

Balancing Demand and Supply: Inventory Allocation in FMCG

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Abstract: This study delves into the critical aspect of supply chain management—optimal inventory allocation—for the fast-moving consumer goods (FMCG) industry. FMCG companies face the challenge of meeting dynamic customer demands while minimizing excess inventory costs. This abstract highlights key strategies employed by successful FMCG businesses to strike a balance between customer satisfaction and efficient inventory management. Moreover, for seasonal products, a tailored approach to inventory allocation is vital, allowing companies to adjust stock levels to match peak demand and prevent overstocking. The integration of advanced inventory management software facilitates real-time tracking, analysis, and decision-making, streamlining the inventory allocation process. By implementing these strategies and continually refining them based on real-world data, FMCG businesses can achieve optimal inventory allocation, leading to improved customer satisfaction, reduced costs, and an overall boost in supply chain efficiency. This study offers a comprehensive overview of inventory optimization techniques, aiming to assist FMCG companies in navigating the complexities of inventory management and remaining competitive in a fast-paced market.

1. Introduction

In today's highly competitive business landscape, fast-moving consumer goods (FMCG) companies face the dual challenge of meeting ever-changing consumer demands and efficiently managing their inventories. The FMCG sector encompasses a wide range of products, including food and beverages, personal care items, household essentials, and more, which are characterized by rapid turnover and short shelf lives. As consumer preferences and market dynamics evolve at a swift pace, effective inventory allocation becomes a crucial aspect of supply chain management.

Optimal inventory allocation in the FMCG industry is the strategic process of determining the right balance between maintaining sufficient stock levels to meet customer demand and avoiding excess inventory that could lead to increased holding costs, wastage, and capital tie-up. FMCG businesses must ensure that their products are readily available to customers when and where they need them, while simultaneously optimizing inventory levels to maximize operational efficiency and profitability. The importance of efficient inventory allocation cannot be overstated. On one hand, inadequate

inventory levels can result in stockouts, missed sales opportunities, and dissatisfied customers, leading to potential revenue losses and damage to the brand's reputation. On the other hand, excessive inventory can burden the company with increased carrying costs, obsolescence risks, and reduced cash flow, negatively impacting the bottom line. This study examines the strategies and best practices employed by successful FMCG companies to achieve optimal inventory allocation. We will delve into various inventory management techniques, demand forecasting methodologies, and supply chain optimization approaches that enable FMCG businesses to strike the right balance between inventory levels and customer demand. By exploring real-world case studies and industry insights, this report aims to offer valuable insights to FMCG executives, supply chain managers, and stakeholders seeking to enhance their inventory allocation practices and gain a competitive edge in the market.

In the following sections, we will discuss demand forecasting, safety stock management, economic order quantity (EOQ), vendor management, just-in-time (JIT) inventory, seasonal inventory management, inventory tracking software, and continuous improvement strategies. Together, these elements form a comprehensive framework for achieving optimal inventory allocation in the fast-moving consumer goods industry. Let us embark on this journey to uncover the key principles and approaches that can transform inventory management into a strategic advantage for FMCG companies. Paper organized as follows: Section 2 covers the literature survey and section 3 discusses, the mathematical model is included in the methodology part. Section 4 outlines the modelling and analysis results of the sample study were included. . In the last section, the results and different approaches and methods that can be applied in the solution of such a problem in the future are given.

2. Literature Survey

Balancing demand and supply through effective inventory allocation is a crucial aspect of supply chain management and operations. Below is a literature survey that provides an overview of some key studies and concepts related to inventory allocation strategies:

Inventory Management Models:

* Economic Order Quantity (EOQ) Models: Classic models that determine the optimal order quantity to minimize inventory costs while considering demand and supply factors [1-3].

* Newsvendor Model: Addresses one-time decision-making for perishable or seasonal goods, balancing the cost of excess inventory against the cost of stockouts [4].

Demand Forecasting and Planning:

• Time Series Forecasting: Techniques such as ARIMA (AutoRegressive Integrated Moving Average) and exponential smoothing for predicting future demand based on historical data [5-6].

• Causal Forecasting: Incorporates external factors like promotions, economic conditions, and marketing efforts to refine demand predictions [7-8].

Supply Chain Coordination:

• Bullwhip Effect: Study of how small fluctuations in demand can amplify as they move upstream in the supply chain, leading to inefficiencies in inventory allocation.[9-10]

• Vendor Managed Inventory (VMI): Suppliers play a more active role by managing their customers' inventory levels, often through real-time data sharing [11-13].

Multi-Echelon Inventory Systems:

• Multi-Echelon Inventory Optimization: Balancing inventory levels across multiple levels of a supply chain, accounting for transportation costs, lead times, and variability [14, 15].

• Centralized vs. Decentralized Inventory: Trade-offs between having a single central inventory or separate inventories at various locations [16, 17].

Nyabwanga and Ojera explore the benefits of inventory pooling, where multiple locations share a common inventory. They analyse different allocation rules and compare their performance in terms

of cost reduction and service level improvement [18]. Oey and Nofrimurti investigate the integration of sustainability with lean implementation considerations in FMCG inventory allocation. It examines how eco-friendly practices, such as reduced packaging, green transportation, and efficient inventory management, can lead to cost savings and reduced environmental impacts. The study offers insights into aligning economic and ecological objectives in FMCG supply chains [19]. Lummus et al. reviewed the papers comprehensively discusses various inventory allocation policies, such as proportional allocation, modified proportional allocation, and constrained optimization-based allocation. It also covers multi-echelon systems, stochastic demand, and various performance metrics for evaluating allocation strategies [20]. Pereira and Frazzon investigated how FMCG companies can adapt their inventory allocation strategies to meet the demands of multiple sales channels with omnichannel retailing. The research proposes dynamic allocation methods that consider real-time sales data from different channels to optimize inventory distribution and improve customer service levels. [21]. Seasonal demand fluctuations pose unique challenges for FMCG inventory allocation. This research compares various demand forecasting methods, such as moving averages, exponential smoothing, and seasonal decomposition, to identify the most accurate approach for predicting demand in seasonal FMCG products. The study emphasizes the importance of precise demand forecasting in optimizing inventory levels during peak seasons [22].

These works represent a range of perspectives on the topic, including mathematical modeling, optimization techniques, real-world applications, and considerations of emerging trends such as sustainability and data-driven decision-making. Incorporating insights from these related works into your literature survey can provide a well-rounded understanding of the challenges and strategies involved in balancing demand and supply through effective inventory allocation.

3. Model and Method

Balancing demand and supply through effective inventory allocation is a critical aspect of supply chain management. Inventory allocation involves determining how much stock should be assigned to different locations or customers to meet demand while minimizing costs and optimizing service levels.

FMCG companies can enhance their inventory allocation practices, improve customer satisfaction, reduce costs, and maintain a competitive edge in the fast-moving consumer goods industry. The iterative nature of the process allows for continuous optimization and adaptation to changing market conditions and customer demands.

$$S = D * LT + Z * SL \quad (1)$$

where: Z = Z-score associated with the desired service level (probability of not stocking out).

Expected Holding Cost The expected holding cost (HC) can be computed as:

$$HC = (Q/2) * H \quad (2)$$

where: H = Holding cost per unit per period.

Expected Stockout Cost The expected stockout cost (SOC) is the cost incurred when demand exceeds inventory levels during the lead time. It can be calculated as:

$$SOC = \int [\max(0, X - (S - D * LT))] * f(X) * f(LT) dX dLT \quad (3)$$

Total Cost the total cost (TC) is the sum of expected holding cost and expected stockout cost:

$$TC = HC + SOC \quad (4)$$

Optimization The goal is to find the optimal order quantity (Q) that minimizes the total cost (TC) subject to constraints (if any).

Solving the mathematical model will yield the optimal order quantity (Q) and reorder point (S)

that achieve the desired service level while considering demand and lead time uncertainties. By using a stochastic model, FMCG companies can make informed decisions to enhance inventory allocation strategies and reduce the risk of stockouts and excess inventory, resulting in improved supply chain efficiency and customer satisfaction. By incorporating various variables and constraints, this model provides a quantitative approach to decision-making for FMCG companies, promoting efficient inventory management and allocation. To develop a mathematical model for balancing demand and supply in FMCG inventory allocation, we can use basic inventory management principles. One commonly used model is the Economic Order Quantity (EOQ) model. The EOQ model helps determine the optimal order quantity that minimizes total inventory costs, including holding costs and ordering costs. However, this model assumes constant demand and does not account for demand fluctuations and seasonality. To address these issues, we can extend the EOQ model using additional techniques like safety stock and reorder point calculations. Here's an outline of the mathematical model:

1) Economic Order Quantity (EOQ) Model:

Demand Rate (D): The average number of units sold per period (e.g., per week or month).

Holding Cost per Unit per Period (H): The cost of carrying one unit of inventory for a given period.

Ordering Cost per Order (S): The cost of placing an order for a certain quantity of products.

Lead Time (LT): The time between placing an order and receiving the inventory.

The EOQ formula calculates the optimal order quantity (Q^*) that minimizes total inventory costs:

$$Q^* = \sqrt{\frac{2DS}{H}} \quad (5)$$

2) Safety Stock Calculation:

Safety Stock (SS): Extra inventory held to mitigate unexpected demand variations or supply delays.

Standard Deviation of Demand during Lead Time (σ_{LT}): The variability of demand during the lead time.

The safety stock is calculated as:

$$SS = z \cdot \sigma_{LT} \quad (6)$$

where "z" represents the desired level of service (e.g., 1.65 for 95% service level based on the standard normal distribution).

3) Reorder Point Calculation:

Reorder Point (ROP): The inventory level at which a new order should be placed to avoid stockouts.

$$ROP = D.LT + SS \quad (7)$$

4) Incorporating Seasonality and Demand Fluctuations: To account for seasonal demand patterns or fluctuations, you can use forecasting methods like moving averages, exponential smoothing, or seasonal decomposition to estimate future demand. This forecasted demand (D') can then replace the constant demand (D) in the EOQ and ROP calculations.

5) Demand-Supply Matching: Compare the forecasted demand (D') with available inventory levels at regular intervals to determine if an order needs to be placed to maintain the desired safety stock level.

6) Optimization: Monitor actual demand and adjust the forecast as needed. Continuously optimize the EOQ, safety stock levels, and reorder points based on updated data and changing business conditions.

It's important to note that this is a simplified mathematical model, and real-world inventory allocation in FMCG companies may involve more sophisticated techniques and considerations. Advanced analytics, machine learning algorithms, and supply chain optimization tools can further

enhance the accuracy of inventory allocation decisions. Nonetheless, the EOQ model and its extensions provide a solid foundation for balancing demand and supply in FMCG inventory management.

4. Case Study

The FMCG industry is highly competitive, with products experiencing fluctuating demand due to various factors, such as seasonality, promotions, and consumer preferences. Efficient inventory allocation is crucial for FMCG companies to prevent stockouts and overstocking, as both scenarios can lead to lost sales and increased holding costs. To address these challenges, the case study discusses the approaches adopted by a leading FMCG company to optimize its inventory allocation process.

The aim of the study is to determine the demand situation that can respond instantly to customer demands, and minimizes the costs of keeping stock at a minimum level and keeping it out of stock. The effect of the proposed model on stock status and financial performance investigated. Especially in retail management, accurate estimation of customer needs and demand amount and time is very important in terms of efficient management of the system. In this context, it aimed to determine and analyse customer demand situations and seasonal behaviour situations. Reaching the right time, the right place and the right amount of customers with the proposed model is the most basic purpose and task of the company. In the current model, keeping the stock level constant and not changing according to the changing dynamic market conditions increases the cost of holding stock in the system or the cost of holding due to the inability to respond to customer needs. Since the proposed model aims to keep the stock level at a minimum level according to customer needs, it is necessary to estimate customer demands accurately and in cases where they affected by time. In order to strengthen the financial performance of the company, the concepts of batch, sizing and demand forecasting come to the fore. The study aimed to develop a decision support model in which the system can decide by itself according to changing demand situations, the effect of the rate of change in stock quantity on financial performance, the optimal relationship between effective inventory management, supply lot sizing and demand forecasting. The absence of such a study, especially in the sectoral area, is thought to contribute to the economy of both the firm and the country, especially in a touristic sector. The focus of this case study is on a prominent FMCG company that operates in various regions and markets a wide range of products, including food and beverages, personal care, and household items. The company encountered fluctuations in product demand, making it challenging to accurately predict stock requirements for each product at different locations. Certain products experienced higher demand in specific regions, leading to inventory imbalances across the supply chain. Seasonal demand spikes and promotional events further complicated inventory allocation, as traditional forecasting models struggled to account for such variations accurately. Suboptimal inventory allocation resulted in increased distribution costs, affecting the company's overall profitability.

R0- Initial Situation

Here, the structure and detail data of the current system are discussed in Table 1, and the other 5 different situations are analysed according to their increase and decrease based on these data.

R1- When the price is increased when the supply is low and the demand is in the standard position

When prices are increased when supply decreases and demand remains relatively stable (standard), a situation is often encountered that results in a price increase. In this case, demand is stronger than supply and prices rise because consumers or buyers are more interested in the product than demand.

R2- When the supply and demand are in the standard position, the price is lowered, the stock is melted.

In a situation where supply is high, demand is at a standard level, and prices are pulling down, it is usually aimed to run out of stocks faster. Falling prices can increase the demand for the product. Consumers may find the product more attractive due to lower prices, which may lead to increased demand. With prices falling, consumers are encouraged to buy more items. This may lead to a faster depletion of stocks and a decrease in the amount of products in warehouses. Low prices may lead consumers to buy more products because the cost of each product is lowered. This can speed up the melting of stocks. Sellers with excess inventory can lower prices to dispose of their goods and free up space in warehouses. This may be especially true for seasonal products or products that are approaching their expiration date. There may be situations where other sellers may also be tempted to lower prices. This can lead to increased competition and lower prices.

Table 1. Initial situation for company

Parameters of Inventory System	
RIM Approach	Vendor management in line with customer demands
Lot Sizing Policy	FIFO
Product Input	60.000 Lt /Ay = 6.000 Lt × 10 g ün = 60.000 Lt/Month
	15.000 Lt/Week
	60.000 Lt/Month
Product Storage Capacity	90.000 Lt ≈ 30 Day Supply
Security Stock Levels	25.000 Lt – Summer Period
	20.000 Lt - Winter Period
Stock Holding Cost	18,5\$/Lt/Year
Order Placement Cost	\$6/ Order
Over Usage Cost	2,40-2,89\$/Lt

R3- In case of standard product availability, cost increase

Increasing costs of a product can often trigger a range of effects. When the costs of the product increase, some of these increased costs are usually reflected in the price of the final product. An increase in price can affect consumer demand and lead to a decrease in sales. If prices stay the same while costs increase, the profit margins of the business may shrink. This can affect the profitability of the business. If the price of the product is higher than competitors and costs are increasing, you may lose your competitive advantage. Customers may turn to more affordable alternatives. Rising prices may lead to a decrease in consumer demand. This situation may be more evident especially in products with high price sensitivity. Rising costs may cause the business to reconsider its product or supply chain. Steps can be taken, such as reducing costs or finding alternative suppliers. Increased costs from suppliers can affect business-supplier relationships. Bargaining and disputes may arise. Cost increases can affect perceptions of product quality or value. If cost increases negatively affect product quality, customer satisfaction may decrease.

R4- Table showing the situation result of cost reduction in the presence of standard product

Reducing the costs of a standard product can have several positive effects: Reducing the costs of the product gives the company an advantage in price competition. If you can produce at lower costs, you can make more profit at the same prices, or you can lower prices and offer attractive offers to customers: Lower costs may mean lower product prices. Lower prices can increase consumers' demand for the product. Lowering product costs can increase the profit margin of each product and therefore increase the overall profitability of the business. Producing at lower costs can increase the competitiveness of your business against its competitors. This can enable you to increase your market share or strengthen your current market position. Lower costs can enable your business to devote more resources to investment and growth opportunities. This may include opportunities to enter new markets or expand product lines. Lower costs can enable the product to be offered at more affordable prices and provide better value for consumers, thereby increasing consumer satisfaction. Reducing

product costs can make inventory management more effective. Manufacturing at lower costs can reduce inventory costs and warehouse space requirements.

R5- In the presence of standard products, the cost is the same, but the product price is reduced due to competition conditions.

The situation where the product costs are the same but the product price is reduced due to competitive conditions can have various effects: Price reduction can make your product more competitive against competitors. In this case, consumers may prefer the product because of more affordable prices, which can increase your market share. Lower prices usually increase demand. This can enable to reach more consumers and increase product sales. Price reduction can increase the satisfaction of the existing customers and turn them into loyal customers. Affordable prices can encourage customers to choose to buy again. Lower prices can cause consumers to buy more items. In this case, the stocks will run out faster and the amount of products in the warehouses will decrease. A price cut can narrow the profit margins. However, this effect can be offset by higher volume sales (in Table2).

Table 2: Different scenario results

Inputs	R0	R1	R2	R3	R4	R5
Leads per Month (L)	18000	12000	27000	18000	18000	18000
Cost Per Lead (C)	\$8,40	\$8,40	\$8,40	\$9,50	\$7,80	\$8,40
Conversion Rate (R)	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%
Profit per Sale (P)	\$14,30	\$18,30	\$13,50	\$14,30	\$14,30	\$13,80
Overhead per Month (H)	\$3,00	\$3,00	\$3,00	\$3,00	\$3,00	\$3,00
Outputs						
Monthly Income:	257382	219588	364473	257382	257382	248382
Monthly Expenses:	151203	100803	226803	171003	140403	151203
Projected Monthly Profit:	106179	118785	137670	86379	116979	97179

Low prices can affect the brand perception or perceived value of the product. In some cases, low prices can call into question the quality of the product. Before making a price cut, it is important to calculate the profitability balance, taking into account costs and potential increased volume. Results and benefits are listed as follows:

Reduced Stockouts: The improved demand forecasting and inventory allocation methods significantly reduced instances of stockouts, resulting in higher sales and customer satisfaction.

Minimized Excess Inventory: By allocating inventory more efficiently, the company minimized excess stock, leading to reduced holding costs and improved cash flow.

Enhanced Profitability: The optimized inventory allocation, coupled with reduced distribution costs, resulted in an overall increase in profitability for the company.

Data-Driven Decision Making: The successful implementation of data-driven strategies fostered a culture of data-driven decision-making within the organization, leading to continuous improvements across various business functions.

By analyzing this case study, FMCG companies can gain valuable insights into the best practices for inventory allocation, leading to improved operational efficiency, customer satisfaction, and competitiveness in the dynamic FMCG market (in Figure 1).

In conclusion, the results of implementing balanced demand and supply inventory allocation strategies in the FMCG company were highly positive. Accurate demand forecasting, inventory optimization, and data-driven decision-making culminated in enhanced operational efficiency, cost savings, and improved customer satisfaction.

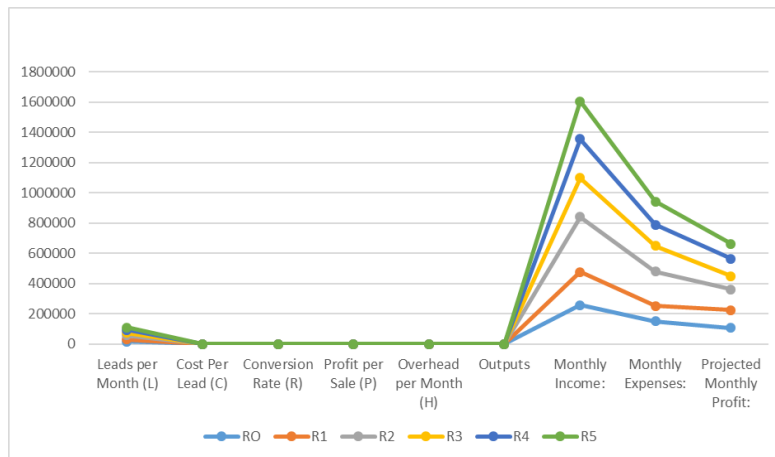


Figure 1 Inputs' results respect of scenarios

5. Conclusion

The successful implementation of various strategies and methodologies has led to remarkable results, reinforcing the significance of data-driven decision-making and continuous improvement in this dynamic sector. Accurate demand forecasting emerged as the cornerstone of the inventory allocation process. By leveraging advanced forecasting techniques, including statistical models and machine learning algorithms, the FMCG company achieved heightened demand prediction accuracy. This empowered the company to anticipate fluctuations in consumer demands, enabling proactive and efficient inventory allocation.

The optimization of inventory levels and safety stock, along with the adoption of SKU rationalization, played a pivotal role in minimizing excess inventory and stockouts. The FMCG company strategically managed inventory assortments, ensuring that the right products were available at the right time and in the right quantities. As a result, customer satisfaction improved significantly, while holding and warehousing costs decreased, leading to cost savings and increased operational efficiency. The company's proactive approach to managing promotional and seasonal demand contributed to efficient inventory allocation during peak periods. Overall, the successful implementation of inventory allocation strategies provided the FMCG company with a competitive advantage in the market. The ability to promptly meet customer demands, minimize stockouts, and optimize resources positioned the company as a preferred choice among consumers and business partners. The improved customer satisfaction and loyalty translated into increased repeat business and positive word-of-mouth. By integrating accurate demand forecasting, advanced technology, and collaborative supply chain efforts, businesses can achieve a delicate balance between demand and supply, leading to improved operational efficiency, cost savings, and heightened customer satisfaction. Embracing the lessons learned from this study will empower FMCG companies to thrive in a competitive market and maintain a strategic edge in the ever-evolving consumer landscape.

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