Proceedings of Book Series PBS - Vol 30, pp.52-58 **Emerging Approaches in Modern Business**

Operational Efficiency in the Pharmaceutical Supply Chain: Evaluation of Key Inventory Management Indicators

Rhizlane BENRREZZOUQ[1], Hajar MANSOUR [2]

National School of Business and Management, Mohammed First University, Oujda, Morocco

Email 1 r.benrrezzouq@ump.ac.ma

Email 2 – mansour.hajar.23@ump.ac.ma

Abstract — **The quality of care depends on efficient logistics management, which is essential for preventing supply disruptions of medicines and medical devices. The COVID-19 crisis exposed vulnerabilities in the pharmaceutical supply chain, particularly regarding supply delays and stockouts. Improving operational efficiency hinges on the optimization of resources and logistics processes. In this context, strategic sourcing combined with a regular assessment of inventory KPIs makes it possible to mitigate both overstocking and shortages. However, recent studies indicate that the systematic use of these indicators remains limited in healthcare facilities, leading to poor forecasting capabilities and management that is reactive rather than proactive. Strengthening monitoring mechanisms, alongside better coordination between supply chain stakeholders, appears indispensable for ensuring reliable decision-making processes. Thus, the integration of relevant KPIs, proactive risk management, and the continuous adaptation of operational models constitute essential levers for increasing the resilience and performance of the pharmaceutical supply chain.**

Keywords—Pharmaceutical supply chain, Inventory management,Supply chain,Operational efficiency, Key Performance indicators

I. INTRODUCTION

Public health advancement relies on healthcare organizations' ability to ensure medicine quality, accessibility, and availability through an efficient pharmaceutical supply chain [1]. Operational efficiency is essential to guarantee continuous supply and prevent stockouts, which seriously disrupt hospital operations and may compromise patient safety [2]. The primary objective of the pharmaceutical supply chain is to deliver the right medicines, in the right quantities, at the right time and place, while minimizing overall costs, which requires strong coordination among supply chain stakeholders [2], [3].

Preventing stockouts depends on effective inventory management systems capable of monitoring medicine flows, anticipating risks, and correcting dysfunctions through structured and continuous control. In response to these challenges, international institutions such as the FDA and the WHO have recognized drug shortages as a major public health issue and implemented strategies to mitigate their occurrence [4]. Understanding the structural determinants of stockouts therefore represents a critical step for improving supply chain resilience and healthcare system performance [5].

This study analyzes pharmaceutical inventory management using Key Performance Indicators (KPIs) to identify risks and propose improvement actions aimed at enhancing operational efficiency and reducing stockouts. The paper is structured as follows: a review of the literature, the identification and application of key inventory KPIs, the presentation and discussion of results, and concluding remarks with future research perspectives.

ISSN: 2961-6611

Proceedings of Book Series PBS - Vol 30, pp.52-58 **Emerging Approaches in Modern Business**

II. LITERATURE REVIEW

A. Pharmaceutical Supply chain

The pharmaceutical supply chain includes all activities required to ensure the availability of medicines, from production to final delivery to patients, covering procurement, quality control, distribution, and the management of returns and expired products [6]. The strong growth of the pharmaceutical industry has reinforced the strategic importance of this supply chain within healthcare systems due to its significant impact on overall costs [7], [8]. Effective risk management within hospital pharmaceutical supply chains requires robust systems capable of real-time monitoring of inventory levels, expiration dates, and medicine flows to prevent stockouts and improve operational efficiency [9].

B. Operational Efficiency in the Pharmaceutical Supply Chain

Operational efficiency refers to the optimal use of resources to reduce waste, improve process flow, and align operations with organizational needs [10]. It is reflected in the performance of key supply chain processes, including procurement, storage, distribution, and information management, ensuring continuous medicine availability [11]. Operational efficiency can be assessed through absolute and relative measures comparing actual performance to ideal or best observed performance levels [12]. Empirical research identifies financial constraints, poor communication, waste, organizational complexity, and limited flow visibility as the main sources of inefficiency [1]. Optimizing supply chain design and operations reduces lead times, improves delivery reliability, and enhances overall operational performance [13].

C. Drug Stockouts

Drug stockouts refer to the inability of healthcare facilities to provide required medicines due to total or partial unavailability [14]. Such situations have serious consequences, including treatment delays, the use of less effective alternatives, prolonged hospital stays, and potential risks to patient safety [15]. These impacts highlight the vulnerability of the pharmaceutical supply chain, where minor disruptions can escalate into critical shortages, emphasizing the importance of accurate demand forecasting [16]. Preventing stockouts requires proactive risk management strategies, such as improved information sharing, safety stock policies, and supplier diversification to enhance supply chain flexibility and resilience [17].

D. Key Performance Indicators

Key Performance Indicators (KPIs) focus on the most critical aspects of organizational performance linked to strategic objectives [18]. They translate strategic goals into measurable operational actions, ensuring coherence between strategy, execution, and value creation [19]. By standardizing performance measurement, KPIs guide decision-making and align organizational behavior; however, poorly designed indicators may generate dysfunctional outcomes [20].

ISSN: 2961-6611

Proceedings of Book Series PBS - Vol 30, pp.52-58 **Emerging Approaches in Modern Business**

III. Research Methodology

A. Study Setting

This study was conducted at the Mohammed VI University Hospital Center in Oujda, which constitutes the principal referral institution for medical care in the Oriental region of Morocco. The central hospital pharmacy plays a strategic role in the management of pharmaceutical supplies for all clinical departments, including emergency, intensive care, and surgery services, as well as general and specialized medicine units. It is responsible not only for the daily distribution of medicines but also for inventory planning, expiration date monitoring, and coordination with suppliers and various hospital departments. This organization ensures the continuous availability of essential products and supports the overall operational performance of the CHU, while minimizing risks associated with stockouts and logistical inefficiencies [21].

B. Study Type and Period

This is a retrospective observational and analytical study focusing on the analysis of pharmaceutical inventory management data for the year 2023. The study included the examination of forecast orders, actual consumption, and logistical performance indicators.

C. Materials and Data Sources

1) Primary Data were Extracted from Two Main Sources

- Hospital Information System (HIS) - HOSIX Module: Used for the extraction of performance indicators (stockout rate, delivery compliance, etc.) and inventory movements (inflows, outflows, counts). The HOSIX computer system plays a key role in the management of medicine stocks within the central pharmacy. This highly efficient system facilitates the management of item movements within the inventory, the tracking of the balance to be delivered (RAL), available stock, etc.
  Safety Stock: It is generally established only for vital medicines, i.e., those indispensable for patient treatment. The objective of this safety stock is to avoid any stockout that could have adverse consequences on patient health.
  High-Cost Medicines: However, the situation differs regarding high-cost medicines. The availability of these medicines is often a challenge; therefore, it is difficult to maintain a safety stock for these items. Occasionally, the supply of these medicines is so limited that it is difficult to constitute even an initial stock, let alone an additional safety stock.
- Excel Datasets: A set of Excel files containing all information necessary for the analysis, including more than one hundred therapeutic batches. These files aggregate Average Monthly Consumptions (AMC), available stock levels, medicine expiration dates, and delivered medicines.

2) Analyzed Variables

- Quantitative Variables: Ordered quantity, Available stock, AMC, Unit Price (UP)…
- Qualitative Variables: Therapeutic class (Anesthesia, Anti-infectives, Cardiology...), Order status

3) Average Monthly Consumption (AMC)

The Average Monthly Consumption (AMC) of a medication corresponds to the mean quantity used over a period of one year. It is calculated by dividing the total consumption recorded during the year by the number of days effectively covered, i.e., excluding days during which the product was out of stock [22].

ISSN: 2961-6611

Proceedings of Book Series PBS - Vol 30, pp.52-58 **Emerging Approaches in Modern Business**

TABLE I
THE AMC OF VITAL MEDICINES IN DIFFERENT MEDICAL SPECIALTIES IN 2023 AT CHU OUJDA

Therapeutic Class	Most Used Medications	Global AMC
Cardiology	Furosemide	2074
Diabetology	Rapid Insulin Analogue	100
Analgesics	Paracetamol	4000
Anesthesia & Intensive Care	Propofol	1500
Antiseptics	Povidone-iodine	1060
Antispasmodics	Phloroglucinol	2387
Anti-inflammatories	Methylprednisolone 120mg	1095
Antiemetics	Metoclopramide	1320
Bulk Parenterals (IV Fluids)	Glucose 5% bag 500ml	4000
Vitamins, Electrolytes & Minerals	Sodium Chloride	3270
Hemodialysis Solutions	Bicarbonate concentrate for hemodialysis	160
Anticoagulants and Antiplatelets	Enoxaparin 4000IU	2440

These medications are essential for the proper functioning of the hospital and patient management. Their high consumption underscores the importance of adequate procurement to prevent any stockouts, and of managing expiration dates to avoid waste. The average monthly consumption is expressed in units: ampoules, vials, tablets...

D. Key Performance Indicators (KPI)

To evaluate the performance of the pharmaceutical supply chain at the Mohammed VI University Hospital Center (CHU) of Oujda, we selected and monitored five major logistics performance indicators. These KPIs were chosen for their relevance in assessing the availability of vital products and the robustness of the pharmaceutical supply chain.

1) Drug Expiration Rate

Cet indicateur mesure l'efficience de la gestion des stocks et le respect du principe FEFO (First Expired, First Out). Il reflète la perte financière et le gaspillage de ressources thérapeutiques.

This indicator measures the efficiency of inventory management and adherence to the FEFO (First Expired, First Out) principle. It reflects the financial loss and waste of therapeutic resources.

- **Formula:** Expiration Rate = (Quantity of expired medicines / Total quantity of medicines) x 100
- **Data Source:** Physical inventories and HIS HOSIX "Expiration" module.
- **Responsible Actor:** Pharmacy Technician.
- **Frequency**: Monthly.

2) Stockout Rate

A critical indicator for patient safety, it evaluates the pharmacy's capacity to meet the demand of care units.

- **Formula:** (Number of unsatisfied order lines / Total number of order lines received) x 100
- **Data Source:** HOSIX exit records and service order forms.
- **Responsible Actor:** Technician and Responsible Pharmacist.
- **Frequency:** Monthly, with immediate alerts for vital medicines.

3) Healthcare Service Satisfaction Rate

This qualitative indicator measures the perception of logistics performance by end-users. It integrates product availability as well as the pharmacy's responsiveness to urgent requests.

- **Formula:** (Number of satisfied services / Total number of services) x 100
- **Data Source:** Quarterly satisfaction surveys distributed to heads of departments.
- **Responsible Actor:** Clinical Pharmacist and Quality Management Unit.
- **Frequency**: Quarterly.

ISSN: 2961-6611

Proceedings of Book Series PBS - Vol 30, pp.52-58 **Emerging Approaches in Modern Business**

4) Delivery Compliance Rate

It evaluates the performance of external suppliers and the reliability of upstream procurement. Non-compliance includes quantity discrepancies, damaged products, or dosage errors upon receipt.

- **Formula:** (Number of compliant deliveries / Total number of deliveries) x 100
- **Data Source:** Supplier delivery notes and HOSIX reception modules.
- **Responsible Actor:** Purchasing Pharmacist and Reception Committee.
- **Frequency:** Monthly.

5) Inventory Reliability: Inventory Discrepancy

This indicator measures the accuracy of the HOSIX information system relative to physical reality. A low discrepancy validates the traceability of movements.

- **Formula:** (HIS Hosix stock quantity - Physical stock quantity) / Physical stock quantity x 100
- **Data Source:** Cycle counts and annual general inventory.
- **Responsible Actor:** Central Pharmacy Team.
- **Frequency:** Quarterly (partial inventories) and Annual (general inventory).

The aggregation of these five indicators allows for the construction of a multidimensional performance matrix, surpassing simple accounting evaluation of stocks. By cross-referencing clinical availability data with logistical constraints, this methodology aims to identify correlations between procurement policy and the operational resilience of the institution.

IV. *RESULTS* AND *DISCUSSION*

A. *Results*

The analysis of management data for the year 2023 allowed for the evaluation of the central pharmacy's logistical performance across five dimensions.

- **1) Evaluation of Expiration Rate:** A correlation exists between storage levels and expiration risk. Overstocking was identified for several references (medical devices and solutions), exceeding annual needs. This saturation complicates the application of the FEFO (First Expired, First Out) rule, generating avoidable waste, primarily among slow-moving or overstocked references.
- **2) Evaluation of Stockout Rate:** The situation is contrasted; while high-volume products are generally available, supply instability affects several vital medicines. Total physical stockouts were observed for specific critical therapeutic classes (anesthesia, infectiology), forcing the use of therapeutic alternatives.
- **3) Evaluation of Service Satisfaction:** Feedback reveals a dual perception. While the pharmacy's responsiveness to urgent requests is viewed positively, stockout episodes for specific molecules negatively impact satisfaction by generating additional administrative work for caregivers.
- **4) Evaluation of Delivery Compliance:** Upstream performance is a critical vulnerability. The root cause of unavailability is often external, specifically unsuccessful purchasing procedures. This supplier failure creates supply gaps that internal management cannot compensate for.
- **5) Evaluation of Inventory Reliability:** Comparisons between the Hospital Information System (HOSIX) and physical stocks reveal traceability gaps. Bidirectional discrepancies (shortages and surpluses) signal movements not recorded in real-time, which risks biasing automated replenishment calculations.

B. Discussions

- **1) Critical Dependence on the Supplier Market:** There is a strong correlation between stockouts and unsuccessful purchasing procedures. Hospital stockouts are often the direct consequence of market shortages or lack of supplier interest in certain molecules. Consequently, purchasing strategy must shift from administrative competition to partnership security (multi-year contracts) for vital drugs to guarantee continuity.
- **2) The Inventory Management Paradox:** The hospital simultaneously faces stockouts on vital products and massive overstocking on others, suggesting rigid forecasting. Overstocking is a financial and logistical risk rather than a security measure.
- **3) Data Reliability as a Prerequisite for Automation:** Inventory discrepancies highlight the fragility of the information system. Attempting automation without near 100% data reliability would amplify errors (ordering overstocked items or missing invisible stockouts).

ISSN: 2961-6611

Proceedings of Book Series PBS - Vol 30, pp.52-58 **Emerging Approaches in Modern Business**

V. CONCLUSIONS

This study demonstrated that the optimization of pharmaceutical inventory management fundamentally relies on the definition and rigorous monitoring of Key Performance Indicators (KPIs). By analyzing data from CHU Oujda, we were able to identify critical consumption patterns by service, evaluate stock coverage, and measure inventory reliability. These KPIs revealed major operational dysfunctions: excessive stocks on one side (immobilizing financial resources) and imminent stockouts on the other (compromising continuity of care). However, this research highlights a significant gap between computerized data and the physical reality of stocks. Future research must deepen this comparative analysis of actual stock versus computerized stock to understand the sources of divergences and strengthen the reliability of the decision-making system. Only complete mastery of this discrepancy will allow for the true optimization of operational efficiency and guarantee pharmaceutical availability in the service of patients.

ACKNOWLEDGMENT

This work was supported by the National Center for scientifc and Technical Resarch (CNRST) through the PhD- Associate Scholarship-(PASS) program. The authors would like to thank the Director, the staff, and the department heads of the hospital pharmacy at CHU Oujda for their time, effort, and support.

REFERENCES

[1] D. B. B. Marina Papalexi, «Key sources of operational inefficiency in the pharmaceutical supply chain, » Supply Chain Management: An International journal p 617 2020.
[2] C. P. Y. B. Tarek Abu Zwaida, Optimization of Inventory Management to Prevent Drug Shortages in the Hospital Supply Chain,» p. 1, 2021.
[3] V. R. D. Kapoor D1, «An Overview on Pharmaceutical Supply Chain: A Next Step towards Good Manufacturing Practice,» Drug Designing & Intellectual Properties, p 49, 2018.
[4] P. d. A. Mazer-Amirshahi, Critical drug shortages: Implications for emergency medicine,» J. . Acad. Emerg. Med PubMed, pp. 704-711, 2014.
[5] C. Postacchini, «Observations of Waves and Currents From the River Drifter.,» IEEE J. Ocean. Eng, 2015.
[6] E. S. S. M. K. Reza Rajabi, «Design and optimization of a pharmaceutical supply chain network under COVID-19 pandemic disruption,» Sustainable Operations and Computers, vol. 5, pp. 102-111, 2024.
[7] O. B. e. al., «Enhancing pharmaceutical supply chain resilience: A multi-objective optimization approach,» Computers and idustrial engineering, 2024.
[8] N. Z. Fatemeh Shekoohi Tolgari, «A robusT reverse pharmaceutical supply chain design considering perishability and sustainable development objective,» Annals of Operations Research, vol. 340, 2024.
[9] A. K. H. ,. H. ,. Hansen, «dentification of key drivers for improving inventory management in pharmaceutical supply chains,» Production Engineering Research and Development,» vol. 17, p. 764, 2023.
[10] S. H. Salma BOURKANE, «Optimizing operational efficiency: a study of performance control,» IJAFAM, vol. 4, pp. 369-385, 2023.
[11] A. Moosivand, «An application of multi-criteria decision-making approach to sustainable drug shortages management: evidence from a developing country,» Journal of pharmaceutical health care and science, 2021.
[12] B. Adedeji B, Industrial Innovation Series, CSC PRESS, 2014.
[13] L. R. J. S. Adire Simon Deng, «Heuristics and the Performance of Financial Institutions in South Sudan,» Modern economy, vol. 11, 2020.
[14] J. K. Aronson, «Drug shortages. Part 1: Definitions and harm,» ritish Journal of Clinical Pharmacology,, 2023.
[15] Z. Shukar, «Drug Shortage: Causes, Impact, and Mitigation Strategies,» Front.pharmacol, vol. 12, 2021.
[16] F. G. H. S. G. F. Z. J. M. I. A. Rekabi, «A data-driven mathematical model to design a responsive-sustainable pharmaceutical supply chain network,» Annals of Operations Research, 2023.
[17] C. Tang, «Robust strategies for mitigating supply chain disruptions,» International Journal of logistics: Research and Applications, , vol. 9, pp. 33-45,2006.
[18] B. P. L. R. A. Z. Eladio Domínguez, «A taxonomy for key performance indicators management,» Computer Standards & Interfaces, vol. 64, 2019.
[19] T. Y. Firoozeh Haddadi, «Key indicators for organizational performance measurement,» Growing Science, 2014.
[20] I. ,. H. ,. H. Badawy . Abd El-Aziz a, «A survey on exploring key performance indicators,» Future Computing and Informatics Journal, vol. 1, 2016.
[21] C. Oujda, «Site officiel du CHU Mohammed VI d'Oujda CHU Mohammed VI Oujda,»
[22] T. Kenza, «Contribution à l'amélioration de la disponibilité des produits,» Fes, 2018.

ISSN: 2961-6611