Optimizing Inventory and Pricing to Enhance Profitability and Reduce Impact of Currency Fluctuations in Wholesale Distribution

An End Term report for the BDM capstone Project

Submitted by

Name: Deev Bharat Savla

Roll number: 23F1001931

IITM Online BS Degree Program,

Indian Institute of Technology, Madras, Chennai

Tamil Nadu, India, 600036

Contents

1 Executive Summary and Title

The wholesale business “Kid Shopper Stop Limited”, located in Nairobi, Kenya, imports and sells aluminum cans, stainless steel hotpots and pressure cookers. The owner has started this business since Jan 2023. In a highly competitive market, the company sells these products to retail shops. The main aim of the business is to provide quality products at affordable prices and seeks to maintain its market presence while improving profitability and efficiency.

However, the business faces several challenges while running it. Currency fluctuations is the main problem faced which raise the cost of imports and reduce the profit margin. Additionally, limited storage space makes the inventory management difficult, often leading to inefficiency in stocking products. Also, due to products being damaged via cargo shipping and the low quality of products sent by the supplier, such products are not being sold or if sold, then sold at very low rates which leads to overstocking of products in the inventory and gives delay in ordering the next consignment. The highly competitive market also gives a lot of pressure in deciding the pricing which in turn affects the profit margin. Some strategies need to be made to ensure long-term sustainability in the market.

To address these issues, we have adopted a data-driven strategy using Excel and Python based machine learning. By analyzing historical sales data, currency trends, and customer purchase patterns, the business aims to optimize inventory management and improve pricing to reduce the impact of currency fluctuations on the profit margin. We will use SARIMA model for analyzing and predicting the exchange rates from historical data and trends. The expected outcome is more dynamic pricing based on seasonal trends, better stock management to reduce the wastage and also improve the communication with customers to get review about the products. These strategies will help Kid Shopper Stop Limited in achieving long-term profitability and sustainability in the market.

2 Detailed Explanation of Analysis Process/Method

Kid Shopper Stop Limited provided data for the financial year 2023. The data was given in the form of photos of bills, hence no analysis could be done, so first the data has been transformed into a computerized manner in an Excel sheet through which insights could be found. The 12 months dataset was inconsistent, hence in-depth look was needed to find any missing values and duplicate information. The key objectives included:

- Cleaning the data to remove any inconsistencies or inaccuracies.
- Applying mathematical formulas for sales and revenue calculations.
- Generating multiple types of visualizations to understand the data better.

The first step required in the analysis process was data cleaning. Columns involved in the dataset initially were Date, Month, Invoice_No, Customer_Name, Quantity_PC, Quantity_Hotpots, Quantity_cans and Tax.

The goal was to ensure that all financial figures and dates were in the correct format for further analysis. The dataset was imported to google colab and the following code was run to make sure all values are in numeric format and the date column was in date and time format.

```
df['Quantity_PC'] = pd.to_numeric(df['Quantity_PC'], errors='coerce')
df['Quantity_Hotpots'] = pd.to_numeric(df['Quantity_Hotpots'], errors='coerce')
df['Quantity_cans'] = pd.to_numeric(df['Quantity_cans'], errors='coerce')
```

```
df['Date'] = pd.to_datetime(df['Date'], format='%d/%m/%Y',errors='coerce')
```

(2.1) Code snippet to format the data

The company provided me with quantities sold to the customers. So, to make the data better for analysis I had created some new fields such as:

Sales_cans which was derived from Quantity_cans multiplied with each box price (12000).

$$Sales\_cans = 12000*Quantity\_cans$$

Sales_PC which was derived from Quantity_PC multiplied with each box price (15000).

$$Sales\_PC = 15000*Quantity\_PC$$

Sales_Hotpots which was derived from Quantity_Hotpots multiplied with each box price (11000).

$$Sales\_Hotpots = 11000*Quantity\_Hotpots$$

Selling_Price which was addition of sales of products by each customer.

$$Selling\_Price = \Sigma(Sales\_PC+Sales\_cans+Sales\_Hotpots)$$

Quantity_PC	Sales_PC	Quantity_Hotpots	Sales_Hotpots	Quantity_cans	Sales_cans	Selling_Price	Tax	US_to_KES_ExchangeRate
8	=15000*E2	8	=11000*G2	7	=I2*12000	=SUM(F2,H2,J2)	43298	123.5
11	=15000*E3	3	=11000*G3	2	=I3*12000	=SUM(F3,H3,J3)	26573	123.45
13	=15000*E4	5	=11000*G4	3	=I4*12000	=SUM(F4,H4,J4)	41354	123.55
7	=15000*E5	4	=11000*G5	1	=I5*12000	=SUM(F5,H5,J5)	15789	123.55
1	=15000*E6	1	=11000*G6	1	=I6*12000	=SUM(F6,H6,J6)	4765	123.55
2	=15000*E7	2	=11000*G7	0	=I7*12000	=SUM(F7,H7,J7)	21345	123.6
2	=15000*E8	5	=11000*G8	2	=I8*12000	=SUM(F8,H8,J8)	7856	123.6
10	=15000*E9	9	=11000*G9	8	=I9*12000	=SUM(F9,H9,J9)	43325	123.7
3	=15000*E10	3	=11000*G10	1	=I10*12000	=SUM(F10,H10,J10)	6053	123.7
3	=15000*E11	2	=11000*G11	1	=I11*12000	=SUM(F11,H11,J11)	7568	123.75
2	=15000*E12	1	=11000*G12	0	=I12*12000	=SUM(F12,H12,J12)	6753	123.75
3	=15000*E13	0	=11000*G13	1	=I13*12000	=SUM(F13,H13,J13)	8432	123.8
7	=15000*E14	7	=11000*G14	6	=I14*12000	=SUM(F14,H14,J14)	43362	124
4	=15000*E15	0	=11000*G15	3	=I15*12000	=SUM(F15,H15,J15)	8346	124.01
4	=15000*E16	5	=11000*G16	2	=I16*12000	=SUM(F16,H16,J16)	16234	124.03
8	=15000*E17	5	=11000*G17	3	=I17*12000	=SUM(F17,H17,J17)	12589	124.35
4	=15000*E18	5	=11000*G18	2	=I18*12000	=SUM(F18,H18,J18)	13457	124.45
9	=15000*E19	8	=11000*G19	7	=I19*12000	=SUM(F19,H19,J19)	43389	124.65
6	=15000*E20	15	=11000*G20	6	=I20*12000	=SUM(F20,H20,J20)	31234	124.8
2	=15000*E21	3	=11000*G21	1	=I21*12000	=SUM(F21,H21,J21)	5278	125.1
7	=15000*E22	5	=11000*G22	3	=I22*12000	=SUM(F22,H22,J22)	37298	125.15
3	=15000*E23	3	=11000*G23	1	=I23*12000	=SUM(F23,H23,J23)	7981	125.15
11	=15000*E24	5	=11000*G24	9	=I24*12000	=SUM(F24,H24,J24)	39801	125.4
5	=15000*E25	5	=11000*G25	4	=I25*12000	=SUM(F25,H25,J25)	19156	125.5

(2.2) Formulas in the cleaned dataset

The data was then categorized and separated according to the relevant month, where data can be eligible for reviewing and comparing monthly performance. Briefly reviewing this data and filtering out key information helped in further analysis. Categorizing monthly was the best option as it gave a complete analysis on the data. Daily or weekly analysis did not result in meaningful insights and there was not enough data to be worked upon as this is a wholesale business.

The data was therefore summarized and rearranged by using pivot tables so that any important insights or trends could then be viewed across the various dimensions such as month and customers. Pivot tables allow for very powerful dynamic analysis whereby the view of the data may be changed with ease so the underlying trends may be identified.

After data cleaning step and creating pivot tables, some descriptive statistics such as mean, variance, standard variation and skewness of the fields were been calculated and evaluated. After calculating them these are the summarized points that I gathered:

1. The high variance of 7296684384.7875 of Selling_Price indicates fluctuations in the pricing of products over time.
2. Variance of 93.414526476 shows that US dollar to KES exchange rate fluctuates considerably. This can have direct impact on the profitability of the business.
3. Slightly rightly skewed (0.6931) of Selling_Price, suggesting that most products are sold at consistent prices with minor variations and only few sales occur at higher selling prices which reduces the overall profit margin.
4. The standard deviation 3.0558, 2.9947 and 2.8925 of PC, cans and Hotpots respectively indicate that PC sales are most variable, followed by cans and Hotpots being the most consistent in terms of sales quantities.

After this, many visualizations in the form of graphs were created to facilitate insight into trends and distributions within this data. Line chart was used to show the trends in entire sales as well as sales of each product over the year, which showed how the company's revenue changed month by month. Then after some more detailed analysis it was found that Pressure Cooker generated the most revenue which is 44.5% which is almost half of the revenue followed by Hotpots which was 30.7% and then the cans which is 24.7% and generated the least revenue. A pie chart was created to find the above analysis of the best and worst product for the company's revenue.

A heatmap showing correlation Between Quantity_PC, Sales_PC, Quantity_Hotpots, Sales_Hotpots, Quantity_cans, Sales_cans and US_to_KES_ExchangeRate was drawn and gave valuable insights about how one is related to another. Using these graphs, the peak season for the business was found and the most selling product was found.

Hence, from this data, solutions can be found about which products should be ordered more and at which time which will help in inventory management and faster selling of products. We can also get to know the product sales and how profit is getting affected by the exchange rates.

These steps helped transform the data from a jumbled and unorganized collection of data to a structured and insightful data. The cleaning and analysis of data was done using excel and python libraries like NumPy and pandas. The graphs were plotted using the python libraries - matplotlib and seaborn.

```
total_cans = df['Sales_cans'].sum()
total_hotpots = df['Sales_Hotpots'].sum()
total_pc = df['Sales_PC'].sum()
print("Total sales of cans:",total_cans)
print("Total sales of hotpots:",total_hotpots)
print("Total sales of PC:",total_pc)
```

```
Total sales of cans: 11184000
Total sales of hotpots: 13882000
Total sales of PC: 20130000
```

```
import pandas as pd
import matplotlib.pyplot as plt
total_sales = [total_pc, total_hotpots, total_cans]
products = ['PC', 'Hotpots', 'Cans']

# Plot pie chart
plt.figure(figsize=(8, 8))
plt.pie(total_sales, labels=products, autopct='%1.1f%%', startangle=140)
plt.title('Percentage of Total Sales by Product')
plt.show()
```

(2.3) Code snippet to plot products based on sales (%)

Along with this, I calculated the ROP and EOQ of each product to get better understanding in terms of business context.

The following formulas were used to find ROP and EOQ:

1) ROP = d * L + SS (L – lead time and SS – safety stock)
2) EOQ=sqrt(2DS/H) where D – demand rate, H – holding cost per year, S – ordering cost.
3) Holding Cost – Avg Selling Price * 20%
4) Annual Demand – sum of quantity of each product.

After calculating the ROP and EOQ these are the summarized points that I understood:

1. The demand variability is highest for Pressure Cookers (**58.53**), followed by Hotpots (**55.04**) and Cans (**40.70**). This highlights the need for more cautious inventory management for Pressure Cookers and Hotpots to prevent stockouts, while Cans show more predictable demand.

2. The EOQ values are small for all these 3 products, which suggests that company

favors small orders to avoid high holding costs like limited storage costs or high warehousing costs which is also a problem for the business.

3. The demand variability is highest for Pressure Cookers (**58.53**), followed by Hotpots (**55.04**) and Cans (**40.70**). This highlights the need for more cautious inventory management for Pressure Cookers and Hotpots to prevent stockouts, while cans show more predictable demand.

The above steps and processes helped me in detailed analysis of the problem of inventory management and helped me make some strategies to optimize it.

For analyzing the currency fluctuations and future predictions of exchange rates I have used **SARIMA** (Seasonal Autoregressive Integrated Moving Average) and it is most efficient in time series forecasting and also exhibits seasonal patterns or trends.

Below is the entire procedure of how I have used SARIMA for this problem:

Data Preparation: I have trained the SARIMA model with the entire 2023 exchange rates historical data between US and KES. Firstly, sorted the data by date.

Train-Test Split: split the data into 80:20 ratio of training:test set. Trained the model from the above dataset. The model predicted for the test set period.

Model Fitting: Defined the SARIMA model parameters eg: - order(1,1,1)

Making Predictions and Evaluating Metrics: Also calculated RMSE (Root Mean Square Error) and MAPE (Mean Absolute Percentage Error) to evaluate model performance. These are the stats:

- Root Mean Squared Error: 0.6551
- Mean Absolute Percentage Error: 0.0030

This suggests that model is performing well in terms of percentage accuracy and the model has captured the patterns well.

The mathematical equation is:

$$(1-B^s)^D(1-B)^d y_t = \mu + (1+\theta_1 B+\theta_2 B^2+...+\theta_q B^q)(1+\Theta_1 B^s+\Theta_2 B^{2s}+...+\Theta_Q B^{Qs})\varepsilon_t$$

where:

- y_t = time series data
- BBB = backshift operator (i.e., $B^k y_t = y_{t-k}$)
- ε_t = white noise error term

The SARIMA model is represented as:

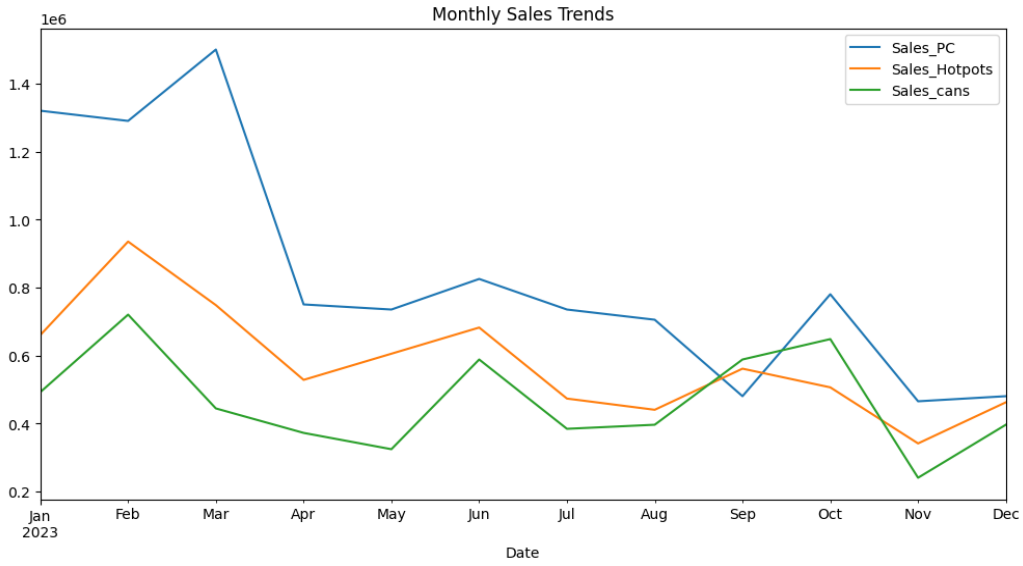
SARIMA(p, d, q)(P, D, Q)s

where:

- p = order of the autoregressive part
- d = degree of differencing
- q = order of the moving average part
- P = order of seasonal autoregressive part
- D = degree of seasonal differencing

- Q = order of seasonal moving average part
- s = length of the seasonal cycle

3 Results and Findings



(3.1) Monthly Sales of each product.

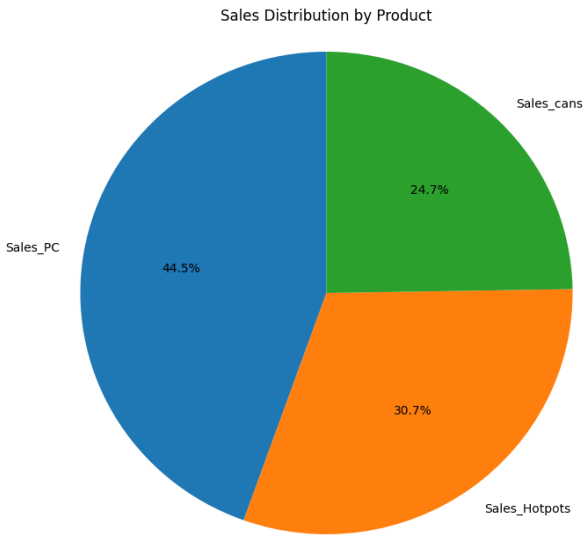
Based on the graph a few things can be observed -

The sales pattern shows significant fluctuations, indicating variations in demands for Pressure Cookers, Hotpots and cans. There is a significant rise in sales at the first 2 months which peaked at January.

From, **March to August** there is a sharp decline in all three products mainly in Pressure Cookers and Hotpots. This can be due to inflation or cheap quality products due to which they are sold at very cheap rates.

There is a slight improvement in September mainly for pressure cookers so targeting this period with strategic marketing and inventory stocking could maximize the revenue. Despite the festive season in December, all product categories, especially Pressure Cookers and Hotpots, show a sharp decline in sales during this month.

After analyzing the graph, it highlights there is a need for flexible inventory management. The company can benefit from data-driven methods to calculate reorder points, economic order quantities, and safety stock to ensure adequate supply during peak months such as February and September, while avoiding overstock during low-demand months.



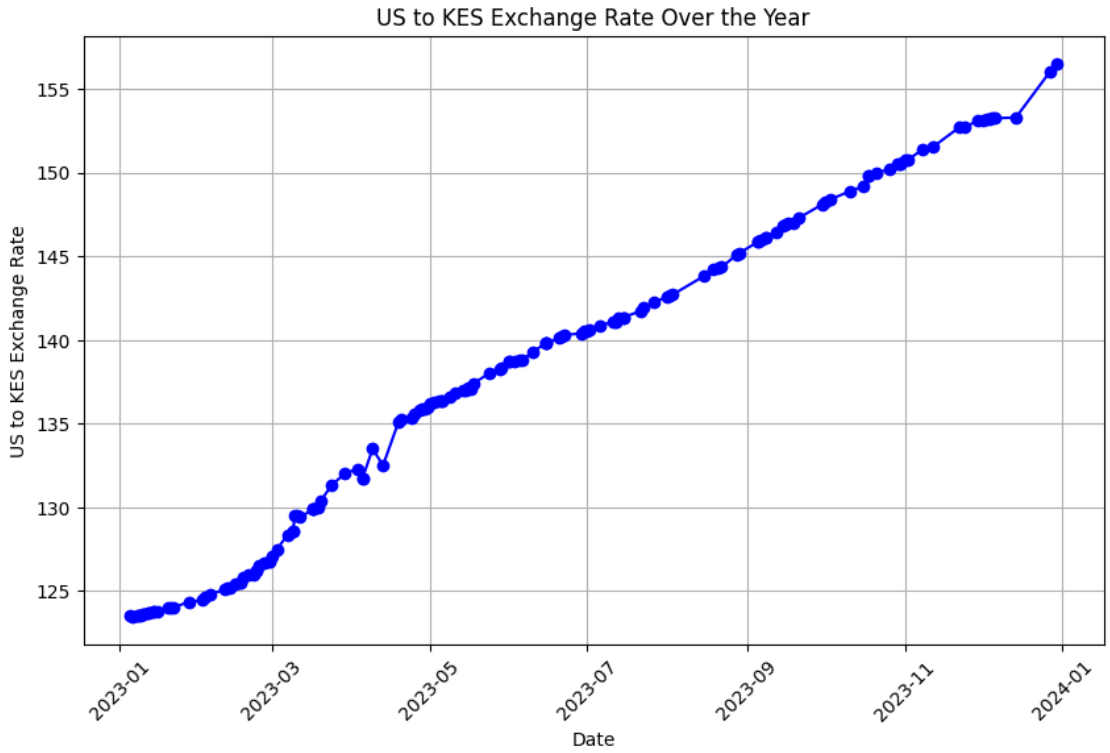
(3.2) Sales Distribution by Product

The blue segment represents the sales of **Pressure Cookers**, which account for **44.5%** of total sales. This is the largest segment, indicating that Pressure Cookers contribute the most to the company's overall revenue. This suggests that the demand for Pressure Cookers is relatively high, making it a key product for the business. Strategies to optimize sales performance for this product category, such as targeted marketing and inventory management, would likely have a significant impact on the company's overall performance.

The orange segment represents **Hotpots**, which contribute **30.7%** of total sales. This indicates that Hotpots also play a significant role in the business but are less dominant compared to Pressure Cookers. While still an important product category, the smaller share suggests there may be room to increase its market presence, perhaps by focusing on marketing campaigns or promotional offers to boost sales in this category.

The green segment represents the sales of **cans**, which make up **24.7%** of total sales. This is the smallest share of the three categories, showing that cans have a relatively lower demand compared to Pressure Cookers and Hotpots. The lower percentage may indicate an opportunity to explore ways to either boost sales of cans or manage the inventory to focus on higher-performing product categories.

Overall, the pie chart provides a clear breakdown of the company's sales distribution, with **Pressure Cookers** leading as the top-selling product, followed by **Hotpots** and **cans**. This data can guide strategic decisions regarding which products to prioritize for marketing and inventory management. It may also suggest where the company could invest in growth opportunities, such as increasing the share of Hotpots and cans in the sales mix, or focusing on expanding the lead of Pressure Cookers.



(3.3) Exchange Rates over the year 2023

The most attracting feature is that there is a clear upward trend throughout the year. This indicates that USD has been consistently strengthening against the KES, or in the opposite that the KES has been depreciating against the USD.

The exchange rate starts around 123-124 KES per USD at the beginning of 2023 and ends at approximately 157 KES per USD in early 2024. This represents a significant depreciation of the Kenyan Shilling, about 27-28% over the year.

The rate of increase is not uniform throughout the year. We can observe a slow start in rise (123 to 125 KES/USD) between Jan-Feb 2023, then a rapid rise between Mar-May which is (125 to 135 KES/USD) and a steady climb in May-Nov 2023 from which is (135 to 150 KES/USD). At the end there is a sharp spike in Nov 2023 - Jan 2024.

The steady depreciation of the Kenyan Shilling against the US Dollar indicates that if you're importing goods or materials priced in USD, your costs have increased significantly over the year. By early 2024, you're paying about 27-28% more in KES for the same USD-priced goods compared to early 2023.

This suggests that there is a clear need for more KES to purchase the same amount of USD-priced inventory and faster inventory turnover becomes crucial to minimize exposure to currency fluctuations between purchase and sale of goods but this is not case in this business. As it is clearly seen in Fig 3.1 that sales have been decreasing gradually through the year. This gradual decrease in sales and increase of exchange rates combined have reduced the profit margin drastically and affected the business severely.

Sales and Payment Table			
Each consignment	Starting_Payment	Sales	Ending_Payment
Jan - Mar	62,98,500	81,09,000	64,82,100
Apr - July	67,47,300	70,01,000	71,68,050
Aug - Dec	72,72,600	74,88,000	78,10,650

(3.4) Sales and Payment Table over the Year 2023

After analyzing the Fig (3.1) Monthly sales of each product and Fig (3.3) Exchange Rates over the year 2023, I created a table of entire sales and payment of the owner for the entire year which is shown in Fig 3.4 which helped in finding better and accurate results. As you can see the owner had ordered goods 3 times in the year 2023. Each consignment's price was fixed which was 51000 dollars.

So, Starting_Payment is the payment of 51000 dollars in terms of KES which was calculated according to the exchange rates in the starting month which were Jan, Apr and Aug respectively. The owner had used these values to estimate the selling of each product to ensure profit in the business. Sales fields depicts the total revenue generated for that particular consignment. Ending Payment is the actual payment of 51000 dollars that the owner has to pay at the end of 3 months which were calculated according to the ending months Mar, July and Dec.

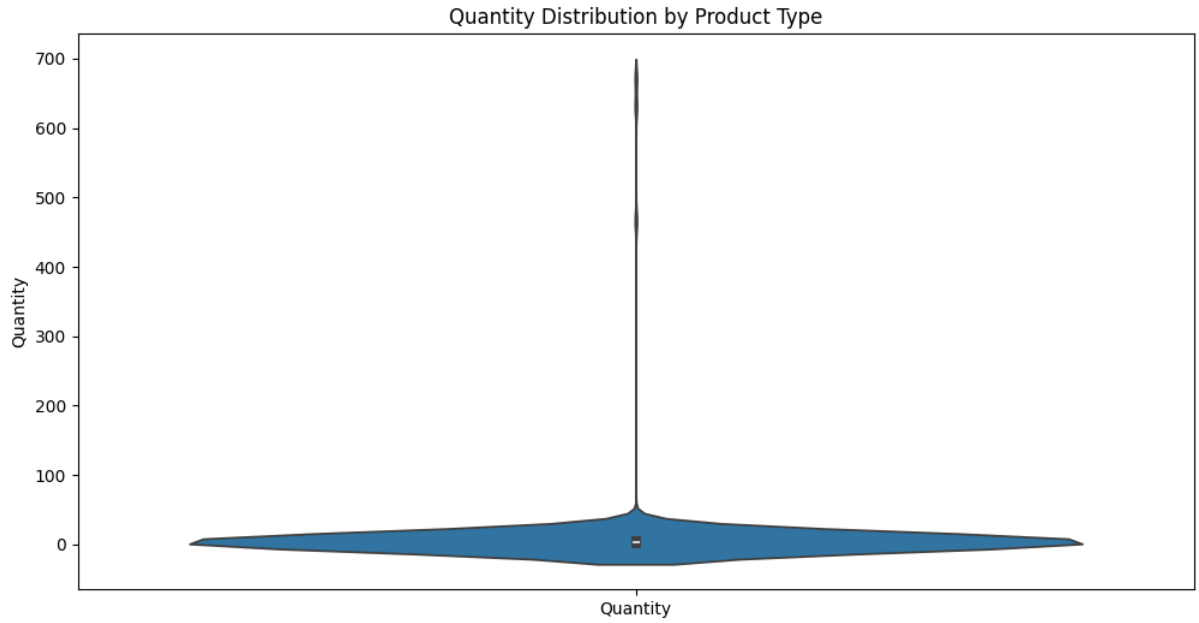
The Ending_Payment is higher than the Starting_Payment which reflects the depreciation of KES against USD over each period.

- Jan-Mar: 62,98,500 to 64,82,100 (2.92% increase)
- Apr-July: 67,47,300 to 71,68,050 (6.24% increase)
- Aug-Dec: 72,72,600 to 78,10,650 (7.40% increase)

In Jan-Mar the sales of 81,09,000 comfortably exceeded Ending_Payment (64,82,100) which means that consignment was sold with profit of 16,26,900 and took an ideal time of 3-months for complete selling and also indicates that the owner correctly judged the pricing of products to be sold at. But in Apr-July the sales of 70,01,000 are much closer to Ending_Payment (71,68,050) which generated a profit of only 1,67,050 which has decreased drastically than the last profit. You can also see that it has taken 4 months for entire selling of goods which is a month more than the previous consignment. This indicates slow selling rate of goods and decrease in profit margin. This may be due to increased competition in the market and difficulty for the owner to predict a correct price was selling the products to gain more profit.

Then the last consignment of Aug-Dec was the worst sales for the owner. The sales of only 74,88,000 and Ending_Payment of 78,01,650 suggests that the owner was at loss of 3,13,650 for this consignment. This indicates that owner couldn't judge the pricing and such spike in the exchange rates.

In general, looking at the table it is clearly noticed that there is a need to adjust pricing strategy to account for the growing currency risk, especially evident in the later consignments. The growing discrepancy between Starting and Ending Payments highlights the increasing importance of implementing currency risk management strategies. In the Aug-Dec period, the Ending_Payment exceeding the Sales, suggests the current business model may not be sustainable if this trend continues. This variability of exchange rates makes it challenging to accurately predict costs and set prices for future consignments.

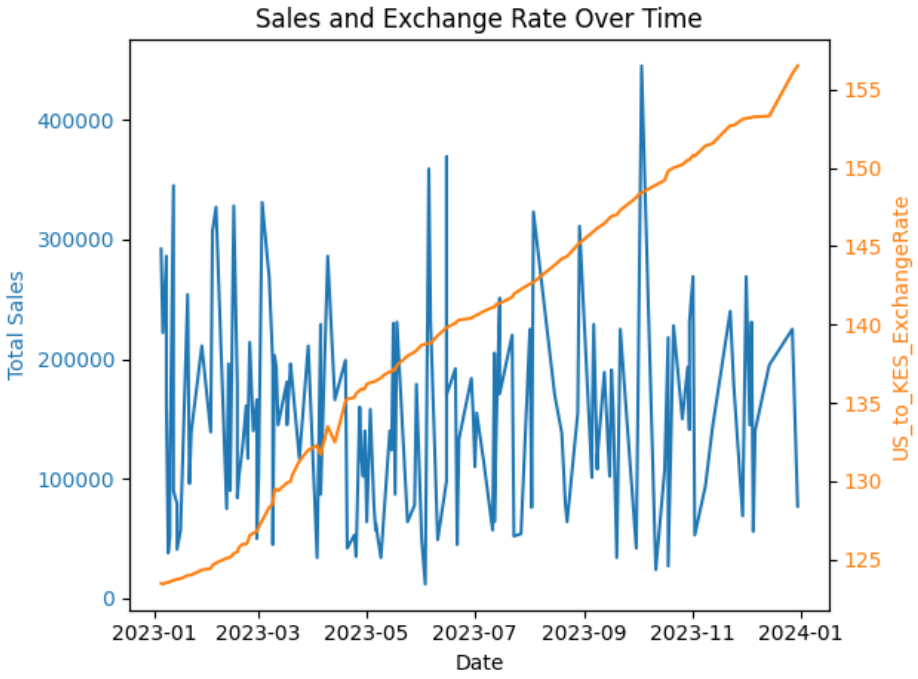


(3.5) Quantity Distribution

The quantities range from near 0 to over 200 in the violin plot, indicates significant variability in product quantities. This could complicate inventory management, especially for items at the extremes.

The long tail extending to higher quantities could represent slow-moving inventory making it difficult to order new goods due to limited storage capacity. The distribution is not symmetrical, with more products at lower quantities. This could indicate many low-volume items that may be costly to manage individually.

The diverse quantity ranges suggest a need for segmented inventory strategies. Along with currency fluctuations impact purchase costs this further complicates in maintaining optimal stock levels, potentially leading to stockouts or excess inventory.



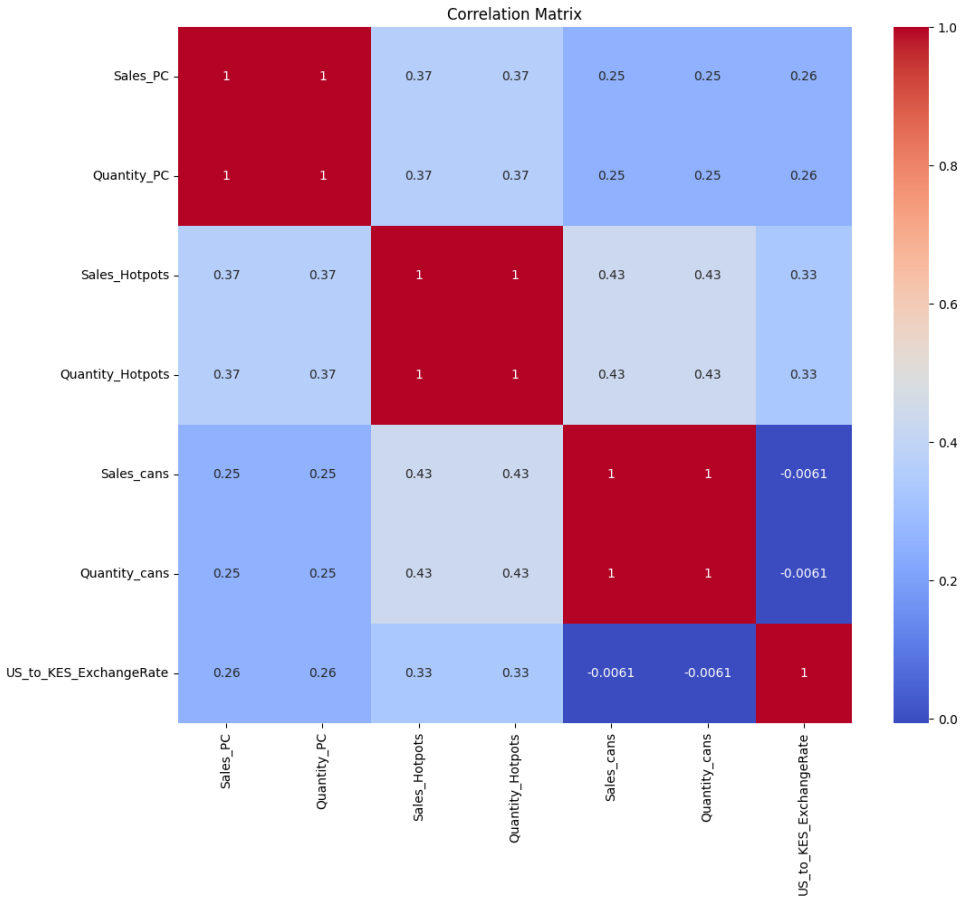
(3.6) Time series plot of sales and exchange rates

The sales data appears highly volatile, with significant spikes and dips. This could indicate seasonality, fluctuating demand, or external influences (e.g., economic conditions, or stockouts). The exchange rate (USD to KES) is steadily increasing from early 2023 to the end of the year. This means that the value of the Kenyan Shilling is depreciating against the dollar as we have in Fig 3.3.

As the exchange rate rises and KES depreciates, sales do not seem to follow a clear upward or downward trend. Instead, they remain volatile. This suggests that while currency fluctuations might affect costs, other factors may also influence sales trends. The rising exchange rate would increase import costs. This could reduce profit margins unless prices are adjusted.

Volatile sales pattern makes it difficult to manage the inventory, making it harder to predict when to reorder stock and how much to keep on hand. Rising exchange rates affects the ability to stock products if they become expensive to import. Due to both of these combined problems the owner might overstock when demand drops or understock when prices increase, leading to potential stockouts or high holding costs.

In the future, if exchange rates continue rising and are not countered by price adjustments or cost-saving measures, sales might start to decline as goods become more expensive. If sales do not increase proportionally with the rising costs, profitability will suffer.



(3.7) Heatmap for correlation between Products and US_to_KES_ExchangeRate

This heatmap presents a **correlation matrix**, which visually represents the strength and direction of linear relationships between various variables. The matrix includes different product categories (pressure cookers, hotpots, and cans) and the exchange rate between the US dollar (USD) and the Kenyan Shilling (KES). The correlations range from -1 (perfect negative correlation) to +1 (perfect positive correlation), with 0 indicating no correlation. Using the correlation matrix a lot of insights can be drawn.

1. Pressure Cooker and Hotpots (Correlation: 0.37)

The correlation between sales and quantity of pressure cookers (PC) with hotpots is **0.37** for both. This suggests a **moderate positive correlation**. When sales of pressure cookers rise, sales of hotpots tend to rise as well, though not as strongly as within each product category. This might indicate that customers who buy one product (e.g., pressure cookers) may also be inclined to buy hotpots, but the relationship is not as strong as within the product category.

2. Pressure Cooker and Cans (Correlation: 0.25)

The correlation between sales (and quantity) of pressure cookers with cans is lower, at **0.25**. This is a weak positive correlation, indicating that there's a small tendency for sales of pressure cookers and cans to rise together, but the relationship is not very strong.

3. Hotpots and cans (Correlation: 0.43)

The correlation between hotpots and cans is **0.43**, which is slightly higher than the other inter-product relationships. This shows a moderate positive relationship, suggesting that sales and quantities of hotpots and cans are somewhat related. This could mean there are occasions or events where these products are bought together.

4. Pressure Cooker and USD to KES Exchange Rate (Correlation: 0.26)

The correlation between both sales and quantity of pressure cookers and the USD to KES exchange rate is **0.26**, a weak positive correlation. This means that when the exchange rate (USD to KES) increases, sales and quantities of pressure cookers tend to increase only slightly. This might be due to pricing adjustments or other external factors impacting consumer purchasing power or stocking patterns.

5. Aluminum cans and USD to KES Exchange Rate (Correlation: 0.26)

For hotpots, the correlation with the exchange rate is slightly higher, at **0.33**, indicating a moderate positive relationship. This suggests that as the exchange rate rises, sales and quantities of hotpots tend to increase more than for pressure cookers. This could reflect higher demand or higher price elasticity for hotpots compared to other products when facing currency fluctuations.

6. Stainless Steel Hotpots and USD to KES Exchange Rate (Correlation: 0.33)

The correlation between sales (and quantity) of cans and the exchange rate is almost **0** (-0.0061). This implies that there's virtually no relationship between the exchange rate and sales/quantities of cans. The price of cans or consumer demand for them might be more resilient to currency fluctuations compared to pressure cookers and hotpots. of pressure cookers tend to increase slightly. This might be due to pricing adjustments or other external factors impacting consumer purchasing power or stocking patterns.

Below are some key points that are understood from the heatmap:

Inter-Product Co-relation: Hotpots and cans show a slightly stronger correlation with each other (0.43) than pressure cookers with either hotpots (0.37) or cans (0.25), indicating some cross-product purchasing patterns but not highly dependent relationships.

Co-relation with exchange rates:

- Pressure cookers and hotpots are weakly to moderately correlated with the exchange rate (0.26 and 0.33), suggesting they are somewhat sensitive to currency fluctuations.
- Cans, however, show no significant correlation with the exchange rate, indicating their sales might not be directly impacted by currency changes.

This suggests that the exchange rate is influencing the ability to price and sell certain products (like hotpots and pressure cookers), but it has less effect on others (like cans).

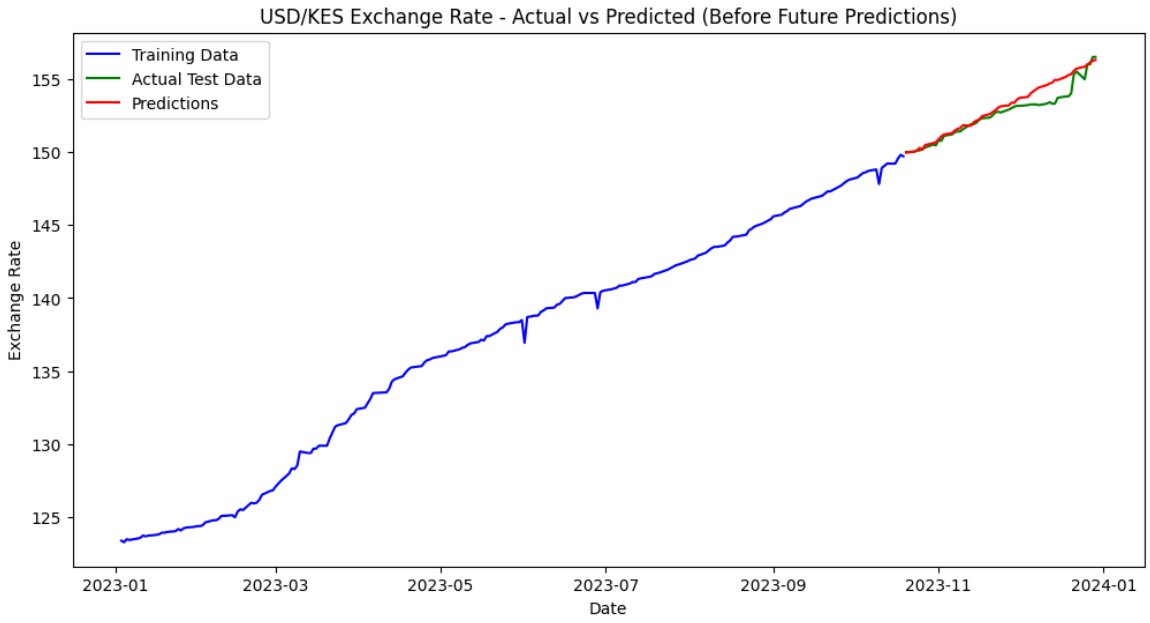
Recommendations based on Heatmap

1) **Product-Specific Pricing Strategies:** Since the exchange rates affects pressure cookers and hotpots more than the aluminum cans, we should consider some different pricing strategies for each product. For example, seeing from the heatmap, we need to adjust the prices of hotpots frequently based on currency fluctuations to ensure profitability.

2) **Inventory Management:** The correlations suggest that hotpots and pressure cookers may benefit from joint inventory management strategies, while aluminum cans might be managed separately due to their different sales dynamics.

These were the graphs and analysis without using python-based machine learning and were plotted through matplotlib and seaborn.

After using SARIMA model for predicting the future exchange rates here are some visualizations and results that model has given:



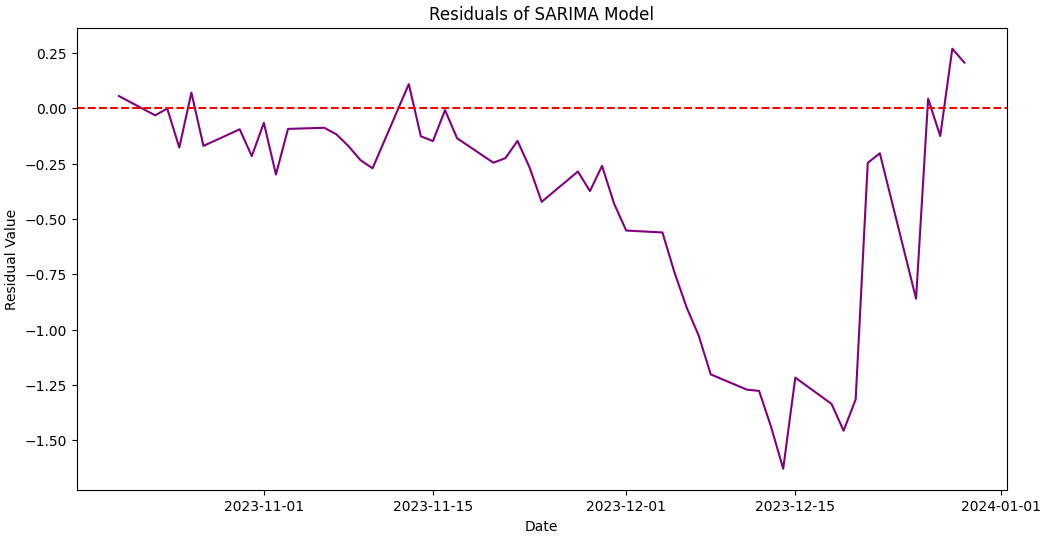
(3.8) Before Future Predictions Graph

Training Data (Blue): This represents the historical data used to train the prediction model, which spans from early 2023 until around October or November 2023. The exchange rate generally shows an upward trend, indicating that the USD has been gaining value against the KES during this period.

Actual Test Data (Green): This is the actual exchange rate data after the training period, likely representing the real values of the USD/KES exchange rate for the test phase of the model. It continues the upward trend with some minor deviations.

Predictions (Red): This line shows the model's predictions for the exchange rate, compared to the actual test data. The predictions closely follow the actual values, suggesting the model is performing well.

Overall, the graph shows an increasing trend in the USD/KES exchange rate over 2023, with the model's predictions aligning closely with the actual test data in the latter part of the year.



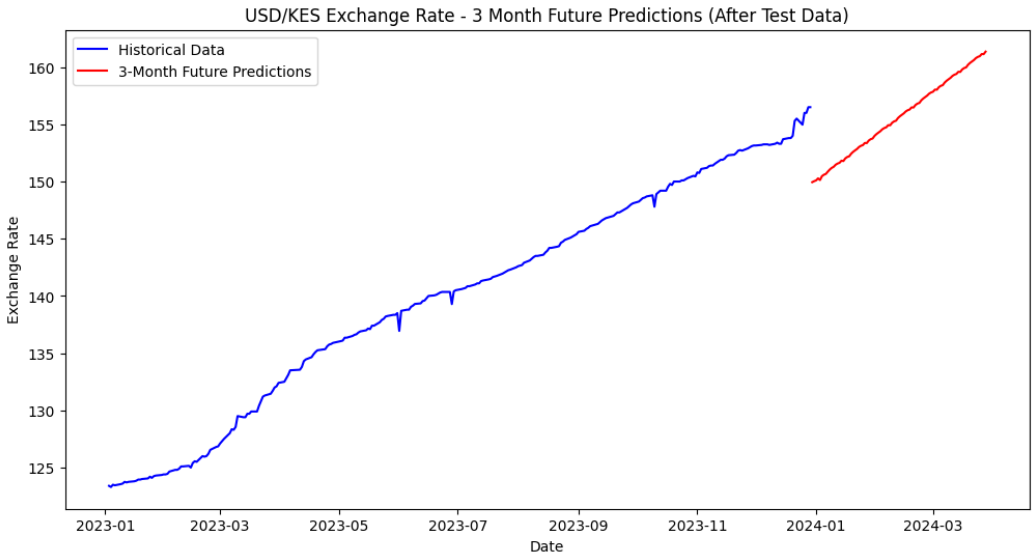
(3.9) Residuals of SARIMA Model

This graph shows the difference between the actual values and model's predicted values.

The residuals fluctuate around 0, indicating that the model is generally performing well, as errors are distributed both positively and negatively. However, there are periods where the residuals deviate more significantly from 0, particularly in late November and December 2023.

From around December 2023, there is a clear downward trend in the residuals, with values reaching below -1.5. This suggests that during this period, the SARIMA model consistently **underestimated** the actual values.

Ideally, residuals should be randomly distributed around zero which is seen at the starting phase in the graph without showing any clear patterns, which would suggest that the model is capturing the underlying process well. The increasing trend in residuals toward the end indicates that the model may need adjustment to better capture the dynamics in the latter part of the test period.



(3.10) 3 Months Future Predictions Graph

SARIMA Model has predicted for a 3-month period of Jan – Mar 2024. The forecast suggests a continued depreciation of the Kenyan Shilling against the US Dollar. The predicted rate of depreciation appears to be steeper than the historical trend, suggesting an acceleration in the weakening of the Kenyan Shilling.

By March 2024, the model predicts the exchange rate could reach around 162 KES per USD. These exchange rate predictions can be influenced by numerous factors such as economic policies, global events etc.

In summary, the model's forecast of a steep depreciation of the KES suggests Kenya is entering a period of heightened currency instability. Economic policies and external global factors will likely continue to play pivotal roles in determining whether the Kenyan Shilling can stabilize or face further depreciation in 2024.

4 Interpretation of Results and Recommendation

(4.1) Recommendation 1: Adjust Pricing Strategy to Reduce Currency Risks

The sharp depreciation of the Kenyan Shilling (KES) against the US Dollar (USD), especially in the Aug-Dec period, has led to higher costs for imported goods and reduced profit margins. The growing gap between Starting and Ending Payments indicates significant currency risk.

Therefore, implement a dynamic pricing strategy that adjusts product prices based on currency fluctuations. For example, use data-driven forecasting to predict future exchange rates and price products accordingly. You could also consider introducing price bands that automatically adjust within a predefined range if the exchange rate crosses critical thresholds. Additionally, adopting forward contracts with the supplier to lock in favorable exchange rates for future purchases can help stabilize costs and improve profit margins. This helps maintain profit margins and shields the business from abrupt changes in exchange rates.

(4.2) Recommendation 2: Implement Flexible Inventory Management Based on Sales Seasonality

The sales pattern shows significant fluctuations, with peaks in January and September, but steep declines from March to August and in December. Pressure Cookers, being the highest-selling product, represent 44.5% of total sales, followed by Hotpots (30.7%) and cans (24.7%).

Introduce a **seasonal inventory strategy** that aligns with fluctuating demand. For peak months like January and September, stock up on high-demand items like Pressure Cookers. During low-demand months (March-August and December), reduce inventory to prevent overstock and associated holding costs. Utilize **economic order quantity (EOQ)** and **safety stock** calculations to maintain optimal stock levels, ensuring that you can meet demand without tying up too much capital in inventory.

(4.3) Recommendation 3: Enhance Marketing and Promotions for Low-Performing Products

While Pressure Cookers contribute the most to sales, Hotpots and cans represent 30.7% and 24.7% of total sales, respectively, indicating lower market share. The declining sales trend, especially in the second half of the year, highlights potential demand issues.

Increase promotional activities, particularly for Hotpots and cans. Create **bundled offers** (e.g., buy a Pressure Cooker and get a discount on Hotpots or cans) to stimulate cross-product sales. Leverage customer data to identify key segments and run **targeted campaigns** through social media platforms, focusing on price-sensitive customers during periods of economic uncertainty. Additionally, launching seasonal discounts, loyalty programs, or referral incentives can help boost sales in underperforming product categories.

(4.4) Recommendation 4: Monitor Exchange Rates and Adjust Import Timing for Cost Savings

The exchange rate fluctuation has increased costs over time, with the most significant spike occurring between November 2023 and January 2024. Payment costs for the same consignment rose from KES 62,98,500 in Jan-Mar to KES 78,01,650 in Aug-Dec.

Implement a **currency monitoring system** to track real-time exchange rate movements and use this data to time imports strategically. If favorable exchange rates are predicted, you could accelerate future purchases or bulk-buy at a lower cost. Similarly, defer imports when exchange rates are expected to improve. You can use forex tools like **forward contracts** or **options** to lock in favorable rates for future transactions, protecting against adverse currency movements.

(4.5) Recommendation 5: Focus on Faster Inventory Turnover to Reduce Exposure to Exchange Rate Risk

The slower sales pace during the second consignment period (Apr-Jul), combined with a 6.24% increase in payment costs, reduced profit margins significantly. The third consignment (Aug-Dec) resulted in a loss due to slow sales and rising import costs.

Aim to **increase the speed of inventory turnover** by improving the sales cycle through targeted marketing, optimizing pricing, and adjusting stocking levels. This will help minimize the time goods spend in inventory while exposed to exchange rate fluctuations. Introducing incentives like **limited-time discounts**, **seasonal offers**, or **loyalty rewards** for bulk purchases can help accelerate sales and improve cash flow.

(4.6) Recommendation 6: Diversify Supplier Base Across Multiple Countries

To reduce vulnerability to currency fluctuations in a single market, Kid Shopper Stop Limited should diversify its supplier base across multiple countries. By sourcing products from various geographic locations, the company can take advantage of favorable exchange rates in different markets. When one currency becomes unfavorable, the company can shift more of its purchasing to suppliers in countries with more favorable exchange rates. This strategy not only helps in managing currency risks but also provides additional benefits such

as reduced dependence on a single market, access to a wider range of products, and potential cost savings. However, it requires careful management of multiple supplier relationships and potentially more complex logistics.

(4.7) Recommendation 7: Implement ABC Inventory Analysis

Kid Shopper Stop Limited should implement ABC inventory analysis to categorize products based on their importance and adjust stock levels accordingly. In this system, 'A' items are the most valuable products with the highest sales volume, 'B' items have moderate sales and value, and 'C' items have the lowest sales volume and value. By categorizing inventory in this way, the company can prioritize its inventory management efforts and allocate resources more efficiently. For instance, 'A' items might warrant more frequent reordering and closer monitoring, while 'C' items might be ordered less frequently in larger quantities. This approach helps in optimizing storage space, reducing inventory costs, and ensuring that the most important products are always in stock.

By implementing these strategies, Kid Shopper Stop Limited can reduce the impact of currency depreciation, optimize inventory, boost sales, and improve overall profitability. These recommendations align with the business's data-driven approach and provide a comprehensive solution to address both short-term and long-term operational challenges.

5 Important links

SARIMA Model Colab File - https://colab.research.google.com/drive/1PsoR4Ndqcf-vqHALoTGhHBUHg4ZhhrGW?usp=drive_link

BDM Project folder -
https://drive.google.com/drive/folders/1BNsFY6IcLuN0pbf_zB5I2HTYAf_AcV2a?usp=drive_link