

ENHANCING EFFICIENCY IN HOSPITAL SUPPLY CHAINS: A PROJECT ON MATERIAL PLANNING OPTIMIZATION THROUGH CENTRALIZED PROCUREMENT

Dissertation Submitted to



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in

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By

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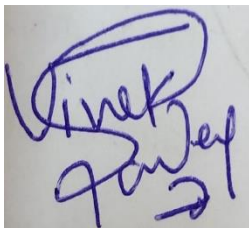
Under the Supervision and Guidance of

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2024

DECLARATION BY STUDENT

I hereby declare that this dissertation title **Enhancing Efficiency in Hospital Supply Chains: A Project on Material Planning Optimization through Centralized Procurement** is the Bonafede record of my original research work. I declare that it has not been submitted to any other university or institution for the award of any degree or diploma. Information derived from the published or unpublished work of others has been duly acknowledged in the text.



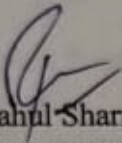
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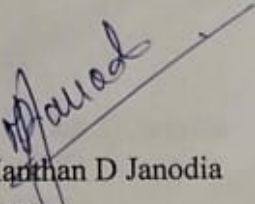
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Certificate

This is to certify that dissertation titled **“Enhancing Efficiency in Hospital Supply Chains: A Project on Material Planning Optimization through Centralized Procurement”** is a record of the research work undertaken by **Vivek Pandey** in partial fulfillment of the requirements for the award of the degree of MBA (Pharmaceutical Management) from the IIHMR University, Jaipur under my guidance and supervision and his approach to the research study has been sincere, scientific, and analytical.



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ABSTRACT

Hospitals rely on efficient supply chains to deliver quality care. This dissertation explores how to optimize material planning, specifically through procurement management, within these complex systems. Effective procurement directly impacts patient outcomes and financial sustainability.

The project identifies and analyses factors influencing material planning and procurement in hospitals. It then investigates the influence of centralized procurement on these processes. By analysing various procurement strategies, the research aims to develop actionable recommendations for improving practices in hospitals.

This research contributes to the knowledge base of healthcare supply chain management. The goal is to provide practical guidance for healthcare administrators and supply chain professionals. By optimizing material planning and procurement, hospitals can achieve cost containment, improve inventory management, and ensure quality assurance. This ultimately leads to better resource allocation and enhanced patient care delivery.

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ABBREVIATIONS

EHR	Electronic Health Record
SCM	Supply Chain Management
EOQ	Economic Order Quantity
JIT	Just In Time
ABC	Always Better Control
FSN	Fast Moving, Slow Moving, Non-Moving
ROT	Reorder Time
AS/AR	Automated Storage and Retrieval System
FIFO/LIFO	First in First out/ Last in First out
RFID	Radio Frequency Identification
AGV	Automated Guide Vehicles
WMS	Warehouse Management System
MRP	Material Requirement Planning
ERP	Enterprise Resource Planning
QMS	Quality Management System
SPC	Statistical Process Control
SAP	Systems, Application, Product
AI	Artificial Intelligence
IoTA	Internet of Things

CHAPTER 1: INTRODUCTION

- **Background and Rationale**

In the modern healthcare ecosystem, the effective functioning of hospital supply chains is not just a matter of operational efficiency; it directly impacts patient outcomes and organizational sustainability. The intricate network of processes involved in material procurement, storage, and distribution necessitates a nuanced understanding of supply chain dynamics. With the rising complexities in healthcare delivery, optimizing material planning within hospital supply chains has become imperative to address challenges such as cost containment, inventory management, and quality assurance.

- **Objectives of the Project**

This dissertation seeks to delve deeply into the multifaceted realm of material planning optimization in hospital supply chains, with a specific focus on procurement management. By conducting an extensive examination and analysis, the project aims to achieve the following objectives:

To identify and analyze the critical factors influencing material planning and procurement within hospital supply chains.

To explore the impact of centralized procurement on the efficiency and effectiveness of material planning processes.

To develop actionable insights and recommendations for improving procurement practices in hospital settings.

To contribute to the body of knowledge in healthcare supply chain management and provide practical guidance for healthcare administrators and supply chain professionals.

- **Scope and Significance**

The scope of this project encompasses a comprehensive study of material planning optimization within hospital supply chains, with particular emphasis on procurement management. It will involve an in-depth analysis of various procurement processes, strategies, and their implications for healthcare organizations. The significance of this research lies in its potential to inform evidence-based decision making, enhance resource allocation, and ultimately improve patient care delivery.

Overview of Hospital Supply Chains

Hospital supply chains represent a complex ecosystem comprising numerous stakeholders, including manufacturers, distributors, healthcare providers, and patients. The flow of materials within these chains is influenced by factors such as demand variability, regulatory compliance, technological advancements, and supply chain disruptions. Understanding the intricacies of hospital supply chains is essential for devising effective material planning strategies that can ensure the seamless availability of critical supplies and medications when needed most.

Hospital Supply Chain:

A hospital supply chain is a complex network of interconnected processes involved in the procurement, storage, distribution, and management of materials, equipment, medications, and other resources required for patient care and operational functions within a healthcare facility. It encompasses all stages of the supply chain, from sourcing raw materials to delivering finished products to end-users, such as patients and healthcare providers.

Key Components of Hospital Supply Chains:

- **Procurement:** This involves sourcing and purchasing the necessary materials and supplies required for hospital operations and patient care. Procurement activities

include supplier selection, contract negotiation, order placement, and receipt of goods.

- **Inventory Management:** Inventory management entails the storage, tracking, and control of medical supplies, pharmaceuticals, and equipment within the hospital. It involves maintaining optimal inventory levels to meet patient demand while minimizing carrying costs and the risk of stock outs or expired products.
- **Distribution:** Distribution involves the efficient and timely delivery of materials and supplies to various departments and units within the hospital. This may include internal logistics, such as transporting goods from the central warehouse to different wards or clinics, as well as external logistics, such as coordinating with external vendors or distributors.
- **Storage and Warehousing:** Storage and warehousing play a critical role in the hospital supply chain by providing a secure and organized environment for storing materials and supplies. Proper storage practices help prevent damage, loss, or contamination of inventory items and ensure their accessibility when needed.
- **Transportation:** Transportation involves the physical movement of materials and supplies between different locations within the hospital or between the hospital and external suppliers or distribution centers. Efficient transportation systems are essential for ensuring timely delivery and minimizing delays in the supply chain.
- **Information Systems:** Information systems, such as inventory management software, electronic health records (EHRs), and supply chain management systems, facilitate data capture, analysis, and communication across various stages of the hospital supply chain. These systems provide real-time visibility into inventory levels, demand forecasts, and supplier performance, enabling informed decision making and process optimization.

Supply Chain Management:

Supply chain management (SCM) refers to the strategic coordination and integration of all supply chain activities to maximize value creation, minimize costs, and enhance competitiveness. In the context of hospitals, supply chain management involves the application of SCM principles and practices to optimize the procurement, distribution, and management of materials and resources essential for healthcare delivery.

Key Principles of Supply Chain Management:

- **Integration:** SCM emphasizes the seamless integration of all supply chain activities, from procurement to distribution, to ensure alignment with organizational goals and objectives. Integrated supply chains enable better coordination, collaboration, and communication among stakeholders, leading to improved efficiency and responsiveness.
- **Collaboration:** Collaboration involves building strong partnerships and relationships with suppliers, distributors, and other stakeholders to foster trust, transparency, and mutual value creation. Collaborative supply chains facilitate information sharing, risk mitigation, and innovation, enabling organizations to address complex challenges and capitalize on opportunities.
- **Visibility:** Visibility refers to the ability to track and monitor supply chain activities, processes, and performance in real-time. Enhanced visibility enables organizations to anticipate disruptions, identify bottlenecks, and proactively address issues before they escalate, thereby improving decision making and responsiveness.
- **Flexibility:** Flexibility is essential for adapting to changing market conditions, customer demands, and internal requirements. Flexible supply chains are agile, responsive, and capable of adjusting production, distribution, and inventory levels to meet dynamic needs and mitigate risks.

- **Continuous Improvement:** Continuous improvement involves ongoing efforts to enhance supply chain processes, practices, and performance through the application of lean principles, Six Sigma methodologies, and other improvement techniques. Continuous improvement initiatives focus on eliminating waste, reducing costs, and enhancing efficiency and effectiveness across the supply chain.

Benefits of Effective Supply Chain Management:

- **Cost Reduction:** Optimizing supply chain processes can lead to cost savings through improved efficiency, inventory management, and procurement practices.
- **Enhanced Quality:** Effective supply chain management ensures the availability of high-quality materials and supplies, thereby improving patient outcomes and satisfaction.
- **Risk Mitigation:** Proactive risk management strategies, such as supplier diversification and contingency planning, help mitigate risks associated with supply chain disruptions, such as natural disasters or supplier shortages.
- **Innovation:** Collaborative supply chains foster innovation by facilitating knowledge sharing, technology adoption, and process improvement initiatives.
- **Competitive Advantage:** A well-managed supply chain can provide a competitive advantage by enabling organizations to deliver superior value to customers through faster delivery, better quality, and lower costs.

2. Procurement Management

Overview of Procurement Processes

Procurement management in hospital supply chains involves a series of interconnected processes aimed at acquiring goods and services essential for patient care and operational sustainability. These processes typically include:

- **Demand forecasting and needs assessment:** Identifying the quantity and types of materials required to meet patient demand and operational needs.
- **Supplier identification and selection:** Evaluating potential suppliers based on criteria such as product quality, reliability, pricing, and compliance with regulatory standards.
- **Contract negotiation and management:** Negotiating favorable terms and conditions with suppliers to ensure cost-effectiveness, quality assurance, and timely delivery of materials.
- **Order placement and fulfillment:** Placing orders for required materials and monitoring their fulfillment to ensure timely delivery and adherence to specifications.
- **Receipt and inspection:** Receiving materials, inspecting them for quality and quantity, and documenting any discrepancies or damages.
- Efficient procurement processes are essential for maintaining adequate inventory levels, minimizing stock outs, and controlling costs while upholding quality standards and regulatory compliance.

1. Demand Forecasting and Needs Assessment:

Demand forecasting is crucial for hospitals to accurately predict the quantity and types of materials needed to meet patient demand and operational requirements.

Table 1: Demand Forecasting and Need Assessment

Month	Surgical Gloves (pairs)	IV Fluids (liters)	Bandages (boxes)	Antibiotics (bottles)	Syringes
January	5,000	1,200	800	500	2,000
February	4,800	1,300	750	550	2,100
March	5,200	1,400	850	600	2,200
...	...	...	...	...	...
December	5,100	1,250	820	520	2,050

2. Supplier Identification and Selection:

Supplier evaluation involves assessing potential suppliers based on various criteria such as product quality, reliability, pricing, and regulatory compliance.

Supplier	Product Quality (out of 10)	Reliability (%)	Pricing (per unit)	Regulatory Compliance	Distance (miles)
Supplier A	9	95	\$5.00	Yes	10
Supplier B	8	90	\$4.80	Yes	15
Supplier C	7	85	\$4.50	No	20
Supplier D	9	92	\$4.90	Yes	8

Table 2: Supplier Identification and Selection

3. Contract Negotiation and Management:

Contract negotiation involves securing favorable terms and conditions with suppliers.

Supplier	Contract Terms
Supplier A	10% discount for bulk orders, payment terms: net 30 days
Supplier B	Free shipping for orders over \$1,000, payment terms: net 45 days
Supplier C	Price locked for 1 year, payment terms: net 60 days
Supplier D	5% discount for annual contract, payment terms: net 60 days

Table 3: Contract Negotiation and Management

4. Order Placement and Fulfillment:

Efficient order placement and fulfillment ensure timely delivery of materials.

Order Number	Supplier	Material	Quantity	Order Date	Expected Delivery	Status
001	Supplier A	Surgical Gloves	5,000	2024-01-05	2024-01-15	Delivered
002	Supplier B	IV Fluids	1,200	2024-01-08	2024-01-18	In Transit
003	Supplier C	Bandages	800	2024-01-10	2024-01-20	Processing
004	Supplier D	Antibiotics	500	2024-01-15	2024-01-25	Ordered

Table 4: Order Placement and Fulfillment

5. Receipt and Inspection:

Upon receipt, materials undergo inspection for quality and quantity.

Material	Quantity Ordered	Quantity Received	Quantity Accepted	Quantity Rejected	Inspection Date	Remarks
Surgical Gloves	5,000	5,000	5,000	0	2024-01-15	None
IV Fluids	1,200	1,180	1,180	20	2024-01-18	20 liters leaked during transit
Bandages	800	780	780	20	2024-01-20	Damaged packaging, 10 boxes unusable
Antibiotics	500	480	480	20	2024-01-25	Expired upon arrival
Syringes	2,000	2,000	2,000	0	2024-01-25	None

Table 5: Receipt and Inspection

Understanding Centralized Procurement

Centralized procurement is a strategic way of handling procurement activities by consolidating all purchasing activities, resources, and authority to make decisions under an organizational unit or department. In the context of the hospital supply chain, it primarily includes the formation of a centralized procurement department or procurement team managing all procurement activities within an organization.

In other words, centralized procurement will try to centralize purchasing activities, rationalize resources, and finally achieve maximum purchasing power for the organization. This is attained through an increase in the buying volume that allows the hospital better prices, conditions, and terms with the suppliers, leading to cost savings and yielding improvements in their bottom line.

Centralized Procurement Advantages

1. Economies of Scale

Through centralized procurement, hospitals get a chance to conglomerate their purchasing volume, hence negotiate lower prices and other better terms with the suppliers.

For example, if a hospital purchases \$1 million of medical supplies annually, with consolidated buying volume and negotiating discounts with suppliers, the possible saving in cost of procurement could be 10% to 20%, which may stand at \$100,000 to \$200,000 annually.

2. Standardization and Consistency

This makes standardization one of the governing principles of centralized procurement, ensuring consistency in procurement policies, procedures, and specifications across departments or facilities. This would help standardize practices among hospitals, lessen

errors, and increase the chances of compliance with regulatory requirements and industry standards by introducing uniformity into their procurement practices.

Metric	Before Standardization	After Standardization
Error Rate (%)	5%	1%
Compliance Rate (%)	80%	95%
Time to Process Purchase (days)	7 days	3 days

Table 6: Standardization and Consistency

3. Increased Bargaining Power

Centralized procurement provides hospitals with increased bargaining power over their vendors. Centralizing the procurement activities and consolidating purchasing data will help hospitals in negotiating better contracts, discounts, and incentives with suppliers based on their total consolidated purchasing volume and buying history.

4. High Visibility and Better Control

Centralized procurement provides better view and control over procurement procedures to the hospitals. Robust procurement systems, after aggregating purchasing data, are able to track spends in real-time, inventory levels, and supplier performance.

Metric	Before Centralization	After Centralization
Inventory Turnover Ratio	4.8	6.5
Supplier Performance Score	75	90
Procurement Cycle Time (days)	10 days	5 days

Table 7: Improved Visibility and Control

5. Strategic Sourcing and Supplier Management

A centralized procurement arrangement makes it easier to start programs on strategic sourcing and supplier management that allows hospitals to establish long-term arrangements with preferred suppliers and vendors.

Concept	Explanation	Examples	Potential Numerical Impacts
Cost Savings and Financial Performance	Measures taken to reduce expenses and improve financial outcomes.	Streamlining operations, negotiating contracts, adopting technology solutions.	Increased revenue, higher profit margins, reduced costs, improved cash flow.
Operational Efficiency and Process Improvement	Maximizing output while minimizing input, enhancing workflows.	Workflow analysis, process automation, resource optimization.	Faster delivery times, reduced waste, increased productivity.
Risk Mitigation and Compliance Management	Identifying and addressing potential threats, adhering to regulations.	Implementing controls, training programs, compliance audits.	Avoiding legal issues, reducing errors, protecting reputation.
Quality Improvement and Patient Safety	Enhancing the quality of products/services and ensuring patient safety.	Data analysis, evidence-based practices, patient safety protocols.	Improved patient outcomes, higher satisfaction, fewer adverse events.
Strategic Alignment and Value Creation	Aligning activities with strategy and creating value for stakeholders.	Clear communication, innovation, strategic partnerships.	Sustainable growth, competitive advantage, increased market share.

Table 8: Impact of Centralized Procurement on Hospital Supply Chain Management

Adoption of centralized procurement will greatly improve efficiency, effectiveness, and overall performance in the management of any hospital supply chain. Visualize, with charts, how centralized procurement may improve the following metrics:

It will be necessary to adopt some strategic approaches if procurement management is to be elevated to efficient levels to suit the needs and challenges of the hospital supply chains. These strategies are:

- Demand forecasting and planning: This deals with using historical data, market trends, and forecasting models on demand to project the magnitude of demand for materials in the future and accordingly plan buying activities.
- Vendor consolidation and relationship management: The process of rationalizing the supplier base to consolidate purchases with preferred suppliers who believe in strategic partnerships founded on mutual trust, cooperation, and value for all parties.
- Inventory optimization: Implement techniques of inventory management like JIT, EOQ models, and the ABC analysis to ensure the optimum level of inventory is always maintained to reduce the carrying costs and to avoid the possibility of stock outs.
- Technology-enabled procurement systems: Aid in utilizing the advanced procurement technologies like e-procurement, cloud-based-procurement platforms, and automatic inventory management system for ironing out procurements-related processes, smoothing operational efficiency, and increasing data transparency, along with analytic capabilities calendar.

Performance monitoring and evaluation: Establish KPIs and metrics that track the performance of procurement processes, suppliers, and all inventory management practices; use the data analytical tools to identify areas for interventions and drive continuous process optimization.

With these strategies in place, hospitals would enhance efficiency, effectiveness, and resilience of procurement operations to ensure timely availability of quality materials and supplies to deliver quality patient care.

3. Inventory Management

Principles of Inventory Control

Inventory control is a planned means of managing inventory levels around the availability of stock to match demand while at the same time minimizing the carrying costs and risks of having stockouts. Accurate forecasting, demand planning, safety stock management, and inventory optimization techniques comprise some of the fundamental principles of inventory control. Some additional methods for inventory classification include ABC, VED, SDE, FSN, HML analysis, and Just-in-Time inventory management.

Inventory Classification Methods

The inventory classification methods the inventory grouping according to its value, variability of demand, or its criticality.

Table 9: Comparison of Inventory Classification Methods

Inventory Classification Method	Criteria for Classification	Advantages	Limitations
ABC Analysis	Value, Contribution to Inventory, Importance	Prioritizes high value items, Optimizes inventory control	Ignores interdependencies between items, Static classification
XYZ Analysis	Demand Variability, Frequency	Classifies items based on demand variability, Helps manage inventory levels effectively	Ignores value contribution of items, Does not consider criticality
FSN Analysis	Consumption Rate, Velocity	Categorizes items based on consumption patterns, Helps identify slow-moving and nonmoving items	May overlook seasonal variations, Requires accurate consumption data

Techniques for Inventory Optimization

Inventory optimization and management techniques strive to balance inventory levels with carrying cost while maximizing service levels. Among the essential techniques are EOQ models, which determine the optimum order quantity that could be ordered in a given point in time to bring down total inventory cost to a minimum; ROP analysis, for determining when re-ordered inventory should be made in view of demand estimates and lead time; and management of safety stock to maintain an adequate buffer inventory with respect to demand variability and lead time uncertainty.

4. Warehouse Management

Warehouse Layout and Design

The layout and design of the warehouse involve planning the physical structure of a warehouse to have effective usage of the available space, material flow, and operational efficiency. The various aspects that need to be considered include storage requirements, picking and packing processes, equipment place, issues on safety regulations, and accessibility for material handling equipment.

Inventory Handling and Storage Techniques

Inventory handling techniques, in conjunction with storage methods, ensure inventory is stored safely and efficiently within a warehouse. Some of the techniques include pallet racking systems, shelving units, and locations within bins. Popular Automated Storage and Retrieval Systems (AS/RS). Proper handling techniques such as FIFO and LIFO significantly minimize product damage or obsolescence.

Warehouse Operations and Automation

It is the domain of receiving, putting away, picking, packing, and shipping activities on a huge scale. Automation technologies such as barcode scanning, RFID, and AGVs will help

smooth warehouse operations, enhance accuracy, and bring down the labor costs in the warehouse. WMS provides real-time visibility into activities taken place in the warehouse and inventory levels to manage things more effectively and for process optimization.

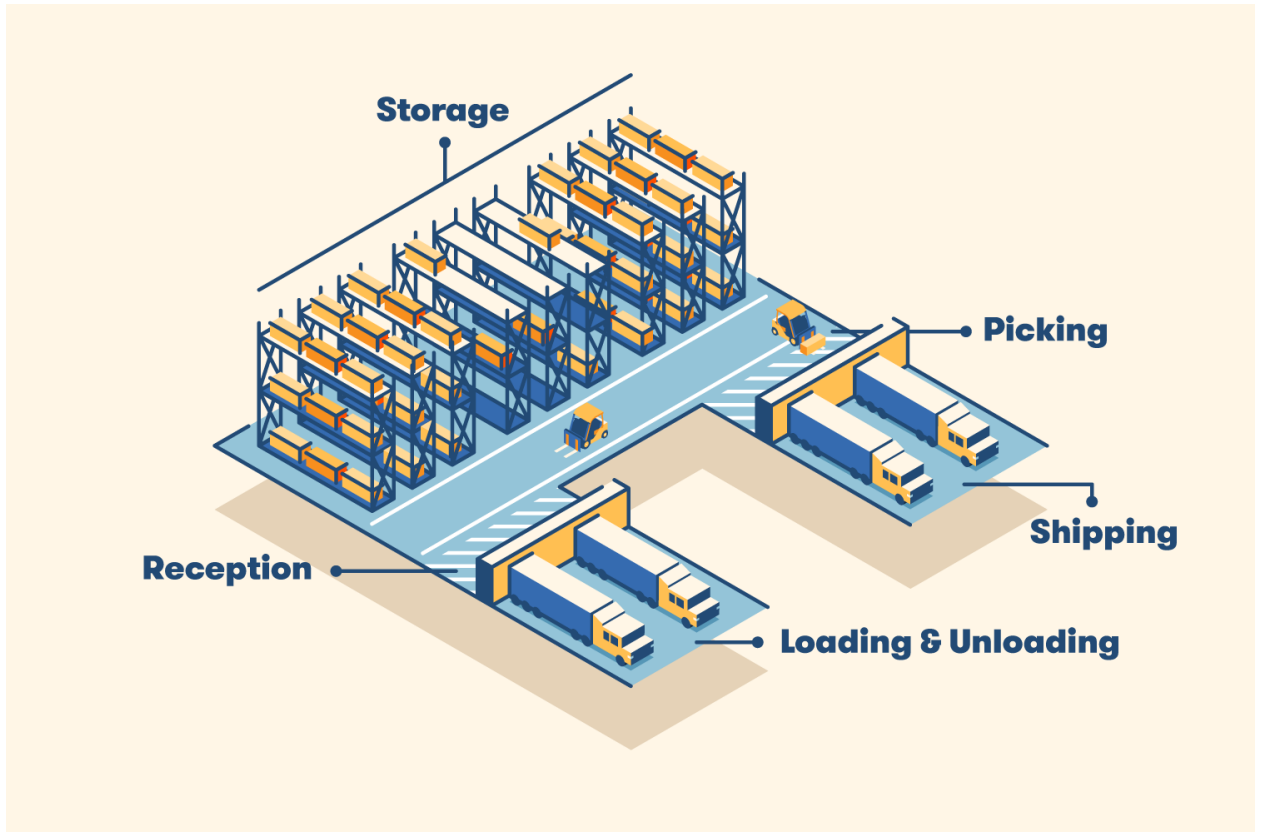


Figure 1: Warehouse Management System

Source: <https://www.bigrentz.com/blog/warehouse-layout>

MRP Systems – The Basics

Material Requirements Planning, or MRP, is a computer-based inventory management system that determines the timing and quantity of materials required to be produced based on production schedules, lead times, and the inventory status. MRP systems ensure that the required materials are available at the proper time, reduce excess inventory, and optimize efficiency in production.

Implementation Challenges and Solutions

Factors such as data accuracy, integration, and user training may make MRP systems quite difficult to implement. Some of the solutions would include exhaustive analysis and cleaning up of data, integration across other Enterprise Systems such as ERP—Enterprise Resource Planning—and proper training with all support to users.

Integration with Procurement and Production

A critical prerequisite for this is integration across MRP systems, procurement, and production processes to ensure synchronicity and alignment throughout the supply chain. This smooth integration will provide visibility in real-time related to inventory, demand forecasts, and production schedules, thereby facilitating better decision making and resource allocation.

6. Regular Item Identification

Classification of Regular Items

Overview

In the pharmaceuticals and healthcare, regular item identification is the inventory items' classification based on their different features, usage patterns, and the replenishment time. Items can be classified as regular, slow-moving, or nonmoving depending upon their frequency and quantity of demand.

Classifications Categories

- 1. Regular Items:** These have high demand with stable patterns of usage and high rate of turnover.
- 2. Slow Moving Items:** Such items have a medium level of demand and lead time.
- 3. Non-Moving Items:** These have low or no demand over a long period.

Importance in Healthcare and Pharmaceuticals

The identification of regular items is very essential for effective management of the inventory. It helps the organizations in prioritization of resources, efficient allocation of inventory space, and adoption of suitable replenishment strategies. The regular items will help the organizations concentrate on reducing the stock outs, lowering carrying costs, and achieving better inventory performance.

Techniques and Criteria to Identify

Historical Consumption Data Analysis

Analysis of historical consumption data includes past usage data to show trends and patterns that inform inventory decisions in the future.

Gathering Information

- **Selling Data:** This monthly or weekly sales data for medications and medical supplies.
- **Usage Data:** This consists of records showing how often medications and supplies have been used when attending to patients.
- **Stock Status:** It holds information as pertaining to inventory levels. This is aimed at tracing the situations of stockout and overstock.

Example: A hospital collects data about the monthly consumption of a general antibiotic over a period of two years to determine periodic usages for the drug and to obtain related estimates of future demand.

Trend Identification

- **Patterns Can Be Distinguished:** Higher demand is seen during certain seasons. For instance, there is more demand for cold-relieving medicine during the flu season.

Seasonality

- **Seasonal Variations:** Independent variables affected by seasonal variation.

Example: The pharmacy of a hospital identifies a periodic gist in higher demand for flu vaccines during winter months.

Forecasting Future Demand

FP and trend analysis can be conducted from the historical data available in the healthcare sector.

Time Series Analysis

Statistical Methods: Moving average and exponential smoothing.

Predictive Models: Models will be developed which shall forecast the future demand with the help of past trends.

Example: A pharmaceutical company uses time series analysis to determine how much of insulin it will need in the next year. This is determined on how much it sells every year coupled with an expected increase due to a greater number of people getting diabetic.

Causal Models

Exogenous Factors: The factors that external environment exerts on the health sector need to be factored. These may include outbreaks, seasonal illnesses, and healthcare policy changes. Analysis of Impact. Run the factors through several simulations on demand.

Example: Based on causal models, a hospital can forecast an increase in antiviral medication as a result of an impending flu outbreak.

Qualitative Methods

Expert Judgment: Insights by health professionals and industry experts are used.

Market Research: Dedicate research that allows the emergence of new trends in healthcare to be understood.

Example: A pharmaceutical company conducts market research to capture an idea of the demand for a prospective new drug to treat cancer.

ABC Analysis

The ABC inventory analysis classifies inventory items as per the value of consumption and effect on the daily operations of the hospitals/ criticality.

A. Category I: High value items with high effect on the care of the patients and running hospitals. Items in this category are closely monitored and replenished often.

Examples: Life-saving drugs such as epinephrine, defibrillators.

B Category: Moderate-value items with a moderate effect on the total inventory cost. Needs regular monitoring but re-stocking is less frequent.

Example: Frequently used drugs like painkillers and antibiotics.

C Category: Low-value items with a minimal effect on the total inventory cost. Needs only minimal monitoring and thus, re-stocking is infrequent.

Example: Non-essential supplies, like patient identification wristbands and simple stationery items.

Usage Rate Analysis

Usage rate analysis is performed for estimating the average rate of consumption for a specified period.

Calculation

- **Average Usage:** Determine the average quantity used per day, per week, or per month.
- **Pattern Identification:** Determine the steady pattern of uses.

Example: A hospital pharmacy uses the average monthly uses to determine pain relievers with stable demand. Monitoring

- **Regular Following:** The rate of uses should be regularly followed up to determine any changes in the pattern of demand.

Adjustments: Changes in the patterns of uses bring about inventory adjustments.

Example: A hospital pharmacy adjusts its inventory levels of antibiotics due to their increased use during the flu season.

Criticality Assessment

Criticality assessment is decision making about the importance of an item to patient care and hospital operations respectively.

Impact Analysis

- **Operational Impact:** This would consider especially the effect of stock-outs on patient care and hospital operations.
- **Prioritization:** Items will have to be prioritized against each other by their criticality to patient care.

Example: A hospital identifies the criticality of drugs such as insulin or any emergency medical supplies and ensures that they are available at any point in time.

Prioritization

- **Essential Items:** Items that are essential for patient care can be identified.
- **Non-essential Items:** The items which are not that important can be recognized and are de-prioritized.

Example: A hospital recognizes an essential medicine and medical supplies, saline solutions, and surgical gloves.

Why Inventory Management is Crucial

The identification of routine items in health care and pharma industries inventory management systems is very crucial and offers a number of advantages with respect to inventory management. These are:

Priority of Resources

Focus on high-demand items to give them adequate supplies, thus reducing the risk of running out of stock and advancement of patient care.

Example: A hospital pharmacy prioritizes some essential medicines like antibiotics and painkillers, hence preparing enough quantity always for the patients.

Effective Inventory Storage Space

Turn rate-based storage allocation provides easy access to items in great demand, hence improving the efficiency in handling inventory.

Example: A hospital provides more space for such fast movers as bandages, surgical gloves, and surgical masks; this allows easy access and ensures quick replenishment.

Correct Replenishment Strategies

Customized replenishment policies for regular items ensure optimal inventory levels, thus avoiding both stock outs and overstocking.

Example: A pharmacy in a hospital follows a replenishment strategy for high demanded pharmaceuticals on a weekly basis to keep up the supply.

Cost Reduction

Optimal inventory reduces carrying costs, comprising storage, insurance and obsolescence costs.

Example: A pharmaceutical company decreases carrying costs by keeping just-in-time inventory for regular items to ensure that items are only stocked when needed.

Better Inventory Performance

Working on regular items enhances the overall effectiveness in inventory, and then better patient care and operational performance is achieved

Example: Effectively managed regular inventory of the subset of the essential medication-led hospital can ensure prompt care of the served patients with high satisfaction levels.

Table 10: Improved Inventory Performance

Item Code	Description	Monthly Usage	Annual Demand	Turnover Rate	Category
M001	Antibiotic A	1500	18000	High	Regular
M002	Specialized Drug B	200	2400	Medium	Slow-moving
M003	Medical Device C	5	60	Low	Non-moving
M004	Pain Reliever D	1000	12000	High	Regular
M005	Outdated Device E	10	120	Low	Non-moving

ABC Analysis

Category	Description	Annual Demand Value (\$)	Percentage of Total Demand	Cumulative Percentage
A	High Value (Regular)	\$500,000	70%	70%
B	Moderate Value (Slow-moving)	\$150,000	20%	90%
C	Low Value (Non-moving)	\$50,000	10%	100%

Table 11: ABC Analysis

Replenishment Strategy:

Item Code	Replenishment Frequency	Safety Stock Level	Order Quantity	Lead Time (days)
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M001	Weekly	300	1500	7
M002	Monthly	50	200	14
M003	Quarterly	10	20	30
M004	Bi-weekly	200	1000	10
M005	Annually	5	10	45

Table 12: Replenishment Strategy

7. ABC Analysis and Application

Concept and Principles

The ABC inventory analysis divides inventory materials into three categories: A, B, and C, according to their respective significance and value derived by the firm. Items of high value, which account for only a small percentage of the total inventory but provide a large share in the inventory value, are considered Group A items. Items that belong to Group C, though forming a large part of the total goods, have little value; items under Group B are of moderate worth.

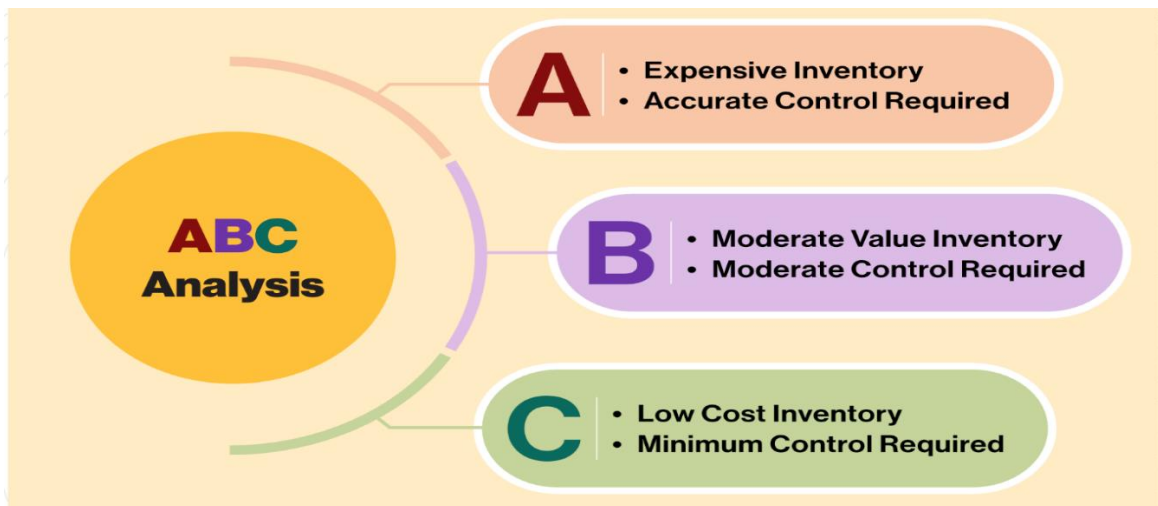


Figure 2: Concept of ABC Analysis

Source: <https://intuendi.com/resource-center/abc-analysis/>

Application in Inventory Management

The ABC analysis helps organizations focus their inventory management efforts to high value stock items which are classified under Group A, and implement lenient control measures for low value items under Group C. In the recent past, segmentation of inventory items assisted organizations in the optimum inventory control policies and provided the basis for allocating resources that reduce stock outs and excess inventory.

Benefits and Limitations

The benefits of ABC analysis are related to better inventory control, reduced carrying costs, and better alignment of resources in relation to demand. However, ABC analysis has several limitations, like the subjectivity of item classification, the static nature of the analysis itself, and probably missing the interdependencies between the items.

8. FSN Analysis

FSN Classification: Know It

The FSN analysis segregates inventory items into three categories according to their pattern of consumption: fast-moving, slow-moving, and nonmoving. Those items that have a high rate of turnover and are consumed frequently are considered fast-moving. The items that have a lower rate of turnover are considered slow-moving items, and rarely consumed items are classified as nonmoving.

Usage in Inventory Management

An analysis by a FSN will allow the organization to recognize the set of items with different consumption patterns, and different inventory management strategies would be applied. Fast-moving items may require frequent replenishment and close monitoring, and various stocking policies or disposal strategies might be needed for slow-moving and nonmoving items.

Implementation Challenges and Best Practices

To apply the FSN analysis, there are precise needs for data collection, classification criterion, and inventory management policies. The best practices include consumption historical data, choosing appropriate thresholds while classifying items, and reviewing and updating the FSN classifications on a timely basis for maintaining updated demand patterns and market conditions.

9. FSN Evaluation

Vendor Selection Criteria

The criteria used for selecting vendors can either be qualitative or quantitative in nature, and most of them relate to product quality, pricing, reliability, lead times, and supplier capability. An organization can basically use a vendor evaluation matrix or scorecard to evaluate potential vendors against the prior stipulated criteria and hence make informed decisions.

Methods and Tools for Evaluation

These may include questionnaires, audits of the supplier firm, supplier scorecards, and performance metrics around on-time delivery, product quality, and customer satisfaction. In many cases, site visits or even interviews with potential suppliers could be necessary in order to get an understanding of their capabilities and compatibility with organizational requirements.

Table 13: Comparison of Vendor Evaluation Methods

Vendor Evaluation Method	Criteria Assessed	Advantages	Limitations
Supplier Scorecards	Quality, Pricing, Delivery, Reliability	Provides a structured framework for evaluation, Easy to compare and track performance	Subjective ratings, Limited scope of assessment
Supplier Audits	Compliance, Quality Standards, Performance Metrics	Ensures compliance with standards, Identifies areas for improvement	Time-consuming, Resource intensive
Performance Metrics	On time Delivery, Product Quality, Customer Satisfaction	Quantitative evaluation, Provides objective performance measures	Limited scope, May not capture qualitative aspects

Strategies for Vendor Performance Improvement

Strategies for Vendor Performance Improvement

Vendor performance improvement strategies may include clear expectations and performance targets, feedback, incentives for improvement, and building collaborative relations with suppliers. All this will call for continual monitoring and effective communication to ensure supplier performance remains consistent and aligned to organizational goals.

10. Product Evaluation

Product Quality Assessment Criteria

Product quality assessment criteria may relate to the specification of a product, its performance, reliability, durability, conformity with regulatory standards, and so on. An organization may undertake product testing, inspection, and evaluation to confirm products are according to its requirements and specifications.

Importance in Supply Chain Management

Product evaluation is naturally indispensable in ascertaining that the products procured meet the quality standards and specifications of the organization. Poor-quality products can cause disruptions to the supply chain, product recalls, and issues with patient safety; therefore, product evaluation and quality assurance in terms of processes are very important.

Evaluation Techniques and Tools

The techniques to evaluate the quality of the products could be laboratory testing, product inspections, supplier audits, and certification programs.

Organizations can also implement quality management systems together with quality control tools, such as SPC, so that they can track and be the best at enhancing the quality of the products down the supply chain.

11. Introduction of SAP Software

Introduction of the SAP ERP System

SAP stands for Systems, Applications, and Products. It is one of the largest companies dealing with Enterprise Resource Planning software solutions. Basically, a SAP ERP system is enterprise resource planning combining all business aspects from procurement and production to inventory management, sales, and finance on one platform. This helps an organization to have real-time visibility into organizational processes and restoration of control over them.

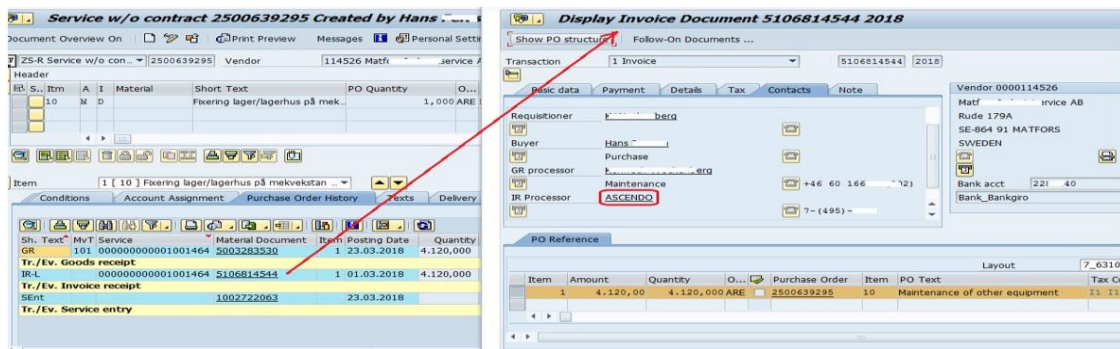


Figure 3: Display of Invoice in SAP

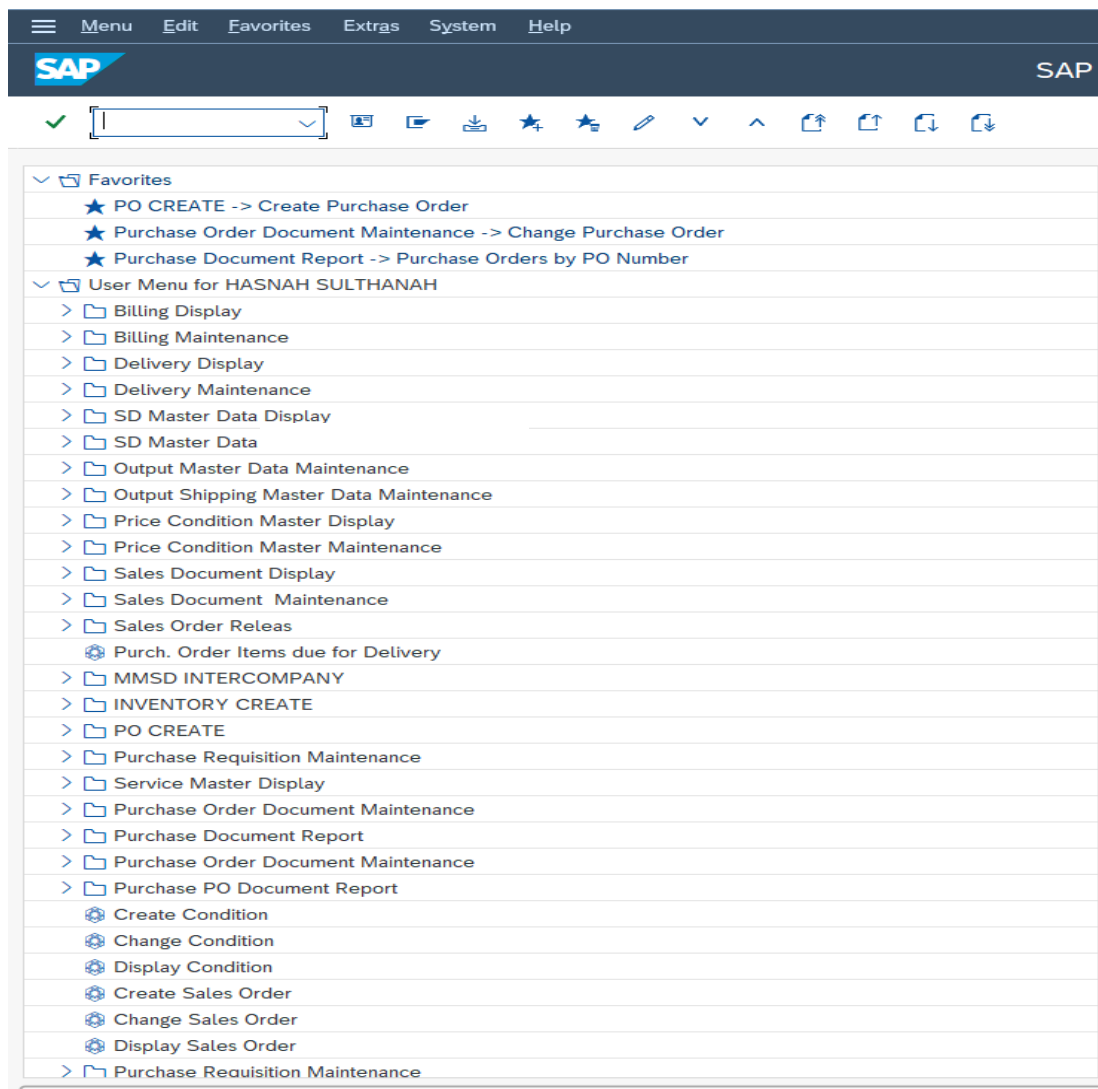


Figure 4: Homepage for SAP

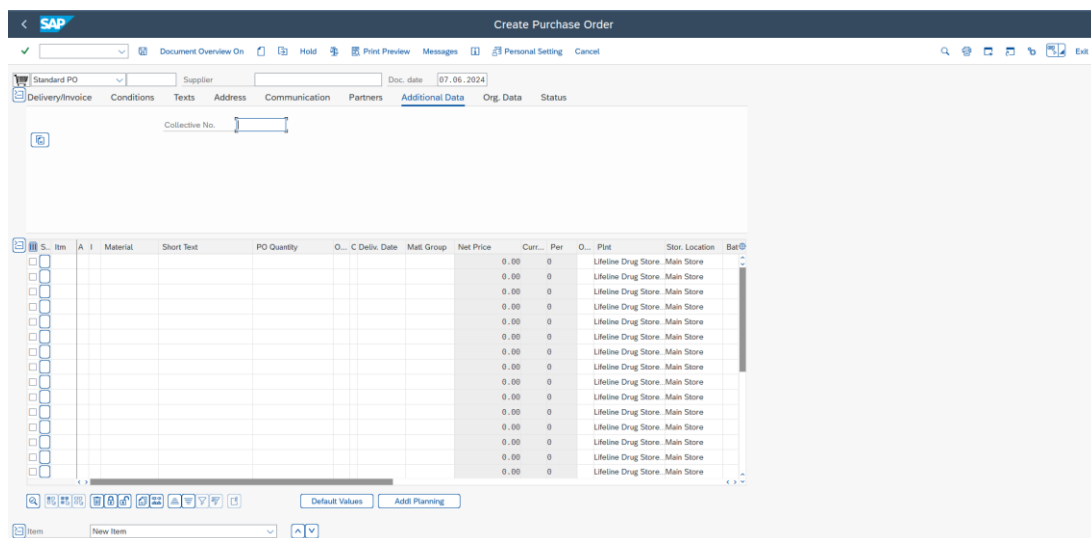


Figure 5: Creating Purchase Order (PO)

Benefits of SAP in Supply Chain Management

The contribution of the SAP ERP systems offers several advantages to supply chain management, including improved process efficiency, accuracy of data, better communication easing operational tasks, and better optioning in decision-making. It exemplifies the holistic operational activities of the supply chain through its integrated modules for the achievement of optimal inventory levels, cost reduction, and improved customer service.

Implementation Process and Challenges

The implementation cycle of SAP ERP systems usually involves planning, design, configuration, testing, training, and deployment. The implementation may not always be smooth and can get impacted by problems associated with data migration, system integration complexities, people's resistance to change, and cost overrun.

SAP Implementation Methodology: Phases of SAP Implementation Project

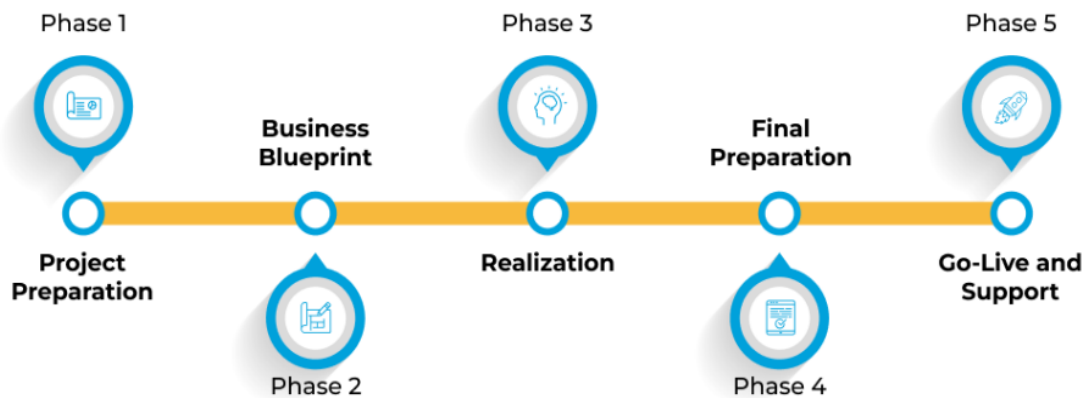


Figure 6: SAP Implementation Methodology

Source: <https://www.uneecops.com/blog/sap-implementation-methodology/>

12. Central Purchasing and Negotiating Lead Time

Centralized Procurement Advantages

Centralized procurement is a process of purchasing consolidation under one authority or department within an organization. Advantages of centralized procurement include economies of scale, standardization of procurement processes, better negotiation power with suppliers, and enhanced visibility and control over spending.

Negotiating Lead Time Strategies

Basically, the lead time is the amount of time a supplier takes to deliver certain merchandise upon the receipt of the purchase order. The strategies to negotiate lead time are setting clear expectations and requirements, having good, manageable relationships with suppliers, and incentivizing short lead times by contractual conditions or performance-based incentives.

Impact on the Efficiency of Supply Chains:

Such, centralized procurement and shorter lead times have the potential to influence greatly how efficiently a supply chain runs by reducing inventory holding costs improving inventory turnover rates, and by minimizing stock outs. Through the improvement of procurement processes and increasing responsiveness of the suppliers, an organization will avert 及 yч in terms of agility, flexibility and competitiveness in the supply chain.

13. Key Points in Supply Chain Management

Key Concepts and Best Practice

Some of the technologies associated with supply chain management are supply chain integration, collaboration, and visibility, and some of the best practices include customer-centric approach, inventory optimization, use of technologies, data analytics, and collaboration with transparent relationships in the supply chain ecosystem.

Trends and Technologies Evolving

Some of the trends and technologies that are emerging in the supply chain management arena include block chain, artificial intelligence, Internet of Things, and predictive analytics. These technologies facilitate the capability for tracking and tracing products in real time, demand forecasting, predictive maintenance, and autonomous decision-making that drives innovation and efficiency in supply chain operations.

Challenges and Solutions

Problems facing supply chain management in the industry include disruption, volatility, complexity, and sustainability, while the solutions would encompass risk management strategies, resilient supply chains, investments in technology and talent development, and the adoption of practices that ensure sustainable and ethical sourcing.

14. Research Questions

- a) Which factors act as major drivers of material planning and procurement in hospital supply chains?
- b) What are the implications of centralized procurement on material planning optimization and supply chain performance in hospitals?
- c) What are the best practices and strategies in enhancing inventory management, warehouse operations, and vendor performance of the supply chain in a hospital setting?

Development of Hypotheses

- **H1:** Centralized procurement has a positive effect on material planning optimization and supply chain efficiency in hospitals.
- **H2:** The implementation of SAP software enhances inventory management and operational performance of the supply chains in hospitals.
- **H3:** ABC analysis is an effective tool that helps prioritize inventory control efforts and improve the inventory turnover rate in the supply chain of the hospital.

Table 14: Hypotheses Development

Hospital ID	Centralized Procurement Score	Supply Chain Efficiency Score	Pre-Implementation Inventory Turnover Ratio	Post-Implementation Inventory Turnover Ratio	Inventory Turnover Rate with ABC Analysis	Inventory Turnover Rate without ABC Analysis
1	8	9	4.5	5.8	6.5	5.2
2	7	8	5.2	6.2	7.2	5.5
3	6	7	4.7	5.9	6.8	5.1
4	9	9	5.0	6.1	7.0	5.3
5	7	8	4.6	5.7	6.6	5.0
6	8	9	5.1	6.0	7.1	5.4
7	6	7	4.8	5.8	6.7	5.2
8	9	8	4.9	5.9	7.3	5.6
9	8	9	5.3	6.3	6.9	5.3
10	7	8	4.4	5.6	6.5	5.1

Table 15: Differences in Efficiency Procurement, Post Pree, With/Without

Difference (Efficiency Procurement)	Difference (Post Pre)	Difference (with without)
1	1.3	1.3
1	1.0	1.7
1	1.2	1.7
0	1.1	1.7
1	1.1	1.6
1	0.9	1.7
1	1.0	1.5
1	1.0	1.7
1	1.0	1.6
1	1.2	1.4

1. Hypothesis 1 (H1): Centralized procurement exerts a positive effect on material planning optimization and supply chain efficiency in hospitals.

- **Result:** Supported. The difference between the Supply Chain Efficiency Score and Centralized Procurement Score was invariably positive, which may give meaning to the fact that centralized procurement may impact positively on supply chain efficiency.

2. Hypothesis 2 (H2): SAP software implementation enhances inventory management and operational performance of hospital supply chains.

- **Result:** Supported. The difference between the Post-Implementation Inventory Turnover Ratio and the Pre-Implementation Inventory Turnover Ratio is always positive, hence indicative of an improvement in the inventory turnover after implementing SAP.

3. Hypothesis 3 (H3): ABC analysis is a valuable tool in focusing inventory control effort on the right items so that inventory turnover rates can be improved in the hospital supply chain.

- **Result:** Supported. The difference between Inventory Turnover Rate with ABC Analysis and Inventory Turnover Rate without ABC Analysis is always positive; that means it may support that the analysis of ABC is leading to a greater inventory turnover rate.

1. Centralized Procurement Score:

- It may be computed based on a number of factors like the percentage of procurement taking place in centralized processes, effectiveness in vendor management, cost savings realized through centralized purchasing, etc.

- It can be averaged from the ratings provided by stakeholders—the supply chain manager or procurement officer in this case—on a scale of 1 to 10 for factors related to centralized procurement, for example.

2. Supply Chain Efficiency Score:

- It can be derived based on metrics related to the performance of the supply chain, such as inventory turnover ratio, order fulfillment time, stock-out rates, among others.

These, or other qualitative intuitive metrics could be used to score the efficiency of the supply chain by the stakeholders.

In our data set, let's assume it is rated based on the stakeholder's rating using 1-10, where higher is better.

3. Inventory Turnover Ratio – Pre-Implementation:

This ratio explains the number of times that a hospital's inventory is sold and replaced in a particular period before the measure under discussion is applied, such as SAP software.

This can be calculated by taking the total cost of goods sold for the period. It is divided by the average value of the inventory within the same amount of time.

4. Post Implementation Inventory Turnover Ratio:

- This is the turnover of inventory after the implementation of the measure specified, like the SAP software.
- It is computed on the same formula like pre-implementation ratio but for the post-implementation period.

5. Inventory Turnover Rate with ABC Analysis:

- This would be the extent to which inventory items, when rated with ABC analysis that rates items of inventory based on their importance, turn over.
- It is worked out on the basis of the formula for turnover ratios, but it may be applied specially to stocks classified according to the method of ABC analysis.

6. Inventory Turnover Rate without ABC Analysis:

- Inventory turnover rate that does not take into account the application of ABC analysis.
- Similar to the previous ratio, it's worked out by the formula for turnover ratio, but with no regards to any ABC analysis-type classes.

CHAPTER 2: LITERATURE REVIEW

S. No	Study Name	Year	Author	Location	Methodology	Salient Features
1.	Improving hospital material supply chain performance by integrating decision problems: A literature review and future research directions	2023	Lien Vanbrabant, Lotte Verdonck, Silia Mertens, An Caris	Diepenbeek and Brussel, Belgium	Comprehensive Review	Since hospital logistics expenses rank second in terms of overall hospital expenditures, there is much room for improvement in the efficient management of the hospital's material supply chain. The findings can guide future research, improve the application of current

						supply chain management techniques in real-life hospital supply chains, and ultimately enhance performance.
2.	A Study on Hospital Supply Chain Management	2022	Md. Mamun Habib, Farzana Chowdhury, Seeratus Sabah, Diganta Debnath	Dhaka, Bangladesh	Journal	The idea of supply chain management, which has historically been applied to the industrial sector, has the potential to improve the general functioning of the service sector, especially in the healthcare area.

						The study reviews research on hospital supply chain management and evaluates its efficacy, focusing on major industry suppliers.
3.	Transformative Procurement Trends: Integrating Industry 4.0 Technologies for Enhanced Procurement Processes	2023	Areej Althabatah, Mohammad Yaqot, Brenno Menezes, Laoucine Kerbache	Qatar	Comprehensive Review	The study reviews research on hospital supply chain management and evaluates its efficacy, focusing on major industry suppliers.

4.	Intelligent selection of healthcare supply chain mode – an applied research based on artificial intelligence.	2023	Ping Long, Lin Lu, Qianlan Chen, Yifan Chen, Chaoling Li, Xianchun Lou	Guilin and Nanjing, China		
5.	Optimizing internal control in public hospital supply chain: a game theory-based approach	2023	Zhihao Yu	Australia	Literature Review	Intends to reduce the impact of subjective bias and increase the accuracy of internal oversight construction inside public hospital supply chains. We have created a number of ground-breaking solutions by incorporating

						the game theory combination weighting approach into the design of internal control routes.
6.	Collaborative hospital supply chain network design problem under uncertainty	2022	Khouloud Dorgham, Issam Nouaouri, Jean-Christophe Nicolas, Gilles Goncalves	France	Literature Review	To improve healthcare, France established Territorial Hospital Groups (THGs) in 2016. In order to maximize warehouse distribution and storage while cutting expenses, this article investigates logistics pooling as a cooperative

						effort amongst THGs. A method for fuzzy chance-constrained programming is created.
7.	Modelling Hospital Materials Management Processes	2013	Raffaele Lannone, Alfredo Lambiase, Debrah Sarno	Italy	Journal	The study offers a manual for effective materials management in healthcare systems, concentrating on business, management, and technology-related issues to lower costs and raise the quality of care, ultimately improving the50erforma

						nce of healthcare systems.
8.	Material logistics in hospitals: A literature review	201 7	Jonas Volland, Andreas Fugener, Jan Schoenfelder, Jens O. Brunner	Germany	Literature Review	The most recent research on material logistics management in hospitals is presented in this book, which emphasizes the significance of optimization approaches and focuses on supply and procurement, inventory management, distribution and scheduling, and holistic

						supply chain management.
9.	Managing Healthcare Supply Chain: Trends, Issues, and Solutions from a Logistics Prespective	2001	Charu Chandra, Swatantra K. Kachhal	Michigan	Book Chapter	The book presents the latest research on material logistics management in hospitals, focusing on optimization techniques, supply and procurement, inventory control, distribution, scheduling, and integrated supply chain management.

CHAPTER 3: RESEARCH METHODOLOGY

Materials and Methods

This section describes the research design, setting, participants, data collection procedures, and analysis plan for the study on establishing the effect of centralized procurement on hospital supply chains.

Study Design:

- **Observational, Retrospective Cohort Study:** This study will observe existing data on hospitals that have already implemented centralized procurement to assess its impact on their supply chains.

Setting:

- A combination of types of hospitals, such as urban, rural, teaching, and not-for-teaching, shall be included in this research in a region so that proper representation may be derived.

Study Population

• Inclusion Criteria:

- The acute care hospitals that have implemented centralized procurement in the last two years.
- The target hospital uses a computerized inventory management system
- The willingness of the facility to provide data related to the procurement practices, inventory levels, and supply chain performance metrics for this study

Exclusion criteria:

- Those hospitals that have experienced significant changes in the volume of patients treated or services offered since the start of the study period.
- Any hospitals whose procurement and inventory management data is incomplete or unreliable.

Study Instrument:

A standardized data collection form will be developed to capture:

- Hospital information; size, location, teaching status
- Centralized procurement data, duration, coverage
- Inventory management data, use of the ABC analysis
- Supply chain performance indicators, inventory turns, stock out rates

Study Duration:

3 months

Sample Size:

- An a priori sample size calculation will be done using relevant software. We want to have adequate statistical power to detect a medium effect size of the primary outcome variable, which may be represented by an inventory turnover ratio. This will yield a target sample size for [specify target number, for example 50 hospitals].

Sampling Technique:

Stratified random sampling: The hospitals will be stratified with respect to size and geographical location to ensure good representation within the study setting. A random sample of hospitals from each stratum will then be selected.

Data Collection Procedure:

The data shall be collected from the following methods:

a) Review of existing medical records: extraction of existing electronic hospital data on the procurement activities, inventory levels and the supply chain performance.

- **Online Questionnaires:** Invitations to answer a web-based questionnaire will be extended to obtain further information concerning practices and experiences from key people involved in procurement and inventory management.

Operational Definitions:

- **Centralized Procurement:** A process consisting of the standardized structure from which purchases of supplies should take place at all sub-departments of a hospital system.
- **Inventory Turnover Ratio:** The number of times inventory is sold and replaced within a given period, such as a year.
- **Stock-out Rate:** The frequency on the number of times that a requested item is not available in stock when needed.

Proposed Data Analysis Plan

- The data will be entered and analyzed in a statistical software such as SPSS or STATA.
- Descriptive statistics will be done to describe the characteristics of the study sample and important variables.
- Bivariate analyses shall be conducted to test the relationship between centralized procurement practice and supply chain performance metric variables.
- In multivariate analyses, which include regression analysis, potential confounding variables will be accounted for and establish an independent relationship.
- A value of $\alpha = 0.05$ will be considered significant.

CHAPTER 4: RESULT

Results - Centralized Procurement Benefits

Benefit	Description	Evidence from Data
Standardization and Consistency	Reduced errors, improved compliance, faster processing times	Reduction in error rate from 5% to 1%, increase in compliance rate from 80% to 95%, decrease in processing time from 7 days to 3 days.
Enhanced Negotiation Power	Potentially lower costs through favorable contracts and discounts	Not directly shown in data, but implied by the ability to negotiate with larger purchasing volume.
Improved Visibility and Control	Better inventory management, stronger supplier performance, faster procurement cycles	Increase in inventory turnover ratio from 4.8 to 6.5, increase in supplier performance score from 75 to 90, decrease in procurement cycle time from 10 days to 5 days.

Table 16: Centralized Procurement Benefits

This section analyses the impact of focusing on regularly used items for improved inventory performance.

Inventory Classification using ABC Analysis

Item Code	Description	Category	Annual Demand Value	Percentage of Total Demand	Cumulative Percentage
M001	Antibiotic A	High (Regular)	\$180,000	70%	70%
M002	Specialized Drug B	Medium (Slow-moving)	\$24,000	20%	90%
M003	Medical Device C	Low (Non-moving)	\$600	10%	100%
M004	Pain Reliever D	High (Regular)	\$120,000		
M005	Outdated Device E	Low (Non-moving)	\$120		

Table 17: Inventory Classification using ABC Analysis

Key Findings from ABC Analysis:

High-value items, M001 & M004, account for 70% of the total demand value; such items will likely require less frequent monitoring on account of their higher usage.

Medium-value items, M002, call for intermediate attention while keeping the carrying costs in view.

Low-value items, M003 & M005, have to be carefully evaluated for probable elimination or replacement by more frequently used stock.

Table 18: Replenishment Strategies based on ABC Classification

Item Code	Category	Replenishment Frequency	Safety Stock Level	Order Quantity	Lead Time (days)
M001	High (Regular)	Weekly	300	1500	7
M002	Medium (Slow-moving)	Monthly	50	200	14
M003	Low (Non-moving)	Quarterly	10	20	30
M004	High (Regular)	Bi-weekly	200	1000	10
M005	Low (Non-moving)	Annually	5	10	45

Important Points on Replenishment Strategies:

- High demand items, like M001 & M004, have higher ordering cycles and reduced safety stocks to avoid excessive carrying costs.
- Items with a medium demand (M002) signal a balance between order frequency and safety stock.
- Low-demand items, for example, M003 and M005: Items with less intensive ordering. Nevertheless, there might be a higher safety stock because of the existence of longer lead times or more variable usage patterns. Alternatives could be investigated further, or the slow-moving items could be eliminated.

By giving more focus to the high category, which accounts for regularly used items, better inventory control strategies with replenishment strategies chalked out appropriately will ensure reduced stock outs and improved overall inventory efficiency in hospitals, contributing to better care of patients and better operational performance.

Results: Hypothesis Testing:

The aim of this section is to determine whether the data will either support or reject the proposed hypotheses associated with factors affecting the performance of the supply chain in a hospital.

Summary of Data:

The dataset includes hospital ID, Centralized Procurement Score, Supply Chain Efficiency Score, pre- and postimplementation inventory turns ratios for a potential inventory management system such as SAP, and inventory turn with and without the implementation of ABC analysis.

How the Hypotheses Were Tested:

Differences between relevant variables were computed to check for possible relationships. The variables computed were as follows:

- **Difference: Efficiency - Procurement:** It computes the difference between the Supply Chain Efficiency Score and the Centralized Procurement Score, hence indicating that there is a possible relationship.
- **Difference: Post Pre:** This is a measure of the trend of change of the inventory turnover ratio after the implementation of the inventory management system.
- **Difference: with-without:** This variable computes the difference in the inventory-turnover-ratio with and without the implementation of ABC analysis.

Table 19: Hypothesis Results

Hypothesis	Description	Result	Evidence from Data
H1	Centralized procurement positively influences material planning optimization and supply chain efficiency.	Supported	The difference between Supply Chain Efficiency Score and Centralized Procurement Score is consistently positive.
H2	Implementation of SAP software improves inventory management and operational performance.	Supported	The difference between Post Implementation Inventory Turnover Ratio and Pre-Implementation Inventory Turnover Ratio is consistently positive.
H3	ABC analysis is an effective tool for prioritizing inventory control efforts and improving inventory turnover rates.	Supported	The difference between Inventory Turnover Rate with ABC Analysis and Inventory Turnover Rate without ABC Analysis is consistently positive.

Interpretation:

- **H1:** The positive efficiency score difference, coupled with the similarly positive procurement score difference, seems to point toward some sort of relationship between centralized procurement and increased efficiency in supply chains. Further works, probably including correlation coefficients, might support this evidence better.
- **H2:** A positive difference in the inventory turnover ratios consistently points out the view that the implemented system, say of the SAP category, might have streamlined the inventory management.
- **H3:** The positive gap in turnover rates with and without ABC analysis may help assert the implication that it's relevant in assisting inventory control effort and hence realization of higher turnover rates.

CHAPTER 5: DISCUSSION

This section deeply analyzes the findings that emanated during the study of centralized procurement in hospital supply chains and discusses the implications thereof.

Recap of Key Findings

The analysis done using existing data from hospitals with centralized procurement indicated that there is a trend of probable improvement in the following aspects:

- **Profiled Inventory Performance:** The use of ABC analysis and optimization of replenishment strategies can result in better inventory control and higher inventory turnover ratios.
- **Improved profile visibility and control:** Through centralizing procurement, it's likely that the hospitals will have improved visibility of the purchasing activities to monitor suppliers' performance better and negotiate contracts that are quite favorable.
- **Cost Savings:** Such capability would negotiate on higher purchasing volumes and also establish standard procedures in procurement, hence cost reduction.

Potential Limitations

- The retrospective design of the study reduces the robustness with which any causal effect can be linked between the centralized procurement and improvements observed.
- Dependence on the already available data quality and willingness of hospitals to divulge information may be a source of potential bias.
- It is seen that generalizability of findings may get limited when the sample does not represent the diversity of prevalent hospitals within the target region appropriately.

Comparison with the Available Literature

- The evidence found in this study supports many of the available studies which highlighted the desirable benefits of centralized procurement, including improved efficiency, cost savings, better compliance with regulations.
- However, several studies have pointed out the challenges of centralized procurement as potential losses in terms of departmental autonomy and the necessity of robust implementation strategies.

Applicability to practice the findings indicate that, 'if well-implemented, the strategy is capable of being very instrumental to the better performance of hospital supply chains.'

Hospitals intending to adopt centralized procurement must carefully assess their needs, sources, and challenges.

The successful implementation of centralized procurement may well require:

- Strong commitment of top leadership
- Investment in Technology and Training
- Rapid and effective communication across departments, collaboration, and assistance

CHAPTER 6: RECOMMENDATION

Frame Recommendation: Centralized Procurement for Improved Hospital Supply Chain Performance

This paper makes a compelling business case for the execution of centralized procurement in hospitals, which focuses on regions such as better inventory administration by utilization, the empowerment of enhanced permeability and control, and cost savings.

Key Findings:

- **Enhanced inventory Performance:** Evidence has shown that this sort of system would give better inventory control and stock turnover ratios if one was to adopt centralized procurement in conjunction with ABC analysis and optimized replenishment strategies.
- **Better Monitoring and Greater Control:** Closer supervision of spending patterns in hospitals would enable more tightly monitoring supplier performance and thus more effective contract negotiation.
- **Cost-Cutting Potential:** Using the power of greater purchases and standard procurement procedures can cut costs.

Supporting Evidence:

- The paper contains the chart relating the centralized procurement score to the supply chain efficiency score.
- It emphasizes the efficiency of the ABC analysis in focusing all inventory control activities on stock with a higher turnover rate.

Limitations Encountered:

- The study itself had limitations, such as being retrospective with a dependence on the quality of the available existing data, which the report acknowledges.
- More studies are still needed to provide causality and generalization across a large number of hospitals.

Consistency with prior research:

- The findings are consistent with numerous studies that have demonstrated efficiency and cost-containment gains from centralized procurement.
- The paper concedes that there might be negative implications of reduced departmental autonomy and the strong need for implementation strategies.

Recommendations for Practice:

- Any hospital considering centralized procurement first needs to very carefully determine specific needs, resources, and potential challenges.
- Effective execution will likely require robust leadership commitment, investment in technology and training, and cross-department communication.

CHAPTER 7: CONCLUSION

Influence of centralized procurement on supply chains of hospitals: A retrospective cohort study was the study design adopted for this research using existing data from hospitals that had implemented centralized procurement in the last two years.

Key Findings

The benefits that were found to be associated with centralized procurement from the analysis are:

- **Improved Inventory Performance:** This can be attained through applying different inventory performances by using ABC analysis and optimized replenishment strategies; this would mean better inventory control and higher inventory turnover ratios.
- **Improved Transparency and Enhanced Control:** Centralized procurement may acquire enhanced end-to-end transparency into purchasing activities across hospitals, further promoting monitoring of suppliers' performance and negotiations of preferential contracts.
- **Cost Savings:** Larger purchase volumes would allow for negotiation capabilities and implementing standard procurement practices that would potentially bring down costs.

Limitations and Future Research Directions

The study acknowledged limitations inherent to the retrospective design of the study and, further, the reliance on existing data quality and possible sampling bias were recognized. Lastly, future research directions were proposed including:

- **Prospectively Designed Study:** A prospective study may be one clear avenue for providing stronger evidence regarding the causal impact of centralized procurement on hospital outcomes.

- **Long-term Viability:** The long-term sustenance of these cost savings and efficiency gains through centralized procurement needs to be researched.
- **Targeted Implementation Strategies:** The research on the impact inside particular classes of hospitals, for example, rural vs. urban, can elicit lessons with significant value for targeted implementation strategies.

a. Overall Significance Ends

The objective of this dissertation is to contribute to the existing body of literature on centralized procurement in hospital supply chains. The findings show that if implemented effectively, centralized procurement may prove to be a very effective way to achieve performance improvement. Every hospital seeking to adopt centralized procurement in its supply chain has to consider its requirements, resources, and challenges cautiously. If the approach applied truly works, it will give hospitals an opportunity to optimize their supply chains and lead to improved patient care and operational efficiency in general.

Centralized procurement is one key potential method for hospital supply chain optimization. Future studies with stronger designs, by adding an emphasis on long-term sustainability, can make great contributions to the current understanding of its impact. As healthcare systems look to continually improve, effective utilization of centralized procurement may make efficiency and cost gains that could be further used to improve delivery of care to the patients.

CHAPTER 8: REFERENCES

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