SUPPLYCHAIN MANAGEMENT ANALYSIS

An exploratory data analysis and predictive modelling using R and Power BI

CONTENTS

INTRODUCTION

Supply chain analysis is a crucial aspect to develop data driven insights which fuels productive decision making in various industries such as Retail and E-Commerce, Pharmaceuticals and Healthcare, Manufacturing, Textiles, Technology etc. It is the process of analyzing how a product moves from the supplier to customer to find efficient ways to make it fast, cheap and optimized.

In this project I have given a data set from a beauty and fashion venture, where the data contains all relevant information about the supply chain of cosmetics which includes columns such as, SKU, Price, Availability, Number of products, Revenue generated, stock levels etc.

The data contains 24 columns and 100 real world data of customers crucial for this analysis

OBJECTIVE OF THE STUDY

- To analyze key performance indicators across the supply chain data
- To identify trends and patterns in supply chain activities
- To build a demand forecasting model using time series analysis techniques
- To develop an interactive dashboard that supports real time tracking and business insights.

METHODOLOGY

1. DATA PREPERATION

First ensure the columns that are relevant for your analysis, So, the main columns that I have worked in this analysis are

- Product type
- Price
- Availability
- Number of products sold
- Revenue Generated
- Stock levels
- Order quantities
- Shipping time
- Location
- Transportation modes
- Supplier name
- Supplier name
- Manufacturing costs
- Manufacturing lead time

2. DATA CLEANING

I imported the CSV file into R using the read.csv command then to handle the missing values, use the code,

```
> data = na.omit(data)
```

Additionally, I created a date column in R which was not available in the data initially, to do so in R, use the code,

```
> n = nrow(data)
```

```
>data$date=seq(from=as.Date("2023-01-01"), by = "1 month", length.out=12)
```

This column was created to build a demand forecasting model with EMA and SMA (time series analysis) techniques.

3. VISUALIZATION

The major KPI's were visualized in power BI to understand the general trend and summary of the data.

KPI's in the data include:

- Total number of products sold
- Total revenue generated
- Total availability
- Total order quantities

The dashboard also includes insights of other aspects of the data, which is visualized using line chart, pie chart, bar graph, scatter plot and donut chart (refer the power BI dashboard)

- Revenue by product type
- Stock levels over time
- Revenue by location
- Availability by product type
- Order quantities by transportation mode
  and many more.

4. FORECASTING MODEL

The demand forecasting model was built using simple time series analysis techniques such as Simple moving average and exponential moving average (SMA & EMA). These considered predictive models when used for forecasting future demand trends.

Further information of this model will be deeply discussed in other sections.

DEMAND FORECASTING MODEL

In this project, a demand forecasting model was developed as part of the supply chain management analysis to predict future product demand and ensure efficient planning of inventory, procurement and distribution activities. Demand forecasting is a critical tool in supply chain management as it helps businesses understand customer needs, minimize stockouts or overstocking and make productive decisions. To achieve this, two fundamental time series forecasting techniques were used: **S**imple Moving Average (SMA) and Exponential Moving Average (EMA). The SMA method calculates the average of demand over a fixed number of past periods, smoothing short term fluctuations and highlighting long term trends. However, it treats all past data equally, which makes it difficult to respond to sudden changes in the data. The EMA assigns more weight to recent observations, making it more sensitive to demand shifts and better suited for detecting recent patterns. Including both techniques in the analysis provided a comparative understanding of their effectiveness in forecasting. The SMA model produced a forecasted demand of 543 units, while the EMA forecasted 610 units, showing how different smoothing techniques can impact predictions. These forecasting techniques are highly relevant as they support accurate planning and help supply chain managers respond proactively to demand variations, ultimately enhancing overall efficiency.

SIMPLE MOVING AVERAGE

It is basic and commonly used time series forecasting techniques that smooths out fluctuations in data. It is calculated by taking the average of a fixed number of past data points. When new data becomes available, the oldest data point is removed and the newest one is added to the calculation thus creating a "moving" effect.

MA is usually calculated for odd periods such as 3 yearly MA, 5 yearly MA and so on. In the case of even periods, we take centered MA.

EQUATION: Let Y1, Y2, Y3, Y4... are observations corresponding to time t1, t2, t3, t4... then

3 yearly MA = $\frac{Y1+Y2+Y3}{3} + \frac{Y2+Y3+Y4}{3}$ ...

5 yearly MA= $\frac{Y1+Y2+Y3+Y4+Y5}{5} + \frac{Y2+Y3+Y4+Y5+Y6}{5}$ ...

EXPONENTIAL MOVING AVERAGE

The Exponential Moving Average (EMA) is a time series forecasting technique that assigns more weight to recent data points, making it more responsive to changes in the data compared to the Simple Moving Average (SMA).

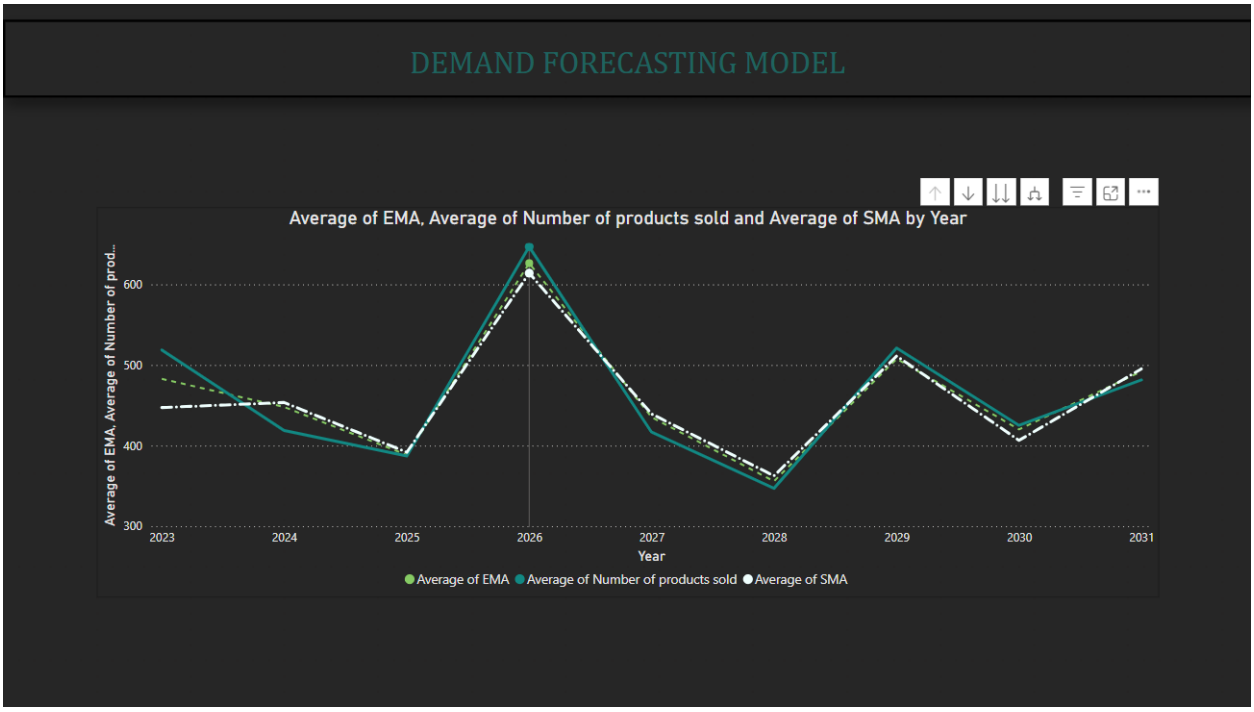
EQUATION: $$EMA_t = \alpha \cdot D_t + (1-\alpha) \cdot EMA_{t-1}$$

EMA_t - EMA at time t

D_t - Demand at time t

α- smoothing factor, $\alpha = \frac{2}{n+1}$, $n = number\ of\ periods.$

Using this logic, the model was created in R and the data was imported to Power BI which is attached below:



The demand forecasting model utilized both Simple Moving Average (SMA) and Exponential Moving Average (EMA) to track and predict sales trends from 2023 to 2031. A clear distinction was observed between SMA and EMA behavior across different phases:

- In 2026, all three metrics, actual product sales, SMA and EMA peaked significantly, with EMA reaching 610 and SMA at 543, indicating a surge in sales during that year. The

higher EMA value reflected a strong momentum in recent sales, making it a reliable indicator of short term demand spikes.

- Between 2023 and 2025, there was a noticeable decline in both SMA and EMA, with sales reaching a low point in 2025. This was followed by a sharp rebound in 2026, likely driven by strategic changes or external factors influencing consumer demand.
- From 2026 to 2028, the averages declined again, with EMA reacting more sharply to falling sales than SMA. This showcases EMA's strength in capturing real-time shifts in demand patterns.
- Notably, during 2029 to 2031, EMA consistently stayed above SMA, indicating a recent upward trend in product sales. This trend signals a likely increase in demand in the near future, suggesting the need for proactive supply chain adjustments.

Overall, the divergence between EMA and SMA values across years helped identify key inflection points in sales performance. While SMA offered a stable long-term view, EMA effectively captured short term demand fluctuations, making it valuable for real-time inventory and procurement decisions.

INSIGHTS AND SUMMARY

INSIGHTS

- Skincare products generate the highest revenue, which is $241,628, indicating strong demand.
- Bangalore and Delhi contribute the most revenue, making them key markets for expansion.
- 42.09% of stock consists of Skincare products
- Stock levels are projected until 2030, allowing early adjustments to inventory planning.
- Road, rail and air transportation model contribute equally (almost 28%) to order quantities.
- Out of all the product type, Skincare is the most stocked product type (42.09%) and haircare and cosmetics are equally stocked (approximately 30%)

SUMMARY

- Total revenue of $577.6K, with Skincare leading at $241,628, followed by Haircare ($174,455) and Cosmetics ($161,521). Bangalore and Kolkata are major revenue contributors.
- Skincare holds the highest inventory (42.09%), followed by Haircare (30.39%) and Cosmetics (27.52%).
- Total orders are 4,922, suggesting steady demand across product categories.
- Balanced distribution across Sea (17.33%), Air (27.25%), Rail (27.27%) and Road (28.16%), offering flexibility in logistics planning.
- Stock level forecasts up to 2030 provide future inventory visibility for demand management.

- Demand alignment with inventory, regional growth opportunities, and cost effectiveness of transportation methods should be refined to improve operational efficiency.

THANKYOU!!!