Implementation Of The ABC Analysis To The Inventory Management

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Abstract.

In an ever-changing market, inventory management is becoming a major problem that requires thorough planning, supervision, and control. If companies are well managed and have good planning and control, they can last a long time. Poor inventory management is very detrimental to the business as it can cause the company to fail to meet customer or consumer demands, which can lead customers to choose other companies that can meet their demands. Plan your stockpiles to maintain balance, avoid excess or deficiency, and control storage costs. ABC analysis, one of the most common inventory management techniques, divides inventory into three categories (A, B, and C) based on total annual product usage or total inventory cost based on the Pareto principle. The goal of this study is to use ABC analysis in the company's inventory management to identify products in categories A, B, and C based on profitability and sales factors. The research phases include data collection, data preprocessing, exploratory data analysis, ABC analysis, key product analysis, and explanatory analysis. According to the research findings, Segment A accounts for 18% of the total product and generates 78% of the overall profit. Segment B contributes 23% of the total number of items and 16% of all revenue.

Keywords: *ABC analysis, exploratory data analysis, inventory management, pareto and product segmentation.*

I. INTRODUCTION

Many companies in various industries and economies, both in developed and third-world countries, are currently grappling with inventory-related issues [1]. All industries, whether manufacturing or service, require supplies to carry out production and sales activities effectively. It has long been considered a must because it allows for adapting to changing demand and uncertain delivery times from suppliers [2]. The stock, one of the company's assets, holds a significant amount of funds and is a crucial component of the working capital that information management requires to make decisions [3]. Stock management is a big problem in an ever-changing market, which requires thorough planning, supervision, and control. Companies can survive long-term if they are well managed and have good planning and control. Businesses need to plan and control capital, technology, manpower, and supplies in particular to survive [4]. Inventory management significantly influences a company's performance, as it is crucial to guarantee the availability of necessary goods to meet consumer demands [5]. If there is no information about the maximum inventory limit, unnecessary goods will fill the warehouse and build up, thereby increasing inventory costs.Companies can suffer losses if they don't have proper inventory control. On the one hand, a shortage of a specific type of good can impede the production process; if the product is not delivered on time, it can lead to customer loss and market erosion, thereby jeopardizing the company's profitability. Conversely, storing excess stocks will increase storage costs, reducing business profitability. Stock is a company's asset that is crucial to business operations, so the company must plan and oversee stock so that the production process can run smoothly [6]. Inventory control can reduce the cost of obtaining supplies according to business needs [7].

Establishing a balance between customer service and inventory investment is one of the objectives of inventory management [8]. Poor inventory management is extremely detrimental because it causes companies to fail to meet customer or consumer demands, which can lead customers to choose other companies that can meet their needs. This will undoubtedly lead to a decline in the company's revenue, and if the situation doesn't improve immediately, there's a risk that the company may face bankruptcy [9]. Therefore, planning for stocks is necessary to maintain balance, avoid excess and deficiency, and minimize storage costs [10], [11].One of the most commonly used methods in inventory management is ABC analysis, which divides product stocks into classes based on total annual product usage or total cost of inventory storage [12]. ABC analysis serves as a straightforward method to identify items that significantly impact overall inventory costs, thereby enhancing the effectiveness and efficiency of inventories [13]. ABC Analytics divides inventory goods into three categories (A, B, and C) based on annual cost usage [14]. ABC

analyses, also known as Pareto analyses, are important tools for companies that want to optimize their inventory management strategies [15]. The Pareto principle, also called the 80/20 rule, shows that about 80% of the effects come from 20% of the causes, emphasizing the importance of focusing on the most significant inventory items [16]. Category A is a high-value and high-demand product that accounts for a small percentage of the total inventory but contributes the most to revenue. These items require strict monitoring and careful management to ensure availability and prevent stock closure.

Category B items are moderate in value and demand, requiring a balance of attention to maintain profitability. Category C items are low in value and demand, often making up the majority of inventory while contributing minimally to income [17]. This approach enables companies to identify the essential items for their success and those that require less attention. This strategic approach to inventory management can help retailers maintain profitability and improve their overall performance in the market. By implementing an efficient and integrated system for inventory management, retailers can optimize their processes and reduce the risk of losing revenue from exhausted inventory. By focusing on Category A items, retailers can make more timely decisions about sales, promotions, and inventory procurement. Thus, retailers can increase customer satisfaction and strengthen their position in the market. ABC analysis has proven to be a valuable tool for retailers who want to optimize their operations and inventory management [18], [19]. Regularly reviewing and updating ABC classifications can help retailers stay ahead of changing market trends and ensure they are always competitive. It involves optimizing business processes, improving inventory chain management, targeting marketing and sales efforts, and managing profitable after-sales services [20]. Clothes sellers can use ABC analysis to classify goods into categories A, B, and C based on their consumption value. Goods A are the top sellers, goods B have a lower value, and goods C have a very low value [21].

ABC analysis can help retailers identify slowly moving or obsolete goods that may bind valuable shelves and resources by categorizing goods according to their importance and value [22]. By staying above customer preferences and market trends through data analysis, retailers can ensure that they offer the right product at the right time by using big data and predictive analysis in retail [23]. The implementation of ABC analysis in inventory management has proven to be a valuable tool for optimizing operations for retailers [24].Based on the background described earlier, this study aims to apply ABC analysis in inventory management to companies to identify products that fall into categories A, B, and C based on sales and profitability aspects. By analyzing the relationship between sales performance and profitability outcomes, the study provides valuable insights for those who want to improve their operations and maximize their results. Through a comprehensive review of existing literature and empirical research, the study will examine key factors that affect the effectiveness of inventory management and identify best practices that can drive success in today's dynamic business landscape. Finally, the research offers practical recommendations for companies that want to optimize their inventory management strategies and achieve sustainable growth in an increasingly competitive market environment.

II. METHODS

ABC analysis implementation for Inventory Management is a study involving the application of the concept of ABC analysis in the context of inventory management. This research method combines theoretical concepts with practical applications in business management. It aims to improve the efficiency of inventory management by focusing on the items that have the greatest impact on the overall performance of the company This study's research methods include the steps shown in Figure 1.

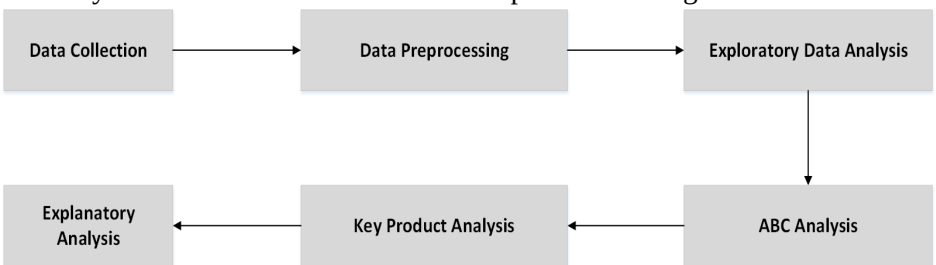


Fig. 1. Research Stage

This study uses a one-year collection of electronic sales transaction data from Kaggle [25]. This data set consists of approximately 185 thousand records or lines of data, each with 11 different attributes or columns. These attributes may include information such as the date of the transaction, the type of electronic goods sold, the sale price, the amount of goods purchased, the location or branch of the store, the method of payment, and possibly other relevant attribute related to the sale transaction. Generally, the electronics industry can use these datasets for sales analysis, sales trend prediction, market segmentation, and other predictive modeling. Data analysis like this can provide valuable insights to companies regarding their sales performance, customer preferences, and other factors that influence sales of their electronic products. Data preprocessing is a very important stage in the data analysis process, involving processing raw datasets into a more useful format ready for further analysis. Exploratory Data Analysis (EDA) is a critical process in data analysis aimed at understanding the structure and characteristics of a given data set. Before running further models or analysis techniques, the primary objective of the EDA is to gain an in-depth understanding of the structure of the data under analysis.

This allows for better decision-making based on insights gleaned from available data.The Pareto principle, also known as the 80/20 rule, determines the ABC product classification, indicating that 80% of sales typically originate from 20% of the product. Certain criteria or metrics, such as sales, revenue, or profits, classify products into three categories (A, B, and C). This algorithm categorizes products into class A if their cumulative percentage is less than or equal to 80%. Class B assigns products with cumulatively contributing percentages between 80% and 95%. We classify the remaining products as class C. The ABC analysis categorizes items based on their impact on the company's profitability, classifying them according to their level of influence. Implementing inventory management strategies for the top 20% of products can result in improved operational efficiency and profitability. The primary objective of key product analysis is to identify products that are crucial to supporting a company's business strategy. By understanding the roles and contributions of each product, companies can allocate resources more efficiently, increase sales of key products, and optimize their marketing strategy and inventory management. We will perform a product segmentation analysis on categories A, B, and C as part of the explanatory analysis process, followed by a visualization of the most popular products based on sales data.

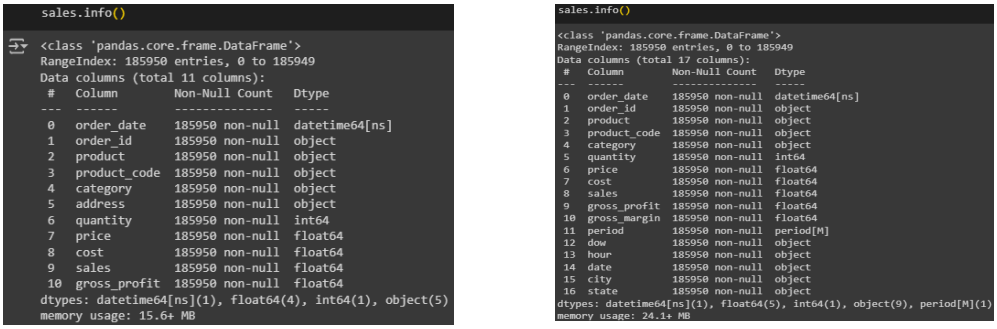
III. RESULT AND DISCUSSION

Semua tahapan dalam penelitian ini menggunakan Bahasa pemrograman Python yang diimplementasikan pada editor text Google Colab. Setelah dilakukan tahapan penelitian langkah demi langkah sesuai dengan metodologi, maka hasil penelitian akan ditampilkan secara sistematis.

	Order Date	Order ID	Product	Product_ean	catégorie	Purchase Address	Quantity Ordered	Price Each	Cost price	turnover	margin
0	2019-01-22 21:25:00	141234	iPhone	5.638009e+12	Vêtements	944 Walnut St, Boston, MA 02215	1	700.00	231.0000	700.00	469.0000
1	2019-01-28 14:15:00	141235	Lightning Charging Cable	5.563320e+12	Alimentation	185 Maple St, Portland, OR 97035	1	14.95	7.4750	14.95	7.4750
2	2019-01-17 13:33:00	141236	Wired Headphones	2.113973e+12	Vêtements	538 Adams St, San Francisco, CA 94016	2	11.99	5.9950	23.98	11.9900
3	2019-01-05 20:33:00	141237	27in FHD Monitor	3.069157e+12	Sports	738 10th St, Los Angeles, CA 90001	1	149.99	97.4935	149.99	52.4965
4	2019-01-25 11:59:00	141238	Wired Headphones	9.692681e+12	Électronique	387 10th St, Austin, TX 73301	1	11.99	5.9950	11.99	5.9950

Fig 2. A part of dataset

Figure 2 shows some of the datasets used in this study. The dataset consists of 185950 entries with 11 columns, all of which have non-null values. Data types vary, with columns containing object data types, integers, and decimal numbers. This information is useful to understand the structure and size of data sets before carrying out further analysis. Here is a description of the features that exist in the dataset. Order Date: The time and date of the order's placement. Order ID: Order identification number. Product: Name of the ordered product. Product_EAN: The product's EAN (European Article Number). Catégorie: product categories in French. Purchase Address: Ensure that you purchase the product's address. Quantity Ordered: The quantity of products ordered. Price per Unit: The product's price per unit. Cost price: cost price per unit product. Turnover: revenue or revenue from the sale of the product. Margin: The profit margin of the sale of the product, calculated as the difference between the sale price and the cost price.



(a) before preprocessing (b) after preprocessing

Fig 3. Data preprocessing

Figure 3 shows the use of sales.info() in the preprocessing phase of data exploration to understand the structure and composition of the data frame. This ensures the absence of unwanted null values in the data and the correct data type in the column for the analysis. The image shows two views of a data set before and after preprocessing. Before preprocessing, the datasets consisted of 11 columns with different data types, such as object, int64, and float64. After preprocessing, we expand the dataset to 17 columns with more specific data types and modify it for further analysis. For example, the order date is changed to order_date with the datetime type. New columns such as product_code, category, sales, gross_profit, gros_margin, and some others are added to enrich the data set. We have added the period, dow (day of the week), and hour columns for time analysis. For location information, add the city and state columns. This preprocessed dataset is ready for use in exploratory data analysis.

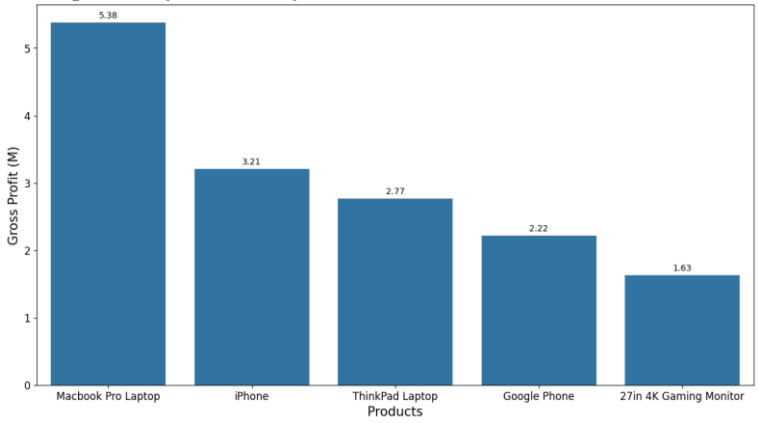


Fig 4. The Highest-performing products based on Gross Profit

Figure 4 shows the five products with the highest performance based on gross profit. The Macbook Pro Laptop has a much higher gross profit compared to other products, $5.38 million, almost twice the second-ranked iPhone, $3.21 million. The gross profit of the iPhone and ThinkPad laptops is also quite significant, but still far below that of the MacBook Pro laptop. Google Phone and the 27-inch 4K Gaming Monitor have lower gross profits but are still in the top five.

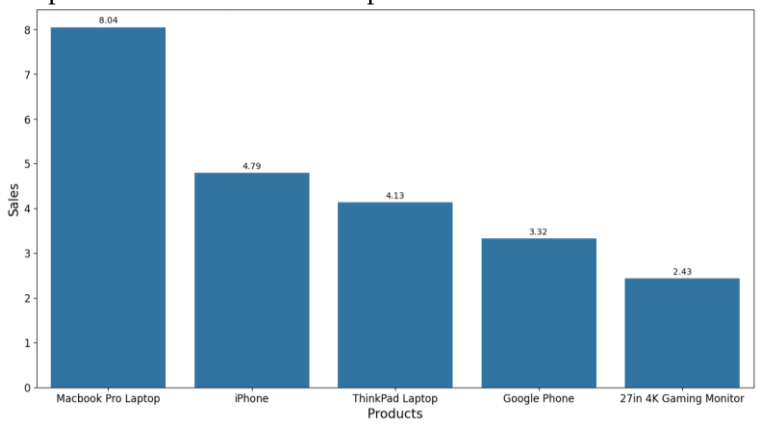


Fig 5. The Highest-performing products based on Total Sales

Figure 5 shows a bar graph of the top five highest-performing products based on total sales. The products are as follows: The products include the Macbook Pro Laptop, iPhone, ThinkPad Laptop, Google Phone, and a 27-inch 4K Gaming Monitor. The Macbook Pro Laptop is the top-selling product, with total sales of 8.04 million units. The iPhone is the second-best-selling product, with total sales of 4.79 million units. The ThinkPad Laptop is the third-best-selling product, with total sales of 4.13 million units. The Google Phone is the fourth-best-selling product, with a total sales of 3.32 million units. The 27-inch 4K gaming monitor is the fifth-best-selling product, with a total sales of 2.43 million units.

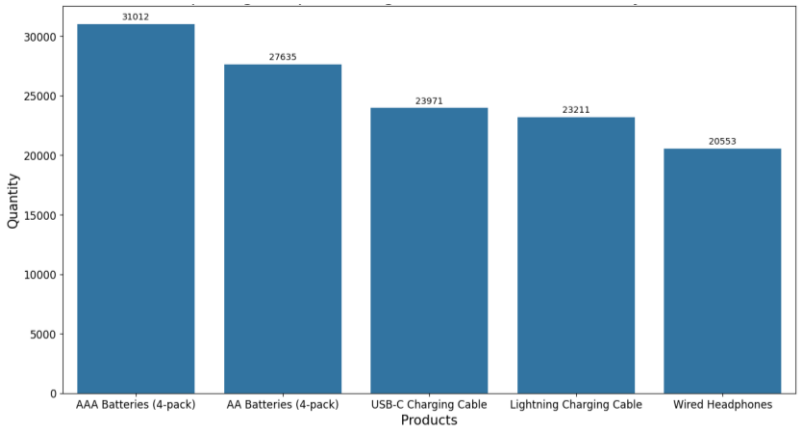


Fig 6. The Highest-performing products based on Quantity Sold

Figure 6 shows a bar graph of the top five highest-performing products based on quantity sold. Batteries are the clear winners in terms of quantity sold, with AAA Batteries (4-pack) and AA Batteries (4-pack) taking the top two spots. This suggests a high demand for these products, likely found in a variety of devices. USB-C charging cables and Lightning charging cables are also popular products, indicating the widespread adoption of these charging standards. Wired headphones, while not as popular as the other products, still show a significant demand for traditional headphones.

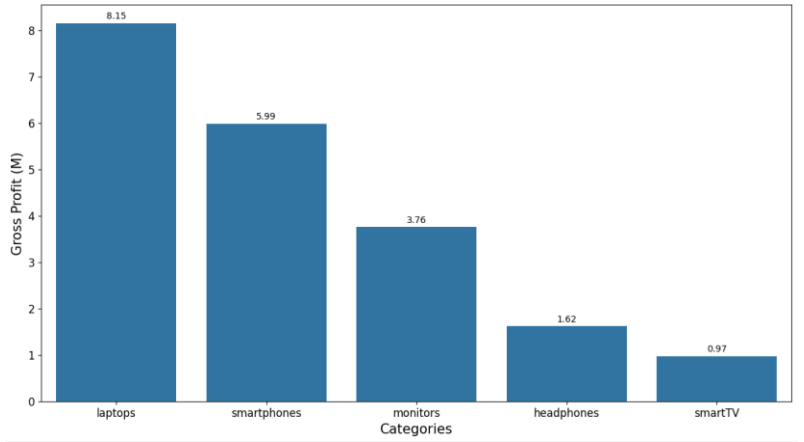


Fig 7. The Highest-performing categories based on Gross Profit

Figure 7 shows a bar graph of the top five highest-performing categories based on gross profit. Laptops are the top-grossing category, with a gross profit of $8.15 million. This suggests that laptops are a very profitable product for the company. Smartphones are the second-highest-grossing category, with a gross profit of $5.99 million. This indicates that smartphones are also a very profitable product for the company. Monitors are the third-highest-grossing category, with a gross profit of $3.76 million. This suggests that monitors are a profitable product for the company, but not as profitable as laptops and smartphones. Headphones is the fourth-highest-grossing category, with a gross profit of $1.62 million. This indicates that headphones are a profitable product for the company but not as profitable as laptops, smartphones, or monitors. Smart TVs are the fifth-highest-grossing category, with a gross profit of $0.97 million. This suggests that smart TVs are a profitable product for the company, but not as profitable as laptops, smartphones, monitors, or headphones.

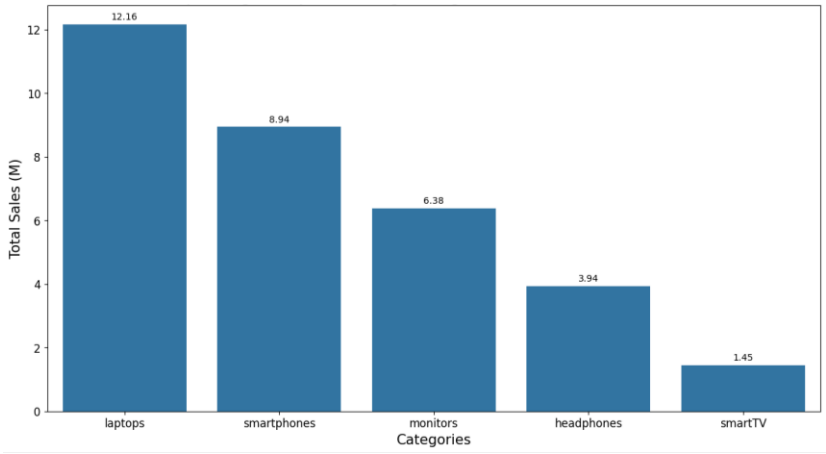


Fig 8. The Highest-performing categories based on Total Sales

Figure 8 shows a bar graph of the top five highest-performing categories based on total sales. Laptops are the top-selling category, with total sales of $12.16 million. This suggests that laptops are a very popular product for the company. Smartphones are the second-highest-selling category, with total sales of $8.94 million. This indicates that smartphones are also a very popular product for the company. Monitors, headphones, and smart TVs are also popular products for the company, but they are not as popular as laptops and smartphones.

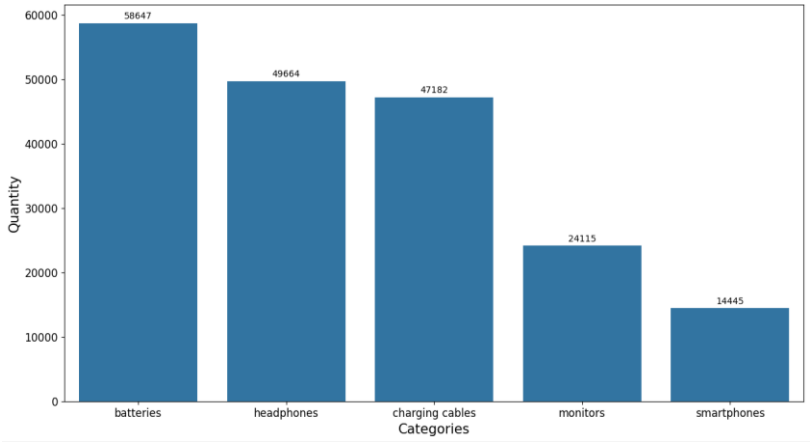


Fig 9. The Highest-performing categories based on Quantity Sold

Figure 9 shows a bar graph of the top five highest-performing categories based on quantity sold. Batteries are the clear winners in terms of quantity sold, with AAA Batteries (4-pack) and AA Batteries (4-pack) taking the top two spots. This suggests a high demand for these products, likely found in a variety of devices. USB-C charging cables and Lightning charging cables are also popular products, indicating the widespread adoption of these charging standards. Wired headphones, while not as popular as the other products, still show a significant demand for traditional headphones.

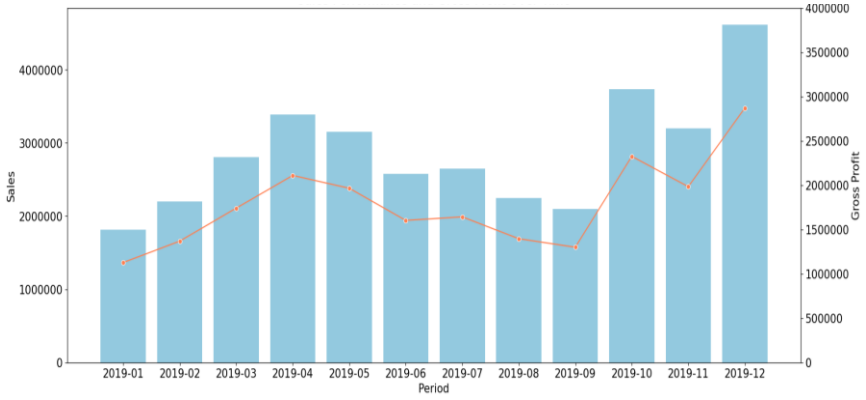


Fig 10. Sales performance and gross profit over time

Figure 10 shows a line graph of sales and gross profit over time. The time period is from January 2019 to December 2019. Sales have generally increased over time. This is a positive trend for the company. Gross profit has also generally increased over time. This is another positive trend for the company. From month to month, there are some fluctuations in sales and gross profit. A variety of factors, including product launches, marketing campaigns, and economic conditions, affect sales and gross profit, as expected.

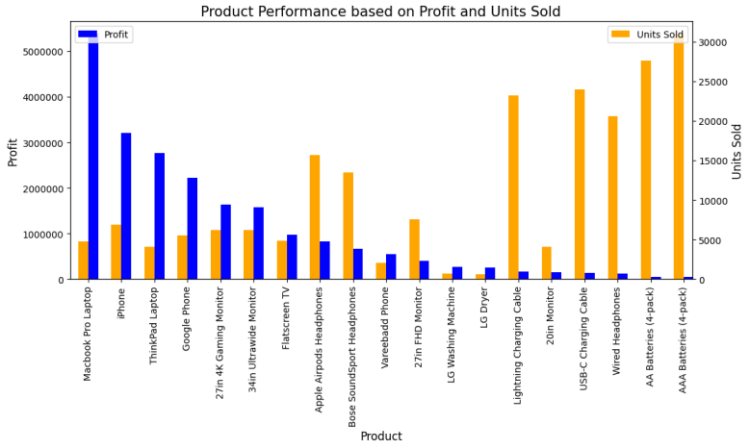


Fig 11. Product performance based on profit and units sold

Figure 11 shows a bar graph of the top 18 products based on profit and units sold. The Macbook Pro Laptop is the most profitable product, earning $5.38 million and selling 4,727 units. Though it sells fewer units than other products, the Macbook Pro Laptop is profitable for the company. The iPhone is the second-most profitable product, with a profit of $3.21 million and 6,847 units sold. This indicates that the iPhone is also a very profitable product for the company. The ThinkPad Laptop is the third-most profitable product, with a $2.76 million profit and 4,128 units sold. This suggests that the ThinkPad Laptop is a profitable product for the company, but not as profitable as the Macbook Pro Laptop or the iPhone. Google Phone is the fourth-most profitable product, with a profit of $2.22 million and 5,531 units sold. This indicates that the Google Phone is a profitable product for the company, but not as profitable as the Macbook Pro Laptop, the iPhone, or the ThinkPad Laptop. The 27-inch 4K Gaming Monitor is the fifth-most profitable product, with a profit of $1.63 million and 6,243 units sold. This suggests that the 27-inch 4K gaming monitor is a profitable product for the company but not as profitable as the Macbook Pro laptop, the iPhone, the ThinkPad laptop, or the Google Phone.

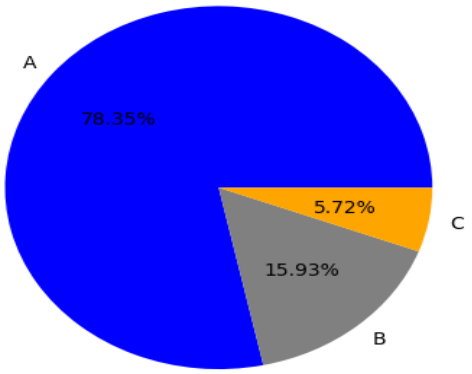


Fig 12. Product segment profitability

Figure 12 shows a pie chart that visually represents the profit distribution across different product segments. Three segments, A, B, and C, divide it. Segment A dominates the pie chart, accounting for 78.35% of the total profit. Segment B: Occupies the second-largest portion with 15.93% of the total profit. Segment C is the smallest, accounting for 5.72% of the total profit. It's colored orange. Segment A is the clear profit driver, contributing a significant majority (78.35%) of the total profit. There's a substantial difference in profitability between Segment A and the other two segments. Segment B contributes moderately, while Segment C has the least impact on overall profit. 18% of products (Segment A) generate 72% of sales and a whopping 78% of profit. Conversely, 82% of products (Segments B and C) contribute to only 28% of sales

and 22% of profit. Products in Segment A have an average profit of $499, while those in Segment C average a much lower $11. To match the profit of a single Segment A product, one would need to sell approximately 45 units from Segment C. Segment A products boast a 67% gross margin, leading to a profit of $67,000 on $100,000 in sales. In contrast, Segments B and C yield lower profits of $48,000 and $52,000, respectively, on the same sales volume.

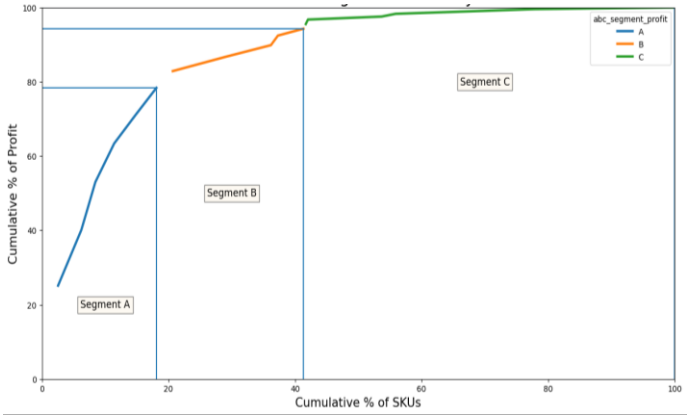


Fig 13. ABC product segmentation analysis

Figure 13 shows a product segmentation analysis based on the ABC method. This method categorizes products based on their relative profitability, with the goal of identifying and prioritizing the most valuable products for the business. The pie chart divides products into three segments: A, B, and C. Each segment represents a different level of profitability. Segment A: This segment represents the most profitable products, accounting for 18% of the total product count but generating a significant 78% of the overall profit. These products are crucial for the company's financial success. Segment B: This segment represents moderately profitable products, accounting for 23% of the total product count and 16% of the overall profit. These products still hold value but may require more attention to optimize their performance. Segment C: This segment represents the least profitable products, encompassing 58% of the total product count but generating only 5% of the overall profit. These products may need further evaluation to determine their strategic importance and potential for improvement. The pie chart and accompanying text provide valuable insights into the company's product profitability and distribution. Segment A products exhibit a high concentration of profitability, indicating that a small number of products drive a substantial portion of the company's financial gains. There is a significant disparity in profitability between Segment A and the other two segments. Products in Segment A generate a much higher profit per unit than those in Segments B and C. Segment C products make up the majority of the product count, but they contribute the least to overall profit. This implies that the company could potentially optimize or phase out a large number of low-profit products.

The analysis supports the following recommendations: To maximize profit and maintain a competitive edge in the most lucrative market segment, prioritize efforts towards Segment A products. Investigate the reasons behind the lower profitability of Segment B products. Identify potential opportunities for improvement, such as cost reduction, product enhancements, or targeted marketing strategies. Critically examine Segment C products to determine their strategic value and potential for optimization. For products with limited profitability prospects, consider strategies such as product repositioning, price adjustments, or potential phase-outs. Segment A products are likely to have higher gross margins compared to Segments B and C, indicating that a larger proportion of revenue remains profit after deducting direct costs. Analyze customer purchasing patterns to understand the factors driving demand for products in each segment. Identify opportunities to leverage customer preferences and market trends to boost profitability. Assess the competitive landscape for each product segment. Identify potential threats and opportunities to maintain a competitive advantage in the most profitable segments. Overall, the ABC analysis provides a valuable framework for identifying and prioritizing products based on their profitability. By focusing on high-value products and optimizing the performance of lower-profit segments, the company can enhance its overall profitability and achieve sustainable growth.

IV. CONCLUSION

The provided information and graphics show an analysis of product segmentation using the ABC approach. This method classifies products according to their relative profitability. The research shows that there is a high level of profit concentration in Segment A items. Although these products make up a small proportion of the total number of products, they contribute to the bulk of the overall profit. Segment B products have a modest level of profitability, while Segment C products yield the lowest amount of profit. Segment A accounts for 18% of the total products and generates 78% of the total profit. Segment B accounts for 23% of the total number of items and contributes to 16% of the total earnings. Segment C accounts for 58% of the total products and contributes 5% of the overall earnings.

Those in Sector A make an average profit of $499, whereas those in Segment C make an average profit of $11. In order to achieve profitability for a product in segment A, a client must acquire approximately 45 units from segment C. If a consumer expresses their intention to purchase items as gifts from our company with a budget of $100,000, which specific products should we suggest? Expensive products? Are you referring to products that have a low rate of movement or turnover? If we generate sales amounting to $100,000 from Section A with a gross margin of 67%, our resulting profit would be $67,000. If we generate equal sales revenue from sections B and C, the resulting profit would amount to $48,000 and $52,000, respectively. We strongly advise him to make a purchase from Sector A.

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