OPTIMIZING INVENTORY AT EFFICIENT LEVEL FOR SMALL KIRANA STORE

A Final report for the BDM capstone Project

Submitted by

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Contents

1. Executive Summary 4
2. Analysis Process and Method 5
3. Results and Findings 6
4. Interpretation of Results and Recommendations 16

Declaration Statement

I am working on a Project titled “Optimizing Inventory at Efficient level for a small Kirana store” I extend my appreciation to Ajay Kirana Store for providing the necessary resources that enabled me to conduct my BDM 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: Raja Kumar

Name: RAJA KUMAR

Date: 03/03/2024

LIST OF FIGURES

SI. No.	Figure No.	Figure Title	Page no.
1	3.1	Pareto chart of top performing SKUs in terms of revenue over the month	7
2	3.2	Volume Pareto chart of top performing SKUs in terms of volume over the month	8
3	3.3	Bar chart which depicts the total revenue over the month for different categories of product	8
4	3.4	Bar chart which depicts summation of the sales over month for different categories of the product	9
5	3.5	Bar chart depicts the distribution of revenue over four weeks for different categories of product	10
6	3.6	Bar chart depicts the distribution of sales volume over four weeks for different categories of product	11
7	3.7	Line chart depicts the distribution of revenue over four weeks for the top three categories of SKUs	12
8	3.8	Time Series Chart predict the future demand using five days moving average	13
9	3.9	Line chart showing the average sales for every five-day period during a month	13
10	3.10	Line chart showing the sales of category essentials for five-days interval	14
11	3.11	Table Provides the re-order point for each SKUs	15
12	3.12	Line Chart showing the growth of item Bisleri	16
13	4.1	Table shows the re-order point and also the order placing date for different SKUs	17

OPTIMIZING INVENTORY AT EFFICIENT LEVEL FOR SMALL KIRANA STORE

1 Executive Summary

Ajay Kirana Store has started their operation in 2005. It is local convenience Kirana store located Near Court, Jail Road Masaurhi, Patna, Bihar. Serving the local communities with range of product Like Snacks, Rice, flour, lentils and household items.

Before Covid their business was running well. But in present time due to limited capital the business is struggling a lot. Which cause a huge problem in managing their inventory. Also, their customer is facing a lot of Stocks up. They are not able to maintain stock at right level. Which is affecting their revenue and their growth is declining. And due to limited working capital, it should be invested efficiently to meet the demand. And, also invest in some new product for the growth of the business.

To address this issue, I have collected the sales data over the month for the 49 different SKU's and update it on excel to do analysis. Also, I took the data and date when he is ordering the stock to fill inventory in month and noted that as he don't have any analysis apart from experience, he used to do shopping every 3rd day to fill the stock otherwise it will get stockout.

With the help of different analysis method like with the help of pareto chart got to know about the top performing SKU in terms of revenue and also in terms of quantity sold. Also, with the help of bar chart by cumulating item according to categories got to know with categories having high revenue. Also done forecasting taking moving average over 5 days. By taking average sales of 5 days and maximum sales got the range in which the inventory should be maintained so as to fulfill the demand along with having some working capital left to invest in a new product for the growth of the business. As the sales was distributed over the week differently, usually in the first week most of the sales happened of the categories essential and edible oil so to manage the inventory level, owner can reorder the stock at the end of the month so that the sufficient num of stock available be in the inventory to meet demand of the first week of the month and the reorder should be weekly for the vegetable and other costly SKU and for the less demanded item economic quantity reorder point should be met, in every 15days, as demand is not varying a lot. This will make the owner make run business efficiently and with less headache of ordering stock in every 3rd day. And also, he can invest in growing SKU's like Bislery bottle whose sales are continuously increasing.

With the 30 days data I have given all the result what I got of the demand of the different items. The result I have given will work for 2 to 3 months. As market grows continuously so it will not be sufficient analysis. So, it should be continuous to know about the inventory analysis of the sales data. In near future owner should invest in system to record data and get better inventory planning.

2 Analysis Process and Method

For the data analysis I have used excel Software.

I have done sales analysis with the sales data which I have collected and updated everything on excel sheet manually over the 30 days period of time. First, I have cleaned the data, And The process involved in cleaning was.

- Removed the SKU which was sold in very less quantity or not sold over this time period.
- Updated all the blank space with Zero.

After that I have done exploratory data analysis and observed each SKU their mean, maximum, variance, standard deviation over the 30 days data. Which help to know about each SKU's how their sales are distributed over 30 days period.

After Cleaning and Exploratory Data Analysis first I have made pivot table of sales data and after that I have made volume pareto to know about the SKU having high volume sales and after that multiplied the total quantity sold to the price for each quantity to know revenue. And also calculated the percentage distribution of revenue then plotted chart for the Revenue pareto to know about the SKU's giving high revenue.

After that to know more about categories of SKU's being sold just calculated the bar graph for the different categories of product. Just summed the SKU's which come in the same categories and plotted the bar chart for the volume of sales made over the month. And also calculated the revenue over the month, to know the revenue distributed over the month for the different categories of products.

Then to know the weekly distribution of the sales over the month. Calculated the weekly sales of different categories of product in different weeks over the month. By taking the sum of the total sales data of different categories of product of each week like (1^{st} week, 2^{nd} week, 3^{rd} week, 4^{th} week) plotted the bar chart for the weekly sales.

Also calculated the total revenue by summing up all the revenue over the different week of the same categories of product and then plotted the revenue bar chart to know the distribution of revenue over the month for different categories to derive some pattern of consumers.

Then done the time series analysis using the moving average over 5 days, took the moving average of the SKUs of previous 5 days sales data and forecast the future sales and plotted the line graph with the actual sales with the moving average sales over 5 days period. This will give the idea of the future demand based on the past few days sales and it will be beneficial for the inventory management as we can maintain according to that. Like product of the type essentials and edible oil come in A class which need to be maintained at right level. To meet demand in normal days and also to meet demand in incase demand surges, some safety stocks needed to be kept.

After that I have categorized the data into different categories, to do ABC analysis for the inventory management so that we can focus more on the categories we need to maintain at right level, as it is one of the important parts in the revenue of the business.

To calculate the efficient number of SKU, belongs to category essentials I have taken 5 days average sales of each SKU from date (1 to 5), (6 to10) and also took the maximum sales of these SKU in each time intervals and plotted the line graph. Which show how much quantity of stock needed to maintain each SKU of type essentials.

After that I have taken the average sales of each SKUs for each week and plotted the line chart with the SKU to see which average would be the best to consider for safety and to calculate reorder quantity.

Then I have made the table with column as SKU, Average Demand, Lead Time, Standard Deviation, service level, Z-score, safety Stock, Re-order Point. Here first I have listed all the SKU's and then listed the average demand of each SKU for that. I took the average demand of the first week as it is the highest among all and with the weekly analysis chart, we can see that it performing very well. After that I have listed lead time which is usually 1 for small Kirana store as there is local wholesaler store from where we can get the product. Then calculated the standard deviation of the demand over a month. After that for the product like essentials and edible oil, took the service level as 99% and for the rest as 95% and then calculated the Z-score with the excel formula (=NORM.S.INT (percentage)). And then with all these values, I calculated the safety stock using the formula (= (Z-score * Standard Deviation*sqrt (lead time)) + (average demand*lead time)). From this I got the safety stock for products. Then calculated the Re-order point when the item should be re-ordered using the formula (=average Demand * Lead Time + safety Stock). And thus, I got the safety stock for each SKU's.

3 Results and Findings

In the Analysis process I have plotted so many charts and got so many results by analyzing that chart.

Now I will analyze each chart and discuss the results associated with it.

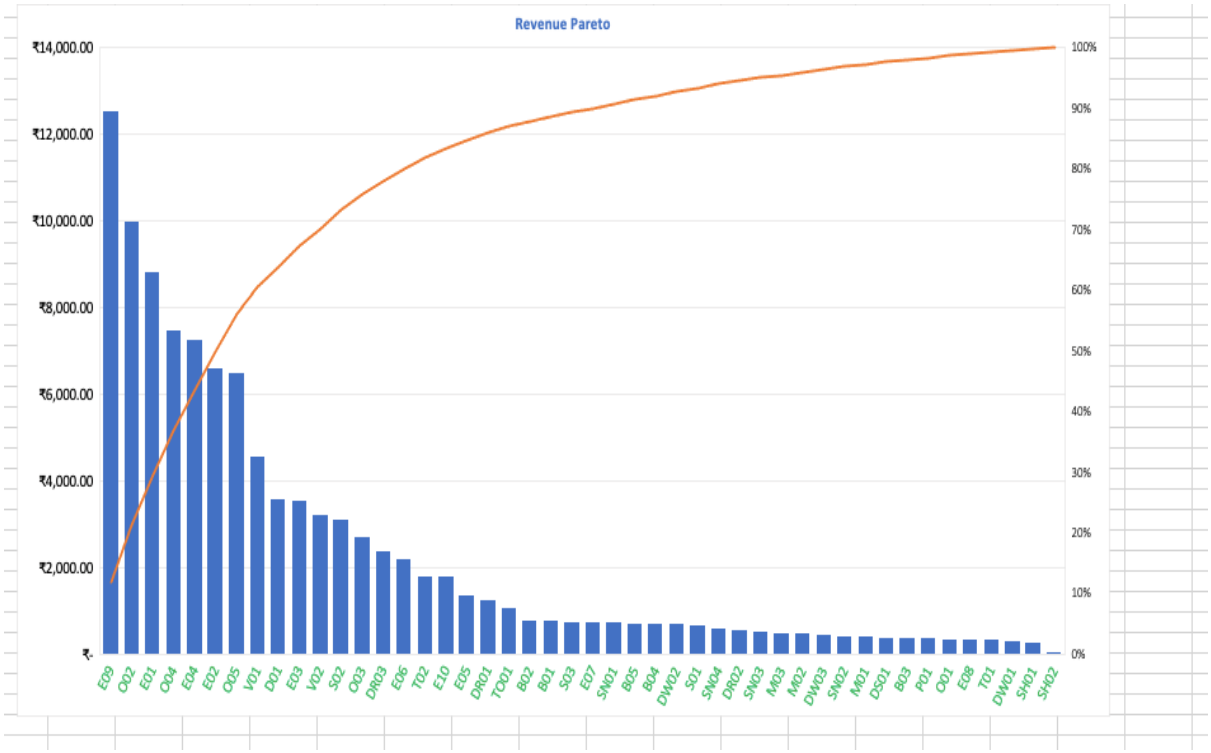

Figure 3.1: Pareto chart of top performing SKUs in terms of revenue over the month

From this pareto chart I got to know that only 7 SKU among 49 SKU's are contributing in more than 60% of the revenue in total. And the main SKU among this 7 are of E09, E04, E01, E02, O02, O04 and O05 where 'E' is of type Essentials (where I have added items like sugar, Flour, rice, besan and salt) and O is of type Oil (where I have added product like Refine, Mustard oil). So, the main revenue is generated through Essentials and Oil category. And rest of the SKU are contributing very less in total revenue. So, we can focus less on that SKU which are contributing very less in total revenue while optimizing inventory and keeping the safety stock. And need to focus more on high generating revenue SKU's.

Also, to know about the top performing SKU in terms of volume lets analyze Volume Pareto chart which I have plotted below.

In this volume pareto chart what wonderful result we got that some of the SKU's which is contributing in more than 60% of the revenue that is not present in the top performers in terms of volume. And in the volume pareto top performing SKU we got is SH01, B01, B05 is performing very less in revenue. So, we come to know that as these SKU are of high demand but since it not generating much revenue, we can stock the item to a certain level so that it meets all the demands arise while maintaining some safety stock.

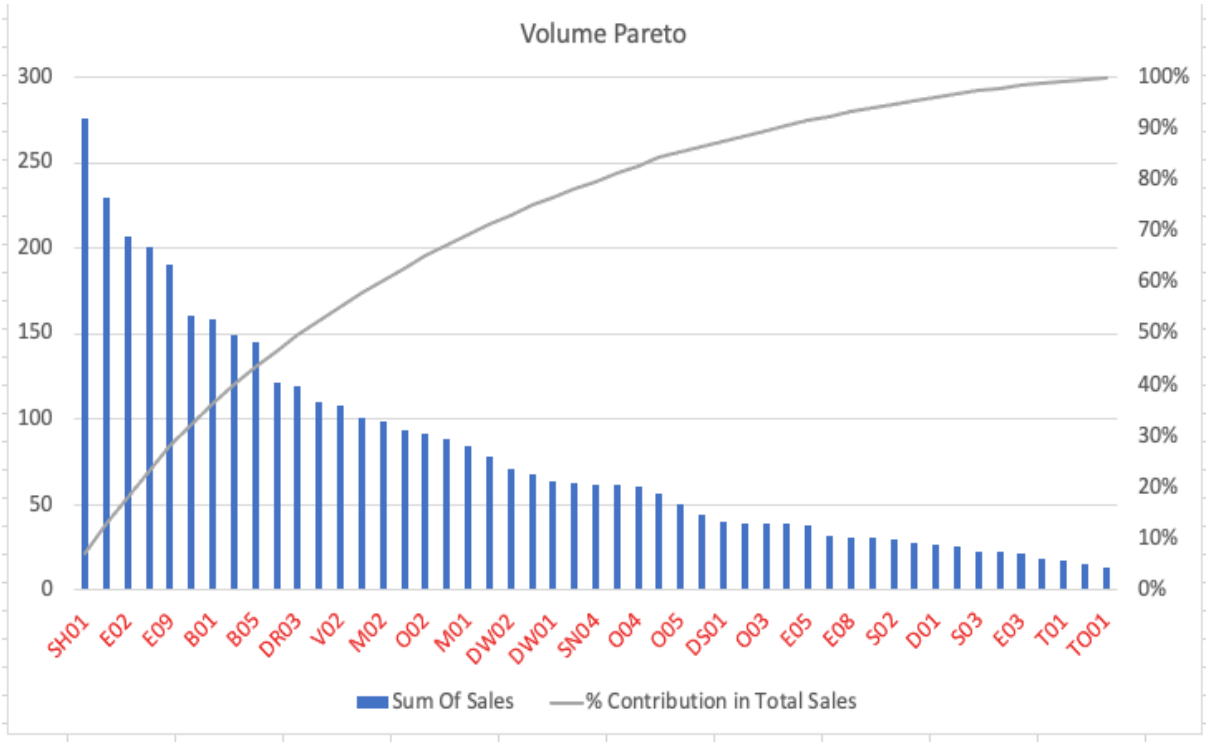

Figure 3.2: Volume Pareto chart of top performing SKUs in terms of volume over the month

After analyzing SKU by the Revenue and volume pareto, to know more about the sales of some SKU's, I have distributed the SKU in categories and plotted the revenue bar chart for the various categories of the SKU's.

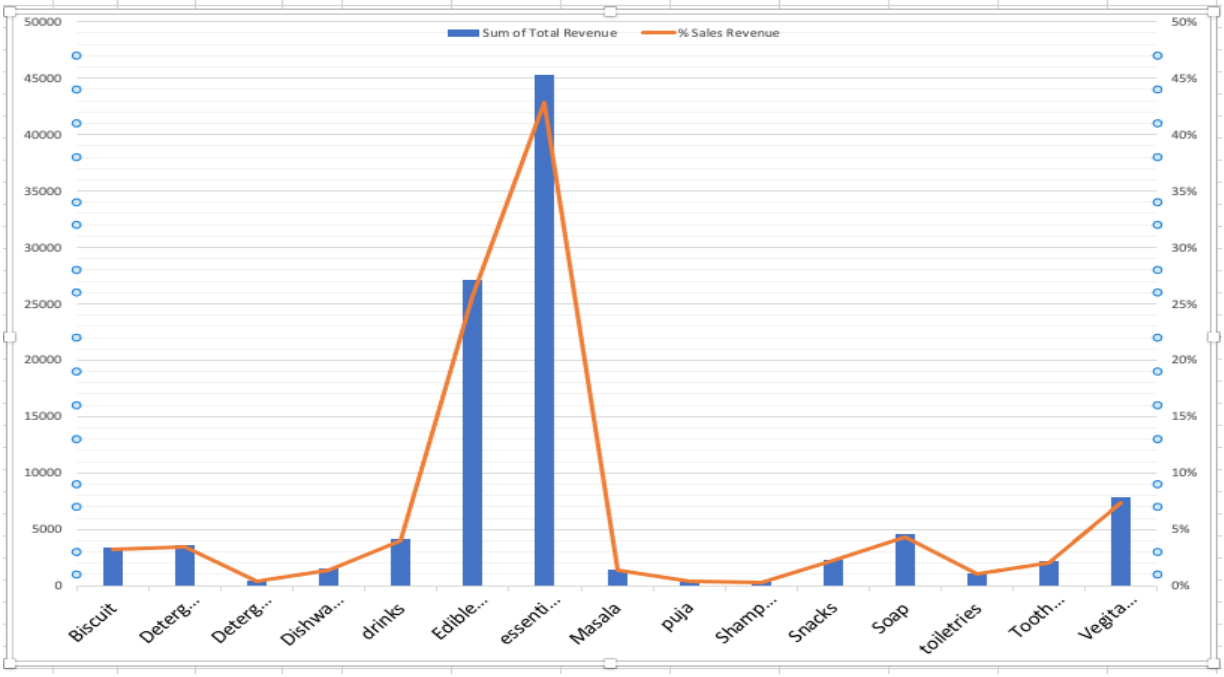

Figure 3.3: Bar chart which depicts the total revenue over the month for different categories of product

From this Bar Chart we can see that the maximum percent of revenue is generated through mainly two categories that is through Essentials and Edible Oil. Also, vegetables are contributing in good amount all though in this category only onion and Potato are there. And rest categories are contributing very little over the revenue.

Now to know, how these are performing over the sales volume, I have also plotted the same chart for the volume sales for different categories.

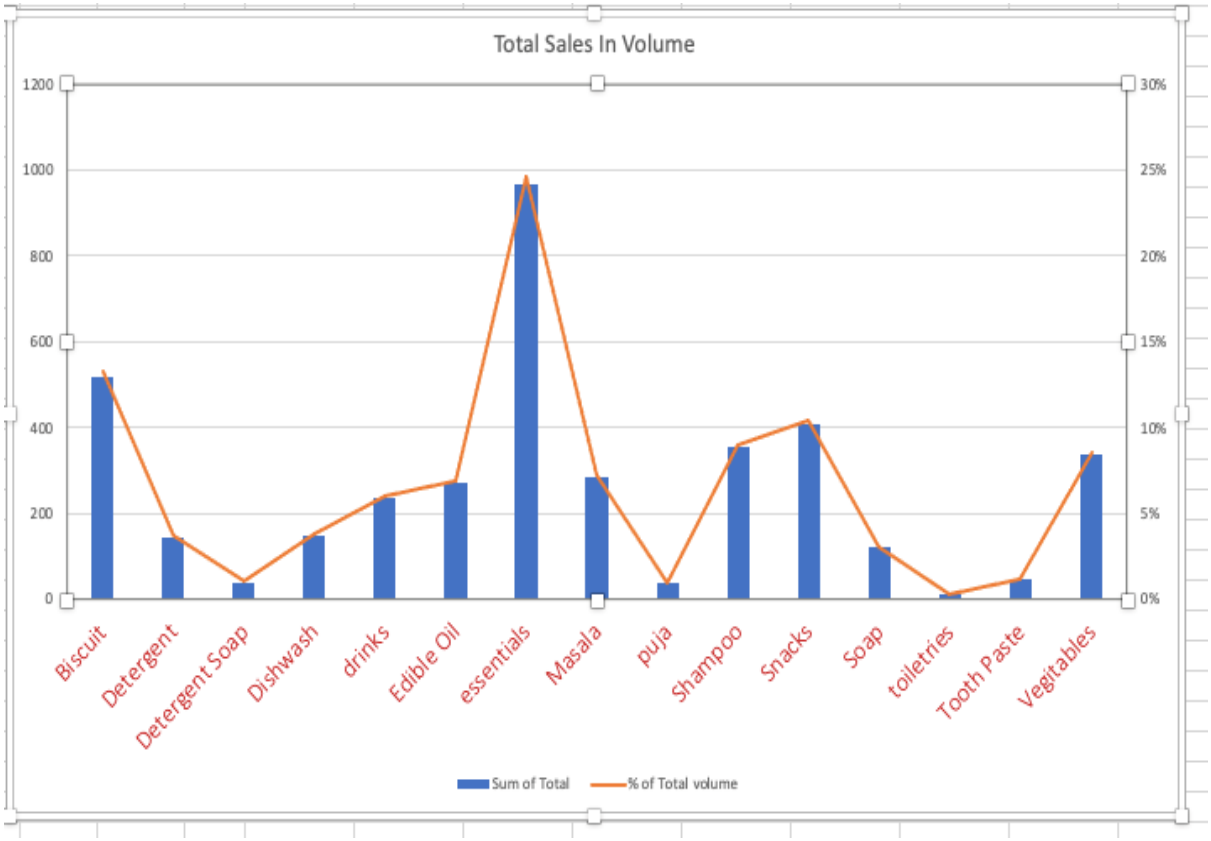

Figure 3.4: Bar chart which depicts summation of the sales over month for different categories of the product

Here we can see that apart from essentials and vegetables some other categories are also performing well in terms of volume that is Biscuits, Shampoo, Snacks. So, from all the charts what I have observed till now is that, I can interpret that the categories like essentials and edible oils and somewhat vegetables are performing well in all the analysis whether it is in terms of volume or revenue.

That's why, we need to focus more on these two categories and stock it well and also needs to maintain some safety stocks for these types of categories so that it doesn't get stockout.

Till now we got the result of the sales of different SKU or different categories on the total summation of the sales over the month. Now we will see the result we got from the weekly

analysis of the sales and volume over the period to know more about the sales pattern over different weeks of the month.

Here is the distribution of the Revenue of different types of products among different period of time in a month over 4 weeks from 1st week to 4th week.

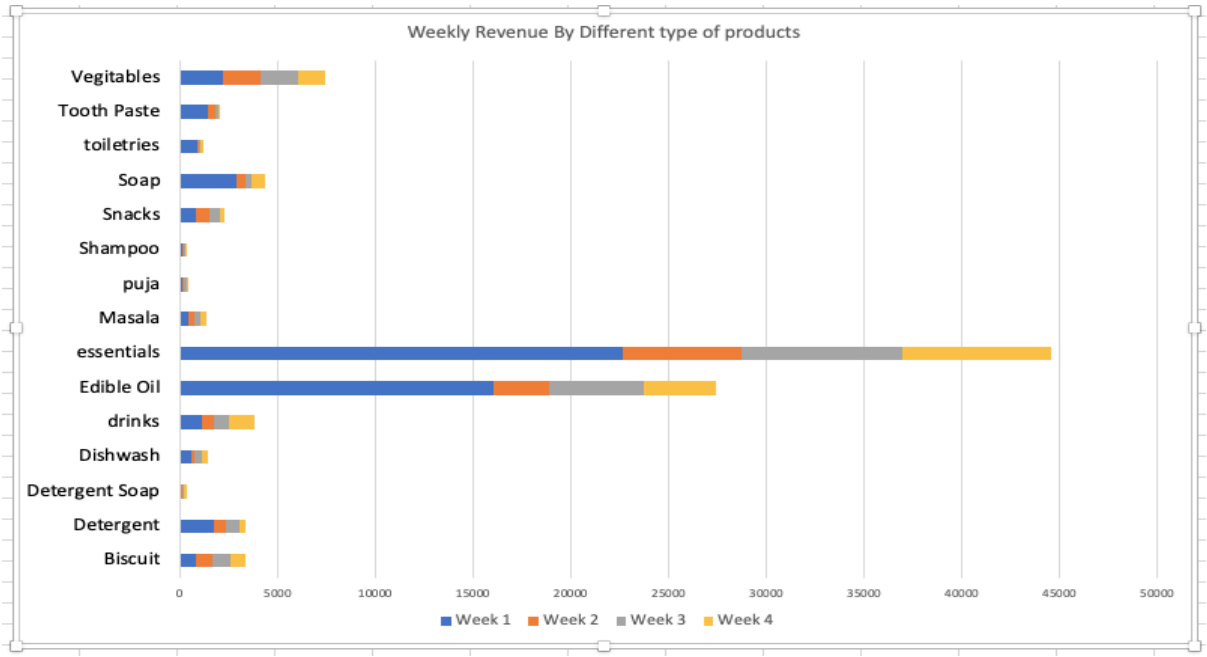

Figure 3.5: Bar chart depicts the distribution of revenue over four weeks for different categories of product

From this chart we got the wonderful result that the SKU's of type essentials are sold mainly on first week. From this we got to know about consumer, as consumer usually preferred to buy all Groceries during 1st week of the month and after that the sales are usually somewhat distributed. Vegetable is usually distributed as consumer buy it over all period as it can't be kept for more than 3 days.

From this chart what we can do about inventory management is, we need to stock up the product for the first week or say 1st to 10th day of the month efficiently to meet all the demands. And keep less quantity after that period so that, can focus more on the other products which is growing.

After this I also plot the bar chart for the volume data in this period to know about the quantity of sales distribution in different weeks of the month among different categories of product. To know more about sales quantity.

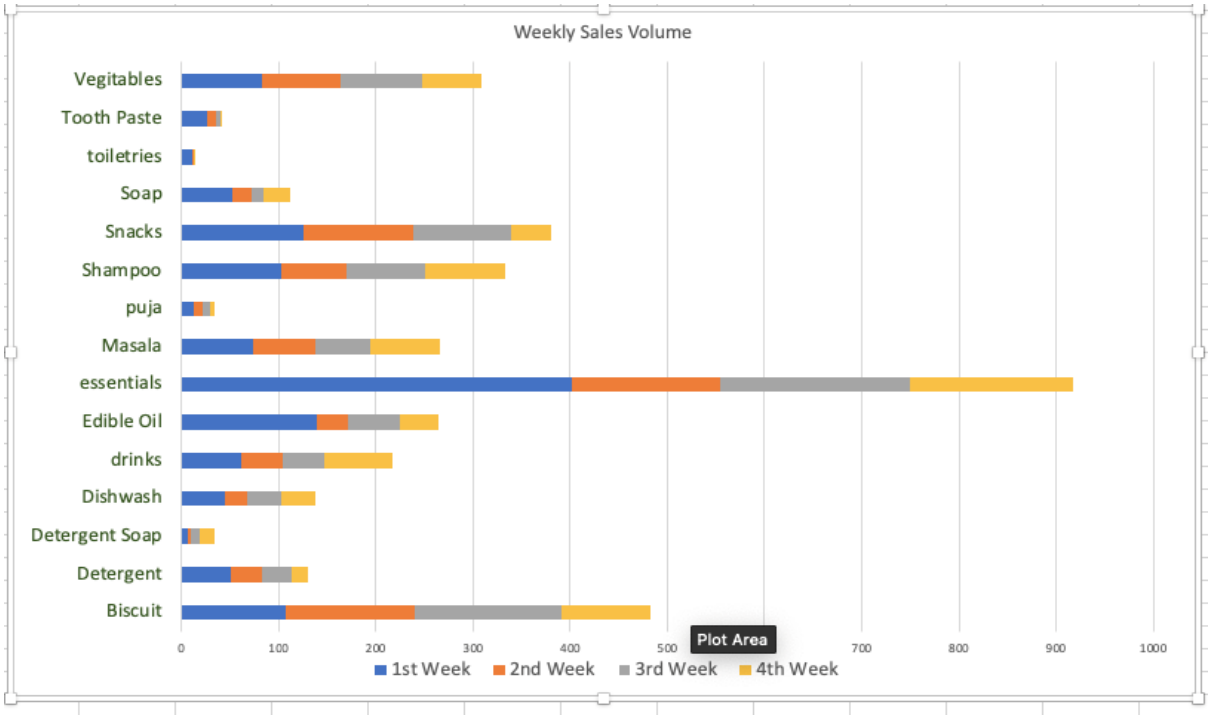

Figure 3.6: Bar chart depicts the distribution of sales volume over four weeks for different categories of product

By observing above graph, we got to know that apart from essentials and edible oil, all other categories sales are equally distributed among different weeks over the month.

So, what we can conclude based on above two chart is that, essentials and edible oils need to be stock up in the last day of a month so that we can meet the demand of the first week of the next month as its demand is usually high over that period. And second re-order date should be in middle of the month, like (10^{th} to 15^{th}).

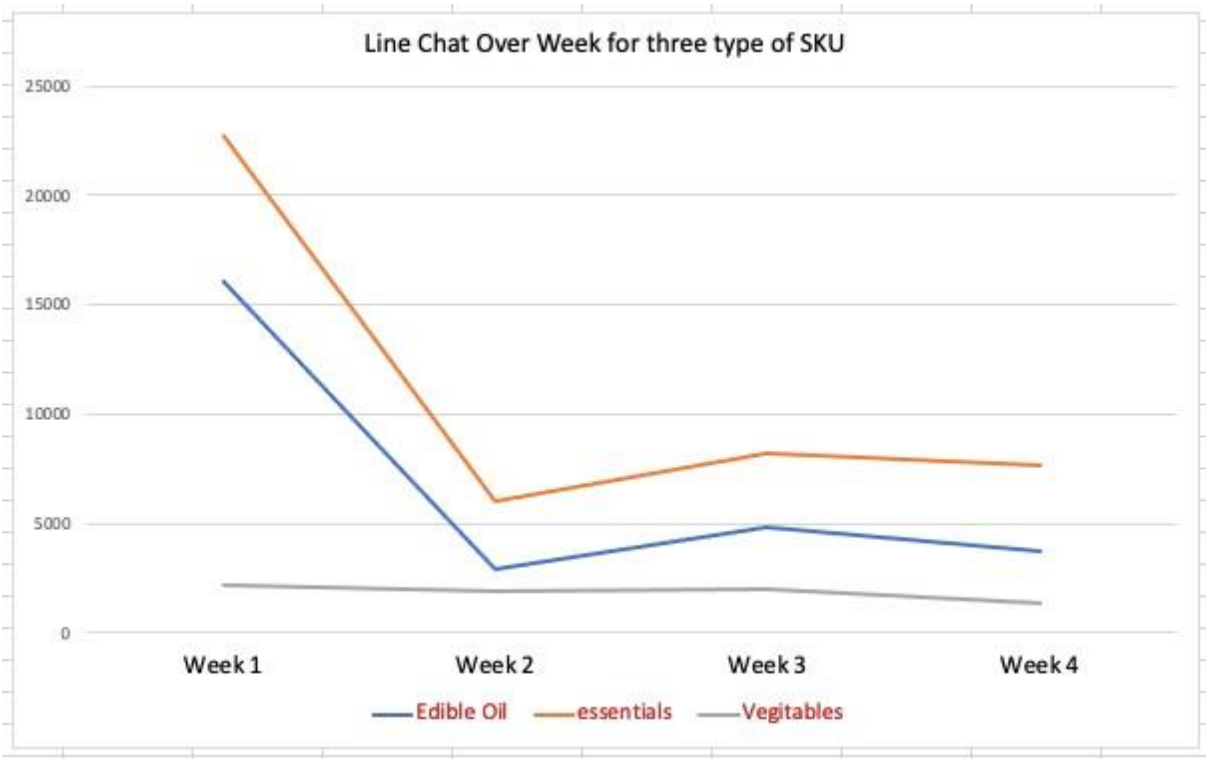

Figure 3.7: Line chart depicts the distribution of revenue over four weeks for the top three categories of SKUs

For further analysis of our top product which comes in A category in ABC analysis. Here we see how these categories are varying over different week. Comparing these three products, I got that essentials product are varying so much during first week to last week over month compared to the other categories like edible oils and vegetables.

Now to forecast future demand we use moving average technique.

Here, I have done 5 Day moving average of the total sales of all SKUs and the result I got was somewhat satisfying. It is somewhat very close to the actual sales. Here one can see that the moving average sales is very close to the actual sales. The only time when moving average sales is down the actual sales, is around the date 12 to 16 and 21 to 24. That can be solved by keeping the safety stock to meet the surge demand.

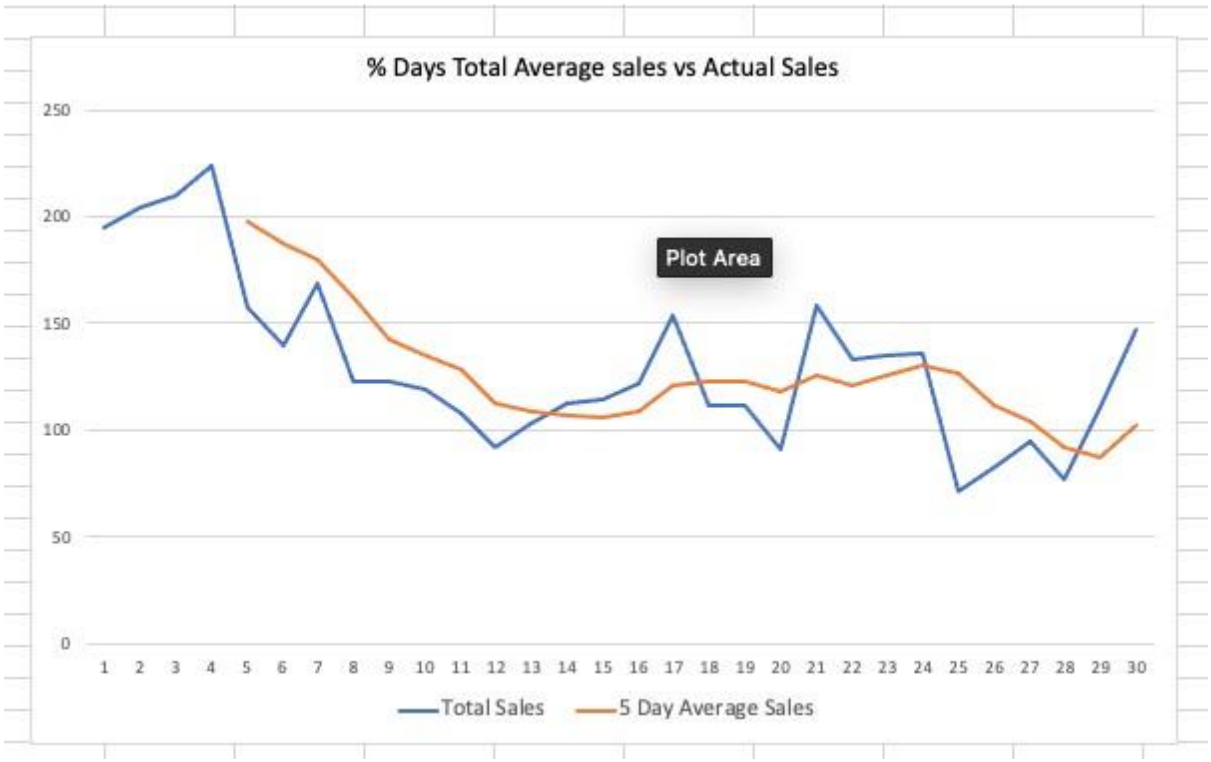

Figure 3.8: Time Series Chart to predict the future demand using five days moving average

After time series analysis result which is quite satisfying, I have calculated the average sales of each product over different week and plotted the line graph to know which week average will be the best suited.

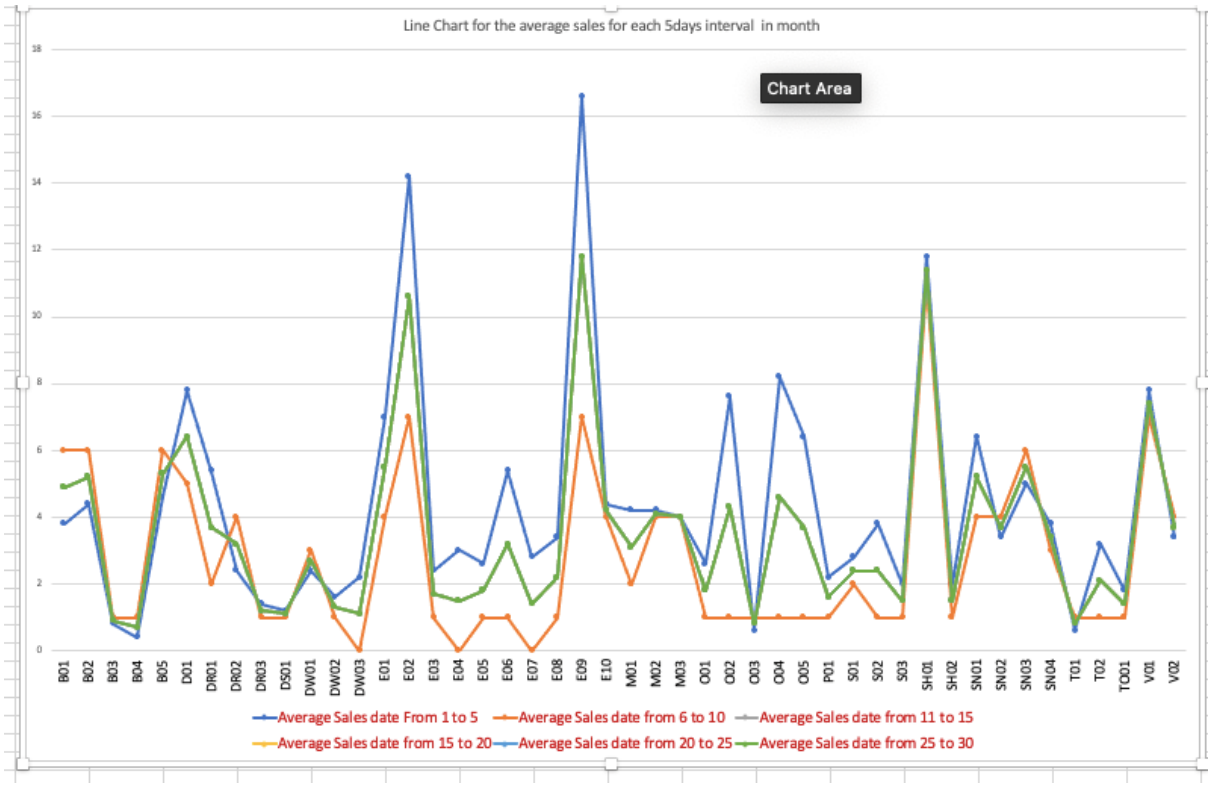

Figure 3.9: Line chart showing the average sales for every five-day period during a month

From this chart we can see that if we maintain the inventor level to the average sales over the first week it never gets stockout and the business will run efficiently. And for the categories of product which is not varying a lot can be maintained less than the growing product.

For the product of categories essential I have analyzed it separately by drawing tables.

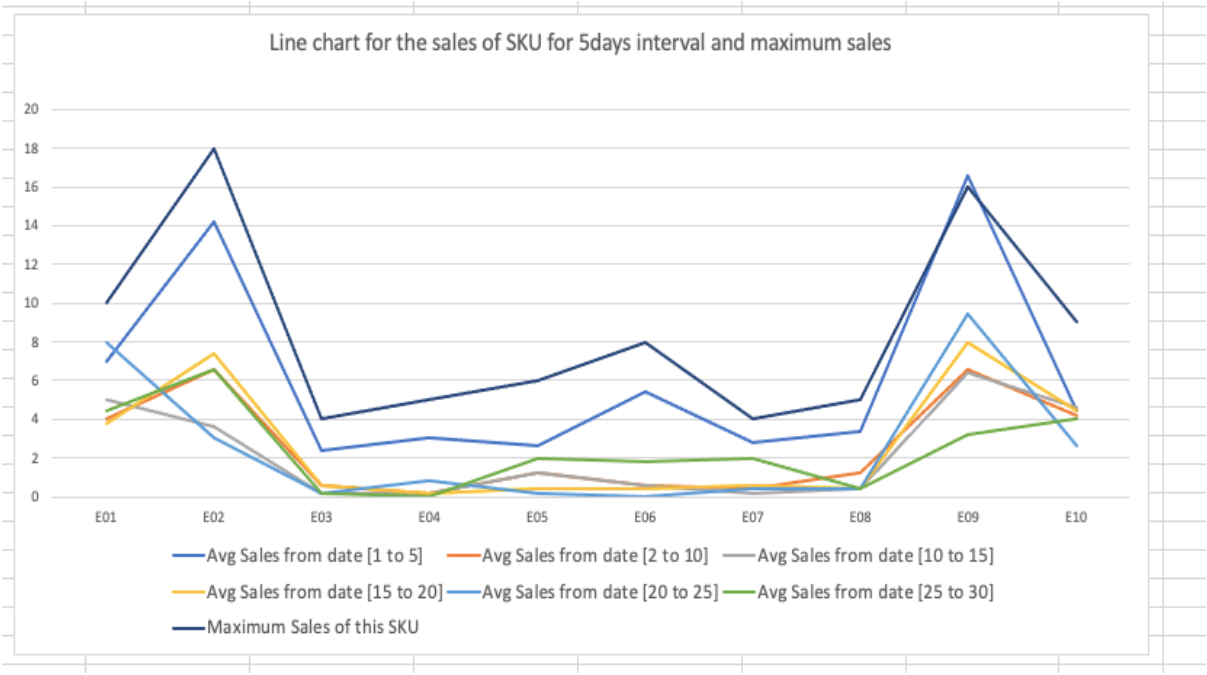

Figure 3.10: Line chart showing the sales of category essentials for five-days interval

Here to maintain the stock so that these categories never get stock out, I have used the maximum quantity sold over the month to the average sales over different weeks. And found that the maximum quantity sold is somewhat little more than the average sales over 1st week of the month.

From all this result I have plotted the table with SKU's, average sales, lead time, std. deviation, service level, Z-score, Safety Stock, Re-order Point

SKU	Average Demand	Lead time	Std. Deviation	Service Level	Z-score	Safety Stock	Re-order Point
B01	4	1	0.70	95%	1.64	5	9
B02	4	1	0.51	95%	1.64	5	10
B03	1	1	0.06	95%	1.64	1	2
B04	0	1	0.19	95%	1.64	1	1
B05	5	1	0.44	95%	1.64	5	10
D01	8	1	0.89	95%	1.64	9	17
DR01	5	1	1.08	95%	1.64	7	13
DR02	2	1	0.51	95%	1.64	3	6
DR03	1	1	0.13	95%	1.64	2	3
DS01	1	1	0.06	95%	1.64	1	3
DW01	2	1	0.19	95%	1.64	3	5
DW02	2	1	0.19	95%	1.64	2	4
DW03	2	1	0.70	95%	1.64	3	6
E01	7	1	0.95	99%	2.33	9	16
E02	14	1	2.28	99%	2.33	19	34
E03	2	1	0.44	99%	2.33	3	6
E04	3	1	0.95	99%	2.33	5	8
E05	3	1	0.51	99%	2.33	4	6
E06	5	1	1.39	99%	2.33	9	14
E07	3	1	0.89	99%	2.33	5	8
E08	3	1	0.76	99%	2.33	5	9
E09	17	1	3.04	99%	2.33	24	40
E10	4	1	0.13	99%	2.33	5	9
M01	4	1	0.70	95%	1.64	5	10
M02	4	1	0.06	95%	1.64	4	9
M03	4	1	0.00	95%	1.64	4	8
O01	3	1	0.51	99%	2.33	4	6
O02	8	1	2.09	99%	2.33	12	20
O03	1	1	0.13	99%	2.33	1	1
O04	8	1	2.28	99%	2.33	13	22
O05	6	1	1.71	99%	2.33	10	17
P01	2	1	0.38	95%	1.64	3	5
S01	3	1	0.25	95%	1.64	3	6
S02	4	1	0.89	95%	1.64	5	9
S03	2	1	0.32	95%	1.64	3	5
SH01	12	1	0.25	95%	1.64	12	24
SH02	2	1	0.32	95%	1.64	3	5
SN01	6	1	0.76	95%	1.64	8	14
SN02	3	1	0.19	95%	1.64	4	7
SN03	5	1	0.32	95%	1.64	6	11
SN04	4	1	0.25	95%	1.64	4	8
T01	1	1	0.13	95%	1.64	1	1
T02	3	1	0.70	95%	1.64	4	8
TO01	2	1	0.25	95%	1.64	2	4
V01	8	1	0.25	95%	1.64	8	16
V02	3	1	0.19	95%	1.64	4	7

Figure 3.11 Table Provides the re-order point for each SKUs

Here I got the safety stock and also the re-order point where the item should be re-ordered to maintain the inventory efficiently and with no stockout.

Apart from this, I also got SKU's which is performing very well with good growth. Need to invest more on that SKU's like Bisleri Bottle.

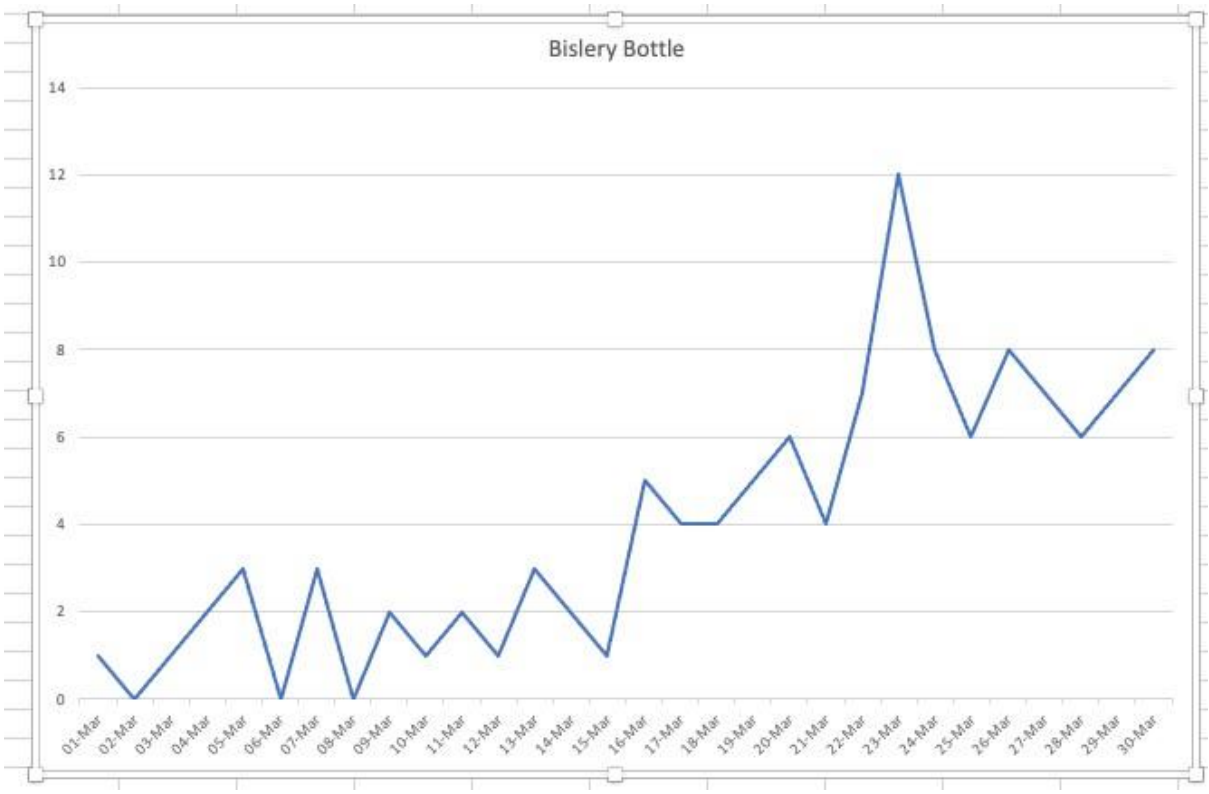

Figure 3.12: Line Chart showing the growth of item Bisleri

As summer season is coming product like water, cold drinks, soft drinks, etc. sales will increase.

4 Interpretation of Results and Recommendations

After analyzing all the data what I Interpreted is, as the sales in the first week of the month is high that means there are a lot of repeated customers, can say permanent customer are there who is buying their monthly groceries. So, shopkeeper should ensure that items should never get stockout and also, he need to invest in different items which is required in the monthly groceries so that his customers don't have to go to any other store for some item which is not available here.

Also, to maintain his working capital efficiently he should order his products on the last day of a month for the first week of the next month and focus mainly on essentials and edible oil. To stock up more for emergencies, demand for the rest of categories is not varying a lot so he can buy economic order quantity.

And also, he can make money by selling the stock of the items whose demand is very less by offering some combo offers with the essential products. And can invest in some new products which is required in grocery or some other seasonal products like water, cold drinks, etc. in summer season.

I have plotted this table for the reference using 1 month data. To give some idea to the shopkeeper while placing order, what should be re-order point for the SKU's and also given 3 dates and quantity to be ordered, so that inventory never face stockout and run efficiently. This is just to get some idea.

		Order placing Dates		
SKU	Re-order Point	30th of month	10th of month	20th of month
B01	9	38	49	44
B02	10	44	52	48
B03	2	8	9	9
B04	1	4	7	6
B05	10	46	53	50
D01	17	78	64	71
DR01	13	54	37	46
DR02	6	24	32	28
DR03	3	14	12	13
DS01	3	12	11	12
DW01	5	24	27	26
DW02	4	16	13	15
DW03	6	22	11	17
E01	16	70	55	63
E02	34	142	106	124
E03	6	24	17	21
E04	8	30	15	23
E05	6	26	18	22
E06	14	54	32	43
E07	8	28	14	21
E08	9	34	22	28
E09	40	166	118	142
E10	9	44	42	43
M01	10	42	31	37
M02	9	42	41	42
M03	8	40	40	40
O01	6	26	18	22
O02	20	76	43	60
O03	1	6	8	7
O04	22	82	46	64
O05	17	64	37	51
P01	5	22	16	19
S01	6	28	24	26
S02	9	38	24	31
S03	5	20	15	18
SH01	24	118	114	116
SH02	5	20	15	18
SN01	14	64	52	58
SN02	7	34	37	36
SN03	11	50	55	53
SN04	8	38	34	36
T01	1	6	8	7
T02	8	32	21	27
TO01	4	18	14	16
V01	16	78	74	76
V02	7	34	37	36

Figure 4.1 Table shows the re-order point and also the order placing date for different SKUs

Recommendations:

- He needs to focus more on the categories like essentials and edible oil as its generating high revenue and also having high volume sale (especially in 1st week of month).

- He needs to maintain the re-order point (what I have calculated based on 1 month data) And place the new order to stock up inventory. He can also take some idea of how much quantity he should order which I have estimated in above table.

- He needs to remove or sell all the stocks which are of less demand but having in high volume in inventory so as to maintain working capital. (By offering some offers with the essentials categories SKU's this will increase the sales.

- He needs to invest more on the seasonals items like water bottle, ice creams, cold drink etc. as its demand is rising. And it will also increase revenue.

- He needs to add more items in essentials categories which is required in monthly groceries purchase as many customers are buying their groceries from him and this increase the customers also as customer wants to buy everything from same shop.

- He can also invest money in some system which will record the data and provide better inventory planning in continuous run. Which will give much relief.