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Optimization of Material Planning for Alcohol Beverage Production: An Empirical Study of Inventory Control and Packaging Logistics at Pernod Ricard India

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Abstract*—Material planning in the alcoholic beverage industry requires balancing line continuity against stringent working-capital and physical storage constraints. Grounded in operations and supply chain management literature on dependent demand, bill of materials (BOM) explosion, and statistical safety-stock formulation ($Z \times \sigma LT$), this study investigates material planning at Pernod Ricard India Private Limited's Dindori plant in Nashik, coordinated by the Central Planning Team in Gurugram. The research pursued four objectives: evaluating end-to-end material planning for bottle availability, analyzing procurement and inventory control, assessing vendor lead times and safety-stock models, and identifying industry-specific planning bottlenecks. Using an empirical case-study method based on a two-month placement (1 June–30 July 2026), primary data were gathered through shop-floor observation, cross-functional reviews, and Oracle JD Edwards (JDE) records, supplemented by internal standard operating procedures (SOPs). The findings reveal pronounced demand lumpiness across brand-size-state SKUs, a projected deficit of −3,032 units for 2-litre SKU T, clerical netting errors in manual worksheets, and a paradox between 60-day purchase-order cycles and a 2-to-3-day pre-production receiving window dictated by warehouse space and fungal-degradation risk on soda-lime glass. The study concludes that resilience requires automated, closed-loop MRP netting in Oracle JDE, a dynamically calibrated 2-to-3-day safety buffer, long-term supplier agreements, strict FIFO rotation, and weekly reconciliation of the observed 1.7%–2.0% consumption-to-plan variance.

***Index Terms*—Material requirement planning (MRP), inventory optimization, safety stock, packaging procurement, alcoholic beverage industry.**

I. INTRODUCTION

The beverage manufacturing sector operates in a high-velocity, highly regulated environment where production continuity hinges on precise coordination across procurement, warehousing, and shop-floor execution. Material requirement planning (MRP) is the core mechanism that translates master production schedules, bills of materials (BOM), current inventory, and open purchase orders into actionable procurement schedules. In alcoholic beverage manufacturing this function carries distinctive complexity: finished goods depend not only on liquid inputs but equally on a synchronized matrix of dry packaging materials, including custom-moulded glass bottles, closures, excise-compliant labels, and shippers. This study evaluates the structured flow of packaging material planning at Pernod Ricard India Private Limited's manufacturing facility in Dindori, Nashik, and examines how packaging inputs are planned, scheduled, and released to prevent downtime while avoiding excessive working-capital lock-up. Mabert, *et.al* (2007).

Pernod Ricard India operates a hub-and-spoke supply chain in which the Central Planning Team in Gurugram coordinates demand forecasts and high-level scheduling, while plant-level teams in Nashik convert rolling plans into daily production schedules using Oracle JD Edwards (JDE) and integrated warehouse management systems (WMS) [4]. Managing packaging inventory in this network involves distinct trade-offs. The industry faces a limited base of quality-certified bottle suppliers, extended supplier lead times, and on-site storage limits at bottling plants. Moreover, because alcohol lies outside the Goods and Services Tax (GST) framework and is governed by divergent state-level excise regulations [5], packaging variations multiply across state borders, and excess inventory carries substantial fiscal and working-capital burdens. The sector's long-term growth outlook [6] raises the stakes for efficient packaging supply. Chopra.*et.al* (2016).

Accordingly, this study seeks to understand end-to-end material planning, evaluate supplier lead-time dynamics, and analyze inventory classification to improve planning accuracy. It adopts an empirical process-study approach that examines operational logic, workflow sequences, and managerial controls without disclosing confidential pricing or supplier data. The paper offers practical insight into how MRP workflows, lead-time monitoring, and inventory optimization frameworks can be refined to reduce stockouts, prevent production interruptions, and strengthen supply chain resilience in large-scale beverage manufacturing.

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II. THEORETICAL BACKGROUND/ LITERATURE REVIEW

Operations and supply chain management (OSCM) theory frames material planning as an interconnected sequence: forecasting demand, translating it into a master production schedule (MPS), exploding the BOM through MRP, netting requirements against on-hand and on-order stock, and enforcing multi-echelon inventory policies. In beverage packaging, components such as glass bottles, closures, and labels are dependent-demand items whose procurement schedules derive directly from finished-goods production rather than from independent sales forecasts. Effective material planning therefore balances line availability against working-capital constraints, trading carrying costs against stockout risk [3]. Heizer, Render,& Munson, C. (2020)

Several standard models underpin this network. BOM explosion generates gross material requirements, and MRP logic nets them against inventory and open purchase orders while accounting for vendor lead times. To manage uncertainty, organizations apply ABC analysis, grounded in the Pareto principle, to place critical, high-value inputs such as glass bottles under rigorous control while handling low-value items with simpler heuristics. Buffers are held as safety stock calibrated to lead-time and demand variability, with replenishment triggered at predetermined reorder points. Economic order quantity (EOQ) and just-in-time (JIT) pull systems provide complementary benchmarks for mitigating storage bottlenecks. Mabert, V. A. (2007).

At Pernod Ricard India this architecture functions through the hub-and-spoke model described above. Central Planning establishes rolling production targets, which local planners convert into daily shop-floor schedules. Net-requirement determination is executed in Oracle JDE using the relationship in (1) (Section III-C). Because of limited warehouse space and material fragility, bulky glass bottles follow a JIT-oriented pull mechanism with a lean safety buffer, supported by active vendor lead-time tracking, cycle counting, and root-cause analysis (RCA) to maintain data integrity. Murthy,& Ma, L. (1991)

III. MATERIALS AND METHODS

A. Objectives of the Study

This study evaluates material planning workflows and inventory control at Pernod Ricard India Private Limited (Dindori, Nashik) under the coordination of the Central Planning Team in Gurugram. It addresses four objectives:

1) To understand the end-to-end material planning process in a beverage manufacturing unit and ensure the timely availability of bottles on the production floor.
2) To study the procurement and inventory management process and identify opportunities to improve efficiency and reduce material shortages or excess inventory.
3) To study supplier lead times and evaluate their impact on safety stock levels, reorder planning, and material availability.
4) To identify the challenges of material planning in the alcoholic beverage industry and suggest measures to improve planning efficiency and inventory management.

B. Research Design and Data Collection

An empirical, plant-level operational case study was conducted over a two-month placement from 1 June 2026 to 30 July 2026. Primary data were gathered through on-site observation of shop-floor workflows, operational planning meetings, and structured interactions with plant planners, dry-goods warehouse personnel, and procurement teams. Secondary data came from internal SOPs, supply chain training documentation, and enterprise transaction records in Oracle JDE. To preserve commercial confidentiality, pricing, proprietary financial figures, and sensitive supplier identifiers were excluded, and the study focuses strictly on planning workflows, scheduling logic, and material movement.

C. Material Planning Analysis and Analytical Framework

The investigation traced the progression from corporate demand forecasting (16-week rolling plans) to local daily schedule execution and shop-floor material issuance. MRP mechanics were examined by evaluating BOM explosion and inventory-netting worksheets using the relationship

$$E_{\text{open}} = I_{\text{hand}} + Q_{\text{PO}} - R_{\text{req}} \qquad (1)$$

where E_{open} is the expected opening position, I_{hand} the in-hand inventory, Q_{PO} the pending purchase-order quantity, and R_{req} the required (gross) quantity. Inbound receiving protocols, including gate entry, goods receipt note (GRN) generation, lot-traceability tagging, and quality inspection, were mapped together with FIFO/FEFO picking rules. Lead-time dynamics and inventory control were analyzed using the standard safety-stock formulation

$$SS = Z \times \sigma_{LT} \qquad (2)$$

where Z is the service-level factor and σ_{LT} is the standard deviation of demand over the supplier lead time. The JIT pull-replenishment model used for space-constrained glass bottles was assessed against push-based ordering for general packaging materials.

IV. DATA ANALYSIS AND DISCUSSION

A. Objective 1: End-to-End Material Planning and Production Floor Availability

Table I summarizes the weekly production plan across four brand-size SKUs over a ten-week horizon.

TABLE I
WEEKLY PRODUCTION PLAN (CASES) ACROSS SKUS, 10-WEEK HORIZON

Week	P1	P2	P3	P4	Weekly Total
W1	15,000	0	8,700	280	23,980
W2	0	8,100	0	145	8,245
W3	547	0	4,112	940	5,599
W4	0	632	1,200	0	1,832
W5	8,012	0	6,887	10,950	25,849
W6	400	0	0	320	720
W7	6,701	0	240	2,700	9,641
W8	0	12,050	330	280	12,660
W9	0	966	160	0	1,126
W10	1,200	550	0	120	1,870

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Total	**31,860**	**22,298**	**21,629**	**15,735**	**91,522**
Mean/Week	**3,186.0**	**2,229.8**	**2,162.9**	**1,573.5**	**9,152.2**

The plan shows pronounced lumpiness and intermittency. Weekly production alternates between peaks, such as 25,849 cases in Week 5 and 23,980 cases in Week 1, and deep troughs, falling to only 720 cases in Week 6 (Fig. 1). Individual SKUs show sharp discontinuities: P1 requires 15,000 cases in Week 1, drops to zero in Week 2, and resurges to 8,012 cases in Week 5. This erratic profile explains why average aggregate forecasting fails in bottling operations. Because packaging inputs exhibit dependent demand tied directly to the MPS, planning cannot rely on static replenishment heuristics. Material scheduling must instead be executed dynamically at the brand-size-state SKU level, translating rolling forecasts into synchronized bottle deliveries that protect line continuity without causing shop-floor staging bottlenecks. Murthy, N. N., & Ma, L. (1991).

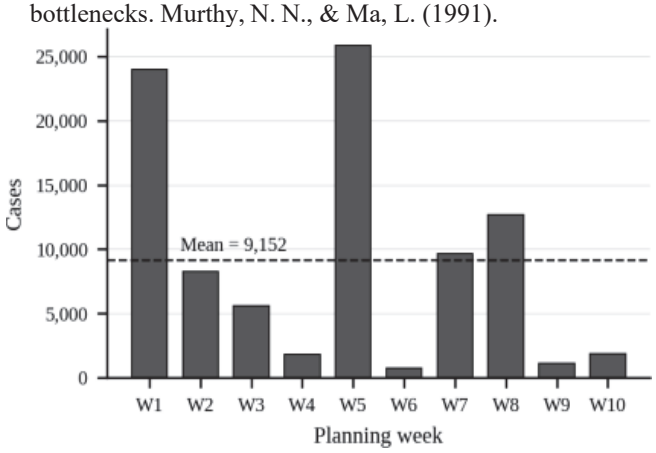


Fig. 1. Weekly total production plan (cases) over the 10-week horizon; dashed line marks the mean of 9,152 cases per week.

B. Objective 2: Stock Optimization

Table II presents the monthly bottle-requirement Material Requirements Planning (MRP) worksheet for selected SKUs. The expected opening stock is calculated by adding in-hand inventory and pending purchase orders and subtracting gross material requirements. This analysis helps identify projected shortages, excess inventory, and procurement requirements before scheduled bottling operations.

TABLE II. MONTHLY BOTTLE REQUIREMENT MRP WORKSHEET (SAMPLE SKUs)

Ref	Brand-Size SKU	Pack (b/cs)	In-Hand Stock	Bal. Plan (cs)	Gross Req. (units)	Pending PO	Expected Opening
A	D (90 ml)	96	248,905	2,896	278,016	264,310	235,199
B	N (180 ml)	48	0	0	0	3,500	3,500
C	P (375 ml)	24	22,942	50	1,200	3,500	25,242
A	Q (750 ml)	12	38,850	0	0	40,000	78,850
C	L (1 L)	9	2,089	1,794	16,146	17,000	2,943
B	T (2 L)	6	5,608	1,940	11,640	3,000	**−3,032**

The worksheet reveals significant differences in inventory availability and material requirements across packaging lines. High-volume SKUs such as D (90 ml) show substantial projected inventory buffers of 235,199 units, whereas SKU T (2 L) indicates a shortage of 3,032 units, calculated as 5,608 units of in-hand stock plus 3,000 units of pending purchase orders minus 11,640 units of gross requirements. This shortage presents a potential bottling-line stoppage risk unless additional materials are arranged or deliveries are expedited. Furthermore, verification of SKU P (375 ml) corrected a clerical discrepancy, establishing the expected opening stock at 25,242 units instead of the previously recorded 56,742 units. These findings demonstrate that aggregate inventory levels may conceal SKU-specific shortages and excess stock. Therefore, systematic BOM-based material netting, automated inventory reconciliation, and exception-based monitoring are essential for preventing stockouts, reducing unnecessary inventory accumulation, and optimising working capital (Stevenson et al., 2021).

C. Objective 3: Supplier Lead Times, Safety Stock Levels, and Material Availability

Table III presents the supplier lead-time parameters, safety stock policies, and material characteristics influencing packaging material availability at Pernod Ricard India. The analysis highlights the need to balance long procurement lead times with limited warehouse capacity and strict material handling requirements.

TABLE III. LEAD-TIME PARAMETERS, BUFFER POLICIES, AND MATERIAL CHARACTERISTICS

Operational Metric	Operating Norm / Parameter	Planning Rationale and Risk Factor
PO Release Lead Time	Up to 60 days (2 months) in advance	Compensates for supplier manufacturing cycles, mould allocation, and raw glass preparation.
Glass Bottle Supplier Lead Time	Supplier-specific; duration not specified	Accounts for transit and dispatch time from approved glassworks to the Dindori facility.
Warehouse Pre-production Inbound Window	2 to 3 days before bottling	Space-constrained JIT staging window that prevents dry-goods floor congestion.
Safety Stock Buffer Policy	2 to 3 days of production cover ($Z \times \sigma LT$)	Dynamic buffer designed to absorb transit slippage, delivery delays, and short-term demand fluctuations.
Material Criticality and Classification	Class A/B packaging material	Bulky, non-compressible, custom-moulded dependent-demand inventory requiring regular monitoring.
Material Degradation	No long-term ambient storage	Soda-lime glass is susceptible to contamination associated with

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Constraint		micro-residues and humid storage conditions.

The framework reveals an operational challenge arising from the difference between procurement lead times and physical inventory holding capacity. Purchase orders must be released up to two months in advance to accommodate supplier manufacturing schedules and material availability. However, inbound deliveries are generally planned only 2 to 3 days before scheduled bottling runs. This restricted delivery window is influenced by limited warehouse space at the Dindori facility and the risk of fungal contamination when soda-lime glass bottles are stored for extended periods under humid, non-climate-controlled conditions.

Consequently, safety stock cannot be maintained through excessive physical inventory accumulation. Instead, a statistically determined buffer covering approximately 2 to 3 days of production is necessary to manage uncertainty in supplier deliveries and material consumption. The study observed that this limited safety stock helped prevent production disruption during a vendor delivery delay. These findings emphasise that systematic lead-time monitoring, statistical safety stock determination, and proactive supplier coordination provide more effective protection against material shortages than maintaining large, uncalculated inventory buffers.

D. Objective 4: Planning Challenges and Optimization Measures

Material planning at Pernod Ricard India operates within regulatory, commercial, logistical, and operational constraints. Differences in state-level excise regulations restrict the interchangeability of packaging materials across geographical markets, while non-recoverable packaging GST increases inventory holding costs. Additionally, fluctuations between planned and actual consumption, supplier concentration, and manual inventory reconciliation create challenges for effective production scheduling. Table IV identifies the principal planning bottlenecks and proposes targeted optimisation measures.

TABLE IV. PLANNING BOTTLENECK TAXONOMY AND TARGETED INTERVENTIONS

Challenge Area	Manifestation at Plant	Proposed Optimization Measure
State Regulatory Complexity	Divergent state excise rules, customised label artwork, and excise stamps for different territories.	SKU-level BOM segregation and late-stage labelling to prevent stranded inventory across state boundaries.
Supplier Concentration Risk	High dependence on a limited number of approved and quality-certified glass bottle and closure manufacturers.	Long-term blanket purchase agreements and proactive dispatch tracking instead of spot purchasing.
Warehouse Space Limitations	Bulky and rigid glass packaging materials restrict the feasibility of maintaining large on-site safety stocks.	High-frequency, pull-based deliveries aligned with the rolling 16-week production schedule.
Consumption-Plan Variance	Weekly bottle consumption remains approximately 1.7%–2.0% below planned MRP allocations.	Weekly planned-versus-actual consumption reconciliation and dynamic scrap-rate adjustments in Oracle JDE.
Data Integrity Discrepancies	Spreadsheet formula inconsistencies and unverified inventory records result in inaccurate stock visibility.	Systematic cycle counting, root-cause analysis of variances, and automated ERP-based material netting.

The analysis indicates that operational inefficiencies arise from the combined effects of regulatory restrictions, supply chain dependence, limited storage capacity, and inaccurate material planning. Weekly consumption records reveal a consistent 1.7%–2.0% difference between planned requirements and actual bottle usage, representing an average weekly variance of approximately 10,000 units. Over extended production periods, such discrepancies can contribute to excess inventory accumulation and unnecessary working capital requirements.

Furthermore, reliance on a limited supplier base increases exposure to delivery disruptions, while manual spreadsheet-based calculations create opportunities for stock-position errors. To address these challenges, the study recommends implementing automated, closed-loop MRP netting through Oracle JD Edwards, periodic cycle counting with root-cause analysis, pull-based delivery arrangements, and dynamically adjusted safety stock levels. Strengthening coordination among central planning, local procurement, suppliers, and warehouse operations can further improve material availability, reduce production interruptions, and optimise inventory investments. These measures support a more responsive and efficient material planning system (Gutierrez & Vidal, 2008).

V. FINDINGS OF THE STUDY

Material planning in beverage manufacturing is characterised by fluctuating production requirements and strict dependent-demand relationships. The study reveals that reliance on average consumption figures may conceal substantial week-to-week variations across different brand-size-state SKUs. Customised packaging materials, particularly glass bottles, require synchronised procurement and production schedules to prevent bottling-line stoppages and warehouse congestion.

A significant finding is the mismatch between available inventory and projected production requirements. The MRP worksheet identifies a shortage of 3,032 units for the 2-litre SKU T, while discrepancies in inventory calculations for other SKUs highlight weaknesses in manual material planning. These observations demonstrate the importance of automated, closed-loop MRP systems and regular inventory reconciliation.

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The study further identifies a critical imbalance between long procurement lead times and limited warehouse storage capacity. Purchase orders may require release up to 60 days in advance, whereas physical deliveries must be coordinated within a 2-to-3-day pre-production window. The risk of glass bottle contamination under humid storage conditions further restricts prolonged inventory holding. A statistically determined safety stock covering 2 to 3 days of production was found to be useful in managing supplier delivery disruptions.

Additionally, weekly consumption analysis indicates a persistent 1.7%–2.0% difference between planned material allocations and actual usage. Such variations can gradually increase surplus inventory and working capital requirements. The findings therefore emphasise the importance of continuous variance monitoring, systematic cycle counting, automated ERP-based material netting, and effective coordination among production planning, procurement, and warehouse teams to achieve uninterrupted bottling operations and improved inventory efficiency.

B. Conclusions

Operational optimization in alcoholic beverage packaging requires a transition from aggregate, manual forecasting to an integrated, SKU-level MRP framework. Dependent-demand items, specifically bulky custom-moulded glass bottles, cannot be managed through static reorder points or generalized safety buffers, given acute demand lumpiness, severe warehouse space constraints, and quality degradation risks such as fungal growth on soda-lime glass.

Operational continuity instead depends on a hybrid planning architecture that pairs long-term procurement visibility (purchase orders up to 60 days ahead) with lean, pull-based delivery windows (2 to 3 days pre-production) backed by statistically calibrated safety stock. Replacing manual spreadsheet calculations with automated Oracle JDE netting is essential to prevent clerical discrepancies, surface projected deficits early, and resolve the recurring 1.7%–2.0% planning-to-consumption variance. Sustainable inventory optimization at Pernod Ricard India ultimately rests on continuous cross-functional synergy among central demand planners, local procurement, dry-goods warehousing, and shop-floor execution, striking a dependable balance between zero line stoppages and minimal working-capital lock-up.

V. SUGGESTIONS FOR IMPLEMENTATION

Pernod Ricard India should implement the following measures across key stakeholders:

1) *Central Planning and IT:* Move from manual spreadsheets to automated, closed-loop MRP netting within Oracle JDE, with real-time early-warning alerts that eliminate clerical errors and catch SKU deficits well before production scheduling.
2) *Local Procurement and Suppliers:* Formalize long-term blanket purchase agreements with approved glassworks and couple them with digital vendor dispatch tracking, absorbing 60-day lead times while ensuring reliable, staggered deliveries.
3) *Warehouse (Dry Goods) and Quality:* Enforce pull-based inbound scheduling within a tight 2-to-3-day pre-production staging window, with rigid FIFO rotation and relative-humidity monitoring to prevent fungal contamination of glass bottles.
4) *Plant Operations and Finance:* Hold weekly planned-versus-actual consumption reconciliation meetings between production and planning to calibrate scrap rates, supported by daily cycle counting and RCA to protect inventory data accuracy.

VI. STAKEHOLDER IMPLICATIONS

The findings carry practical implications for stakeholders across the manufacturing ecosystem:

- *Central and plant planners:* Automated, SKU-level MRP netting in Oracle JDE eliminates clerical errors, gives real-time visibility of projected deficits (such as the −3,032-unit gap for SKU T), and prevents line stoppages caused by demand lumpiness.
- *Procurement and packaging suppliers:* Long-term blanket purchase agreements and proactive dispatch tracking give vendors production predictability while securing the plant's 2-to-3-day delivery windows.
- *Warehouse and quality teams:* Strict pull-based receiving and FIFO rotation relieve on-site storage congestion and mitigate fungal contamination of glass bottles in humid periods.
- *Plant operations and finance:* Closing the 1.7%–2.0% planning-to-consumption variance through regular reconciliation and cycle-count RCA protects data accuracy, curtails scrap of GST-burdened packaging, and optimizes working capital.

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