Advancing Healthcare Service Efficacy by Optimizing Pharmaceutical Inventory Management: Leveraging ABC, VED Analysis for Trend Demand

G. Umadevi and S. Umamaheswari*

Division of Mathematics, School of Advanced Sciences, Vellore Institute of Technology, Chennai, Tamil Nadu, India

Abstract: *Background*: The modern world has witnessed significant advancements across various industries such as food, healthcare, fashion, economics, and education. Among these sectors, healthcare is essential, given its critical role in promoting the well-being of individuals and communities.

Purpose: Pharmaceuticals are a significant part of the healthcare system, as they are a crucial factor in increasing life expectancy and are often considered the heart of the health industry. Maintaining effective inventory management for drugs is essential for pharmacists to provide efficient and reliable services to their patients.

Methodology: The study thoroughly analyzes the cost and consumption data for each type of demand, to develop a well-suited review and issuance policy for the apothecary.

Research Limitations/Implications: The paper delves into the ABC analysis, VED analysis, and trend demand for medical stores, making it a valuable resource for pharmacy stores seeking to optimize their operations and inventory management.

Originality/Value: A total of 564 drugs were included in this study, and data were collected from random strip sales between October 2022 and Mar 2023. The study's findings can be used to make informed decisions about inventory planning and classification strategies. The model utilized in this study is based on three categories of medicines: high priority, medium priority, and low priority. By analyzing the demand for these medicines, they can be categorized based on their priority within the three core groups. Pharmacists can use the model to detect shortages and take proactive measures to avoid them by analyzing demand patterns and inventory levels.

Keywords: ABC analysis, ABC-VED matrix, Pharmaceuticals, Trend demand, VED analysis.

1. INTRODUCTION

The inventory models mainly give the specific attendance for decaying, perishable, obsolescence items, etc. These models enable organizations to make informed decisions regarding the appropriate inventory levels to maintain, the timing of orders, and the allocation of resources to ensure the smooth flow of goods. Designed the optimal inventory model to minimize the total expected cost for deteriorating items with a non-negative lead time within a finite horizon. The model underwent consecutive period analysis [1]. A sustainable EOQ model that manages carbon emissions and deterioration rates by incorporating price-dependent demands was proposed [2]. In the study carried out the optimal order quantity was attained by eliminating the entire backlog and sustaining constant replenishment [3]. Efficiently managing a pharmaceutical inventory ensures timely access to vital medications and medical supplies, particularly for patients who rely on them. Shortages can have serious repercussions, affecting supply chains, prices, access to vital resources, and causing instability. Due to their limited shelf lives, pharmaceuticals require careful monitoring of expiration dates to prevent wastage and ensure the delivery of safe and effective treatments. To prevent loss of efficacy and minimize wastage, pharmaceuticals must be monitored carefully for expiration dates to avoid wastage. Pharmaceutical inventory encompasses a vital component of blood inventory. Research endeavors within the realm of blood inventory management are ongoing and multifaceted. Discussed the determination of the best method for supplying replacement transfusions to neonatal patients [4]. The advent of prospective reimbursement added pressure to the blood bank to control losses by reducing outdating, minimizing product waste, avoiding unnecessary transfusions, and cutting down on laboratory testing. They Investigated a discrete-time inventory system for a perishable product, specifically blood platelets, which featured distinct demand streams for products of varying ages [5]. The modeling framework incorporated inventory holding, outdating, and shortage costs, along with substitution costs for fulfilling the demand for an item of a particular age with an item of a different age. Demonstrated how the

*Address correspondence to this author at the Division of Mathematics, Vellore Institute of Technology, Chennai-600127, India;
E-mail: umamaheswari.suk@vit.ac.in

Subject classification: 90B05.

distinctive problem-solving approach of the Theory of Constraints was instrumental in devising efficacious and uncomplicated solutions to increase the operations of blood banks in resource-constrained regions [6]. In this context, the first policy for issuing Red Blood Cells (RBC) in the A1A2BO system, considering the prioritization of patient treatment was developed. This issuing policy aimed to minimize shortages of A subtypes while maximizing the service level, thereby enhancing inventory management within the sector [7]. In the pharmaceutical realm, drugs occupy a position of paramount importance. Researchers and innovators continually focus on developing novel medicines, optimizing existing formulations, and ensuring their safety and efficacy. Perishable items like pharmaceuticals have a limited lifespan and deteriorate after a specific period, so they need additional consciousness. Ensuring patient safety necessitates effective and efficient management of these items. This study investigated the most effective strategies for pharmaceutical management and the associated risks while offering guidance on risk reduction. Pharmaceutical inventory involves maintaining optimal stock levels, monitoring consumption patterns, identifying underutilized items, improving profitability, and meeting customer demands. Pharmaceutical inventory management involves several crucial parameters, including demand, reorder point, buffer stock, lead time, and more. This paper particularly emphasizes the primary parameter, which is demand. Evaluate the usage trends in demand and establish a suitable policy for the review and issuance process. This study primarily concentrates on the classification of drugs based on retrospective data, categorizing them into four distinct demand patterns: smooth, intermediate, erratic, and lumpy. After constructing the Always Better Control (ABC) and VED (Vital, Essential, and Desirable) analyses, the paper developed a cost matrix to illustrate the finding of the optimum cost and provide insights into drug classification.

2. LITERATURE REVIEW

This literature review offers a comprehensive survey of key themes, emerging trends, and significant findings in the field of perishable inventory management, specifically within the pharmaceutical industry. By synthesizing and analyzing relevant literature, this review clarifies prevailing theories and perspectives while actively enhancing the ongoing discourse on inventory management. Furthermore, it lays the groundwork for the investigation presented in this paper, which appraises developing novel inventory management methodologies. Enhanced the Pareto analysis by introducing a multi-criteria approach to the ABC analysis. This innovation built upon the foundation of earlier work in this field, such as Vilfredo Pareto's classic 80/20 principle. This extended analysis involves considering joint criteria within a cost matrix, factoring in elements like dollar values, lead time, criticality, and obsolescence [8]. Developed an ABC-VED coupling matrix model to categorize drugs and reduce the selection to a smaller subset. The application of the cost inflation index justified an increase in the annual budget [9]. A study established that the primary focus of the inventory control system in hospital logistics is to reduce losses while effectively managing the balance between having excess inventory and facing shortages and achieving this through the application of different criteria [10]. Identified that a good percentage of postgraduate pharmacists have acquired knowledge about the vital role of inventory management proficiency in optimizing drug procurement and cost decisions. It also emphasizes the pressing necessity for fresh graduates and university pharmacists to actively seek opportunities to acquire the knowledge and skills required in this domain [11]. A study highlights the importance of conducting such analyses regularly and applying inventory management tools to ensure the pharmacy is managed effectively and efficiently, as well as closely monitoring items in supreme categories. The researchers communicated their findings and inventory classifications to the drug store officials, who then incorporated this information into their decision-making processes for purchasing, storing, and monitoring pharmacy items [12]. The application of inventory control techniques in the primary healthcare setting significantly improved patient care and the efficient utilization of resources [13]. Discussed ABC and VED analysis and identified the drugs that required stringent control for optimal fund utilization and eliminating out-of-stock situations in the pharmacy [10]. Inspected inventory control techniques in healthcare, aiming to enhance patient care, customer relationships, and the optimal utilization of resources. Their study analyzed pharmacy drug inventory based on cost and criticality properties [14]. This research suggested the importance of prioritizing the first category of the ABC-VED matrix, as it represented the most critical and costly items while diminishing emphasis on the third category due to its lower cost and non-critical nature [15].

The prior literature neglects the review policy and the significance of projective demand in drug

Table 1: A Comparative Assessment of Inventory Analysis to Enhance Work Efficiency

Authors	ABC	VED	ABC-VED	Projective Demand	Software
Thawani [9]	Yes	Yes	Yes	No	MS-Excel
Devani [16]	Yes	Yes	Yes	No	MS-Excel
Wandalkar [17]	Yes	Yes	Yes	No	MS-Excel
Kumar [18]	Yes	Yes	Yes	No	MS-Excel
Mathew [10]	Yes	Yes	Yes	No	MS-Excel
Mohammed [19]	Yes	Yes	Yes	No	MS-Excel
Amer [15]	Yes	Yes	Yes	No	MS-Excel
Enhance Work Efficiency [Proposed]	Yes	Yes	Yes	Yes	Python 3.1

management. This paper addresses these gaps by examining demand patterns with the aid of Python code, utilizing the previous month's sales data. The implementation of a review policy ensures efficient monitoring and ordering, distinguishing this approach from others relying on Excel for similar tasks.

2.1. Research Gap

1. The pharmaceutical industry's substantial commitment to research and development actively enhances the lives of individuals with chronic conditions by uncovering new drugs and therapies. Simultaneously, it addresses emerging challenges and fosters global health equity.

2. The previously mentioned literature focused on conducting ABC and VED analyses for pharmacy stores, using a research sample of 500 drugs or fewer, spanning over one year. However, it didn't specify the criteria for drug selection. In contrast, this paper covers trending demand, ABC analysis, and VED analysis and provides information about the types of drugs included in the study.

3. Assessing the flow of drugs through trend demand is vital for pharmacy stores, aiding in ordering quantities and, as a result, minimizing drug wastage.

2.2. Research Problem

Retrospective data analysis has proven to be a valuable tool for pharmaceutical management and inventory control. By leveraging this approach, businesses can better allocate resources and reduce costs, leading to more efficient operations and improved outcomes. In the context of a study conducted between October 2022 and June 2023, 564 general medicines in the form of strips and some ointments have been randomly selected, and their demand patterns have been analyzed. To effectively manage these medicines, it has been crucial to understand their demand characteristics. This study has employed two key parameters: Average Demand Interval (ADI) and the squared coefficient of Variation (CV^2). ADI has quantified the time between successive demands, while CV^2 has measured the variability of demand. Together, these parameters have helped classify the drugs into different demand categories, enabling more accurate forecasting. To enhance the categorization of drugs based on their significance and criticality, effective ABC and VED classification techniques are applied. By analyzing the cost matrix derived from ABC and VED classifications, it has become possible to identify priority drugs and allocate resources accordingly. Conducting a thorough scrutiny of these medicines will provide us with valuable insights that can be leveraged to improve the availability and accessibility of these life-saving drugs. Additionally, empowers pharmacists to streamline inventory levels and facilitates reducing unnecessary costs, ensuring that everyone who needs these medicines can access them without any hindrances.

2.3. Highlights of the Model

1. Presently, the emphasis lies on the development of trending demand and the implementation of ABC and VED analysis in pharmacy management to enhance efficiency.

2. The ongoing objective of this study is to forecast product trends and align them with upcoming periods, a critical component for successful management.

3. This research is also dedicated to uncovering the cost matrix to improve cost proficiency and increase the profit margin (Figure **1**).

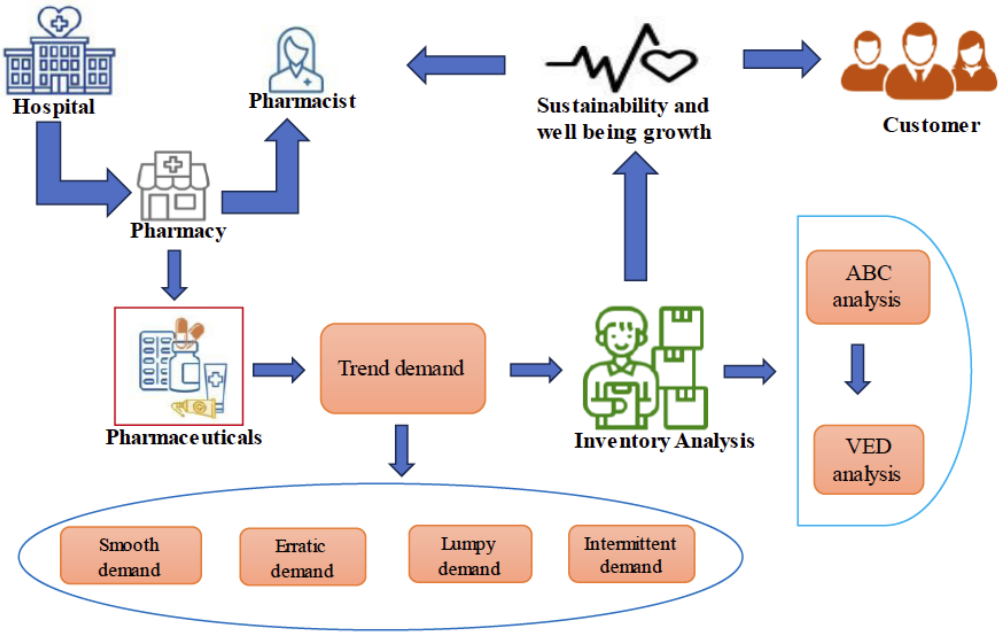

Figure 1: Naturalistic Study (Graphical Abstract).

3. MATERIALS AND METHODS

3.1. Model Formulation

Enhancing the proficiency of pharmaceutical inventory management requires the identification and implementation of a suitable model tailored for pharmacists (Figure **2**). The proposed design prompts users to organize their datasets by considering demand trends, using metrics such as CV^2 and ADI. Following this, users are instructed to apply inventory analysis to minimize costs while maintaining a reliable medication supply. This approach can lead to inventory optimization, reduced stockouts, and ultimately, ensure the availability of essential medicines.

Figure **2** visually depicts the sequential steps involved in the methodologies applied within the pharmaceutical context. Initially, the sales and purchase data are gathered from the primary pharmacy store. Subsequently, the sales data undergoes analysis and segmentation through product forecasting. Further steps include conducting an ABC analysis for purchase costs and a VED analysis for sales data. Ultimately, the

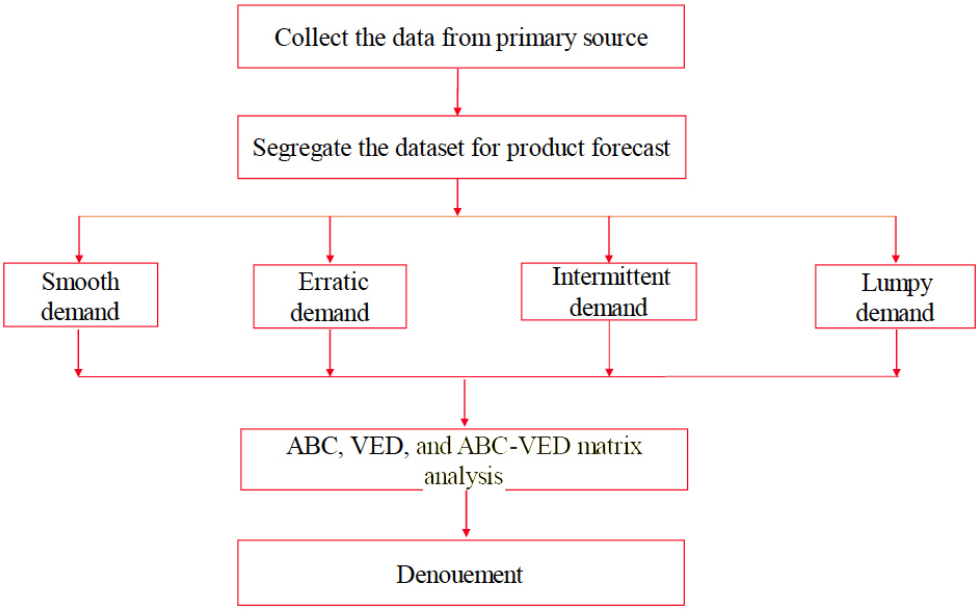

Figure 2: Schematic Flowchart of the Proposed Model.

ABC-VED matrix analysis is employed to ascertain the significance of drugs in terms of both cost and sales. Conclusions are then drawn based on the insights derived from these analyses.

3.2. Methodology

In the analysis of the 564 emerging drugs from the pharmaceutical data. Datasets analyzed based on forecasts require Average Demand Index (ADI) and Coefficient of Variation squared (CV^2) metrics The ADI guides demand planning and inventory management by maintaining balanced inventory levels to satisfy customer needs, while the CV^2 assesses demand variability, aiding in refined inventory control. This combination of metrics helps to establish a reliable supply of crucial healthcare goods and reduces wastage and expenses. These metrics help to identify outliers and analyze the stability of the data. Additionally, they can be used to compare different data sets.

$$ADI = \frac{Total\ number\ of\ periods}{No.\ of\ non\ zero\ demand\ periods}$$

$$CV^2 = \frac{(standerd\ divation\ of\ population)^2}{(Average\ demand)^2}$$

3.2.1. Trend Demand

The ADI and CV^2 criteria are utilized to maintain a standardized approach in categorizing drugs according to their demand trends. Using ADI and CV^2, drugs are categorized based on their demand trend:

- If $CV^2 < 0.49$ and $ADI < 1.32$, it is called Smooth demand.
- If $CV^2 \geq 0.49$ and $ADI < 1.32$, it is called Erratic Demand.
- If $CV^2 < 0.49$ and $ADI \geq 1.32$, it is called Intermittent Demand

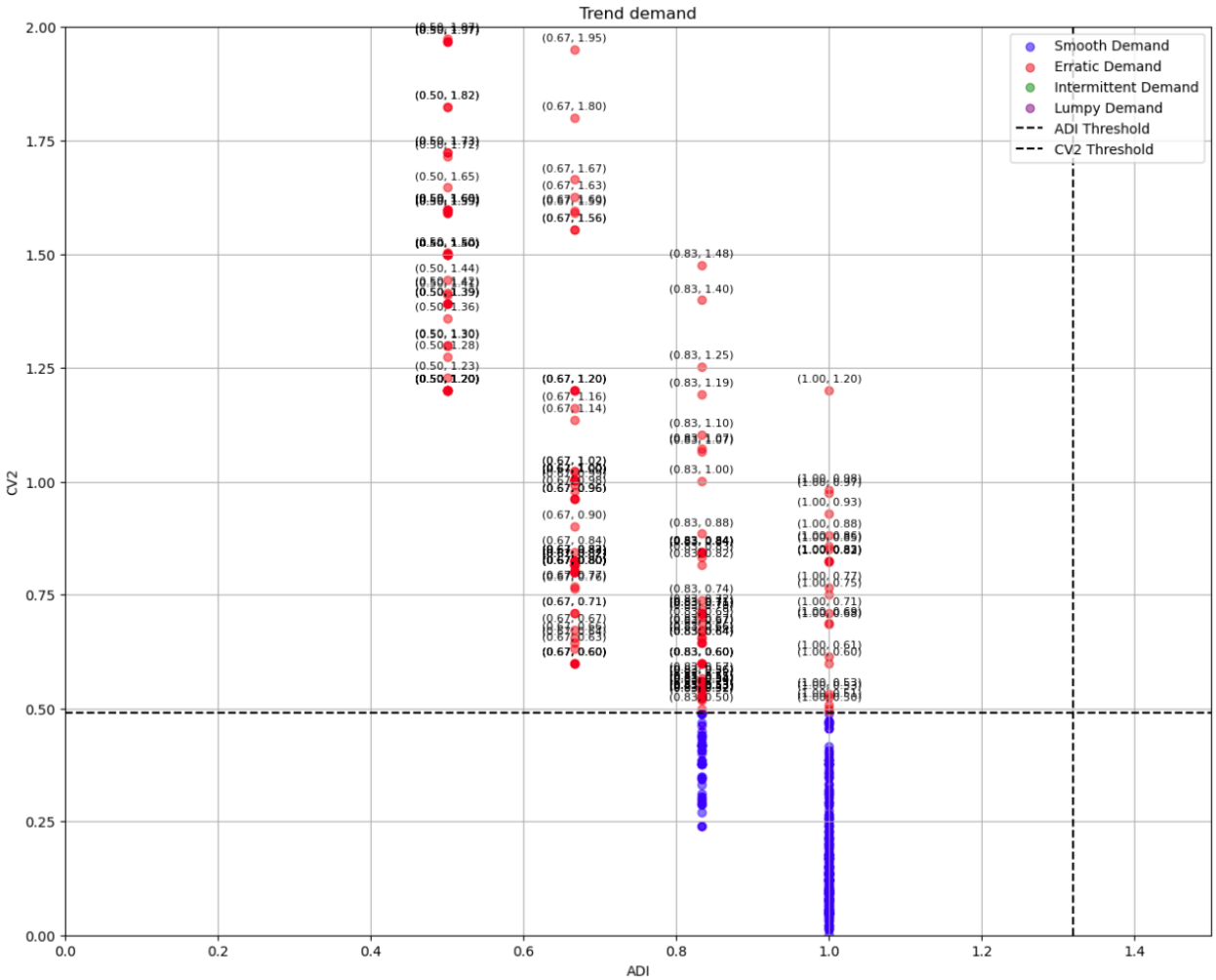

Figure 3: Trend Demand Forecasting (Oct 2022 to Mar 2023).

- If $CV^2 \geq 0.49$ and $ADI \geq 1.32$, it is called Lumpy Demand.

Figure **3** provides a graphical depiction of the demand trend based on the specified criteria. Importantly, this study did not identify instances of intermittent or lumpy demand, further accentuating the contrast between smooth and erratic demand in the pharmaceutical inventory landscape. This highlighted the significance of implementing a crucial continuous review policy for effectively managing both types of demand and achieving customer contentment.

3.2.1.1. Smooth Demand

When the CV^2 is below 0.49 and the ADI is under 1.32, it qualifies as a case of smooth demand. Smooth demand analysis helps pharmacists streamline their workflow by optimizing filling schedules and dispensing processes, enhancing efficiency, and reducing costs, which benefits both pharmacists and pharmacy stores. The product forecast method identified 269 drugs following smooth demand out of 564 in the first six-month dataset (Figure **4**). Afterward, the next three months' predictions, based on previous smooth demand results, indicated a match of 226 (61.71%) drugs out of the total 564. These medicines have consistently maintained average sales throughout the period. To meet these demands, pharmacists should also ensure the continuous availability of stocks as required. Therefore, pharmacists must stay informed about these medicines, their sales, and usage patterns.

3.2.1.2. Erratic Demand

A demand is considered erratic when its CV^2 is greater than or equal to 0.49 and its ADI is less than 1.32. Comprehending unpredictable demand is essential for pharmacy stores to refine inventory control, avoiding remnants or shortages. Erratic demand is identified in 293 drugs in the initial six months out of 564 items using the product forecasting technique (Figure **5**). The last three months dataset matches 158 (53.92%) drugs with the predicted erratic

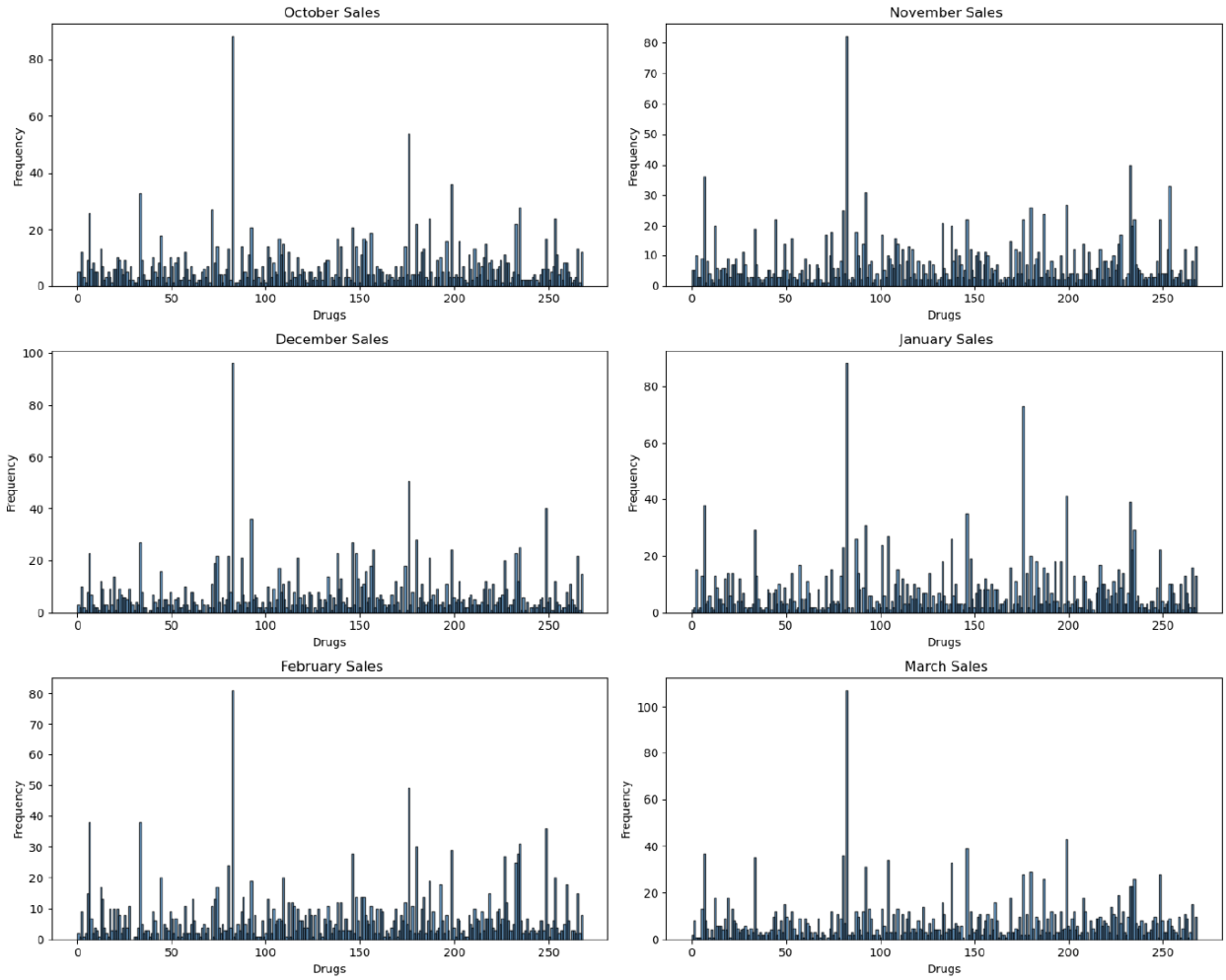

Figure 4: Sales Representation of Smooth Demand Drugs (Oct 2022 to Mar 2023).

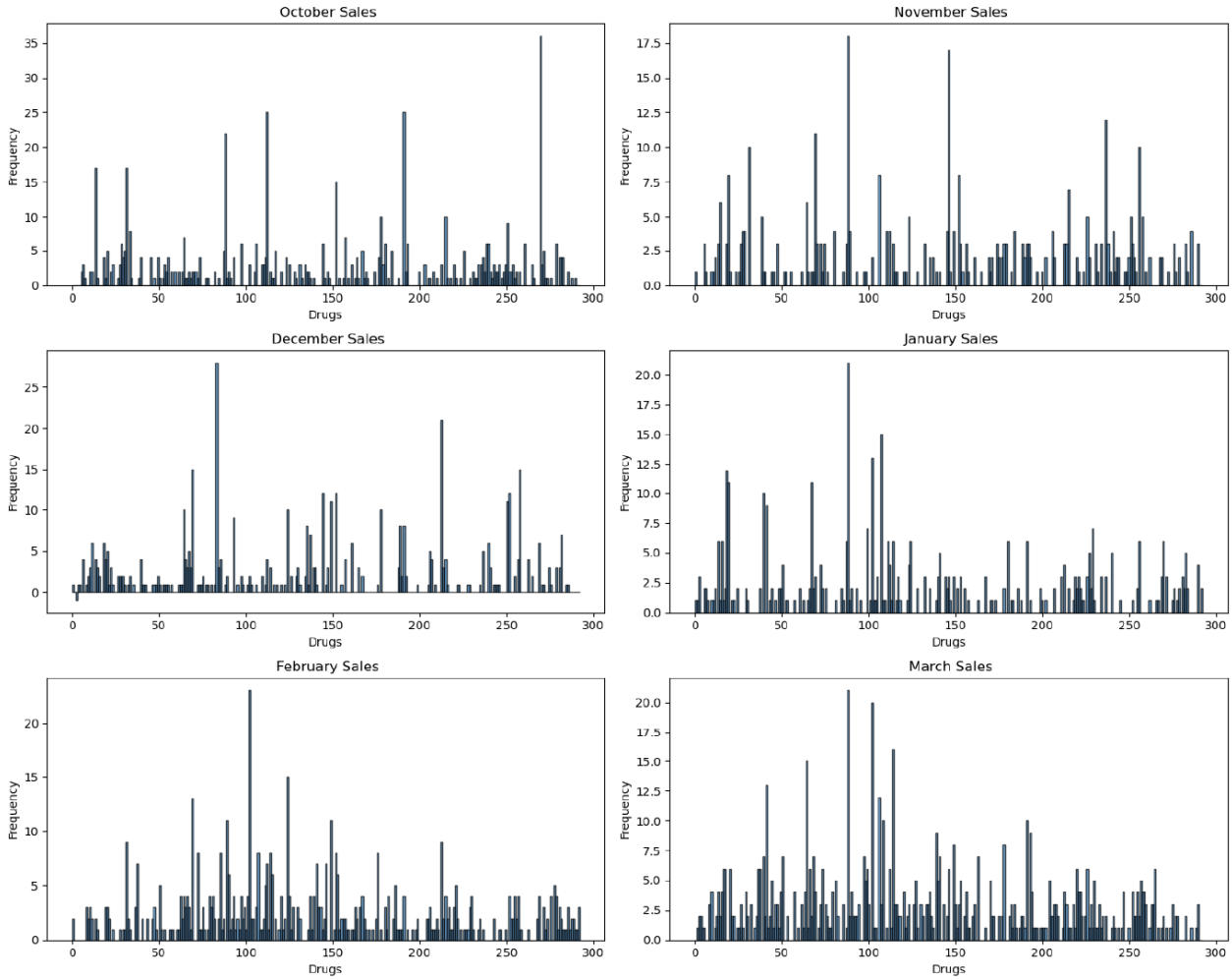

Figure 5: Sales Representation of Erratic Demand Drugs (Oct 2022 to Mar 2023).

demand from the previous set. This adaptability is fundamental for pharmacists in delivering uninterrupted patient care. Furthermore, adept demand management results in cost reductions, benefiting stakeholders.

3.3. Classification

The ABC and VED classifications analyze the data using the cost and item parameters effectively according to the conditions and requirements of the pharmacist. These classifications help them to optimize the cost of items and minimize the loss.

3.3.1. ABC Analysis

ABC classification determines the usage and cost reduction of drugs. A category accounting for 70% of the expense value. B classifies 20% of the cost consumed, while C categorizes 10% of the cost consumption. Table **2** categorizes the 564 drugs into A, B, and C groups based on cost precedence, ensuring a clear and decisive sorting of medications. A-category constitutes 154(27.30%) items and consumes 69.99% of expenditure of purchase cost. The B category consumes 162 (28.72%) commodities and contributes

Table 2: ABC Plan (Oct 2022-Mar 2023)

Classifications	Items	Items (%)	Cost (%)	Purchase Cost
A	154	27.30	69.99	1044587.39
B	162	28.72	20.00	298605.16
C	248	43.97	10.00	149284.94
TOTAL	564	99.99	99.99	1492477.49

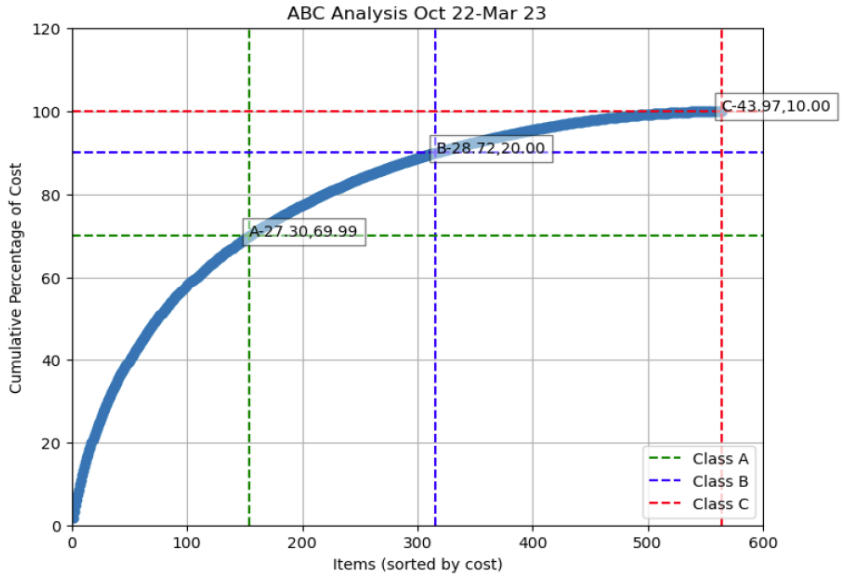

Figure 6: ABC Analysis of 564 Drugs.

20.00% of procurement cost, and the C category consumes a minimal purchase cost of 10.00%, encompassing 248(43.97%) products. Figure **6** provides a visual representation of these findings, highlighting the financial impact of each category. A significant portion of the expenditure is associated with A-category items, whereas B and C-category items contribute relatively less to the costs. This classification makes the purchases appreciable and more credible.

3.3.2. VED Analysis

The VED analysis is an essential tool for any pharmaceutical business aiming to orient with customer requirements. By thoughtfully categorizing products based on sales and costs from a business perspective, this approach provides a comprehensive classification system that enables informed decision-making. In the VED analysis, there are 68 items classified as vital, representing 12.05% of all items, yet they incur a significant 30.69% of the total costs. In the essential category, 276 items make up 48.94% of the items, contributing to 31.53% of the costs. The desirable category comprises 220 items, accounting for 39.01% of the items and 7.07% of the costs. Table **3** offers a clear presentation of the financial discrepancies, with 30.71% of the purchase cost failing to match the corresponding sold-out cost during the six months. Upon comparing the results from Tables **2** and **3**, a financial loss of Rs. 458,324.71 is apparent in the sales cost. These statistics offer valuable insights for optimizing strategic resource management and choice determination.

3.3.3. Cost Matrix

The first six months of data list 564 drugs according to their value (ABC) and criticality (VED)by applying the ABC-VED matrix analysis. In Table **4**, drugs are split into classes of AV, AE, AD, BV, CV, BE, BD, CE, and CD. Categorizing drugs according to their significance provides a beneficial framework. Within this system, drugs in class I (AV+AE+AD+BV+CV) are deemed highly significant, drugs in class II (BE+BD+CE) are considered moderately significant, and drugs in class III (CV) are regarded as having low significance. In Table **4**, the ABC-VED matrix categorizes items into three distinct groups, with the first category (AV+AE+AD+BV+CV) comprising 171 items, incurring a total expenditure of Rs.1,072,223.53(71.84%). The

Table 3: VED Analysis (Oct 2022 to Mar 2023)

Classifications	Items	Item (%)	Soldout Cost (Rs)	Cost (%)
V	68	12.05	458,059.78	30.69
E	276	48.94	470,585.27	31.53
D	220	39.01	105,507.73	07.07
TOTAL	564	100.00	1,034,152.78	69.29

Table 4: Cost Matrix of ABC-VED

ABC-VED	V	E	D
A	52	95	7
B	11	115	35
C	6	65	178

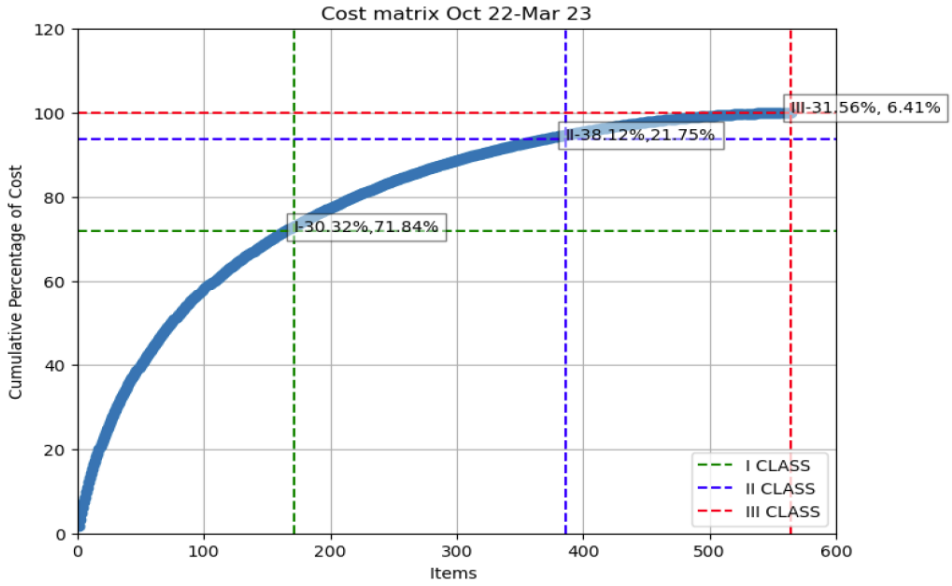

Figure 7: Cost Matrix of 564 Drugs.

second category (BE+BD+CE) encompasses 215 items, with combined expenses amounting to Rs.324,646.96(21.75%), while the third category (CV) comprises 178 items with a total expenditure of Rs. 95,607.12 over six months. A visual representation of this data is presented in (Figure **7**), highlighting the cumulative percentage of the cost matrix. This methodology has a focal role in optimizing pharmaceutical inventory management for enhanced operational efficiency.

4. RESULTS

This section dedicates itself to offering a clear account of outcomes from the pharmacy-oriented methodology, emphasizing trending demand and the use of the ABC, VED, and ABC-VED matrix analysis for classification. It provides a thorough discussion of results obtained through a meticulous analysis of the 564 drugs from Oct 22 – Mar 23.

4.1. Findings in Trend Demand

The product forecasting technique stratifies drugs based on their demand trends, facilitating the identification of both stable and unpredictable patterns in pharmaceuticals. Derived from the earlier results, the demand forecast is harmonized with the three-month dataset of April 2023 to June 2023.

- 61.71% of medicines experienced smooth demand in the subsequent months. The remaining 29% of consistent demand transitioned to erratic, while 9.29% remained unsold.

- Within the initially erratic demand category, 53.92% of medicines transitioned to a stable demand pattern over three terms. 25.60% continued to experience erratic demand, and 20.47% shifted to soft demand.

4.2. Findings in Classifications

The ABC analysis assesses the procurement cost, while the VED analysis focuses on the sales cost. This evaluation has uncovered a 30.71% loss in selling price as indicated by the VED survey. Ultimately, pharmaceuticals are categorized based on both cost and criticality values using the cost matrix.

5. DISCUSSION

This discussion accentuates the importance of providing advice and recommendations to pharmacists. By considering these insights and aligning their practices with the findings, pharmacists can better navigate the complexities of the pharmaceutical industry and enhance their inventory management. The combined application of demand analysis and tools like the ABC-VED matrix serves as a complete strategy to achieve efficient and sustainable pharmaceutical inventory management. To address these challenges effectively, pharmacists must identify the root causes behind these fluctuations and take proactive measures to optimize inventory. The cost matrix is a valuable tool for prioritizing essential drugs based on need. However, it's important to note that relying solely on trend demand or the cost matrix is inadequate. A comprehensive approach that integrates the demand analysis and cost matrix assessment is essential for pharmaceutical inventory management. This approach ensures that the acquisition and stocking of critical medicines align with market demands.

6. CONCLUSION

In conclusion, this research has explored indispensable aspects of managing pharmacy stores, focusing on trending demand, classification, and cost matrix analysis. The study identified two distinct demand patterns: smooth and erratic. This research utilized ABC and VED analysis to decisively uncover crucial insights into the purchase and sales costs of pharmaceuticals over the past six months, providing a solid foundation for cost optimization and improved profitability. It is evident from the findings that there was a substantial loss of Rs.458,324.71 (equivalent to 30.71%) in the purchased price, highlighting the urgency for effective management strategies. The cornerstone of this research lies in the novel concept of Trend Demand, which plays a pivotal role in the efficient management of pharmaceutical inventory. Trending demand assists in predicting the requirements of the drugs. This predictive capability is a game-changer, as it not only informs us about the types of medicine in demand but also guides us in determining the optimal quantities to order. The cost matrix is a powerful tool for identifying priority drugs.

The approach provided a structured way to evaluate the economic aspects linked to the procurement of drugs. The combined application of Trend Demand and the Cost Matrix summarizes the comprehensive strategy to enhance pharmaceutical inventory management. Trend Demand equips professionals with predictive awareness, enabling them to stay ahead of market dynamics, while the Cost Matrix offers a financial perspective, prioritizing resources for maximum impact. The combination of these approaches serves as a solid basis for efficient and long-lasting management of pharmaceutical inventory. In the future, there is substantial potential for expanding this model and incorporating artificial intelligence for more advanced analysis in the pharmaceutical industry. By building upon the foundations laid in this paper, the sector can continue to evolve and refine its operations, ultimately achieving greater cost-effectiveness and making significant contributions to the broader field of pharmacy management.

CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

ACKNOWLEDGEMENTS

We would like to acknowledge the Vellore Institute of Technology, Chennai, for the infrastructural support in carrying out this research work. We are grateful to Rajendar Gowrishankar, proprietor of LAL MEDICALS, for providing crucial data that significantly contributed to the accomplishment of this study.

REFERENCES

[1] Umamaheswari S, Chandrasekeran E, Vijayalakshmi C. Design and analysis of an optimal inventory model for perishable goods with fixed lifetime. Indian Journal of Science and Technology 2016; 9(25): 1-5. https://doi.org/10.17485/ijst/2016/v9i25/85023S

[2] Mishra U, Wu J-Z, Tsao Y-C, Tseng M-L. Sustainable Inventory System with Controllable Non-instantaneous Deterioration and Environmental Emission Rates. Journal of Cleaner Production 2020; 244. https://doi.org/10.1016/j.jclepro.2019.118807

[3] Jayashri P, Umamaheswari S. O2Q: Deteriorating Inventory Model with Stock-Dependent Demand Under Trade Credit Policy. In: Venkataraman N, Wang L, Fernando X, Zobaa AF. (Eds.) Big Data and Cloud Computing. ICBCC 2022. Lecture Notes in Electrical Engineering, Springer, Singapore 2023; 1021. https://doi.org/10.1007/978-981-99-1051-9_22

[4] Suzanne H. Butch. Blood Inventory Management. Laboratory Medicine 1985; 16(1): 17 20. https://doi.org/10.1093/labmed/16.1.17

[5] Civelek I, Karaesmen I, Scheller-Wolf A. Blood Platelet Inventory Management with Protection Levels. European Journal of Operational Research 2015; 243(3): 826-838. https://doi.org/10.1016/j.ejor.2015.01.023

[6] Lowalekar H, Raghavendra RR. Revolutionizing Blood Bank Inventory Management using the TOC Thinking Process: An Indian Case Study. International Journal of Production Economics 2017; 186: 89-122. https://doi.org/10.1016/j.ijpe.2017.02.003

[7] Chithraponnu R, Umamaheswari S. An Anatomization of Study on OID Policy in Blood Inventory Management. NeuroQuantology 2022; 20(10): 1098-1113. http://dx.doi.org/10.14704/nq.2022.20.10.NQ55085

[8] Flores BE, Clay Whybark D. Multiple Criteria ABC Analysis. International Journal of Operations & Production Management 1986; 6 (3): 38-46. https://doi.org/10.1108/eb054765

[9] Thawani V, Turankar A, Sontakke S, Pimpalkhute S, Dakhale G, Jaiswal K, Gharpure K, Dharmadhikari S. Economic analysis of drug expenditure in government Medical College hospital, Nagpur. Indian Journal of Pharmacology 2004; 36(1): 15-19.

[10] Saha E, Ray PK. Inventory Management and Analysis of Pharmaceuticals in a Healthcare System. In: Ray P, Maiti J, (Eds.) Healthcare Systems Management: Methodologies and Applications. Managing the Asian Century. Springer, Singapore 2018. https://doi.org/10.1007/978-981-10-5631-4_7

[11] Hind A, Salah K, Mousnad A. Pharmaceutical Inventory Control in Sudan Central and Hospital Stores using ABC-VEN Analysis. Global Drugs and Therapeutics 2019; 4(10). http://dx.doi.org/10.15761/GDT.1000172

[12] Mathew B, Panavila L, Sindhu K, Rajaneesh P, Bharath V, Doddayya H. A Study on Inventory Management by ABC, VED and ABC-VED Matrix Analysis in Pharmacy Department of a Tertiary Care Teaching Hospital. Asian Journal of Pharmaceutical and Health Sciences 2016; 6(4).

[13] Vaz FS, Ferreira AM, Kulkarni MS, Motghare DD, Pereira-Antao I. A Study of Drug Expenditure at a Tertiary Care Hospital: An ABC-VED Analysis. Journal of Health Management 2008; 10(1): 119-127. https://doi.org/10.1177/097206340701000107

[14] Ceylan Z, Bulkan S. Drug Inventory Management of a Pharmacy using ABC and VED Analysis. Eurasian Journal of Health Technology Assessment 2017; 2(1): 14-18.

[15] Amer HY, Jawad MK. Inventory Analysis Using the ABC-Ved Matrix - Applied Research in Al-Zawraa State Company. International Journal of Professional Business Review 2023; 8(5). https://doi.org/10.26668/businessreview/2023.v8i5.1508

[16] Nigah R, Devnani M, Gupta A K. ABC and VED Analysis of the Pharmacy Store of a Tertiary Care Teaching, Research and Referral Healthcare Institute of India. Journal of Young Pharmacists 2010; 2(2): 201-205. https://doi.org/10.4103/0975-1483.63170

[17] Wandalkar P, Pandit P T, Zite AR. ABC and VED analysis of the drug store of a tertiary care teaching hospital. Indian Journal of Basic and Applied Medical Research 2013; 3(1): 126-131.

[18] Sushil Kumar A, Chakravarty. ABC–VED Analysis of Expendable Medical Stores at a Tertiary Care Hospital. Medical Journal Armed Forces India 2015; 71(1): 24-27. https://doi.org/10.1016/j.mjafi.2014.07.002

[19] Mohammed, Solomon Ahmed, Birhanu Demeke Workneh. Critical Analysis of Pharmaceuticals Inventory Management Using the ABC-VEN Matrix in Dessie Referral Hospital, Ethiopia. Integrated Pharmacy Research & Practice 2020; 9: 113-125. https://doi.org/10.2147/IPRP.S265438

Received on 03-11-2023 Accepted on 29-11-2023 Published on 28-12-2023

https://doi.org/10.6000/1929-6029.2023.12.33