Original Research Article

Inventory optimization and space utilization of Crop Protection Chemicals godowns.

ABSTRACT

This study aims to analyse the storage capacities, space utilization, and inventory management practices of five depots in the South-1 zone: Hyderabad, Khammam, Vijayawada, Guntur, and Kurnool. The primary objective is to understand how effectively these depots manage their stock levels and space utilization, thereby providing insights for optimizing inventory management. Data collection focused on the storage areas, net storage available, and space utilization percentages, followed by an analysis of production, transportation, and storage processes. The study revealed that Hyderabad and Guntur have the largest storage capacities, with space utilization rates of 63% and 61%, respectively. Vijayawada, despite having a smaller storage area, demonstrated the highest space utilization efficiency at 67%. Khammam and Kurnool showed moderate utilization rates of 57% and 59%. Key findings highlight that efficient inventory management practices, including the first-in-first-out (FIFO) principle and meticulous handling during transportation, play a critical role in optimizing storage space and maintaining appropriate stock levels. The research concludes that depots with higher space utilization rates, such as Vijayawada, exemplify how efficient inventory management can enhance overall performance, even within limited storage areas. This study underscores the importance of effective inventory management in achieving optimal storage utilization and meeting customer demands.

Keywords: *Inventory optimization, Space utilization, Stocks and Godowns*

1. INTRODUCTION:

Inventory management is a vital component of supply chain operations, directly impacting the ability to meet customer demand efficiently. Within the South-1 zone, five key depots—located in Hyderabad, Khammam, Vijayawada, Guntur, and Kurnool—serve as crucial storage and distribution hubs for a Crop Protection Chemical (CPC) Company. The effectiveness of these depots in managing stock levels is influenced by their varying storage capacities and space utilization rates. While some depots like Vijayawada excel in space utilization, others experience inefficiencies, leading to potential cost increases and issues such as stockouts or excess inventory.

To address these challenges, this study proposes a thorough analysis of the storage capacities and space utilization rates of the five depots. By examining historical sales data, production schedules, and transportation logistics, the study aims to pinpoint factors contributing to discrepancies in depot performance. The proposed solution includes implementing best practices in inventory management, such as the First-In-First-Out (FIFO) principle, to enhance overall efficiency and optimize inventory management across all depots.

Previous research underscores the significance of efficient inventory management in improving supply chain performance. Real-time inventory tracking and effective management practices are shown to reduce costs and elevate service levels. Additionally, the integration of technology and automation in inventory management processes is proven to enhance accuracy and efficiency. This study's scope includes a comprehensive evaluation of inventory management practices at the five depots, aiming to provide actionable insights for improved resource utilization and competitive advantage.

2. MATERIALS AND METHODS

2.1 Data Collection

Historical Sales Data: Historical sales data for the five depots—Hyderabad, Khammam, Vijayawada, Guntur, and Kurnool—were collected from the company's internal sales management system. This dataset includes sales volumes, transaction frequencies, and types of products sold over the past two years. The data were retrieved from digital records maintained by the company to ensure accuracy and completeness.

Production Schedules: Production schedules were obtained from the production planning department. These schedules include information on planned production runs, batch sizes, and timings for each product line. Data were gathered from the company's production management software, which tracks all production activities and schedules.

Transportation Logistics: Data related to transportation logistics were collected from the logistics department. This includes details on transportation routes, delivery frequencies, and delivery timings. The information was sourced from the company's logistics tracking system to provide a comprehensive view of the distribution processes.

2.2 Analysis of Storage Capacities and Space Utilization

Storage Capacity Assessment: The storage capacities of each depot were assessed by measuring the available storage space and reviewing capacity reports. This involved physical inspections of each depot's storage facilities and consulting capacity documentation provided by depot management.

Space Utilization Rates: Space utilization rates were calculated by comparing the actual storage used against the total available storage space. This was done using physical measurements and storage utilization reports. The formula used for calculation is:

Space Utilization Rate = (Actual Storage Used / Total Available Storage Space)×100%

Inventory Management Practices: The current inventory management practices at each depot were reviewed by examining inventory turnover rates, stock replenishment practices, and adherence to the FIFO (First-In-First-Out) principle.

Table 1.1 Storagecapacityof south-1 zonedepots(Source: Record maintained by godown)

S. no.	Depotname	Storagearea(in sq.ft.)	Net storage available	Net storage in per cent
1	Hyderabad	13000	9100	70 per cent
2	Khammam	4900	3500	71 per cent
3	Vijayawada	5000	4025	80 per cent
4	Kurnool	7500	5250	70 per cent
5	Guntur	12234	8563.8	70 per cent

Table 1.1 reveals that the analysis of the annual stock levels and storage capacities of the five depots—Hyderabad, Khammam, Vijayawada, Guntur, and Kurnool—reveals important insights into their inventory management. Hyderabad, with the largest storage area of 13,000 sq. ft., maintains significant stock levels, indicating high capacity utilization. Guntur, with 12,234 sq. ft., also manages substantial stock variations. Smaller depots like Khammam and Vijayawada, despite limited storage areas, efficiently handle their inventory, peaking in stock levels in November. Kurnool, with moderate storage capacity, maintains steady stock levels throughout the year.

Table 1.2 Average space utilization of five depots

S. no.	Depotname	Net storage available	Space utilization	Per cent of space utilization
1	Hyderabad	9100	8190	63 per cent
2	Khammam	3500	2793	57 per cent
3	Vijayawada	4025	3350	67 per cent
4	Kurnool	5250	4425	59 per cent
5	Guntur	8563.8	7462	61 per cent

Table 1.2 data reveals that all depots are effectively utilizing their storage capacities, with varying levels of efficiency. Hyderabad leads with 63% utilization, followed closely by Guntur at 61%. Vijayawada demonstrates the highest efficiency with 67% utilization, while Kurnool and Khammam show moderate to high usage at 59% and 57%, respectively. Overall, Vijayawada and Hyderabad are the most efficient in terms of space utilization.

2.3 Below is a detailed description of the inventory management practices followed at Coromandel International Limited:

2.3.1 Forecasting and planning

The first step in inventory management is forecasting how much product to produce based on sales data. The sales team will be having historical sales data, Byanalyzing this data, the sales team will identify patterns and trends that helps in future demand predictions. They are employing various forecasting methods such as time series analysis, regression analysis, and advanced statistical models to develop a reliable forecast that reflects anticipated market conditions, customer behavior, and external factors. Once the sales team has developed a forecast, the data is being shared with the supply chain team to ensure alignment across different functions within the company. The forecasted

data includes predicted quantities and timelines for when the products will be needed, helps the supply chain team to plan for raw material procurement, production scheduling, and inventory management. A collaborative discussion is then taken between the sales team, logistics representatives, and the plant team to validate the forecast, address any discrepancies, and ensure that all teams are aligned on the production goals. The logistics team will be providing input, transportation and storage capabilities, while the plant team will be offering insights into production capacity and constraints. During this planning session, the teams are determining the final production quantity by considering sales projections, current inventory levels, production capacity, lead times, and market conditions. By taking all these factors into account, the team will be set a production plan that optimizes resources, minimizes costs, and meets customer demand.

2.3.2. Production

After deciding on the production quantity, the production process will begin at the designated plants. The key locations for domestic formulation of chemicals are Ranipet, Jammu-1, and Jammu-2. At these plants, the products are being technically formulated, and after production, the packaging and labeling are being done. The batch number of the particular production is being mentioned and represented as follows: R21061502 indicates that the product is produced in June 2021, on the 15th day, and belongs to batch 02.

For example, for a batch number R21061502:

R: Alphabetical identifier

21: Year of production

06: Month of production

15: Date of production

02: Batch sequence number

2.3.3 Movement of inventory

Once production is complete, the inventory needs to be moved to warehouses. This process begins with the appropriate packing of products to ensure they are protected

during transportation. Various types of packaging materials are used to secure the products, including cartons and protective wrapping to prevent damage during transit. The next step involves collecting quotations for transportation charges from multiple transporters. The logistics team reaches out to different transport companies to gather these quotations, detailing the costs associated with transporting the products from the production plants to the designated warehouses. These costs depend on several factors, such as the distance to be covered, the volume and weight of the products, and any special handling requirements.

Once the quotations are collected, the financial team evaluates them to select the most cost-effective transporter. This evaluation process considers not only the quoted price but also the reliability and reputation of the transport companies, their ability to meet delivery schedules, and any additional services they may offer. After selecting the transporter, the products are loaded onto the transport vehicles. This loading process involves careful handling to avoid damage and is typically carried out by skilled workers (Hamalis). Loading charges are incurred at this stage, including labor costs and equipment usage fees like using of hydraulic lift associated with moving the products onto the vehicles.

2.3.4. Transportation and documentation

The transport vehicles then transport the products to the warehouses. During transit, the logistics team monitors the shipment. Upon arrival at the warehouse, unloading charges are incurred as the products are removed from the transport vehicles and placed into storage. This entire process of moving inventory from the production plants to the warehouses is critical for maintaining a smooth supply chain operation. It ensures that products are available in the right quantities and at the right locations to meet customer demand, thereby supporting efficient sales and distribution activities. During transportation, several key documents and details are collected to ensure the smooth movement of goods. The company collects the Goods and Services Tax (GST) details, including the GST number and the registered name of the transport company, as well as the registration details of the transporter, verifying their legitimacy and authorization. The Aadhar card of the transporter is also collected for identification and accountability. Upon delivery, the lorry receipt is collected, confirming receipt of goods and detailing delivery information. Additionally, transportation paperwork, such as waybills, delivery challans, and consignment notes, are maintained, providing a comprehensive record of the shipment. These documents ensure compliance with legal and regulatory

requirements, facilitate smooth logistics operations, and provide a clear trail of accountability throughout the transportation process

2.3.5. Unloading and storage

Upon arrival at the warehouse, products undergo careful unloading procedures to ensure they are received intact and in the expected quantities. This process typically involves inspection for damages and verification against accompanying documentation. Once verified, products are directed to designated storage areas where they are arranged according to the First-In-First-Out (FIFO) principle. This method ensures that the oldest stock is positioned at the front of storage shelves or racks, facilitating timely use or dispatch before newer stock. By adhering to FIFO, warehouses mitigate risks associated with product expiration and ensure efficient inventory rotation.

2.3.6. Inventory entry and management:

Inventory entry and management in the warehouse begins with the meticulous recording of received product quantities into the SAP system. Warehouse managers or carrying and forwarding agents are responsible for this crucial task, ensuring that every batch of products is accurately logged. This process not only captures the exact quantities of each item but also updates the SAP database in real-time, reflecting the current stock levels. By inputting this information promptly, the system maintains an accurate record of available inventory, enabling timely decision-making for order fulfillment and stock replenishment.

2.3.7. Order placement and processing:

The C&F team arranges dispatches to customers or other depots in coordination with the local supply chain in-charge. Invoicing is done immediately on the same day an order is received, ensuring prompt processing. Orders are dispatched from the warehouse within 24 hours of document generation, with those placed before 5 pm dispatched on the same day. For technical or bulk sales, the logistics or distribution manager raises a tax invoice in the system and informs the respective depot for dispatch to technical customers. For brand sales, tax invoices are updated in the system only for available materials. Each invoice includes the customer's name and address, product name, quantities, batch number, billing prices, and other necessary information. SAP ensures that each order is accurately recorded and managed according to predefined business rules and inventory policies.

2.3.8. Invoice generation:

Invoice generation is made by depot manager upon receiving orders, where the system generates invoices following the First-In-First-Out (FIFO) principle. This method prioritizes the oldest stock available in the warehouse for delivery or sale. SAP integrates seamlessly with order data to ensure that invoicing reflects the exact products and quantities ordered, maintaining accuracy and compliance with organizational policies.

2.3.9. Product dispatch:

All dispatches include copies of the invoice/STO, LR, and e-way bill (where applicable). LR copies for local transport hubs are obtained from the transporter at the hub, while for direct dispatches from the depot, the LR copy is collected at the C&F depot. Incoming trucks are inspected for damage, and drivers' documents are checked to meet requirements. Goods are dispatched batch-wise on a FEFO basis to prevent expiry, ensuring the oldest stock is prioritized for shipment. Products are dispatched in good condition, with appropriate packaging and protection from rain. Drivers receive all relevant documents, and the LR copy is signed by the transporter's representative. Customers are informed post-dispatch about expected arrivals, and stocks are sent through transporters with negotiated rates, ensuring timely, intact, and safe delivery. Proof of Delivery (POD) is required for settling transporters bills, maintaining an efficient and effective supply chain.

2.3.10. Proof of delivery (POD)

Post-dispatch of materials from the depot, proof of delivery is obtained from the customer by the C&F agent. Upon the vehicle reaching the customer, all documents (two copies of invoice and LR) are submitted by the driver. If the stock is received as per the invoice, the delivery is signed and confirmed by the distributor, and the signed invoice and LR are given to the driver for POD submission. The received documents are submitted at the C&F office by the transporter within 30 days of delivery. If there is any transit damage or short stock, a note of damage/shortage is made on the LR copy by the distributor, listing all details, and returned to the transporter. These documents are handed over as proof of delivery at the C&F location within four days of delivery.

2.3.11. Inter depot transfers

Inter-depot transfers involve the movement of stock between two depots when the initiating depot encounters stock shortage or unavailability of stock to fulfill a customer order, with prior approval from the head office. All inter-depot stock transfers are routed through Head Office logistics only. Inter-depot transfers are initiated by the C&F agent only after written confirmation by company l via email. All inter-depot material transfers strictly follow the LMFO System (Latest Manufacturing First Out System), and short expiry

stocks are never transferred to other depots. Stocks are dispatched to parties through transporters with negotiated rates and a rate contract. Non-contract transporters can be used in emergencies with prior approval from commercial and logistics executives. Whenever possible, inter-depot transfers are conducted on a Full Truck Load (FTL) basis, and the transferring depot should be the nearest to the initiating depot with the required stock.

2.3.12. Sales returns management

Sales returns involve customers returning unsold material to the C&F. According to company policy, inter-party stock transfers are strictly prohibited, and the C&F must avoid any involvement in such transfers. Sales returns are booked in the SAP system only after formal approval from the Business Head. Returns received without prior approval should be immediately reported to the RBH for necessary approval. Only unsold material should be accepted; damaged or expired material is strictly prohibited. Material without visible batch numbers should be returned to the customer at their expense, with notification to the salesperson. The C&F agent verifies received stock for quantity and inspects for physical damage, to check whether the returned stock is intact, saleable, and compliant with the Sales Returns policy. A 100% physical verification of returned material is mandatory. Batch-wise material is stored in designated areas according to the layout. Separate areas should be designated for LED and fresh material storage, if space allows. A distinct physical location is considered for storing returns. Stock with complete batch details is entered into the SAP system after thorough physical verification.

2.3.13. LED/Damaged material management

LED material, including leaky, expired, or damaged items in the warehouse are kept in a specific designated area by the C&F agent, away from fresh material. Material handling is performed with utmost care, and advice from the depot in-charge is sought by floor staff before handling any unfamiliar items. Safety appliances are utilized, and direct contact with the material is avoided during handling. Continuous monitoring for leakage or damage is maintained, and any discrepancies observed are reported to the local supply chain in-charge. Leaky material units are stored upright, and efforts are made by the C&F to completely arrest any leakage without further spillage. Sawdust is used to absorb spills/leakage, which is then stored in closed HDPE drums placed in designated areas for subsequent transport to the factory for incineration, following instructions from the supply chain in-charge. Leaky and damaged stocks are collected in suitable HDPE drums, cans, or recommended containers and stored in designated areas. Empty pesticide containers are stored in polythene bags or covered drums. The presence of LED material is clearly

documented in the monthly physical stock report by the C&F. Dispatch of leakage, damaged, or expired items to customers is strictly prohibited by the C&F. Movement of LED material for reprocessing or incineration is conducted as per instructions from the supply chain in-charge, utilizing transporters with whom negotiated rates and rate contracts are established by the company.

2.3.14. Recording and reporting:

Recording and reporting in SAP encompass every transaction, including order processing, invoice generation, and dispatch details. All data are meticulously recorded and uploaded back into the system, ensuring real-time updates and accuracy in inventory management. This comprehensive data capture allows for detailed monitoring of stock levels, sales trends, and logistical operations. By maintaining accurate and up-to-date records, SAP facilitates better decision-making and operational efficiency.

3. RESULTS AND DISCUSSION

3.1. Inventory Management and Capacity Utilization

The analysis of storage capacities across the South-1 zone shows that all depots effectively utilize their available space, albeit with varying efficiencies. Hyderabad, with the largest storage area, demonstrates significant capacity utilization at 70%, while Guntur, with slightly less storage space, also maintains 70% utilization. Smaller depots like Khammam and Vijayawada, despite their limited storage areas, achieve high utilization rates of 71% and 80%, respectively. Kurnool maintains a steady 70% utilization.

3.2. Streamlined Inventory Movement and Order Fulfillment

The transportation and order fulfillment processes have been optimized to reduce lead times and ensure timely delivery. By selecting cost-effective and reliable transporters, the logistics team has minimized transportation costs while maintaining high service levels. The prompt processing of orders, with invoices generated and dispatches made within 24 hours, has ensured that customer demands are met efficiently.

3.3. Returns Management, LED Material Handling, and Data Reporting

The management of sales returns and LED materials has been effectively integrated into the inventory optimization strategy. By verifying and recording returns in the SAP system, the depots ensure that only saleable items are restocked, reducing waste. LED materials are handled with strict adherence to safety and environmental guidelines, preventing contamination of fresh stock. The comprehensive recording and real-time reporting of inventory transactions in SAP have provided valuable insights into stock levels, sales trends, and operational efficiency.

4. CONCLUSION

The study highlights effective inventory management practices across the South-1 zone depots. High utilization rates and efficient logistical operations have been achieved through advanced forecasting methods and collaborative planning, aligning production with market demand. Resource use has been optimized, and excess inventory minimized. Streamlined transportation and prompt order fulfillment have enhanced customer satisfaction, maintaining optimal inventory levels and ensuring timely deliveries.

Effective management of sales returns and LED materials has ensured product quality and reduced waste. Operational efficiency and supply chain performance have been significantly enhanced through data-driven decision-making and robust inventory strategies. Continuous monitoring and refinement of practices are essential, with ongoing evaluation of inventory management strategies, identification of areas for improvement, and implementation of new technologies and methodologies to maintain high standards. The South-1 zone depots are a model for effective inventory management and supply chain excellence in terms of storage space utilization also.

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