Article

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The impact of lean inventory management on small pharmaceutical companies

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Abstract: "Inventory lean management" is a key strategy for cost savings and quick market response in fast-moving consumer goods industries such as food, retail, and beauty. Recently, the pharmaceutical industry, with its stringent requirements on product shelf life, supply efficiency, and storage methods, has also begun to focus more on effective inventory management. For SMEs, poor inventory management can lead to lost sales and customers, as shoppers will turn to other pharmacies when they cannot find the desired products.

1. Introduction

"The Lean management approach is predominantly grounded in the principles derived from the Toyota Production System Lean methodology. This approach advocates for the efficient utilization of available resources to minimize waste and eliminate non-value-adding activities, thereby enhancing health outcomes for patients" (Khalil and Foo, 2024). Consequently, this study aims to analyze and optimize the inventory structure and operational processes at Options Naturopathic Clinic. Founded by Dr. Erin in Cleveland, Ohio, in 2000, Options Naturopathic Clinic is a comprehensive natural medical clinic dedicated to helping customers optimize their health through non-toxic and systemically supportive medicines. The clinic's exceptional service, experienced physicians, and notable therapeutic outcomes have garnered a high degree of customer loyalty.

2. Objective

The management team of Options Naturopathic Clinic has used Stocky, their inventory management system, to divide their inventory into 3 different categories: fast movers (A items), moderate movers (B items) and slow-movers (C items). There are about 1800 SKUs stored in their shelves as they do not have a warehouse. Customers can choose to purchase products in-store, or order online and have it mailed to their home by Options Naturopathic Clinic. "Applying an inventory model based on Lean Healthcare, ABC-VED and EOQ can improve the availability of stock in the pharmaceutical industry, especially for SMEs." (César Alejandro and Diego Alonso, 2023). Therefore, we will use existing inventory data to baseline inventory metrics, design and implement an inventory management process. Determine reorder points (ROP), economic order quantity (EOQ), and average current inventory of products available for use by onsite physicians and for online sales. Using these data, create an inventory management model to optimize inventory

metrics to positively impact the business, ensure the correct amount of inventory for customer demand, minimize days inventory outstanding, and maximize inventory turnover and thus compare the information with the output of their current inventory system software "Stocky" to utilize their usage of "Stocky" inventory system and maintaining their desired customer service levels. In addition, it is also necessary to draw the current value stream map (VSM) to clarify the work process, find "waste", and design the future value stream map (VSM) to simplify the supply chain and improve work efficiency.

We will use existing inventory data to baseline inventory metrics, design and implement an inventory management process. Determine reorder points (ROP), economic order quantity (EOQ), and average current inventory of products available for use by both on-site physicians and online sales. The Options Naturopathic store front holds $60,000 in inventory, 80% of which is slow moving ("C Items"). Using these data, create an inventory management model to optimize inventory metrics to positively impact the business, ensure the correct amount of inventory for customer demand, minimize days inventory outstanding, and maximize inventory turnover. Our goal is to reduce the current inventory holdings, set new stocking levels that fulfills different service levels, and save costs by utilizing the Stocky inventory system. Value stream map (VSM) information will be based on the Options Naturopathic Clinic official website, purchase list, and on-site workflow records. The project will be limited to the Cleveland Heights location.

3. Data Collection

The Resources we get come from 4 directions:

Quarterly Revenue Information

Received revenue information and sales data for the last year to assist in our revenue calculations and overall analysis of financial metrics in the early stages of the project.

Inventory Data

Historical inventory data that is exported directly from Stocky and Shopify. Information includes item costs, expected demand, product margins, and other financial metrics to generate calculations for ROP, EOQ, and various categories of inventory cost estimation.

Tech Support from Shopify and Stocky

We have access to the Stocky account on the Shopify, as shown in Figure 1. We got several data sets about inventory information: 30 days inventory, 90 days information and 12 months inventory information. By applying these data sets into the model we created, we finally decided to use 30 days inventory information because it has less noise (including blank cells, product name with strange signs or abnormal set of prices) and high accuracy about active and on hand products.
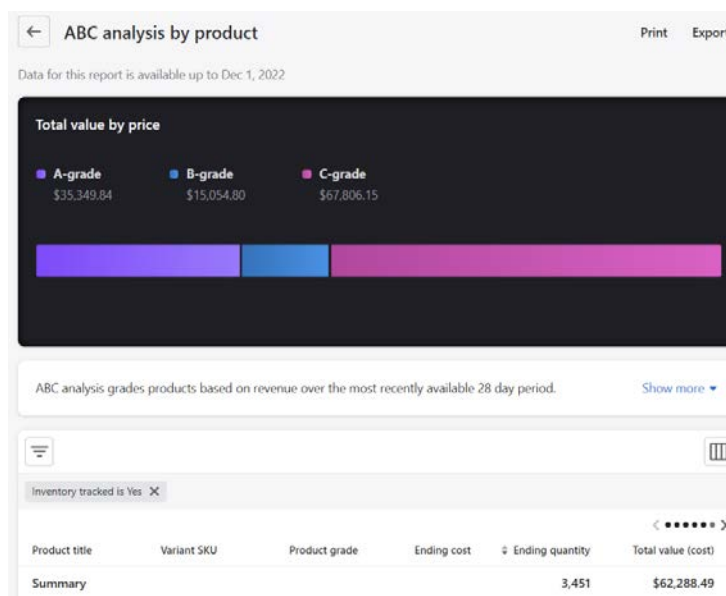
Figure 1. The Stocky account on the Shopify.

    Client POS System

The initial system still needed to incorporate inventory data so that ROP and EOQ values could be automatically processed into the system.

Vend access enabled us to view the current inventory setup and understand how the inventory model deliverable could be implemented into it.

4. Analysis (VSM)

The first task we undertook when beginning this project was creating a Value Stream Map (VSM) for the Naturopathic company, as shown in Figure 2. The VSM helps us understand the overall progress of the company and how Naturopathic deals with each situation. It greatly aids in analyzing and identifying useful data. It also allows us to think about the scope of our project and the issues we need to address. The order process of Naturopathic can be divided into three parts: patient, order system, and OSS (out of stock, including vendor and company office). Through research and information collection, we identified four types of people using the ordering process: usual patients, non-patients, high-priority or high-need patients, and local patients. The rules to distinguish the patients are based on their location, the frequency of their orders, and the urgency of their orders. The shipping cost and time will be higher for usual patients who order online compared to local patients. The quantity and scheduling costs will be higher for high-priority patients than for others. All patients can place orders in two ways: through the online website or by purchasing from the patient care team in the office. From the VSM, we can see that the order system process is too complex for Naturopathic to analyze and manage due to the large amount of information and material flow between customers and the company. The entire order process consists of many exchanges of information and products. When the four types of patients place orders either online or with the patient care team, the order information is transmitted to the Naturopathic office. The office compares the products in the order and checks whether their warehouse inventory can meet the demand. If the inventory is insufficient to fulfill the order, there will be OOS (out of stock) products, which will be addressed in two ways. The vendor will receive out-of-stock information. For the shortage of products for high-priority or high-need patients and local patients, the vendor will directly respond with the shipment of out-of-stock products. The Naturopathic office will handle other OOS products and deliver them to patients once they gather all OOS order products
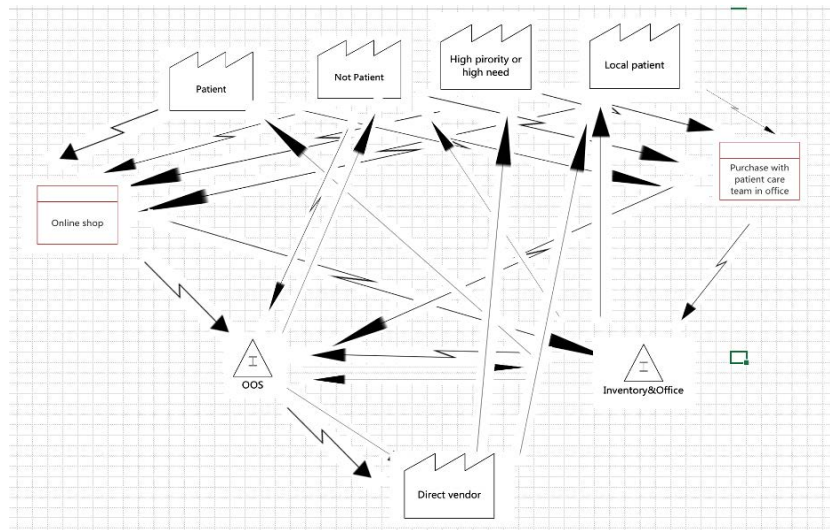
Figure 2. The VSM for the Naturopathic company.

In figure 3, this study has made certain improvements to the VSM, taking into account the possibilities for the future development of the company and the current situation. We added a new data system part in which the office can share the order information with the vendor which is real-time. Also direct vendor response to all OOS production and delivery them to four kinds of patients. Because by the development of Naturopathic company, the number of production company managed will be more and more, the company can only control the inventory of main production at usual demand. When there is some OOS production, the vendor will fix the short problem directly. This method will decrease the inventory cost of Naturopathic company, share the risk of OOS production with vendors and build a stable supply relationship.
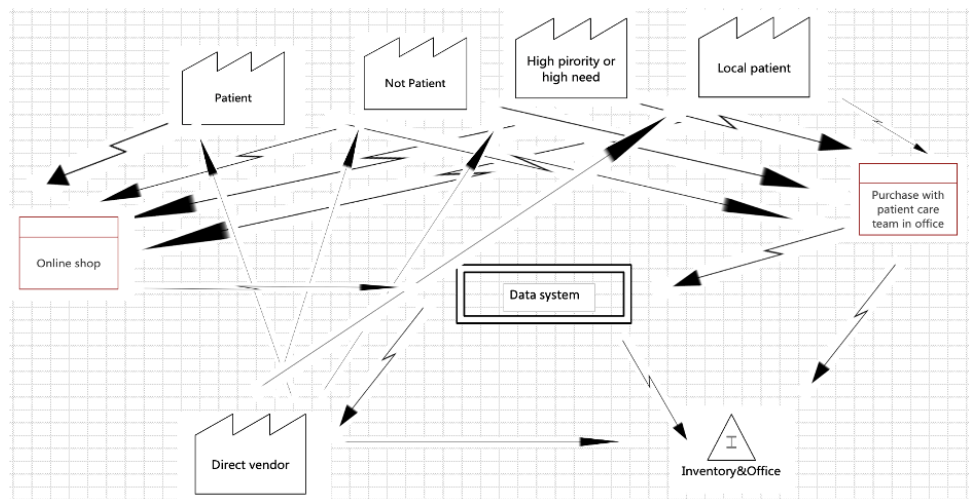

Figure 3. Improvements to the VSM.

5. Analysis (Data and Model)

The current inventory methods of Options Naturopathic rely heavily on personnel to understand product demand and inventory on hand to limit stock-out situations. Employees check inventory visually, gauge demand for products based upon their experience with the sale of items and re-stock based upon personal product knowledge. Staff identified product turn over categories as fast, moderate and slow, but were unsure of which category of sales frequency to assign each product. The breadth of inventory continues to grow as the business matures and is reaching the staff's capacity to track. A

Point-of-Sale system has been implemented for sales records, but not for inventory ordering purposes.

To do data analysis, we first got data from Shopify for 30 days inventory data and we did denoising for the data by removing 'dummies'(product or services with 0 or N/A numbers - for example "shipping" was set up as a product). By using the if algorithm, we filtered out the dummies and deleted them. We also obtained sales and inventory data for roughly an eighteen-month period for over 1800 SKU's. The data was then scrutinized for its validity regarding product type, cost, demand, vendor and lead time. Product items found to lack correct information were turned over to Options Naturopathic for review and removed from our analysis. From the scrubbed data we were able to identify the frequency an item is sold. Coupling this information with lead time and cost, the reorder points (ROP) and economic order quantities (EOQ) could be determined for each product. Assumptions were made for product holding cost, the standard deviation of demand, fixed ordering cost and the service level of the business in the formulas used to determine ROP and EOQ. Sales frequency nomenclature was assigned to each product in the categories of daily, weekly, monthly, quarterly and bi-annually.

6. Model Assumptions:

ROP = D * LT
EOQ = sqrt((2*K*D)/h))
Cycle Stock = EOQ/2
Safety Stock = Additional Weeks of Inventory
Average Inventory on Hand = Cycle Stock + Safety Stock
D = weekly demand rate
h = unit inventory holding costs ($/unit/week) = 10% of product cost K = fixed ordering cost ($/order) = $1
LT = lead time (weeks) based upon distributor
Z = depends on service level
SD = standard deviation of weekly demand = 10% of real demand Growth = multiplier referencing 2021 levels = 40%

7. Sales Frequency Categories:

Daily - days to sell <= 3
Weekly - 3 < days to sell <= 7
Monthly - 7 < days to sell <=31
Quarterly - 31 < days to sell <= 90
Bi-annual - 90 < days to sell <= 189

8. Analysis (Service Level)

By looking at the data sets, ABC classification of Naturopathic is not that clear and to make sure all the items are classified properly we decided to revise the ABC classification.

ABC classification is a ranking system for identifying and grouping items in terms of how useful they are for achieving business goals. We would like to categorize the products by A, B, C and some D:

'A' items – 20% of the items accounts for 80% of the annual consumption value of the items

'B' items – 30% of the items accounts for 15% of the annual consumption value of the items

'C' items – 50% of the items accounts for 5% of the annual consumption value of the items

Therefore, we use the percentage to classify A, B and C items for all the products. Items with sales of less than 2 units per year were classified as "D" grade and suggested to not hold inventory.

Service level measures the performance of a system, in this case for the customers. Goals were defined (the number of customers that can be waiting for a product), and the service level gives the percentage to which those goals should be achieved. Fill rate is different from the service level.

After having a discussion with sponsor, we decide to use different service level for A, B and C item:

A items – 99% service level= 2.33 (very few customers should be waiting for A items)
B items – 95% service level= 1.65 (up to 5 customers should be waiting for B items)
C items – 90% service level= 1.28 (the number of customers waiting for C items is not critical to the business strategy)

Items are extremely important because they make 80% of annual assumption value. Therefore, we decided to set the service level of A items as 99%. For B items, we use 95% service level as our sponsor requires. For C items, we think it could hardly make profit for Naturopathic and set it as 90% service level. These are recommendations based on data; the company should make decisions based on its business strategy.

After denoising the data set and classifying all the items, we could finally plug data into the model. Reviewing the sales and inventory data showed opportunities for Options Naturopathic to minimize inventory cost by adjusting product ROP and EOQ based upon sales frequency. The average cost of inventory could be improved if ROP and EOQ were implemented into the POS. Slightly shifting inventory levels in each category along with the frequency and quantity in which they are ordered could reduce the average cost of inventory by $21,000. Based upon the sales information there is too much inventory held in monthly, quarterly and bi-annual sellers and not enough inventory for weekly and daily sellers. The current inventory levels could lead to a stock out condition for frequent sellers. As can be seen from Figure 4, by following the recommendations, they can achieve their goal of decreasing on-hand inventory value by 50%.
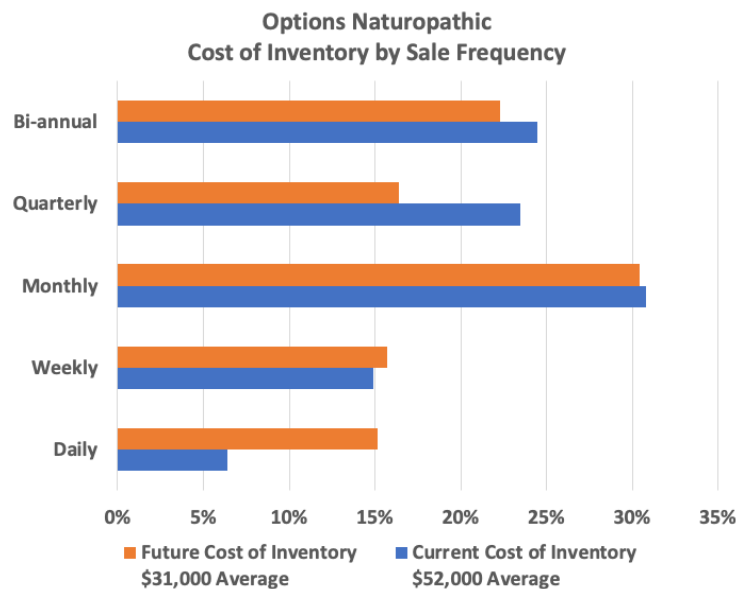

Figure 4. Cost of inventory by sale frequency.

9. Key Finding

Our inventory model findings reveal that Options Naturopathic can make several key changes to minimize costs and track key inventory metrics, notably ROP and EOQ. In the current stage, Options Naturopathic inventory costs are too high. This is likely attributable to quantity discrepancies between actual inventory and our model recommendations, which is more prevalent in slow-moving SKUs where they are holding too much slow-moving inventory than is needed. Thus, we recommend the immediate integration

of our inventory model into Vend, the POS system that the management team of Naturopathic can use coherently with their current Shopify app to plan their stocking more strategically. This will enable Options Naturopathic to evaluate model parameters and track inventory much more effectively.

Considering the amount of inventory we have for inferior products; it naturally became our breakthrough. Within the C level products, we were keen to point out products with more inferiority to start with, which we came up with "D" level products, the logic behind derived from ABC-XYZ analysis for our ABC products. With supportive methodology to increase cost-effectiveness for sourcing and stocking, and a starting point to transit the business, establishing a user guide for management to understand our thoughts is essential for every measurement we spend our time on.

10. Conclusion

"An effective and responsive supply chain network design (SCND) is a vital component of high performance characterized by high efficiency and adequate customer service level." (Darmawan, Wong, and Thorstenson, 2021). Highly utilized inventory and healthy inventory levels are at the core of supply chain network design. "The accomplishment of lean in a system is revealed in waste reduction whereby non-value activities are eliminated or reduced to barest minimum." (Adeodu, Maladzhi, Katumba, and Daniyan, 2023). Therefore, lean inventory management can maximize this goal. At the same time, we should also pay attention to the waste in the supply chain process. From the time the product is processed to the time the consumer purchases it, the value of the product will change at each stage of the process. "In the context of warehousing, value has been defined as the dealer's ability to have access to the right products at the right time. Warehouses do not attach any additional value to the goods, but only to consumers by offering it at the perfect quantity and quality within the stipulated time." (P.G. and Pratap, 2020). Therefore, reducing waste in the process and reducing the risk of product impairment by using Value Stream Mapping (VSM) is also a way can help the corporate managers.

References

1. César Alejandro Daga-Castro and Diego Alonso Gomez-Quea, Inventory Model Based on Lean Healthcare, EOQ and ABC-VED to Reduce Stockouts in a SME in the Pharmaceutical Sector. November 2-4, 2023.
2. Viviane Khalil and Siang Foo, A lean approach for improving medicines management in Australia's first cardiac hospital inventory system. July 3, 2024. https://doi.org/10.1002/hpm.3819
3. Agus Darmawan, Hartanto Wong, and Anders Thorstenson, Supply chain network design with coordinated inventory control. December 16, 2020. https://www.sciencedirect.com/science/article/abs/pii/S1366554520308115
4. Adefemi Adeodu, Rendani Maladzhi, Mukondeleli Grace Kana-Kana Katumba, and Ilesanmi Daniyan. Development of an improvement framework for warehouse processes using lean six sigma (DMAIC) approach. A case of third party logistics (3PL) services. April 2023, e14915. https://www.sciencedirect.com/science/article/pii/S2405844023021229
5. Abhishek P.G. and Maheshwar Pratap. Achieving Lean Warehousing Through Value Stream Mapping. October 26, 2020. https://doi.org/10.1177/2277977920958551