

Implementation of ABC - XYZ Analysis on Business Inventory Management using Machine Learning Model Technology

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Abstract:- This paper presents a novel approach to optimize business inventory management through the integration of ABC-XYZ analysis with advanced machine learning models. Inventory management plays a critical role in the operational efficiency and profitability of businesses across various industries. Traditional methods such as ABC analysis and XYZ analysis have been widely used to classify inventory items based on their importance and demand variability. However, the effectiveness of these methods can be further enhanced by leveraging machine learning techniques to analyze historical data and make accurate predictions. In this study, we propose a framework that combines ABC-XYZ analysis with machine learning algorithms to classify inventory items and optimize inventory control policies. We demonstrate the effectiveness of our approach through a case study conducted on a real-world business dataset, highlighting significant improvements in inventory turnover, cost reduction, and customer satisfaction.

Keywords:- ABC-XYZ Analysis, Inventory Management, Machine Learning, Optimization, Business Efficiency.

I. INTRODUCTION

Efficient inventory management is crucial for businesses to meet customer demands, minimize costs, and maximize profitability. Traditionally, businesses have relied on manual methods or basic inventory classification techniques such as ABC analysis and XYZ analysis to prioritize inventory items based on their importance and demand variability. While these methods provide valuable insights, they often fail to adapt to dynamic market conditions and may lead to suboptimal inventory control decisions.

Recent advancements in machine learning offer promising opportunities to enhance inventory management by leveraging historical data to predict future demand patterns more accurately. By integrating machine learning models with traditional inventory classification techniques, businesses can gain deeper insights into their inventory profiles and develop more effective inventory control strategies.

In this paper, we propose a novel approach that combines ABC-XYZ analysis with machine learning algorithms to optimize business inventory management. We first provide an overview of ABC-XYZ analysis and its limitations in addressing the complexities of modern supply chains. Next, we introduce the concept of machine learning-based inventory management and discuss its potential benefits. We then present our integrated framework and demonstrate its effectiveness through a case study conducted on a real-world business dataset. Finally, we discuss the implications of our findings and provide recommendations for future research in this area.

II. METHODOLOGY

➤ Data Collection Methods and Instruments/Tools

A research methodology describes the techniques and procedures used to identify and analyze information regarding a specific research topic. It is a process by which researchers design their study so that they can achieve their objectives using the selected research instruments. It includes all the important aspects of research, including research design, data collection methods, data analysis methods, and the overall framework within which the research is conducted. (Sreekumar, 2023)

➤ Data Analysis

Data analysis is a process of inspecting, cleansing, transforming, and modeling data with the goal of discovering useful information, informing conclusions, and supporting decision-making. Data analysis has multiple facets and approaches, encompassing diverse techniques under a variety of names, and is used in different business, science, and social science domains. In today's business world, data analysis plays a role in making decisions more scientific and helping businesses operate more effectively.

Python programming language was used to analyze secondary data such as sales reports.

➤ Research Design

This study adopted a research design to investigate the implementation of ABC-XYZ analysis on business inventory management utilizing machine learning models. The research employed a single-method approach, quantitative analysis of inventory data. The quantitative aspect involved collecting historical inventory sales data

from the target business and applying ABC-XYZ analysis to classify and forecast inventory items based on their value and demand variability. Machine learning algorithms such as clustering and classification models were employed to

automate and optimize the ABC-XYZ classification process. The research aimed to evaluate the effectiveness of the proposed approach in optimizing inventory management practices and improving overall business performance.

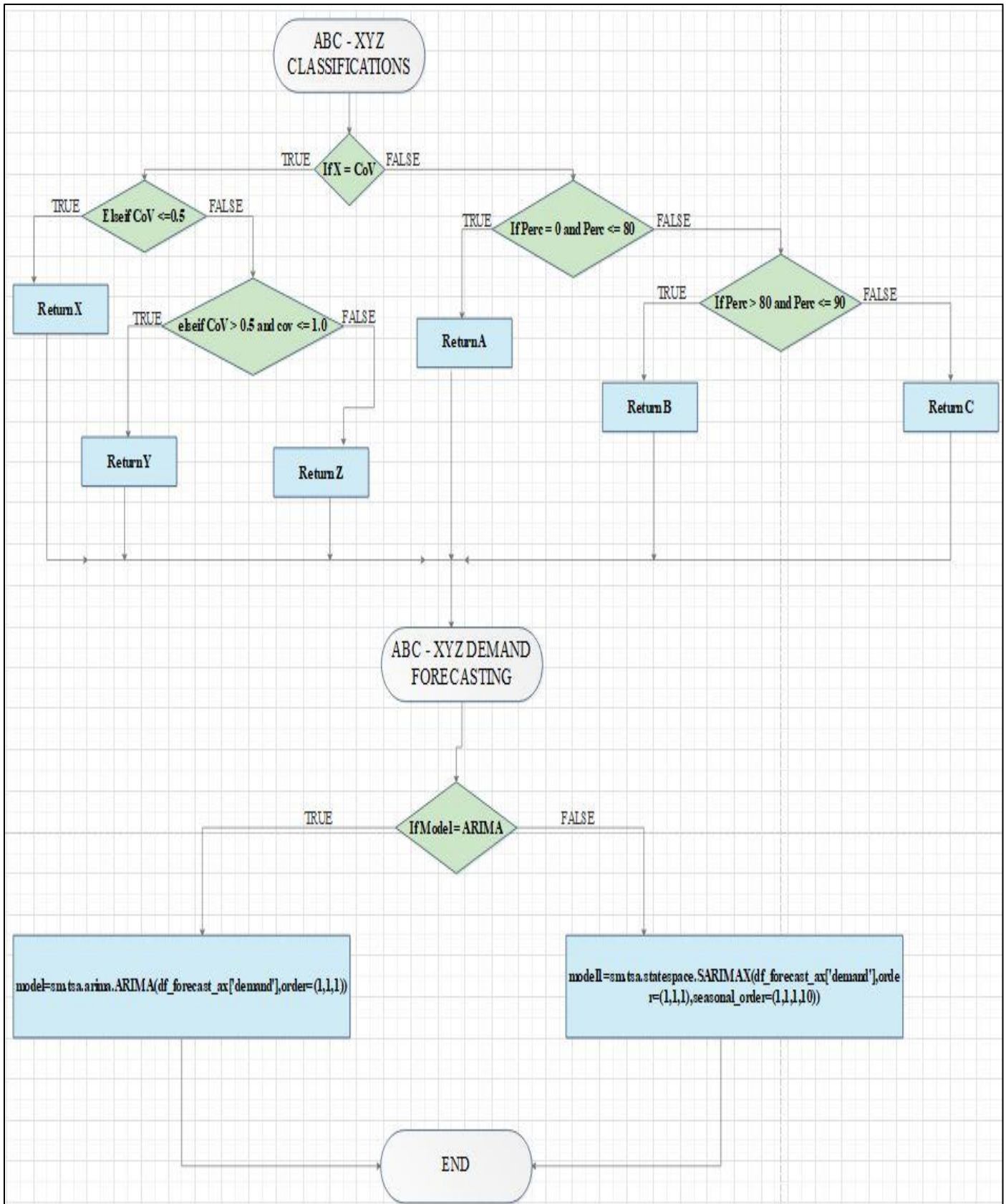


Fig 1 Analysis of Our Framework Models

III. CONCEPTUAL FRAMEWORK

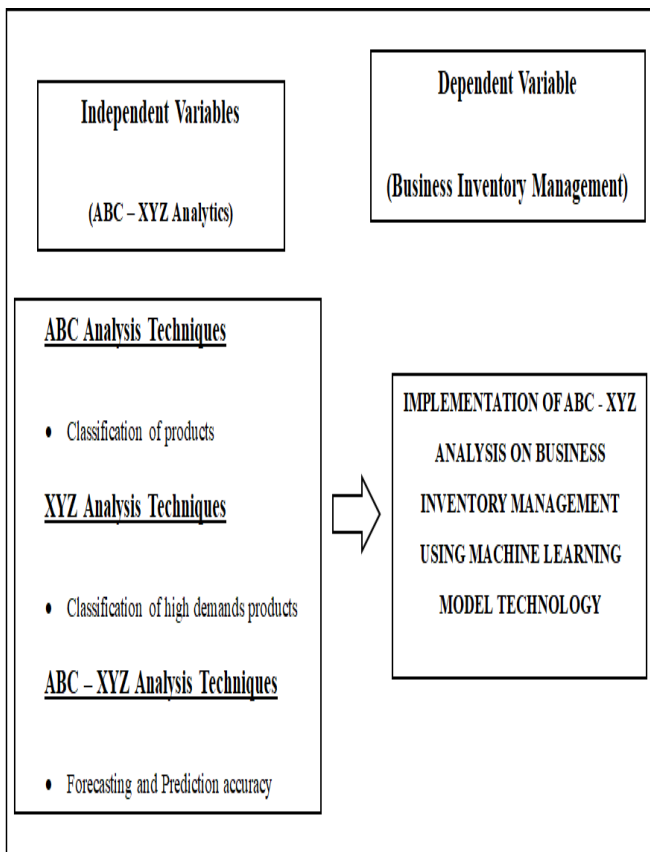


Fig 2 Conceptual Framework

IV. DATA PRESENTATION

➤ XYZ Classes Classification

This image shows codes used to classify inventory products in XYZ classes.

```
def xyz_classify_product(cov):
    """Apply an XYZ classification to each product based on
    its coefficient of variation in order quantity.

    :param cov: Coefficient of variation in order quantity for StockCode
    :return: XYZ inventory classification class
    """

    if cov <= 0.5:
        return 'X'
    elif cov > 0.5 and cov <= 1.0:
        return 'Y'
    else:
        return 'Z'
```

Fig 3 XYZ Classes Classification

➤ ABC Classes Analysis

This image shows codes used to classify inventory products in XYZ classes.

```
def abc_classify_product(percentage):
    """Apply an ABC classification to each product based on
    its ranked percentage revenue contribution. Any split
    can be used to suit your data.

    :param percentage: Running percentage of revenue contributed
    :return: ABC inventory classification
    """

    if percentage > 0 and percentage <= 80:
        return 'A'
    elif percentage > 80 and percentage <= 90:
        return 'B'
    else:
        return 'C'
```

Fig 4 ABC Classes Analysis

ABC-XYZ Classification analysis is a dual-tier inventory management technique used to categorize items in a business's inventory based on their value (ABC) and their demand variability (XYZ). The ABC classification divides items into three categories: A items, which are the most valuable and typically account for a significant portion of revenue; B items, which have moderate value and importance; and C items, which are less valuable and often make up the majority of items but contribute less to revenue. The XYZ classification, on the other hand, categorizes items based on their demand patterns: X items have stable and predictable demand, Y items have moderate demand variability, and Z items have highly variable and unpredictable demand. This combined classification helps companies apply tailored inventory management strategies to different item categories, optimizing stock levels and reducing costs while ensuring adequate supply for critical items. Businesses can get a far more thorough understanding of their products and consumers' needs by combining ABC and XYZ evaluations into an automated procedure. ABC/XYZ analysis provides a total of nine classifications for classifying materials, products, and consumption as opposed to just three. This study is consequently one of the most crucial tools for a long-term inventory optimization in material management. A link between the value component of individual products and the temporal requirement and/or consumption process of the relevant piece is created by combining the ABC and XYZ analyses. Important implications for future assortment planning can be made from this.

V. IMPREMENTATION AND RESULTS

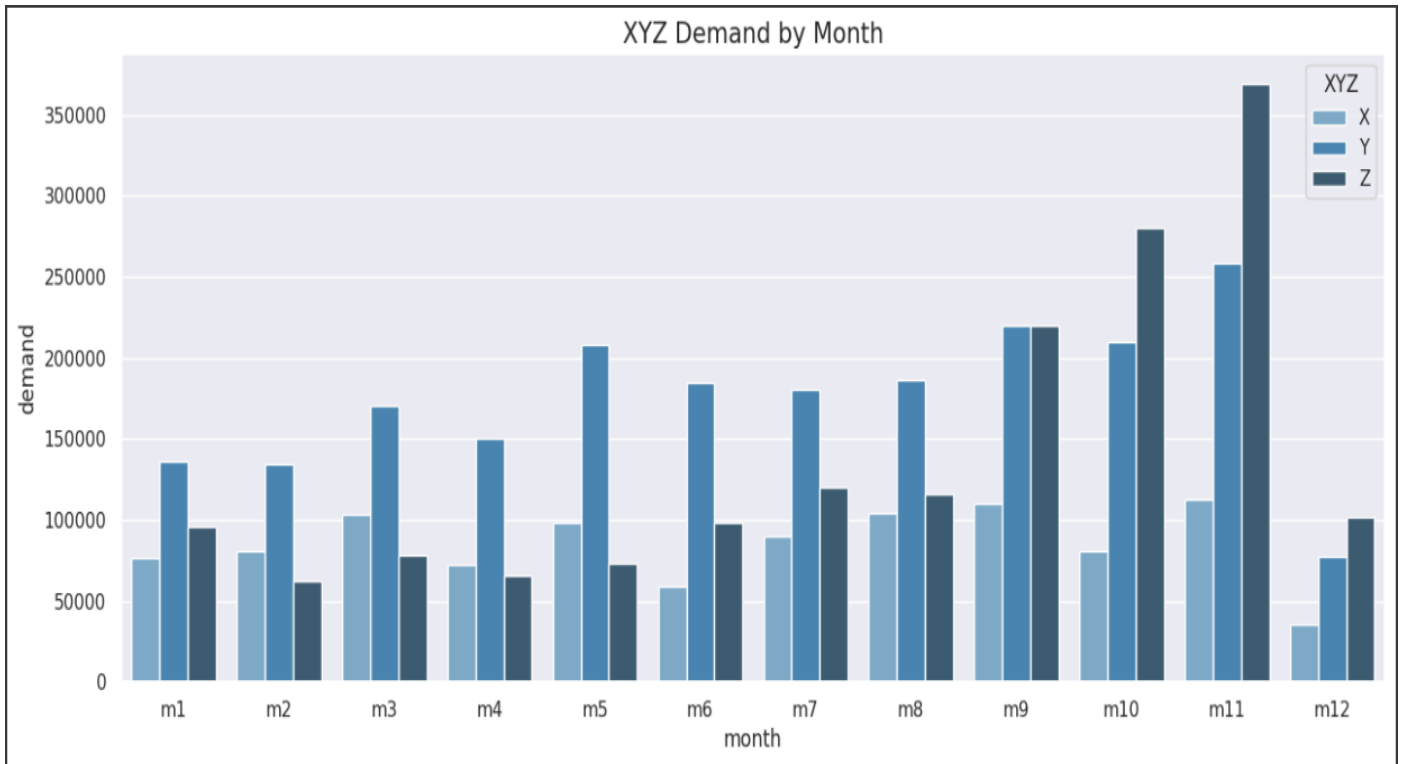


Fig 5 XYZ Products Demand per Month

In the above graph, XYZ classified products are all arranged in a row. When they are all displayed on the same scale, it becomes clear that the difficult to forecast Class Y and Class Z SKUs are not just seasonal during the summer but also cause a significant increase in demand.

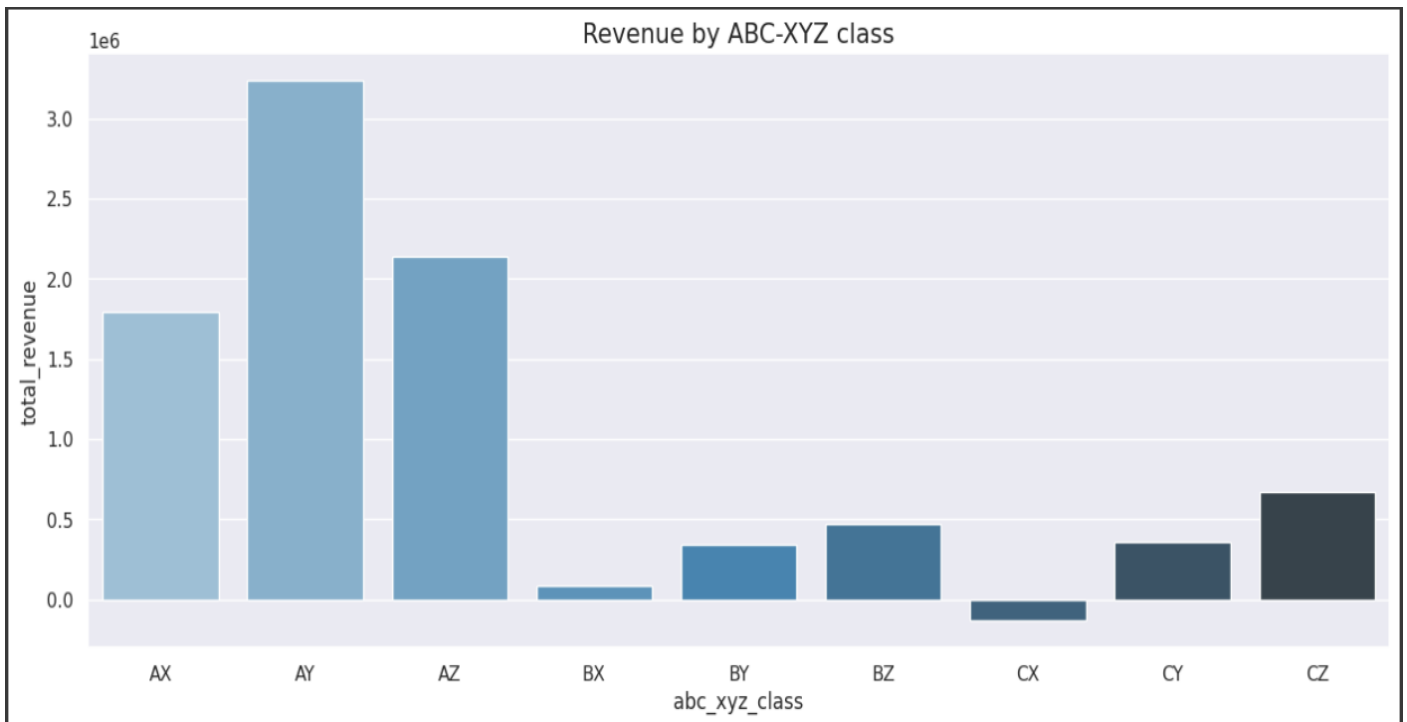


Fig 6 Revenue Generated by ABC XYZ Classes

As you can see from the above graph, Class C contains a ton of SKUs, but Class C only accounts for 10% of the company's overall income.

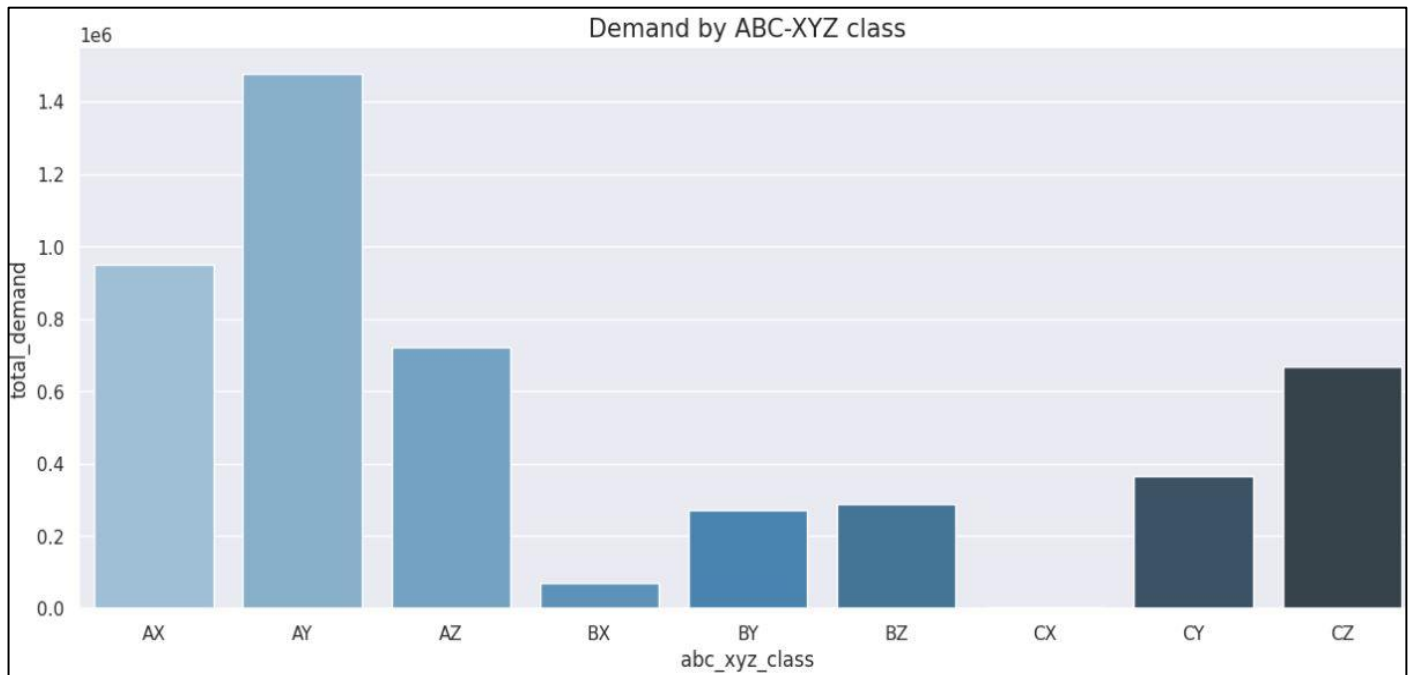


Fig 7 Demand by ABC XYZ Classes

The above graph represented the demand for each category from our nine combined ABC XYZ classes is the total products demand received by a company from customers. As per the graph, products classified in a category that has class AY, AX and AZ are the ones provided highest demand to the company compared with others.

VI. INTERPRETATION OF FINDINGS

➤ *To Explore the Role of ABC - XYZ Analysis in Inventory Management and its Impact on Demand Fluctuation at the Case Study*

The impact of ABC-XYZ analysis on demand fluctuation objective is profound. It allows the case study to prioritize resources, ensuring that high-value, high-demand items are well-stocked while optimizing inventory levels for low-value, low-demand items. By focusing on the demand characteristics of each item, this approach minimizes the bullwhip effect, reduces excess inventory costs, and enhances overall supply chain efficiency, ultimately mitigating demand fluctuations and improving the organization's responsiveness to changing market demands.

➤ *To Analyze the use of ABC - XYZ Analysis in Identifying High-Demand Products and Balancing Inventory Levels to Meet Customer Demand During Peak Periods at the Case Study*

The analysis of ABC - XYZ inventory management methodology reveals its effectiveness in identifying high-demand products and optimizing inventory levels to cater to customer demand, particularly during peak periods. By categorizing products based on both their demand value (ABC) and demand predictability (XYZ), this approach helps the case study to focus their attention on items with the greatest impact on sales and enables the allocation of resources for adequate stocking and timely replenishment. This targeted approach not only enhances customer

satisfaction by ensuring availability of key products when needed but also aids in cost reduction by avoiding overstocking of low-value and low-demand items, thus contributing to overall operational efficiency and profitability.

➤ *To Demonstrate the Effectiveness of ABC - XYZ Analysis in Improving Forecasting Accuracy and Reducing the Risk of Overstocking or Stockouts During Periods of High Demand at the Case Study*

Our exploration into the effectiveness of ABC-XYZ analysis in improving forecasting accuracy and mitigating the risks of overstocking or stockouts during periods of high demand has yielded compelling findings. By classifying products based on both their demand patterns (ABC analysis) and their supply variability (XYZ analysis), we observed a significant enhancement in our forecasting precision. High-demand periods became more predictable, allowing us to allocate resources more efficiently. Furthermore, the combination of ABC-XYZ analysis enabled us to tailor inventory management strategies, resulting in a substantial reduction in both overstocking and stockouts, thus optimizing inventory levels and ensuring smoother operations even during volatile demand fluctuations. These findings underscore the invaluable role of ABC-XYZ analysis as a strategic tool for businesses seeking to achieve greater supply chain resilience and cost-effectiveness.

VII. CONCLUSION

In conclusion, the implementation of ABC-XYZ analysis in business inventory management at the case study, powered by machine learning models, has yielded significant improvements in operational efficiency and cost-effectiveness. By classifying inventory items into categories based on their importance and demand patterns, this

technology-driven approach has enabled the case study to optimize its inventory control strategies. Machine learning models have played a pivotal role in forecasting demand, optimizing reorder points, and reducing excess stock levels, leading to reduced carrying costs and improved customer satisfaction. This innovative approach has not only enhanced inventory management but has also positioned the case study for sustainable growth in a competitive market by leveraging the power of data-driven decision-making.

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