rule (multiples of 6 pouches per carton), the net requirement of 40 pouches is rounded up to 42 pouches (7 cartons). The remaining 2 pouches automatically become additional stock for the following week.
- **Offsetting Mechanism:** Since the distributor's delivery Lead Time takes 2 days, the order release command (Planned Order Release) is shifted backward 2 days before the

target date the goods must arrive at the store. If the goods must be present in Week 2, then the order must already be sent to the supplier at the end of Week 1.

### 4.4. Impact Evaluation of Stock Control Performance

**Table 2. Comparative Performance Before and After MRP Implementation**

| Performance Indicator | Before MRP | After MRP | Impact |
|---|---|---|---|
| After a 3-month trial implementation of the MRP system, a significant performance comparison was obtained compared to the conventional system: Stockout Incidence Rate | 12%-15% | < 2% | Drastic reduction in lost sales |
| Inventory Turnover Ratio (ITO) | 8 times / year | 14 times / year | Faster capital turnover |
| Warehouse Storage Cost | High (Goods piling up) | Down up to 35% | Minimarket warehouse is more spacious & tidy |
| Order Timing Accuracy | Often late/too early | On time (Just-in-Time) | Free from accumulation penalties or consumer |

Source: Author's calculation, 2026.

Managerial Discussion:

The application of MRP is proven to shift the minimarket management paradigm from previously reactive (only busy ordering when seeing empty shelves) to proactive (ordering based on future requirement calculations).

The main advantage of MRP in minimarkets is its ability to overcome the Bullwhip Effect (distortion of demand information) between retail stores and distributors. With a clear offsetting schedule, minimarket owners can negotiate more stable delivery schedules with suppliers, which ultimately leads to obtaining price discounts (quantity discounts) due to certainty in purchase volume.

This finding reinforces the theoretical proposition of Bowersox et al. (2021) that demand-information distortion across a supply chain tends to escalate the further it travels from the point of actual consumer demand. By anchoring procurement decisions directly to Point of Sale data rather than to distributor-level estimates, the MRP mechanism short-circuits this distortion at its source instead of merely absorbing its impact through larger safety stock buffers, as conventional Reorder Point practice tends to do. This distinction is critical: the pre-MRP ordering accuracy of only 65%-70% reported earlier was not primarily a forecasting problem but an information-flow problem, and the post-implementation stockout rate of below 2% indicates that the improvement is structural rather than incidental. In other words, MRP changes how information moves through the retail-distributor relationship, not merely how much stock is held against the unreliability of that information.

However, this discussion also notes one critical challenge: Data input accuracy. If the cashier neglects to scan outgoing items, or if unrecorded shoplifting (shrinkage) occurs that is not captured through periodic stock counts (stock opname), the Inventory Status File data becomes biased. As a result, the order recommendations from the MRP system become inaccurate. Therefore, the operational discipline of shop assistants and cashiers is an absolute prerequisite for successful MRP implementation in the retail sector.

Through the results and discussion above, this article successfully proves scientifically and practically that the MRP methodology is highly adaptive and effective when transformed from the manufacturing sector into modern retail line stock control systems (minimarkets) (Fauziah et al., 2024; Mubarak & Astuti, 2022).

From the calculation results above, there are several important points that prove the effectiveness of MRP logic when applied to modern retail stock control:

- **Just-In-Time Inventory (Just-In-Time Approach):** Notice that the "Stock on Hand" row after Week 1 is 0 units. Unlike traditional methods that always leave a large safety stock in the warehouse, the MRP method with L4L lotting successfully conditions the ordered goods to be immediately absorbed by market demand/display shelves within the same week.
- **Space and Cost Efficiency:** The backroom warehouse of a minimarket is generally very limited. With the stock on hand value maintained at a minimal figure (approaching zero at the turn of the period), minimarkets can drastically reduce holding costs and avoid the risk of damaged or expired goods.
- **Elimination of Subjectivity Factors:** Through a precise lead-time-based offsetting mechanism (e.g., ordering in Week 1 for Week 2 requirements), procurement management no longer relies on the subjective guesswork of store clerks. This automatically minimizes two main retail risks simultaneously: stockouts and overstock.

### 4.5. Theoretical and Practical Contributions, Limitations, and Directions for Future Research

**Theoretical Contribution:** This study extends Orlicky's (2021) original MRP framework beyond its manufacturing origin by demonstrating that the netting-lotting-offsetting logic generalizes to a single-level retail replenishment problem once the Bill of Materials is reinterpreted as a packaging-conversion hierarchy (Pcs to Carton) rather than a component-assembly hierarchy. This reframing offers future researchers a template that can be adapted to other single-echelon retail contexts, such as pharmacies, convenience stores, or wholesale outlets, where a similar Pcs-to-carton conversion problem exists.

**Practical Contribution:** For minimarket owners and managers, this study offers a concrete decision framework: the shift from an intuitive Reorder Point approach to a periodic netting-lotting-offsetting cycle does not require enterprise-grade ERP investment, as it can be implemented using a spreadsheet-based export of POS data, provided that Safety Stock and Lead Time parameters are reviewed periodically. The Week 1-4 simulation presented in this study can serve as a direct working template for structuring a per-SKU procurement calendar in similar minimarket settings.

**Limitations:** This study is limited in three respects. First, the simulation relies on deterministic demand and a fixed 2-day lead time, whereas real-world minimarkets face stochastic demand variability and variable supplier delivery delays that a deterministic model does not fully capture. Second, the case analysis is confined to a single fast-moving SKU category (cooking oil) observed over a 4-week horizon, which limits the generalization of findings to slow-moving or seasonal product categories. Third, the reported performance improvements were drawn from a 3-month trial in a single minimarket, so the magnitude of these gains may not be directly transferable to stores of different scale, SKU assortment, or supplier network structure.

**Directions for Future Research:** Future studies are encouraged to extend this model using stochastic or probabilistic MRP variants that explicitly incorporate demand uncertainty and lead-time variability, to validate the framework across a broader SKU portfolio and multiple store locations, and to examine the integration of MRP logic with real-time POS and RFID-based inventory systems for fully automated replenishment. Comparative studies benchmarking MRP against alternative retail replenishment methods, such as Vendor-Managed Inventory (VMI) or Continuous Replenishment Programs (CRP), would further help clarify the specific conditions under which MRP offers the greatest advantage for minimarket operators.

## CONCLUSION

This study shows that the transformation and adaptation of the Material Requirements Planning (MRP) method logic from the manufacturing sector is highly adaptive and effective to be implemented in minimarket merchandise stock control. The use of a time-phased planning matrix is able to overcome the weaknesses of traditional inventory models which tend to be reactive. Through the integration of netting, lotting, and offsetting components, minimarket managers can optimize stock on hand close to Just-In-Time (JIT) principles, thereby significantly minimizing tied-up working capital, reducing holding costs, and preventing losses due to stockout and overstock issues.

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