

Improving Inventory Turnover in a Meat-Processing Company by Applying MRP II

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Abstract

The objective of this research was to optimize the flow of finished products in a meat-processing company by improving the inventory turnover of the neck cut. The initial situation was characterized by overproduction, a turnover of only 0.95 times per month, and the occupation of approximately one quarter of the storage capacity, which led to losses from unmet demand and higher holding costs. To address this problem, an applied improvement design with a quasi-experimental approach was used, implementing a planning model based on MRP II and supported by simulation using the Streamline software, which made it possible to compare the performance of the current system (As-Is) with an improved scenario (To-Be). The results show an increase of around 20% in the turnover of the neck cut, reaching 1.14 times per month, which evidences a more efficient management of inventory and warehouse space. The main contribution lies in the application of MRP II integrated with forecasting tools in meat supply chains with perishable products and in the potential to replicate this approach for other cuts and companies in the food sector facing similar challenges related to turnover and capacity.

Keywords

MRP II; Inventory Turnover; Streamline; Demand; Planning.

1. Introduction

Lamb meat has a smaller share of total meat consumption but has gained relevance in market niches that demand differentiated and higher value-added products, such as standardized cuts and vacuum-packed presentations (FAO 2022). These supply chains handle highly perishable products, demand variability, and stringent traceability and food safety requirements, so poor inventory and production planning leads to waste, additional costs, and loss of competitiveness in food plants (Higuera-Alzate et al. 2018).

The case study focuses on a lamb meat processing company located in Lima, dedicated to deboning and vacuum packing standardized cuts for the modern channel and retail customers. The vacuum-packed cuts line represents a significant share of sales and reached approximately 55,880 PEN in revenue during the last quarter of 2024, which highlights its commercial relevance. In an environment governed by sanitary and quality standards for food products, this economic relevance increases the need for more consistent and traceable production and inventory decisions (FAO 2022). For the quantitative evaluation presented in this paper, weekly operational data for the critical SKU “lamb neck” are analyzed for the period April–November 2025.

In the company analyzed, demand and production volume planning for the processed cuts line has been carried out mainly on an empirical basis, relying on staff experience and informal rules, without quantitative forecasting models or an integrated planning system. The literature on inventory management for perishable products and advanced planning systems shows that the absence of structured forecasts and formal scheduling schemes increases the risk of overstock, stockouts, and value loss along the chain (Higueta-Alzate et al. 2018). In practice, this situation is reflected in recurrent mismatches between actual demand and available supply, with episodes of overproduction and risk of obsolescence in cold storage, as well as weeks with stockouts and orders not fulfilled in a timely manner.

In this context, the article proposes the design and validation of an integrated planning approach for the lamb processed cuts line, combining a demand forecasting model with a second-generation Material Requirements Planning system (MRP II) adapted to the deboning, packing, and storage process. The study is limited to the processed product line in the company’s plant and uses weekly information from the last semester of 2025 as the basis for the diagnosis and evaluation of results.

1.1 Objectives

The general objective of this research is to design and validate an integrated planning approach, based on a demand forecasting model and an MRP II system, that improves inventory management for the vacuum-packed lamb cuts line and reduces mismatches between actual demand and the available supply at the plant.

2. Literature Review

Food supply chains have adopted the concept of resilience to describe their ability to adapt and recover from disruptions such as demand shocks, health crises, or logistical problems (Ul-Haq et al. 2022). This resilience is linked to sustainability when economic, social, and environmental objectives are integrated into operational decision-making (Beshara et al. 2024). In food systems, environmental assessments show that a life-cycle perspective allows better identification of the impacts of production, processing, and distribution of meat products (Muchangos et al. 2025). In this context, improvement tools such as Lean and sustainable manufacturing approaches are used to reduce waste and increase efficiency in food plants (Ferrer-Blas et al. 2024).

Food waste and poor inventory practices have been identified as recurring problems in perishable product chains (Wang et al. 2025). Some studies show that reducing waste does not always translate directly into lower costs, due to tensions between economic efficiency and environmental objectives (Barto 2024). Other works propose inventory models that simultaneously consider holding costs, service level, and carbon emissions, in order to balance profitability and sustainability (Sebatjane et al. 2024). These results reinforce the need for better structured inventory decisions in industries with limited shelf life products, such as processed meat.

The literature on inventory turnover highlights that low turnover increases storage costs and the risk of product obsolescence (Sunaryo and Lestari 2023). Some studies find a positive relationship between turnover and profitability indicators in commercial firms, while others point out that this link depends on the type of business and demand behavior and is therefore not always conclusive. In the case of perishable products, demand uncertainty has been identified as a structural cause of inventory inefficiencies, and traditional forecasting models show limitations when there is marked seasonality and significant variability (Higueta-Alzate et al. 2018). In response, forecasting and inventory models have been proposed that integrate variables such as shelf life, price sensitivity, and environmental constraints (Bouazizi et al. 2024).

The use of digital technologies has also become relevant in food supply chains. It has been shown that the incorporation of artificial intelligence, data analytics, and the Internet of Things improves the ability to anticipate demand and reduce

waste in fresh and processed products. Other studies show that blockchain can strengthen traceability and trust among supply chain actors, facilitating compliance with safety and quality requirements. Likewise, digital twins have been explored to simulate operational scenarios and evaluate inventory decisions before implementation at plant level. In the specific area of forecasting, ensemble-based models have been developed to reduce food waste through more accurate demand estimates (Seyam et al. 2025).

Regarding material requirements planning, the implementation of MRP systems in small and medium-sized manufacturing companies has been shown to increase productivity, reduce inventory errors, and improve resource utilization. Other studies analyze critical success factors in the adoption of MRP II and emphasize the importance of adjusting system parameters to actual production and supply constraints. In food industries, adequate MRP parametrization has been shown to improve the alignment between planning and inventory levels. There are also cases in which the planned management of co-products under MRP contributes to reducing waste and improving profitability (Guinoubi et al. 2021). In Latin American contexts, the integration of tools such as 5S and MRP has been reported to optimize fill rates and inventory control in small bakery companies (Collao-Diaz et al. 2024). Finally, the integration of big data with planning systems has been identified as an opportunity to improve decision-making in food supply chains (Aktas 2024). Taken together, these studies recognize the importance of combining demand forecasting, inventory models, and MRP systems, but provide little empirical evidence applied to small meat-processing plants that explicitly integrate a forecasting model with an MRP II system to improve inventory turnover, which defines the gap addressed by the present study.

3. Methods

The research is conducted as an applied quantitative study aimed at improving inventory management in a lamb meat processing plant. The design is structured as a single case study, in which the behavior of demand and inventories for the vacuum-packed cuts line is analyzed, and the operational performance under the current empirical planning scheme is compared with an integrated scheme based on demand forecasting and MRP II. The analysis horizon considers weekly information for the critical SKU “lamb neck” from April–November 2025, which makes it possible to capture the operational dynamics of the plant and to evaluate the proposal over a representative period. Forecasts are generated with a fixed 4-week horizon, and April 2025 is used as the initial reference period (As-Is) before continuous use of the planning system.

The methodology is organized into three main phases. In the first phase, a diagnosis of the current system is carried out, including the collection and cleaning of historical sales and inventory data, the calculation of turnover and service level indicators, and the identification of gaps associated with empirical planning. In the second phase, the integrated planning approach is designed, beginning with the construction of a forecasting model for the weekly demand of processed cuts and continuing with the parametrization of an MRP II system adapted to the characteristics of the deboning, packing, and storage process. In the third phase, the proposal is validated by simulating the production and inventory plan using the selected forecasting model and the configured MRP II system, and comparing the results with the performance of the current scheme. These three phases are summarized in Table 1.

This study uses weekly historical data for the critical SKU “lamb neck” covering April–November 2025. Forecasts are generated with a fixed 4-week horizon. The baseline operational state (As-Is) is established using April 2025 as the initial reference period, and performance is tracked throughout the subsequent weeks within the same April–November 2025 window.

Table 1. Methodological design phases

Phase	Scope	Techniques or tools
Problem diagnosis	Identify problems and measure basic indicators; link root causes with engineering tools.	Ishikawa diagram; Problem tree; Direct observation
Conceptual model and intervention design	Design a component-based intervention, specifying its stages and tools; model the current process and its indicators; formulate the Master Implementation Plan for the pilot test.	MRP II
Conceptual model validation	Identify the benefits obtained from the research project based on pilot tests. The results are validated through a pilot implementation.	Streamline; Post-implementation evaluation

Forecasts were produced in Streamline using the weekly historical demand series for the target SKU. The software automatically fits and selects an appropriate forecasting model per item and reports forecast error using MAPE by comparing generated forecasts against observed values from weeks that have already elapsed. As an operational reference point (As-Is), April 2025 is used to represent the pre-adoption baseline performance before continuous use of the planning system.

For the model, quantitative methods are applied to weekly demand time series, assessing different alternatives and selecting the most suitable one based on the observed forecast error. The objective is to obtain estimates that are consistent with the historical behavior of demand and that can be used as a reliable input for production planning and raw material requirements. The structure of the model follows guidelines proposed for demand management in perishable products, in which forecast accuracy is a key determinant of inventory levels. The overall structure of the integrated forecasting and planning model is depicted in Figure 1.

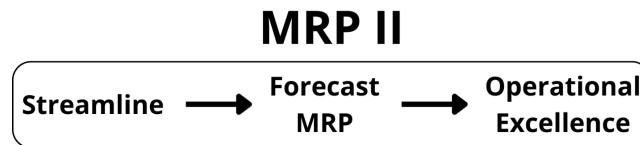


Figure 1. Model diagram

The MRP II system is designed based on the decomposition of the plant's production process, defining bills of materials, lead times, lot-size policies, and inventory parameters for the processed cuts line. The MRP II configuration is inspired by previous applications in small and medium-sized manufacturing companies, where its ability to reduce inventory errors and improve resource utilization has been demonstrated. Likewise, the sequence of design, parametrization, and review of the materials plan takes into account the critical implementation factors identified in studies on MRP II in real production environments.

The proposal is validated by comparing two scenarios using weekly data for April–November 2025. The first scenario reflects operation under the current empirical planning approach and uses April 2025 as the initial reference period (As-Is), representing pre-adoption performance. The second scenario represents operation under the integrated demand forecasting and MRP II approach (To-Be), generating production and inventory plans using Streamline and tracking performance during the subsequent weeks within the same April–November 2025 window. In both cases, inventory turnover, fill rate (service level), and MRP plan compliance are calculated, which makes it possible to

quantify the impact of the solution and determine whether the integrated planning approach improves system performance.

To ensure transparency and reproducibility, all KPIs were computed using explicit formulas, units, and decision rules. Demand, orders, quantities requested, quantities dispatched, and dispatch dates were extracted from the company ERP. The planned production and replenishment orders (MRP plan) were generated in Streamline. Because the analysis focuses on a single SKU, cost of sales (COGS) and end-of-month inventory value were calculated in Excel using the SKU unit cost and the corresponding quantities; the end-of-month inventory value was based on a physical inventory count valued at unit cost (Table 2).

Table 2. KPI definitions, calculation rules, and data sources

KPI	Definition and Formula	Unit / Frequency	Data Source
Inventory Turnover	Inventory Turnover = COGS month / Inventory EOM cost	Times per month (monthly)	Excel (COGS = unit cost × units sold; Inventory EOM cost = physical count × unit cost)
Fill Rate	Fill Rate = Units dispatched / Units requested	Percentage (%) – weekly or monthly reporting	ERP (sales orders vs quantities dispatched)
On-Time Dispatch (OTD)	OTD = On time dispatches / Total dispatches	Percentage (%) – weekly or monthly reporting	ERP (planned dispatch date vs actual dispatch date)
MRP Plan Compliance (Adaptability)	MRP Compliance = Plans fulfilled / Orders requested (real vs plan)	Percentage (%) – weekly or monthly reporting	Streamline (planned orders) + ERP (actual execution)

4. Results

4.1 Numerical Results

This section presents the results obtained from implementing the integrated planning approach based on the demand forecasting model and the MRP II system for the vacuum-packed lamb cuts line. The numerical results of the functional indicators defined in the thesis are summarized in Table 3, which compares the performance of the current (As-Is) and improved (To-Be) scenarios.

Table 3. Functional indicators before and after the proposal

Indicator	Description	As-Is	To-Be	Change
Y. Inventory turnover	Turnover (times per month)	0.95	1.14	+ 20%
X1. Forecast accuracy (MAPE)	Measures the mean absolute percentage error of the demand forecast.	Not reported	23.1%	-
X2. Service level	Percentage of orders or internal requests fulfilled on time and in full	59%	78.25%	+ 32.63%
X3. MRP plan compliance (internal OTIF)	Percentage of production orders completed within the planned time and quantity.	43 %	50%	+ 16.28%

As shown in Table 3, inventory turnover increases from 0.95 to 1.14 times per month, computed as monthly COGS divided by the end-of-month inventory value (both in cost terms), which represents an improvement of around 20% and reflects more frequent renewal of the lamb cuts stock. It is important to emphasize that all KPIs reported in this section were calculated using the definitions, rules, and data sources specified in the “KPI calculations and data sources” subsection. Forecast accuracy X1, measured through the MAPE of the selected model, reaches 23.1%, which

is considered adequate for a weekly demand series in a small food-sector enterprise and represents progress compared to the absence of formal error measurement in the current scenario.

The service level X2 improves from 59% to 78.25%, that is, an increase of 19.25 percentage points and a relative variation of 32.63%, indicating fewer stockouts and more reliable fulfillment of orders and internal requirements. In turn, compliance with the MRP plan compliance X3 increases from 43% to 50%, computed as plans fulfilled over orders requested (real vs plan), which reflects improved alignment between what is planned by the system and what is actually executed on the shop floor.

In addition to these indicators, the thesis reports a reduction of around 20.4% in the finished goods inventory associated with the lamb cuts line, which translates into more efficient use of storage space and lower capital tied up in stock.

4.2 Graphical Results

To complement the numerical indicators reported in Section 4.1, Figure 2 shows the inventory behavior of the neck cut under the current empirical planning approach and under the integrated planning approach based on the forecasting model and the MRP II system, over the analysis horizon.

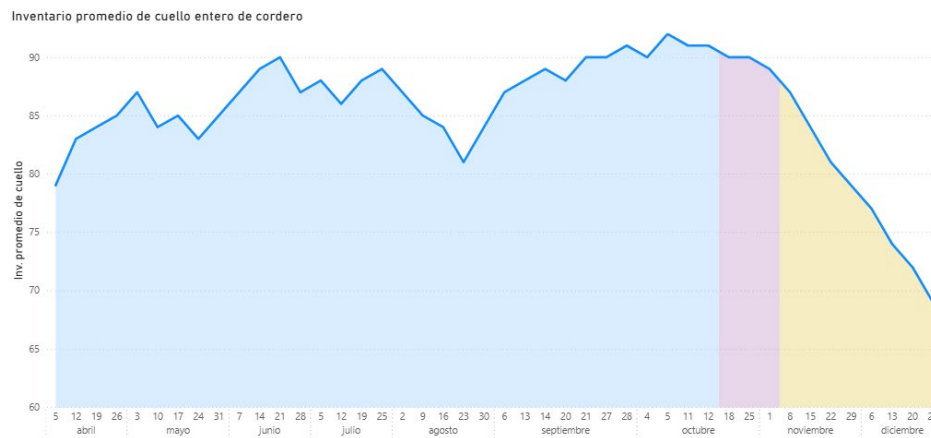


Figure 2. Inventory flow of the neck cut before and after the proposal

As shown in Figure 2, the inventory of the neck cut follows a downward trajectory when the integrated planning approach is applied. Compared with the behavior observed under the empirical planning scenario, there is a reduction in the inventory levels maintained over time and a more controlled dynamic in the replenishment cycles. This graphical result is consistent with the decrease in finished goods inventory reported in Section 4.1 and supports the conclusion that the combined use of forecasting and MRP II allows stock levels to be better aligned with the actual demand for vacuum-packed lamb cuts.

4.3 Proposed Improvements

The results obtained in Section 4.1 make it possible to propose concrete improvements in the way the company plans demand, schedules production and controls inventories for the vacuum-packed lamb cuts line. These improvements are structured around the increase in inventory turnover, the reduction of forecast error, the rise in service level and the improvement in MRP plan compliance, according to indicators Y, X1, X2 and X3 reported in Table 2.

Inventory turnover Y increases from 0.95 to 1.14, an improvement of nearly 20%, indicating more frequent stock renewal and more efficient use of storage space. Forecast accuracy X1, which could not be measured in the current scenario, reaches a MAPE of 23.1%, a value considered acceptable for weekly series in small and medium-sized food sector companies and close to the 20% reference reported in logistics forecasting studies. Service level X2 improves from 59% to 78.25%, reflecting fewer stockouts and more reliable order fulfillment. MRP plan compliance X3 rises

from 43% to 50%, with an approximate variation of 16.28%, showing better alignment between what is planned and what is executed on the shop floor.

These results are consistent with experiences reported in small and medium-sized food companies where the adoption of MRP systems, supported by appropriate parametrization and disciplined use of demand information, has led to simultaneous improvements in logistics efficiency and service level (Collao-Díaz et al. 2024). Taken together, the proposed improvements provide an operational basis to consolidate the integrated planning approach in the plant and to continue monitoring indicators Y, X1, X2, and X3 as key elements of inventory management for the vacuum-packed lamb cuts line.

4.4 Validation

The validation of the integrated planning approach is carried out by comparing the current empirical planning scenario with the scenario including the proposal based on the forecasting model and the MRP II system. The evaluation uses weekly operational data for April–November 2025 for the target SKU and measures performance against observed outcomes from weeks that have already elapsed. The assessment relies on the indicators defined for the study, in particular inventory turnover Y, forecast accuracy X1, service level X2 (fill rate), and MRP plan compliance X3, whose values are presented in Tables 1 and 3.

The results show that inventory turnover Y increases from 0.95 to 1.14, indicating more frequent stock renewal and shorter time in cold storage. Forecast accuracy X1 reaches a MAPE of 23.1%, a value considered acceptable for the weekly series analyzed and contrasting with the absence of formal error measurement in the current scenario. Service level X2 rises from 59% to 78.25%, evidencing fewer stockouts and a greater ability to fulfill orders on time. MRP plan compliance X3 improves from 43% to 50%, computed as plans fulfilled over orders requested (real vs plan), indicating a gradual increase in operational adoption of the planning system.

This comparison between the current scenario and the scenario with the proposal supports the conclusion that the integrated planning approach generates simultaneous improvements in inventory efficiency, service level, and plan compliance, without requiring structural changes in installed capacity or process technology. The quantitative results and the behavior of the neck cut inventory described in Section 4.2 reinforce the conclusion that the forecasting model combined with MRP II represents a relevant improvement over the empirical planning initially used.

5. Discussion

The results show that integrating the forecasting model with the MRP II system generates simultaneous improvements in inventory turnover, service level, and production plan compliance for the vacuum-packed lamb cuts line. The increase in turnover from 0.95 to 1.14 and the reduction in finished goods inventory described in Chapter 4 indicate that the plant is able to meet the same demand with lower stock levels, which translates into less capital tied up and a reduced risk of obsolescence in cold storage. This behavior is consistent with the literature on inventory management for perishable products, where higher turnover is associated with efficiency gains and waste reduction when planning is based on structured demand information (Sunaryo and Lestari 2023).

The increase in service level from 59% to 78.25% confirms that the improvement in turnover is not achieved at the expense of more stockouts, but is instead accompanied by more timely order fulfillment. This result is aligned with the arguments of Higueta-Alzate et al. (2018), who highlight that more rigorous demand planning simultaneously reduces overstock and shortages in perishable product chains. It is also related to approaches that seek to balance logistics costs and service performance under sustainability criteria, where more precise inventory management helps reduce food waste and make better use of available storage and transport capacity (Sebatjane et al. 2024).

The performance of the forecasting model, with a MAPE of 23.1%, can be considered moderate but adequate for a weekly demand series in a small food-sector company. Alharbi and Csala (2022) note that values close to 20% are common in logistics forecasting of this type, especially when demand shows significant variation between periods. In this sense, the model does not eliminate uncertainty but provides a quantitative basis clearly superior to the previous scheme, in which error was not measured and no systematic estimation tool was available. The main contribution lies

in the shift from empirical planning based on staff experience to a decision-making process supported by an explicit precision indicator that can be monitored and adjusted over time.

The improvement in MRP plan compliance, from 43% to 50%, shows that the proposal also strengthens the relationship between what is planned and what is executed in the plant. Although the level achieved still leaves room for further improvement, the observed increase is relevant given that neither installed capacity nor process technology was modified, and the focus was instead on how planning is carried out. Malindzakova et al. (2022) report that proper MRP parametrization in food industries reduces discrepancies between plans and actual inventory levels when demand data and lead times are updated in a disciplined manner. Complementarily, Collao-Díaz et al. (2024) show that, in small and medium-sized food companies, combining workplace organization and standardization tools with material requirements planning helps stabilize operations and reduce variability in production order fulfillment. The results of the present study fall along the same lines, although with a focus centered on the integration between forecasting and MRP II.

In managerial terms, the findings suggest that even a small meat-processing plant can achieve significant gains by formalizing its planning process, without requiring large investments in infrastructure. Systematic use of the forecasting model and MRP II makes it possible to define production quantities and timing on a more solid basis, facilitating coordination among sales, slaughtering, deboning, and storage of vacuum-packed lamb cuts. This is especially relevant in a context where the company operates under cold storage capacity constraints and must comply with strict sanitary and quality requirements, since better alignment between demand and supply reduces the likelihood of waste and the risk of unfulfilled orders.

Despite these results, the study has limitations that must be acknowledged. First, the analysis is based on a single case study, using weekly operational information for April–November 2025, which restricts the generalization of the results to other product lines or periods with different demand patterns. Second, the economic analysis focuses on operational inventory and service indicators, without developing in detail financial metrics such as holding costs, stockout costs, or incremental profitability. These limitations open opportunities for future research to extend the time horizon, incorporate additional forecasting techniques and baselines, and deepen the economic and environmental assessment of inventory management in lamb meat processing plants.

6. Conclusion

The study made it possible to evaluate the impact of an integrated planning approach, based on demand forecasting and an MRP II system, on inventory management for the vacuum-packed lamb cuts line. Using weekly data for April–November 2025, it was verified that the plant can meet the same level of demand with tighter inventory levels and improved operational performance compared to the empirical planning scheme previously used. The observed improvements in inventory turnover, service level (fill rate), and MRP plan compliance support the feasibility of replicating this approach for other cuts and similar food-sector companies facing turnover and capacity constraints.

In functional terms, inventory turnover increased from 0.95 to 1.14, indicating more frequent stock renewal and shorter product residence time in cold storage. Forecast accuracy reached a MAPE of 23.1%, a value that is acceptable for a weekly series in a small food-sector company and close to the 20% reference reported for logistics forecasting. Service level improved from 59% to 78.25%, evidencing fewer stockouts and a greater ability to fulfill orders on time. MRP plan compliance rose from 43% to 50%, within the defined tolerance in quantity and lead time, reflecting a better match between planning and actual execution on the shop floor.

From a managerial perspective, the results show that formalizing the planning process through the systematic use of a forecasting model and an MRP II system configured to the plant's reality generates simultaneous improvements in inventory efficiency, service level, and discipline in plan execution. This is achieved without modifying installed capacity or process technology, which reinforces the feasibility of applying this type of approach in small meat-processing plants that face storage space constraints and stringent sanitary and quality requirements. The study provides an applied case that explicitly integrates forecasting and MRP II in a vacuum-packed lamb cuts line and points to future work extending the analysis to longer time horizons, other product lines, and a more detailed economic and environmental assessment of inventory management.

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Biographies

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