Retail Stores

Open-IIT Data Analytics Report

Chi-Square Analytics

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OUT OF STOCK ALERTS

Out Of Stock situations:

1. Supply-Chain Out of Stock (SCOOS): A situation in which OOS occurs due to exhaustion of inventory in manufacturing or supply chain.
2. Shelf Out Of Stock (SOOS): A situation in which OOS occurs due to exhaustion of inventory in a store itself or poor shelf replenishments practises.

1. Supply-Chain Out of Stock(SCOOS)

Our Approach:

1. Comparison of Sales of a product in the three cities (A, B& C) at the same time **(Alert 1).**
2. Correction for Long period no-sale situation.
3. Moving Average - Percentile Method **(Alert 2).**
4. Checking accuracy of Moving Average - Percentile Method

Comparison of Sales of a product in three cities (A, B& C) at the same time

If there is shortage of supply in upstream supply chains then that product must have zero or less sales in all stores simultaneously. It's not necessarily zero because the stock of that product is different in different shops or few shops may have buffer stock. Here, we have also considered that the effect of SCOOS is visible with some delay in our sales data.

Assumptions:

1. Sales for that product should be zero simultaneously in at least two cities.
2. Sales in the third city must be less than or equal to 50% of mean of non zero-Sales of that product in third city.
3. SCOOS situation cannot extend more than 4 weeks.
4. Percentage change in Sale in last two weeks is more than percentage change in third-fourth last week.

Last assumption is made to include the delay in visible effect of supply shortage on sales data. However for simplification we are dropping the third assumption.

Example: SCOOS for Department-"Ladies Lower", Product-15663

Week	A	B	C	SCOOS	Week	A3	B4	C5	SCOOS
61	31	27	21	0	79	14	48	0	0
62	96	99	15	0	80	78	55	22	0
63	34	27	15	0	81	54	61	10	0
64	23	18	12	0	82	63	55	19	0
65	22	15	16	0	83	73	102	19	0
66	8	2	5	0	84	71	233	43	0
67	8	5	0	0	85	33	102	12	0

68	0	2	0	1	86	71	75	22	0
69	0	0	0	1	87	91	98	26	0
70	0	0	0	1	88	120	98	27	0
71	1	1	0	0	89	120	88	53	0
72	0	2	0	1	90	88	124	33	0
73	0	1	0	1	91	98	100	44	0
74	0	2	0	1	92	91	59	32	0
75	0	2	0	1	93	111	103	25	0
76	1	2	0	0	94	105	135	49	0
77	0	1	0	1	95	125	237	73	0
78	1	1	0	0	96	90	160	58	0

Correction for Long period no-sale situation

Long Period no-sale situation simply implies zero sale for long period. When the above assumptions are applied it gives result which shows SCOOS situation for long periods i.e. 5 or more weeks. But there are more chances that in such situation, there was no demand for that product may be due to seasonal variations and there's nothing wrong with supply chain.

If we consider it as a seasonal effect on sale of that product then a no demand situation arises this automatically removes the OOS situation.

<u>Assumption:</u>

1. If SCOOS continues for more than 4 weeks, than we consider the beginning and ending weeks only as SCOOS situation.

The reason for this assumption is that might be there is small demand of a product but supply has already been stopped for that season. Similarly, we have assumed that customers plan a week ahead and so they may face OOS situation in the end of a season.

Example: SCOOS before and after correction

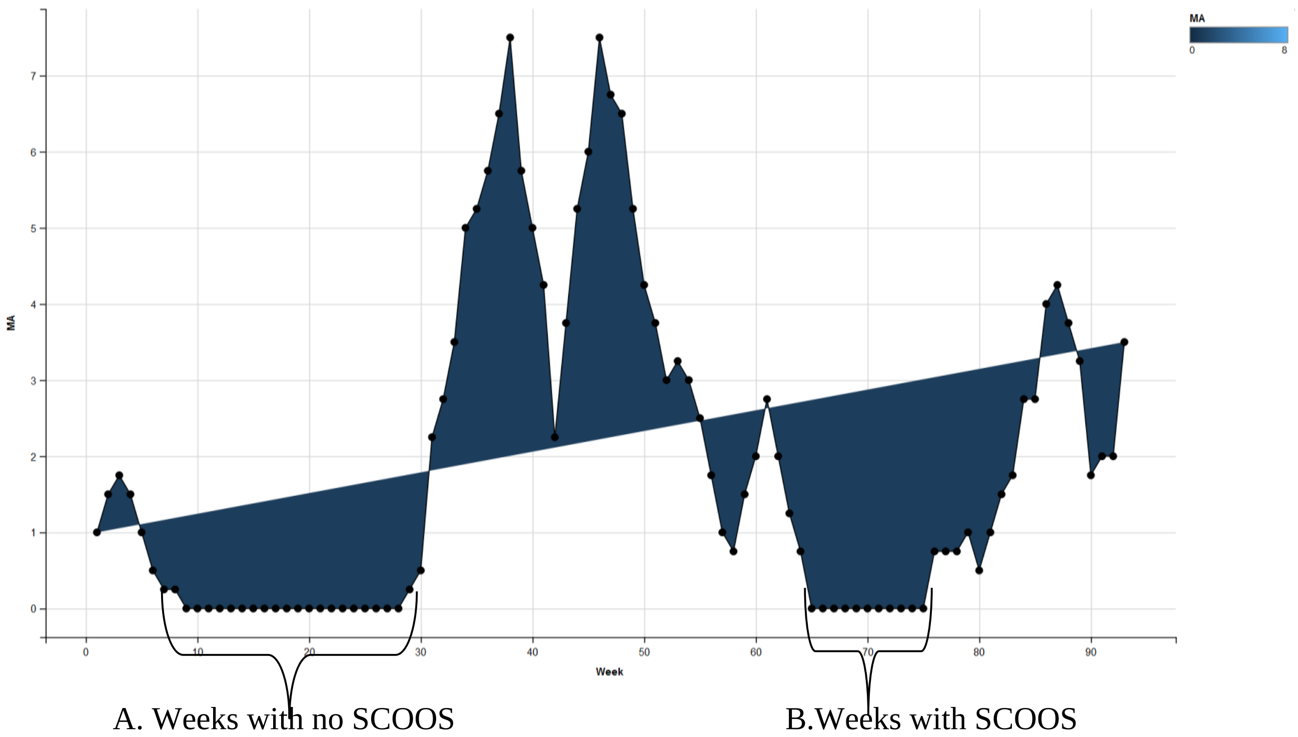
Comparison of Sales for Department="Home Furnishing", Product=17516

Week	Before	After
75	1	1
76	1	1
77	0	0
78	1	1
79	1	0
80	1	0
81	1	0
82	1	1
83	0	0
84	0	0

Moving Average Percentile method

The Comparison of Sales method have a limitation that we should have data on sales from at least three cities. In this case, our sales data indicates that sales have started at different time in three cities. To predict the SCOOS with using data of only one city, we moved to a moving average-percentile method.

If SCOOS occurs, its effect should not be sudden fall in sales and too sudden increase in sales after the SCOOS situation has ended. Sudden growth and decline are part of SOOS situation. The sales during SCOOS situation may not be necessarily zero.



The graph shows the effect of sale in weeks adjacent to A and B in determining SCOOS.

<u>Assumptions:</u>

1. The moving average of sales in the weeks prior to SCOOS should belong to 45-80 percentile.
2. The moving average of sales in the weeks just following SCOOS should belong to 45-80 percentile.
3. During, SCOOS moving average of sales should belong to 0-20 percentile.
4. At least a week will have zero sales.
5. SCOOS can continue at most for four weeks otherwise correction is applied.

Checking Accuracy of Moving Average - Percentile Method

The assumptions clearly indicate that Comparison of sales in three cities simultaneously will give more accurate results than the Moving Average-Percentile Method.

We can check the accuracy by comparing the results of common set of weeks we get from both methods.

Assumption:

1. Comparison of Sales of a product in three cities at the same time gives 100% accurate result.
2. If the SCOOS situation occurs at the same time or one week adjacent in the two methods than it will considered as matching result.

For simplicity, we can drop assumption 2 and use:

%Accuracy = (Number of weeks with matching results/Total weeks) * 100

Result of accuracy measurement:

The accuracy of Moving average-Percentile Method for most of the product came out to be greater than 70%, so for uniformity we presented SCOOS results of this method only in our Excel sheet. For uniformity we showed Moving Average Percentile Method result only in our .csv file as it's a economically fair enough assumption.

Example: The table below shows accuracy of Moving Average Percentile method in the three cities for all the products of department "Home Furnishing". The average accuracy in 71.3%

Product	% Accuracy		
	A	B	C
17514	NA	NA	NA
17515	81.2	81.2	66.7
17516	68.8	65.7	72.85
17517	NA	NA	NA
17518	71.4	75	71.4
17540	74.3	65.7	71.4
243	68.3	54.3	52.8
34327	80.6	80.6	88.9

*NA represents the situation when we can't calculate the accuracy because the product is not sold in all three cities.

2. Shelf Out Of Stock (SOOS)
Week over Week analysis

Generally out of stock situation occurs when there is large deviation in the sales. So deviation in the two consecutive weeks is also a parameter for the out of stock situation. We calculated the difference between every two consecutive weeks. Then we calculated the deviation ratio.

Deviation Ratio = (Current week sales - Last week sales)/Last week sales.

To use the Deviation ratio we set a threshold value. Here threshold value implies the ratio above which we can say there must be a large probability of out of stock situation, so we have taken threshold value of 0.9.
This deviation ratio alone cannot give us the required predicted out of stock situations, so we also calculate a second ratio:

Deviation $Ratio_2$ = (Predicted Sale – Sale) / Std. Dev. Sales

We gave it a threshold value of 2.

Result of OOS alerts:
Count of SCOOS occurrences: 513
Count of SOOS occurrences: 2197
Total OOS occurrences: 2651
Count when both SCOOS and SOOS occurred simultaneously: 59

About .csv file:

***.csv file contains OOS only for historical data because data has less than two periods to complete the time series and lack of information on the attributes on which Predicted sales are given.**

***.csv file contains columns "SCOOS flag" , "SOOS flag" and "OOS flag" containing "1" and "0".**

***"1" indicates TRUE and "0" indicates FALSE.**

<u>BUFFER STOCK</u>

BASIC CONCEPTS:

What is Buffer/Safety Stock?

A supply of stock held as reserve to safeguard against unforeseen demand.

OUR APPROACH:

ASSUMPTION:

We have assumed that the products are procured **weekly**; hence our algorithm gives buffer calculation for each week. Here a product is classified as fast moving, average moving and slow moving and then buffer calculation is done for the week.

We followed a three stage approach to solve the problem:

1) **Separation of Data**
2) **Flag for fast-moving, average and slow-moving products**
3) **Applying Normal Distribution**

SEPERATION OF DATA:

Assuming to find buffer stock for each department separately, we divided the data on the basis of department into different groups. Also, the forecast data was of no use to calculate buffer stock so it is discarded. Data is not separated further on basis of their product ids because it is assumed that the different product of same department does not have much effect on each other.

FLAG FOR FAST-MOVING, AVERAGE AND SLOW-MOVING PRODUCTS:

For each department, the ratio of sales to predicted sale is calculated for each day. It is considered that this ratio will convey that how much sale would take place to what was predicted. Here, we have flagged when this ratio becomes 1. We have considered that if ratio is greater than 1 then product in that specific week is fast-moving (the sale is more than the predicted sale), if ratio equals to 1 then the product is average (the sale equals to the predicted sale) and if ratio is less than 1 then product is slow-moving (the sale is less than the predicted sale).

APPLYING NORMAL DISTRIBUTION:

We then applied normal distribution on ratio of sale to the predicted sale for fast-moving, average and slow-moving products separately for each department. Calculation of mean of ratio (μ), standard deviation of ratio (σ) and also of mean of predicted sale (μp) is done. Then for fast-moving products, the formula

$$\text{Buffer} = (\mu + 3*\sigma) * \mu p$$

is used. Similarly, for average products, the formula

$$\text{Buffer} = (\mu + 2.5*\sigma) * \mu p$$

is used. Similarly, for slow-moving products, the formula

$$\text{Buffer} = (\mu + 2*\sigma) * \mu p$$

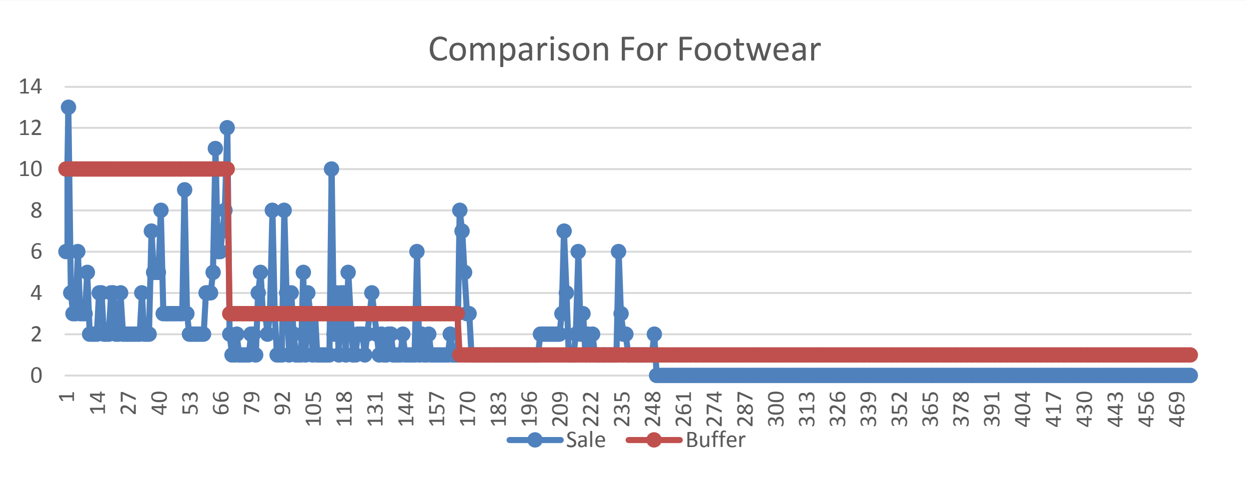
is used.

RESULT OF BUFFER STOCK:

	FAST-MOVING PRODUCTS	***AVERAGE PRODUCTS***	***SLOW-MOVING PRODUCTS***
FOOTWEAR	10	3	1
HOME FURNISHING	19	3	1
INFANT W-WEAR	38	8	2
LADIES LOWER	29	4	3
LADIES UPPER	221	12	15
MENS LOWER	53	13	12
MENS UPPER	146	18	13

FURTHER EXPLANATION:

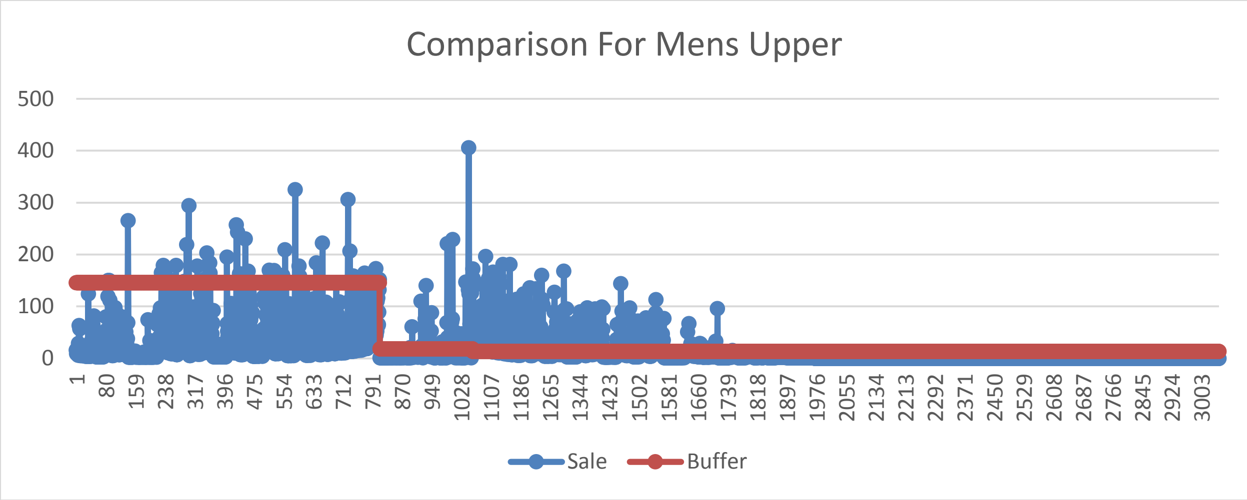
For example, we choose the department *Footwear* to explain the approach. The comparison chart between Buffer Stock and Historical Sales for Footwear is presented below.



In the above chart, the orange line denotes the Buffer Stock and the blue line denotes the Historical Sales. The Buffer Stock curve is in form of staircase. The staircase can be explained as follows:

1) The first stair from left side denotes the Buffer Stock for fast-moving products.
2) The second step denotes the Buffer Stock for average products.
3) The last step denotes the Buffer stock for slow-moving products.

In fast-moving, average and slow-moving products, the most cases beyond 3*σ, 2.5*σ, 2*σ respectively are considered to be outliers. Considering the problems faced in some departments like *Mens Upper*, the chart is shown below.



Some cases are beyond the range in fast-moving products because of highly impractical situations in data such as Predicted sale is 11 but actual sale comes is 63 and other similar cases.

Coming to the average products, the cases like the retailer predicts sale to be 406 and actual sale is also 406, which is a normal condition for retailer and thus makes this case to fall under the average products.

In the range of slow moving products, the cases like retailer predicts the sale to 138 but the sale happens to be 67, which pushes retailer in loss. So it is better to have less buffer stock in such cases.

In practical conditions, the retailers mostly focus on their fast-moving products keeping their buffer stock high enough to get them into large profit so that small losses in average and slow-moving products may be covered, i.e., the fast-moving products are their main source of income. For fast-moving cases, our approach seems to be very effective and practical.