Smart FMCG Distribution: Predictive Analytics and Optimization for Enhanced Inventory and Order Management

A Mid-Term report for the BDM capstone Project

Submitted by

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Declaration Statement

I am working on a Project titled "**Smart FMCG Distribution: Predictive Analytics and Optimization for Enhanced Inventory and Order Management**". I extend my appreciation to **R L ASSOCIATES**, for providing the necessary resources that enabled me to conduct my project.

I hereby assert that the data presented and assessed in this project report is genuine and precise to the utmost extent of my knowledge and capabilities. The data has been gathered from primary sources and carefully analyzed to assure its reliability.

Additionally, I affirm that all procedures employed for the purpose of data collection and analysis have been duly explained in this report. The outcomes and inferences derived from the data are an accurate depiction of the findings acquired through thorough analytical procedures.

I am dedicated to adhering to the principles of academic honesty and integrity, and I am receptive to any additional examination or validation of the data contained in this project report.

I understand that the execution of this project is intended for individual completion and is not to be undertaken collectively. I thus affirm that I am not engaged in any form of collaboration with other individuals, and that all the work undertaken has been solely conducted by me. In the event that plagiarism is detected in the report at any stage of the project's completion, I am fully aware and prepared to accept disciplinary measures imposed by the relevant authority.

I understand that all recommendations made in this project report are within the context of the academic project taken up towards course fulfillment in the BS Degree Program offered by IIT Madras. The institution does not endorse any of the claims or comments.

Signature of Candidate: (**Digital Signature**)

Name: Utkarsh Shukla

Date: 10-11-2024

1 Executive Summary

R L Associates, a sole proprietorship, functions as a super stockist in the FMCG sector from its address at 127/1050, W-1 Block, Saket Nagar, Kanpur (208014). The company is registered as a Wholesaler/Distributor and holds an active GSTIN status as a regular taxpayer under the Kanpur II Zone, Kanpur (D) Range, and KanpurSector-29 in Uttar Pradesh. Utilizing data from the company's "Marg" software, the study examines monthly sales volumes and values across the fiscal year 2023-24 to highlight key trends, performance insights, and seasonality impacts. The enterprise predominantly operates as a B2B middleman, linking 5 manufacturers with a network of around 200 distributors. Then distributors connect to retail, and then to the end consumer.

Key objectives include improving inventory management for seasonal peaks, applying predictive models for order placement, and creating an early warning system for near-expiry products. Additionally, the report proposes a distributor segmentation approach using the forthcoming ledger data to enhance relationships and optimize transaction management.

This data-driven approach aims to strengthen the company's role as a key Super Stockist while enhancing operational efficiency and sales performance for the upcoming fiscal year. Better inventory management and targeted distribution tactics should reduce inventory-related losses, maximize order placement, and boost profitability. These solutions will eliminate inventory money blockage, helping RL Associates maximize profits and streamline operations.

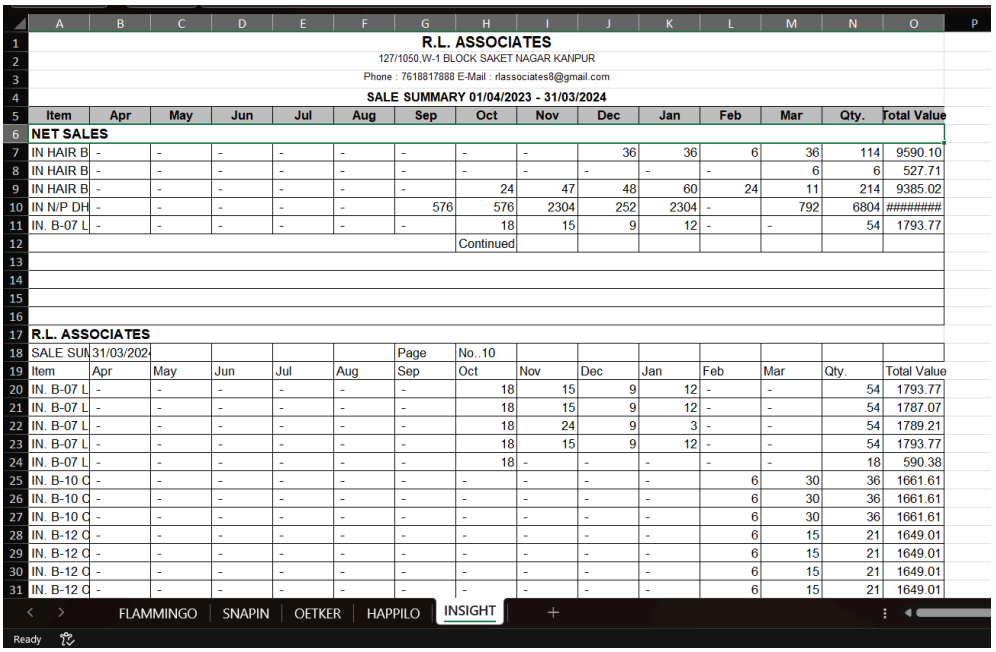
2 Proof Of Originality of Data

Fig 2.1 : R L Associates Office + Warehouse

I requested the authorization letter and interaction video in which the owner Mr. Vinay Kumar Trivedi covers on How the business operates with the problems they face along with his expectations from the project which is given below. Google Drive Link for Authorization Letter and Interaction Video:

https://drive.google.com/drive/folders/1LIYAx2p6jklR-Q_TKmFOXoXyGSnioIQA?usp=sharing

3 Meta Data



R.L. ASSOCIATES
127/1050,W-1 BLOCK SAKET NAGAR KANPUR
Phone : 7618817888 E-Mail : rlassociates8@gmail.com
SALE SUMMARY 01/04/2023 - 31/03/2024

Item	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Qty.	Total Value
NET SALES														
IN HAIR B	-	-	-	-	-	-	-	-	36	36	6	36	114	9590.10
IN HAIR B	-	-	-	-	-	-	-	-	-	-	-	6	6	527.71
IN HAIR B	-	-	-	-	-	-	24	47	48	60	24	11	214	9385.02
IN N/P DH	-	-	-	-	-	576	576	2304	252	2304	-	792	6804	#########
IN. B-07 L	-	-	-	-	-	-	18	15	9	12	-	-	54	1793.77
							Continued							

R.L. ASSOCIATES														
SALE SUN	31/03/202					Page	No..10							
Item	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Qty.	Total Value
IN. B-07 L	-	-	-	-	-	-	18	15	9	12	-	-	54	1793.77
IN. B-07 L	-	-	-	-	-	-	18	15	9	12	-	-	54	1787.07
IN. B-07 L	-	-	-	-	-	-	18	24	9	3	-	-	54	1789.21
IN. B-07 L	-	-	-	-	-	-	18	15	9	12	-	-	54	1793.77
IN. B-07 L	-	-	-	-	-	-	18	-	-	-	-	-	18	590.38
IN. B-10 C	-	-	-	-	-	-	-	-	-	-	6	30	36	1661.61
IN. B-10 C	-	-	-	-	-	-	-	-	-	-	6	30	36	1661.61
IN. B-10 C	-	-	-	-	-	-	-	-	-	-	6	30	36	1661.61
IN. B-12 C	-	-	-	-	-	-	-	-	-	-	6	15	21	1649.01
IN. B-12 C	-	-	-	-	-	-	-	-	-	-	6	15	21	1649.01
IN. B-12 C	-	-	-	-	-	-	-	-	-	-	6	15	21	1649.01
IN. B-12 C	-	-	-	-	-	-	-	-	-	-	6	15	21	1649.01

FLAMMINGO | SNAPIN | OETKER | HAPPILO | INSIGHT

Ready

Fig 3.1 : Monthly Sales Data for Complete fiscal year 2023-24

Dataset Link:
https://drive.google.com/drive/folders/18RPzV7uNeOJwmfkI2UEHBxqQORyF-Lqp?usp=sharing

Dataset Collected: “Excel Workbook of Monthly Sales Data from April 2023 to March 2024”

Source: The organization uses a software named “Marg” to store data. But there was a drawback as the data given in Excel form needs much more cleaning.

Sheets inside Workbook: There are a total 5 sheets for 5 manufacturers the R L Associates is working with. Thus, the names of sheets are names of manufacturers.

- FLAMMINGO
- SNAPIN
- OETKER
- HAPPILO
- INSIGHT

Columns used and Dataset: The dataset is structured in a tabular format with the following columns:

1. For Item Information column used:
    - Item: Product name/identifier
2. For Monthly Sales Data:
    - Apr: Units sold in April 2023
    - May: Units sold in May 2023
    - Jun: Units sold in June 2023
    - Jul: Units sold in July 2023
    - Aug: Units sold in August 2023
    - Sep: Units sold in September 2023
    - Oct: Units sold in October 2023
    - Nov: Units sold in November 2023
    - Dec: Units sold in December 2023
    - Jan: Units sold in January 2024
    - Feb: Units sold in February 2024
    - Mar: Units sold in March 2024
3. Summary Metrics:
    - Qty.: Total quantity sold across the year
    - Total Value: Total sales value in INR

The dataset contains monthly sales data for each product item of each manufacturer across the fiscal year 2023-24, including total quantities sold and value generated. This dataset is specifically used to analyze monthly sales patterns and develop predictive ordering models.

Purpose: This dataset will be used to:

- Analyze monthly sales patterns
- Identify seasonal trends
- Develop predictive ordering models
- Optimize inventory management

4 Descriptive Statistics

An overview of the key descriptive statistics across different manufacturer's product categories: **FLAMMINGO**, **SNAPIN**, **OETKER**, **HAPPILO**, and **INSIGHT**. Each category contains monthly records, detailing **Quantity (Qty)** and **Total Value** of sales. Below, we summarize these statistics to provide insight:

- For FLAMMINGO

Descriptive Statistics for FLAMMINGO	Qty.	Total Value
Count	461.000	461.000
Mean	63.009	17602.576
Std	239.251	64994.786
Min	0.000	0.000
25%	5.000	1523.590
50%	14.000	3901.780
75%	35.000	11128.800
Max	2711.000	629662.420

Table 4.1 : FLAMMINGO descriptive stats for Complete fiscal year 2023-24

The standard deviations for quantity and value are quite high (239.25 and 64,994.79, respectively), indicating significant variability in monthly sales.

- For SNAPIN

Descriptive Statistics for SNAPIN	Qty.	Total Value
Count	66.000	66.000
Mean	19251.909	199881.700
Std	69447.001	446552.300
Min	0.000	0.000
25%	0.000	0.000
50%	350.000	25690.760
75%	4034.000	163724.300
Max	443627.000	2639262.000

Table 4.2 : SNAPIN descriptive stats for Complete fiscal year 2023-24

SNAPIN shows high variability, with 66 observations and an average quantity and value of 19,251.91 and 199,881.70, respectively. The standard deviation for quantity is especially high at 69,447.00, reflecting large fluctuations, likely from bulk or high-value orders.

- For OETKER

Descriptive Statistics for OETKER	Qty.	Total Value
Count	7.000	7.000
Mean	293.286	21396.026
Std	536.985	33525.383
Min	1.000	86.400
25%	26.500	2265.410
50%	48.000	7119.710
75%	230.500	21921.660
Max	1490.000	94191.930

Table 4.3 : OETKER descriptive stats for Complete fiscal year 2023-24

With only 7 observations, OETKER's data shows an average quantity of 293.29 and total value of 21,396.03. The standard deviations (536.98 for Qty, 33,525.38 for Total Value) are large relative to the mean, implying a high variability across these limited observations.

- For HAPPILO

Descriptive Statistics for HAPPILO	Mar	Qty.	Total Value
Count	16.000	16.000	16.000
Mean	402.000	402.000	7587.015
Std	315.792	315.792	5753.351
Min	96.000	96.000	1723.680
25%	144.000	144.000	3078.360
50%	360.000	360.000	5171.040
75%	558.000	558.000	11254.320
Max	1008.000	1008.000	21294.000

Table 4.4 : HAPPILO descriptive stats for Complete fiscal year 2023-24

HAPPILO's 16 records have an average of 402 units per month and 7,587.02 in total value, with relatively lower variability (standard deviations of 315.79 for Qty and 5,753.35 for Total Value). The minimum and maximum quantities are 96 and 1,008 units, respectively, indicating a moderate level of fluctuation.

- For INSIGHT

Descriptive Statistics for INSIGHT	Qty.	Total Value
Count	830.000	830.000
Mean	89.606	3745.390
Std	395.916	10544.310
Min	0.000	0.000
25%	6.000	183.310
50%	21.000	1466.830
75%	60.000	3363.493
Max	6804.000	173521.960

Table 4.5 : INSIGHT descriptive stats for Complete fiscal year 2023-24

With 831 observations, INSIGHT has a larger data set, showing an average monthly quantity of 89.61 and total value of 3,745.39. The standard deviations (395.92 for Qty, 10,544.31 for Total Value) indicate substantial variability.

5 Explanation of Analysis Process/Method

Data Cleaning:

The data collected and stored in Excel needs too much cleaning due to messed up rows and columns. So,

1. I used the text to column option to first arrange the data in nice tabular form.
2. Loaded it in the pandas data frame.
3. First removed empty rows below the Total Value column, then removed the blank lines.
4. Handled missing values.
5. Checked manually, and now data is ready to go.
6. Performed Basic EDA

Predictive Model for Order Placement:

Simple Charts to Create**:**

1. Trend line charts showing monthly sales fluctuations
2. Heatmaps to study correlation of Units Sold within months.

I am planning to use predictive modeling techniques in the analysis process. Many tutorials used as reference recommended **Prophet** or **ARIMA**.

(I started using Prophet as Facebook's forecasting tool. Prophet is designed to prefer data without gaps. In my case, I have many months with zero or missing values which will be fixed using 0. Since I have data with some seasonal or sudden increases in specific months, Prophet's flexibility with seasonal adjustments is useful here)

Both are relatively straightforward for time-series forecasting with monthly data, and they provide reliable results with minimal setup. I start by creating a data frame that specifies the future dates (For this I requested data for April 2024 to October 2024) to forecast. Then I will use the model to generate forecasts, which will include the predicted sales values, as well as lower and upper bounds for the confidence interval. These forecasted values will provide insights into expected future sales.

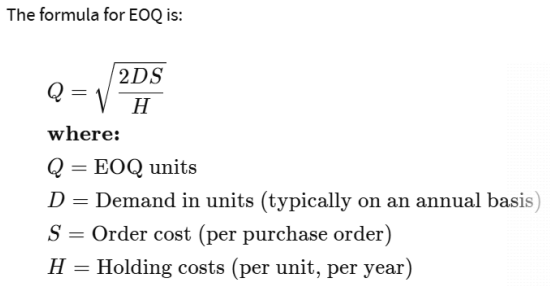
By utilizing Prophet, RL Associates can gain better forecasts for each manufacturer's product line, helping them to anticipate demand and optimize inventory and ordering processes more effectively.

Early Warning System for Near-Expiry Products:

As for now the organization does not store the "EXPIRY DATA" of products , I suggested following:

- ABC Analysis inventory categorization method that segments products based on their relative importance to the business. The approach is particularly useful for identifying high-value, critical items versus lower-value, high-frequency items, allowing for prioritized inventory management. Where **Class A:** High-value, low-frequency products, **Class B:** Moderate-value, moderate-frequency products and **Class C:** Low-value, high-frequency products.

- Optimize Order Quantities Using the Economic Order Quantity (EOQ) Model. EOQ model is a formula that calculates the optimal order size to minimize overall inventory costs.


The formula for EOQ is:

$$Q = \sqrt{\frac{2DS}{H}}$$

where:

Q = EOQ units

D = Demand in units (typically on an annual basis)

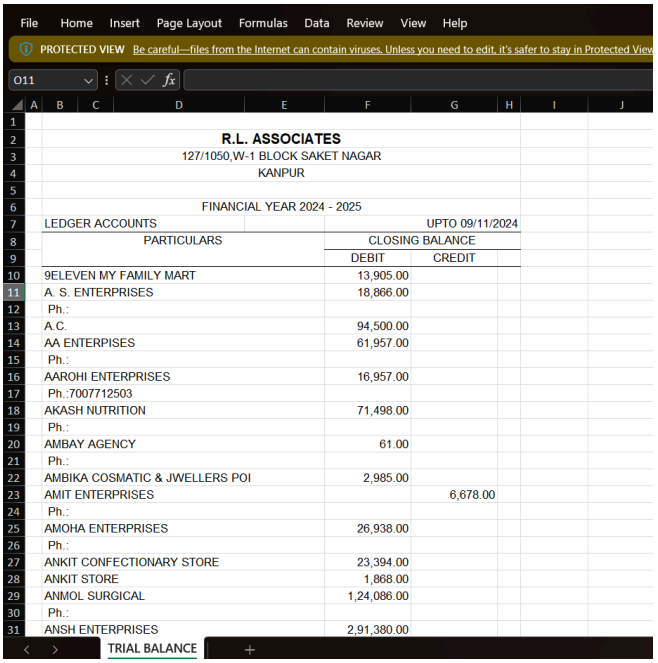
S = Order cost (per purchase order)

H = Holding costs (per unit, per year)

Fig 5.1 : Formula image from Investopedia webpage

Distributor Segmentation Analysis:

I requested the owner to provide me distributor's data but its not specific so I will use Ledger as given image:



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O11

R.L. ASSOCIATES
127/1050,W-1 BLOCK SAKET NAGAR
KANPUR

FINANCIAL YEAR 2024 - 2025

LEDGER ACCOUNTS		UPTO 09/11/2024
PARTICULARS	CLOSING BALANCE	
	DEBIT	CREDIT
9ELEVEN MY FAMILY MART	13,905.00	
A. S. ENTERPRISES	18,866.00	
Ph.:		
A.C.	94,500.00	
AA ENTERPISES	61,957.00	
Ph.:		
AAROHI ENTERPRISES	16,957.00	
Ph.:7007712503		
AKASH NUTRITION	71,498.00	
Ph.:		
AMBAY AGENCY	61.00	
Ph.:		
AMBIKA COSMATIC & JWELLERS POI	2,985.00	
AMIT ENTERPRISES		6,678.00
Ph.:		
AMOHA ENTERPRISES	26,938.00	
Ph.:		
ANKIT CONFECTIONARY STORE	23,394.00	
ANKIT STORE	1,868.00	
ANMOL SURGICAL	1,24,086.00	
Ph.:		
ANSH ENTERPRISES	2,91,380.00	

TRIAL BALANCE

Fig 5.2 : (Incomplete) Ledger Format

For now, data is incomplete but it's assured by owner. This data will be used to extract on basis of CREDIT and DEBIT to:

- Distributor Segmentation using k means.
- High-value vs low-value distributors using basic if else on amount.
- Transaction size patterns.
- Identify key accounts.

This classification can help:

- Identify key business relationships.
- Understand transaction patterns.
- Develop targeted strategies for different categories.
- Optimize inventory based on business type.

6 Results and Findings

Normalized Units Sold by Manufacturer Across Months:

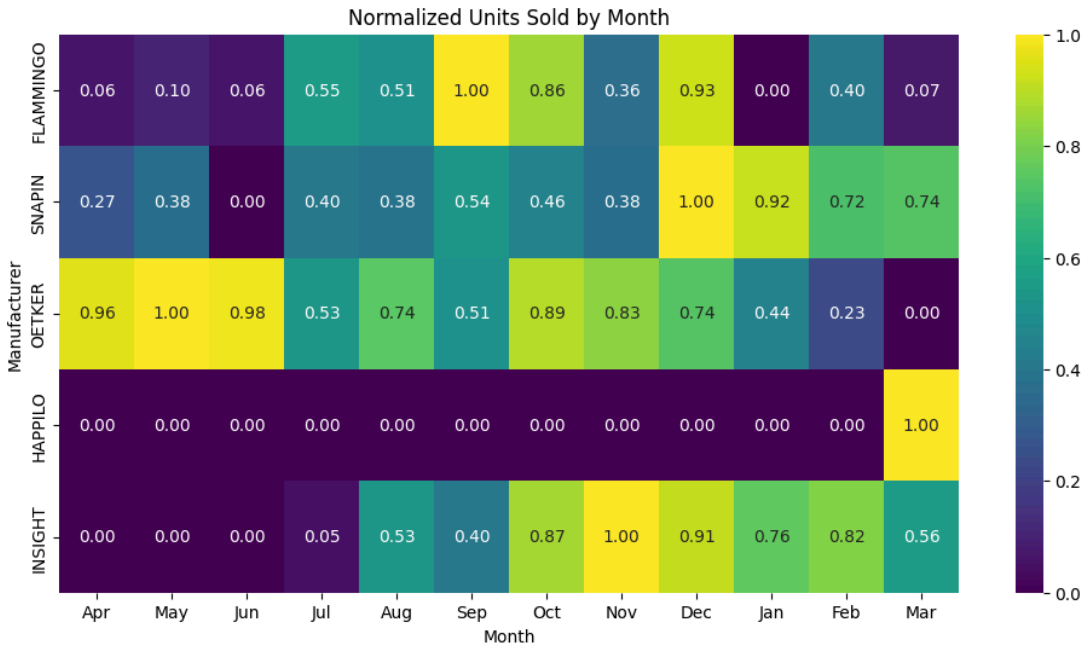

Fig 6.1 : Monthly Sales Correlation Heatmap

October to December generally shows increased sales for most manufacturers (FLAMMINGO, SNAPIN, OETKER, INSIGHT), possibly due to seasonal trends or holiday effects. Also, A summer slowdown is observed for **SNAPIN** and **INSIGHT**, with lower values in June and July, indicating a possible off-season. **INSIGHT** has a gradual increase from August through December, suggesting an end-of-year big up, that could be tied to specific market demands. **FLAMMINGO** peaks in August (1.00), October (0.93), and December (0.93), suggesting strong sales in the late summer and early winter.

Monthly Units Sold Trend for FLAMMINGO

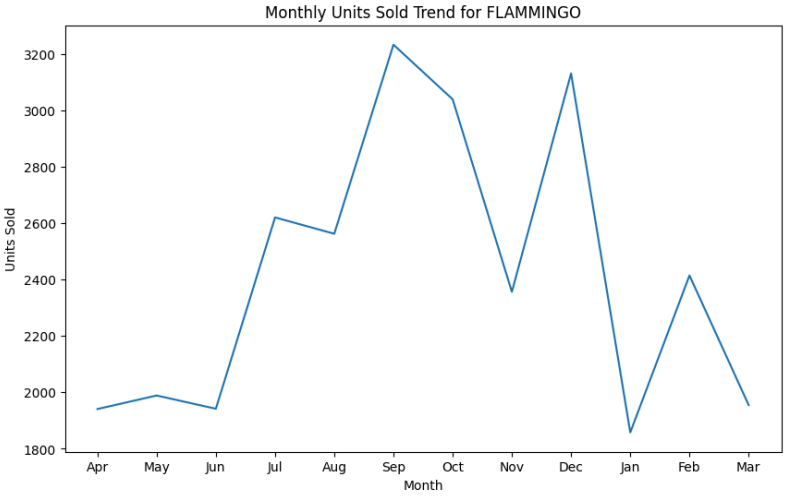

Fig 6.2 : Trend for FLAMMINGO

- Started around 1,900 units in April and remained stable until June
- Sharp increase in July to ~2,600 units
- Major peak in October at ~3,200 units
- Significant drop in December to ~2,400 units
- Second peak in January at ~3,100 units
- Ended March with decline to ~1,900 units
- Shows high volatility with multiple peaks and valleys

Monthly Units Sold Trend for HAPPILO

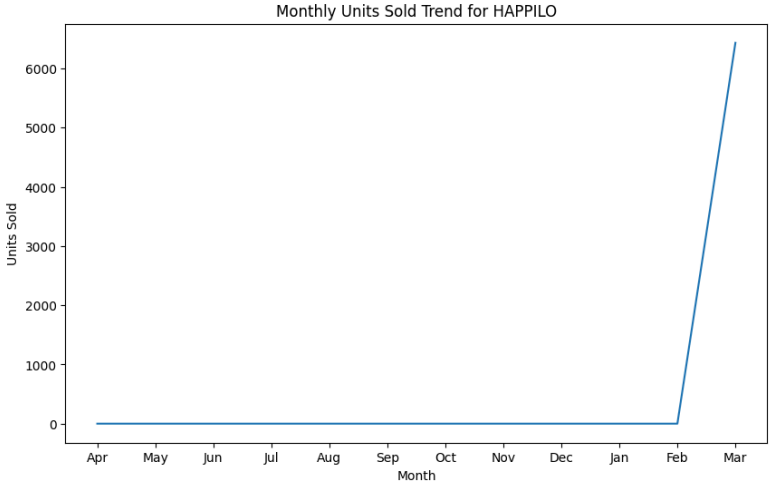

Fig 6.3 : Trend for HAPPILO

- Maintained very low sales (~50 units) from April to February
- Dramatic spike in March reaching over 6,000 units
- Most notable feature is the sudden exponential growth at the end

Monthly Units Sold Trend for INSIGHT

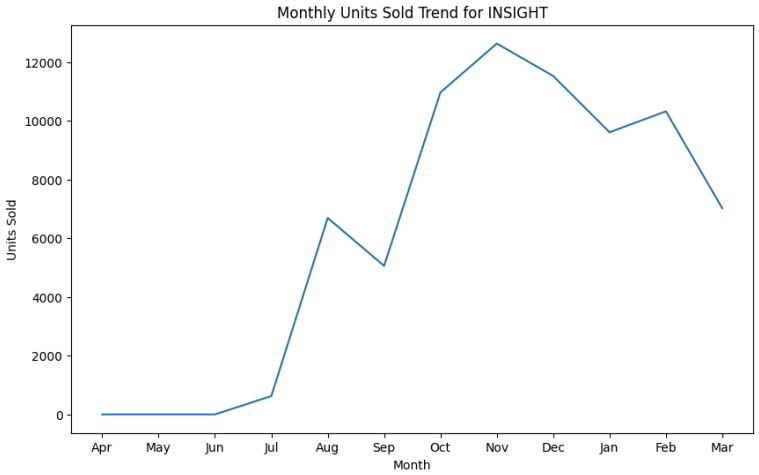

Fig 6.4 : Trend for INSIGHT

- Near-zero sales from April to June
- Started growing in July
- Sharp increase from September to November, reaching ~11,000 units
- Peak in December at ~12,500 units
- Gradual decline through March, ending at ~7,000 units
- Shows successful product launch and stabilization pattern.

Monthly Units Sold Trend for OETKER

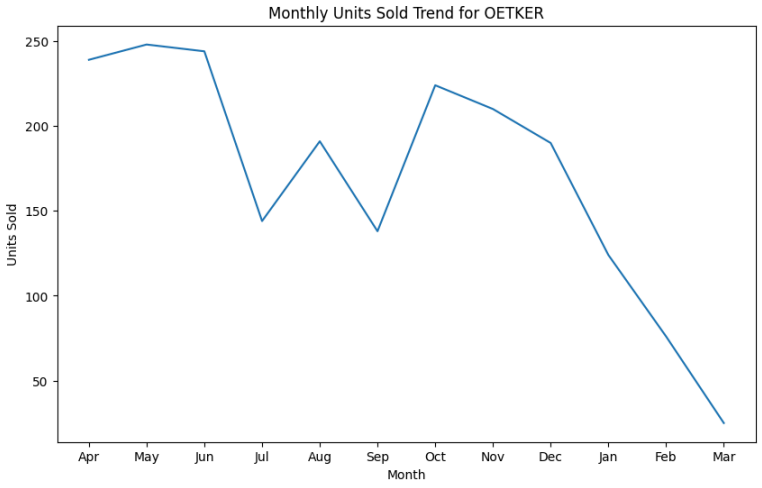

Fig 6.5 : Trend for OETKER

- Started at ~240 units in April
- Maintained relatively stable sales until June
- Sharp decline after June
- Multiple fluctuations between July and October
- Steady decline from November onwards
- Ended March at lowest point (~30 units)
- Shows concerning downward trend

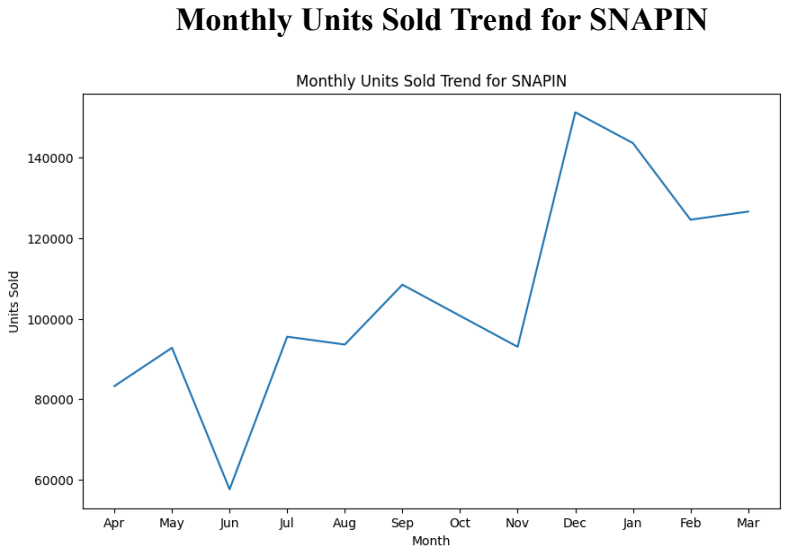

Fig 6.6 : Trend for SNAPIN

- Started at ~80,000 units in April
- Significant dip in June to ~60,000 units
- Recovered and stabilized around 90,000-100,000 units from July to November
- Massive spike in December reaching ~150,000 units
- Slight decline but maintained high volume (~125,000 units) through March
- Shows strong overall performance with seasonal peak