Pathfinder

Purpose. Belief. Responsibility.

CELEBRATING **25** YEARS

KNOWLEDGE LEADER WITH THE DNA OF

INNOVATION & CUSTOMER SUCCESS

Airports

Shopping Centre & Realty

Retail

Aviation

Key Verticals

Data science services and what we do in it ?

Advisory services
- Data science solution consulting in the areas of predictive and prescriptive analytics
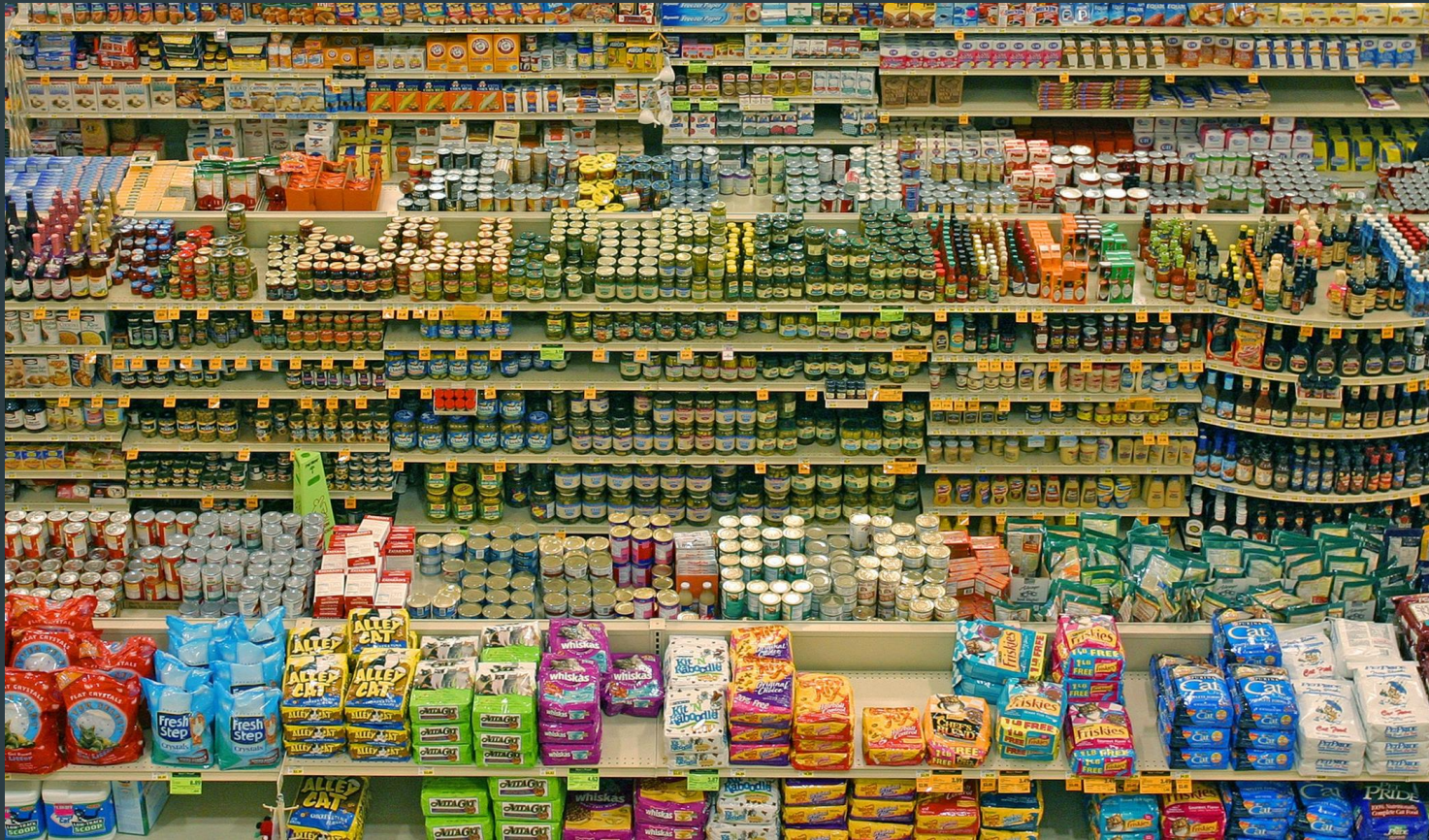
R&D
- Proto-type & product development using open stacks

Premium Services
- Data visualization & blended insights

FMCG
INVENTORY MANAGEMENT USING FORECASTING

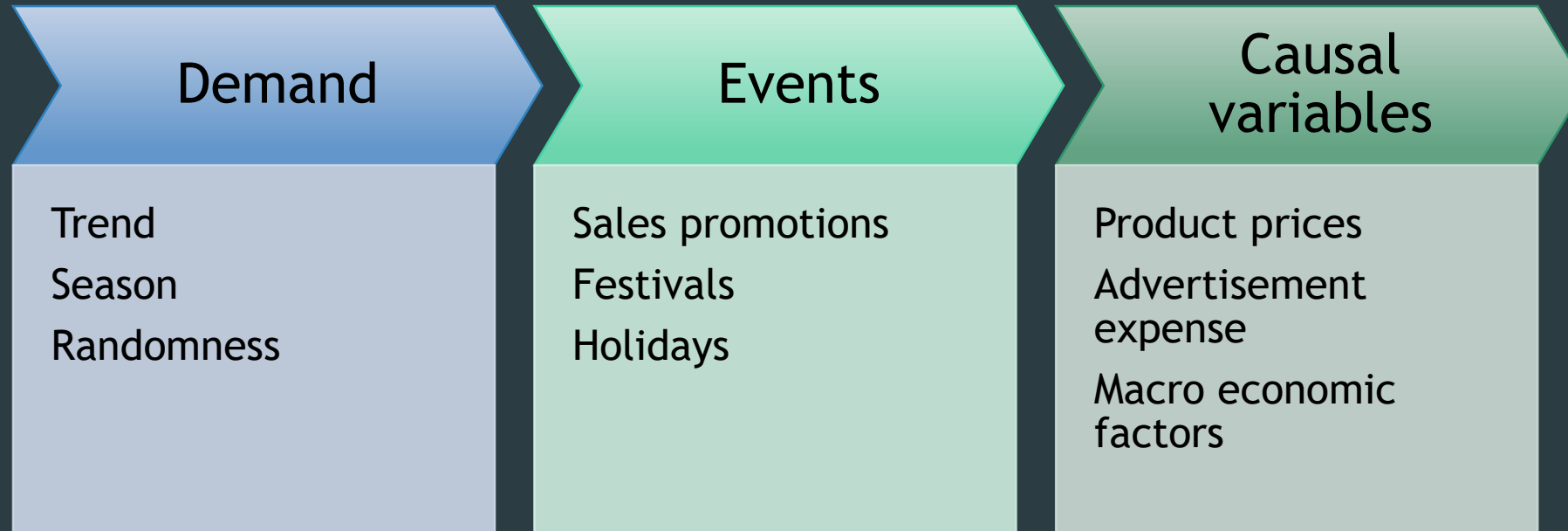Case study-based discussion

Typical FMCG Business Challenge

▶ As a retailer,

1. How can I decide optimal quantity of different SKU's at my shelf ?.

2. How can I maintain my customer service levels with optimal inventory ?.

3. How can I decide upon the effects of weather, holiday and macro economic factors on my sales?.

- Reduce firm's working capital by reducing held inventories.
- Understand product demand in market to reduce stock out situations.
- Localized pattern cognizance.

General Expectation from the solution

Model Selection basis

Demand	Events	Causal variables
Trend Season Randomness	Sales promotions Festivals Holidays	Product prices Advertisement expense Macro economic factors

Pathfinder's Approach – Forecasting

- Formalize forecast framework for quantities at both store and SKU level or department level.

- Detect drift patterns.

- Create seasonal components in Fourier series terms.

- Identify the effects of external variables on sales

- Identify trend components

- Generalized Additive modelling techniques are utilized.

A Daily sales forecasting model at SKU level with holiday effects will help in this case.

**How can we understand daily sales pattern to decide stocking?**
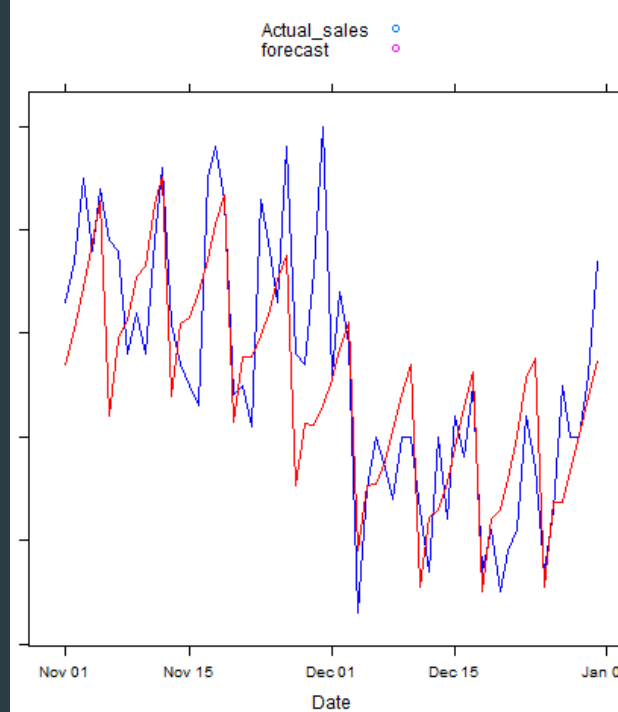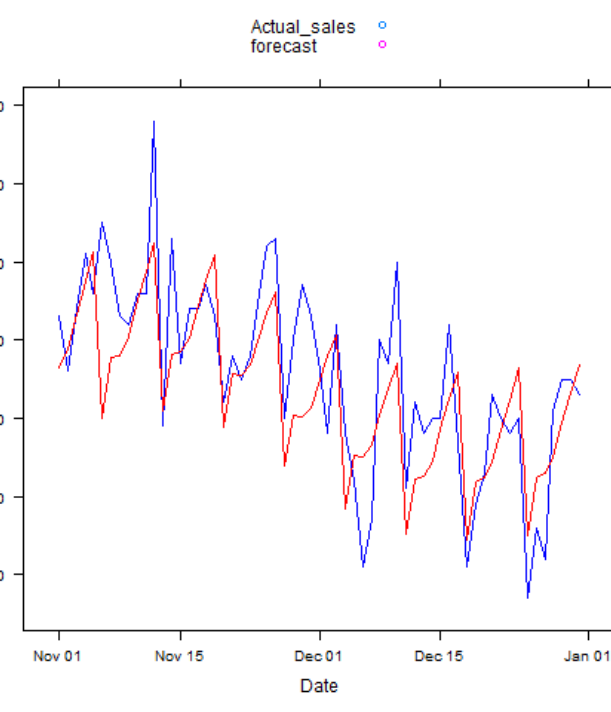
OPTIMIZING INVENTORY

▶ Inventory can be Optimized by Estimating the Demand of item for future Period

▶ Demand Calculation done by forecasting item sales

▶ We are doing forecasting for each stores across all items for future period.

▶ Fig gives you a plot of Actual and forecasting for Sixty days window

FACTORS INFLUENCING FORECASTING

▶ Trend

▶ Seasonality

▶ Holiday Factor
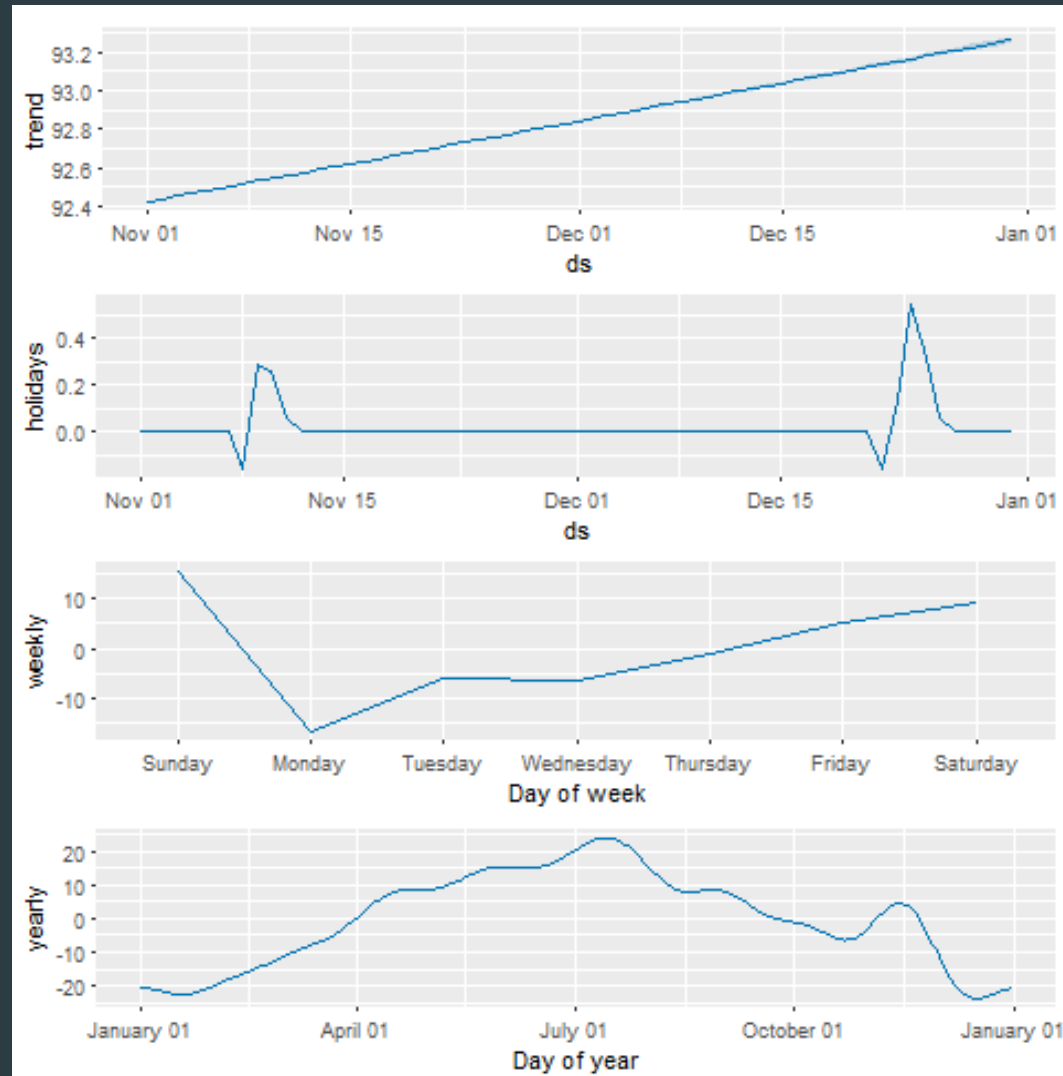
Captures the holiday effect of November month

- Fig shown on the right is the plot of multiple factors and the plot of Actual and forecasted output of two different item id 6 and 12 of two different store id 1 and 2.

- We have Captured the trend, Holiday events and seasonality across the period.

- Figure gives you the view of how these factors on the left affecting the pattern of the forecasting on the right.

Captures the negative effect of November month in another store
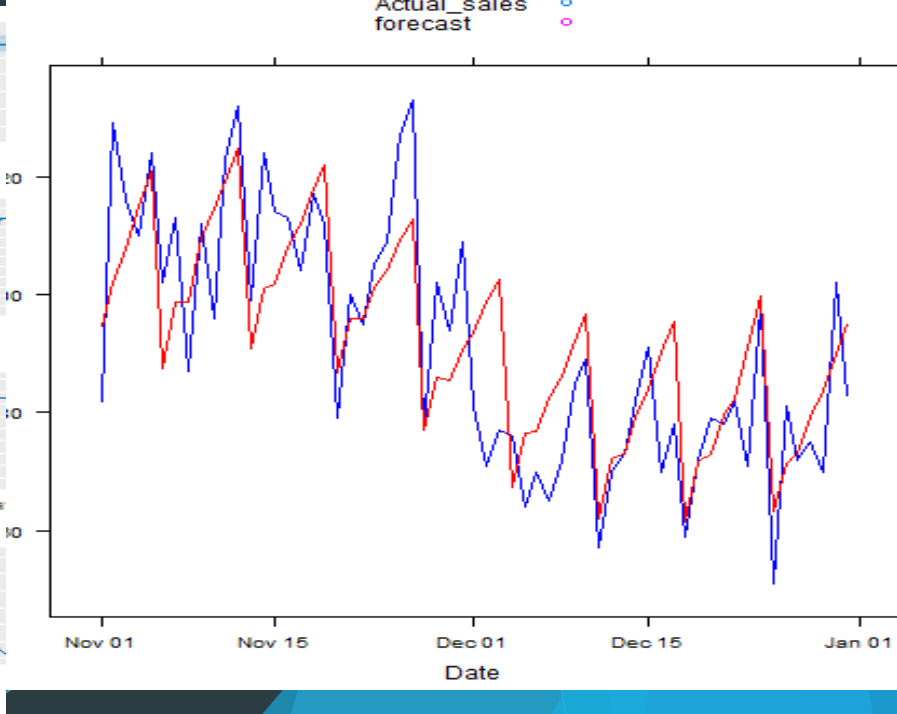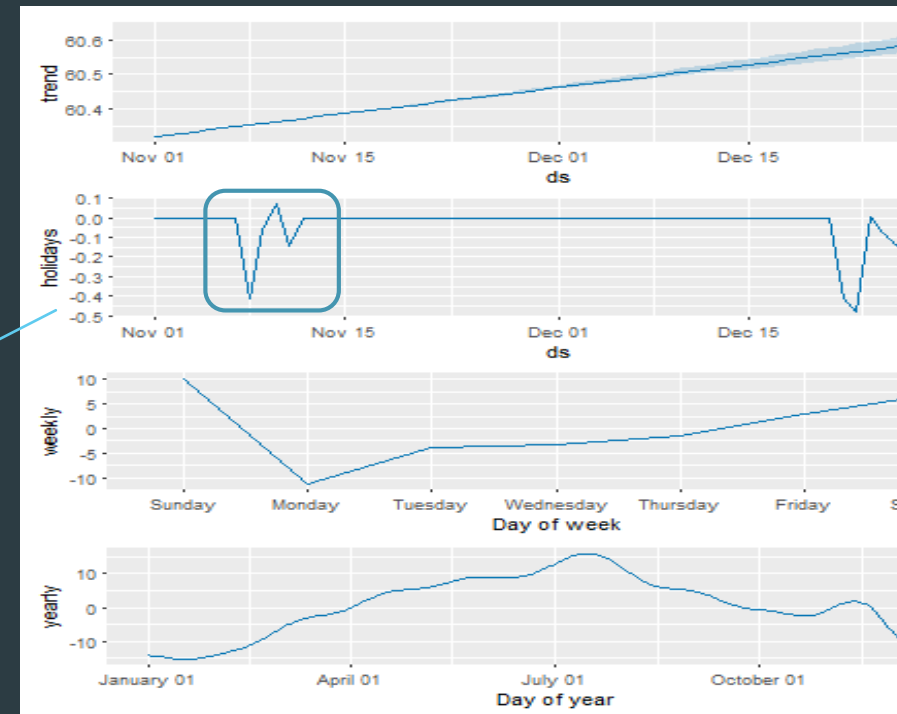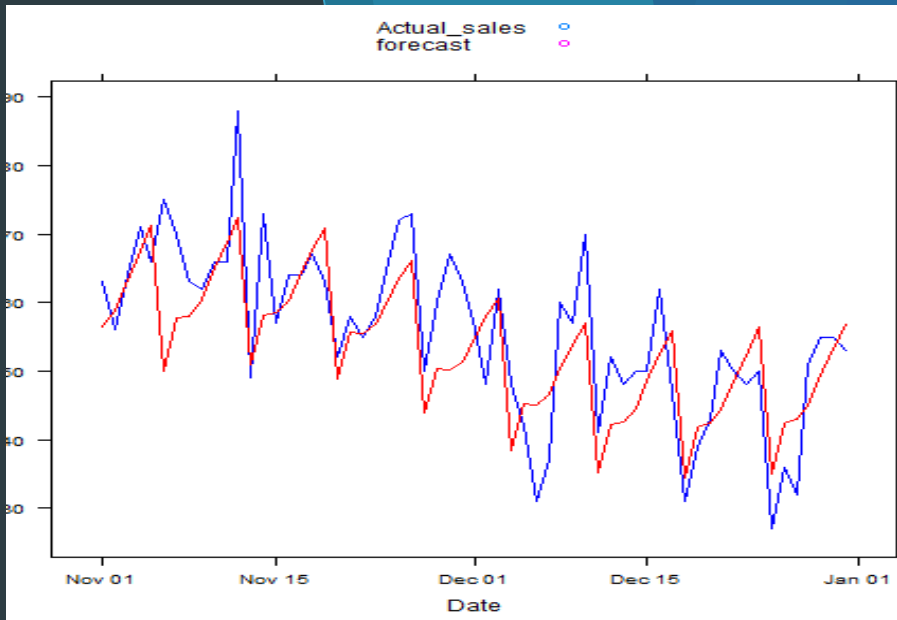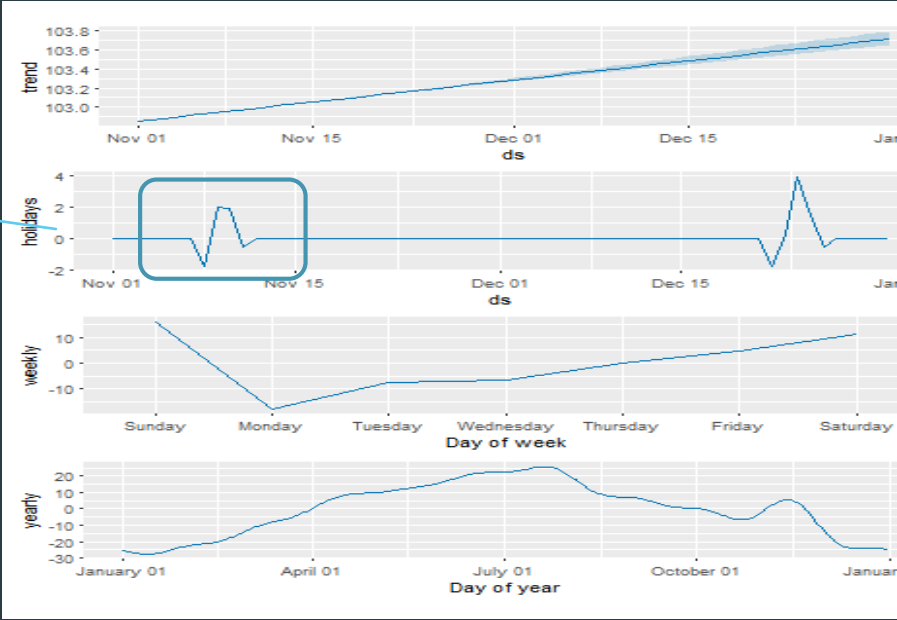
- How does external variables like weather, macro economic variables etc. impact sales ?.

- Let's understand that with a case on a store containing multiple departments and how a single department gets affected by this factor.

Understanding the impact of external variables

Store	Date	Dept	Weekly_Sales	IsHoliday.x	Type	Size	Temperature	Fuel_Price	MarkDown1	MarkDown2	MarkDown3	MarkDown4	MarkDown5	CPI	Unemployment
19	27/04/2012	1	14436.08	FALSE	A	203819	42.45	4.163	3735.30	-265.76	52.82	67.72	2959.27	137.9781	8.150
19	27/04/2012	2	48717.46	FALSE	A	203819	42.45	4.163	3735.30	-265.76	52.82	67.72	2959.27	137.9781	8.150
19	27/04/2012	3	11586.60	FALSE	A	203819	42.45	4.163	3735.30	-265.76	52.82	67.72	2959.27	137.9781	8.150
19	27/04/2012	4	30066.61	FALSE	A	203819	42.45	4.163	3735.30	-265.76	52.82	67.72	2959.27	137.9781	8.150
19	27/04/2012	5	16775.73	FALSE	A	203819	42.45	4.163	3735.30	-265.76	52.82	67.72	2959.27	137.9781	8.150
19	27/04/2012	6	3568.62	FALSE	A	203819	42.45	4.163	3735.30	-265.76	52.82	67.72	2959.27	137.9781	8.150
19	27/04/2012	7	23303.40	FALSE	A	203819	42.45	4.163	3735.30	-265.76	52.82	67.72	2959.27	137.9781	8.150
19	27/04/2012	8	42555.58	FALSE	A	203819	42.45	4.163	3735.30	-265.76	52.82	67.72	2959.27	137.9781	8.150
19	27/04/2012	9	23919.65	FALSE	A	203819	42.45	4.163	3735.30	-265.76	52.82	67.72	2959.27	137.9781	8.150
19	27/04/2012	10	25361.76	FALSE	A	203819	42.45	4.163	3735.30	-265.76	52.82	67.72	2959.27	137.9781	8.150
19	27/04/2012	11	15605.18	FALSE	A	203819	42.45	4.163	3735.30	-265.76	52.82	67.72	2959.27	137.9781	8.150
19	27/04/2012	12	6128.86	FALSE	A	203819	42.45	4.163	3735.30	-265.76	52.82	67.72	2959.27	137.9781	8.150
19	27/04/2012	13	31144.66	FALSE	A	203819	42.45	4.163	3735.30	-265.76	52.82	67.72	2959.27	137.9781	8.150
19	27/04/2012	14	17150.50	FALSE	A	203819	42.45	4.163	3735.30	-265.76	52.82	67.72	2959.27	137.9781	8.150
19	27/04/2012	16	24923.88	FALSE	A	203819	42.45	4.163	3735.30	-265.76	52.82	67.72	2959.27	137.9781	8.150
19	27/04/2012	17	14879.95	FALSE	A	203819	42.45	4.163	3735.30	-265.76	52.82	67.72	2959.27	137.9781	8.150
19	27/04/2012	18	71.03	FALSE	A	203819	42.45	4.163	3735.30	-265.76	52.82	67.72	2959.27	137.9781	8.150
19	27/04/2012	20	6333.17	FALSE	A	203819	42.45	4.163	3735.30	-265.76	52.82	67.72	2959.27	137.9781	8.150
19	27/04/2012	21	6074.60	FALSE	A	203819	42.45	4.163	3735.30	-265.76	52.82	67.72	2959.27	137.9781	8.150
19	27/04/2012	22	11313.27	FALSE	A	203819	42.45	4.163	3735.30	-265.76	52.82	67.72	2959.27	137.9781	8.150
19	27/04/2012	23	23131.88	FALSE	A	203819	42.45	4.163	3735.30	-265.76	52.82	67.72	2959.27	137.9781	8.150
19	27/04/2012	24	3780.32	FALSE	A	203819	42.45	4.163	3735.30	-265.76	52.82	67.72	2959.27	137.9781	8.150

Data collection mechanism

- What are the macro economic factors useful for retailers?

- How can I understand the impact of political unstability via data factors?
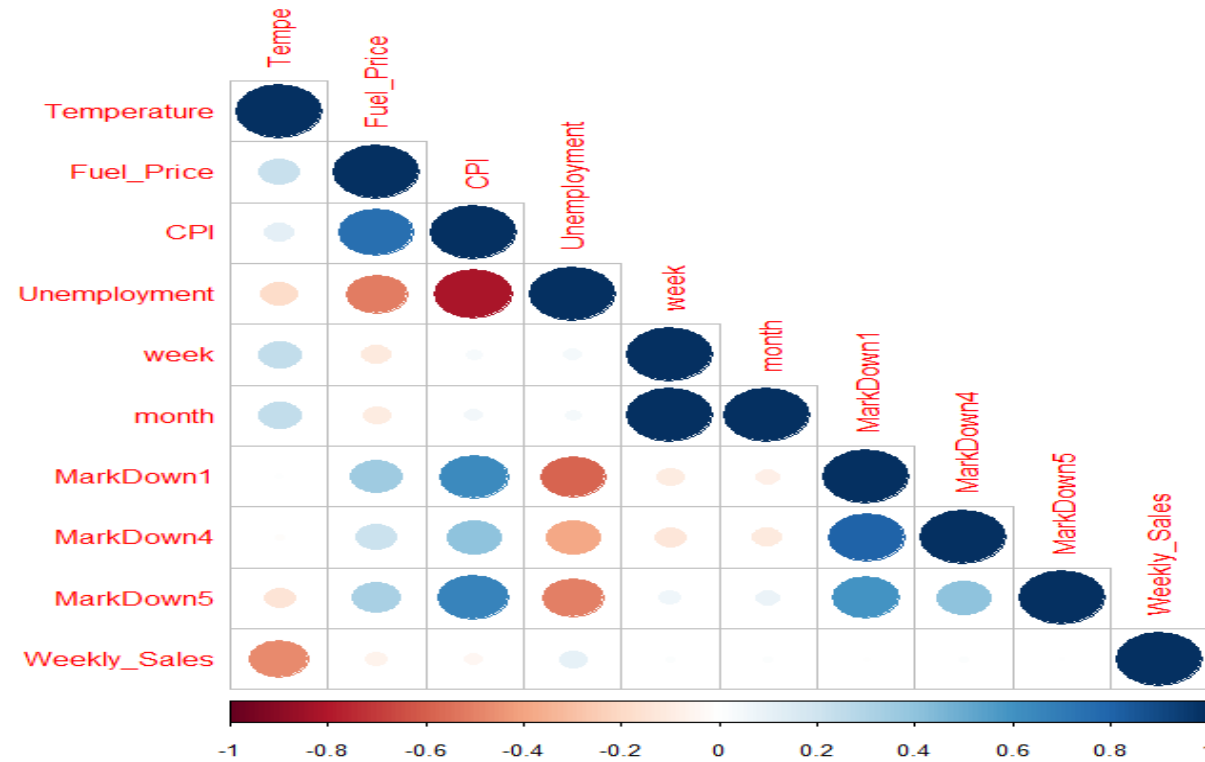
- How should I prepare to capture this data ?
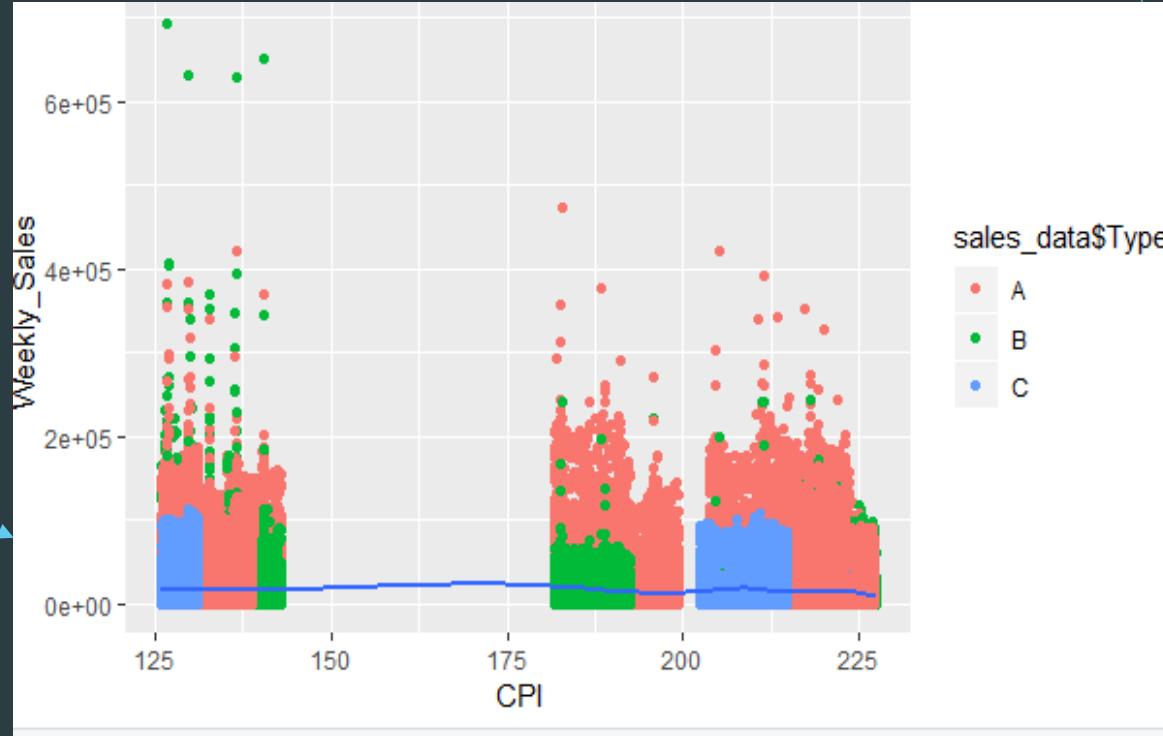
General global factors influencing forecasting

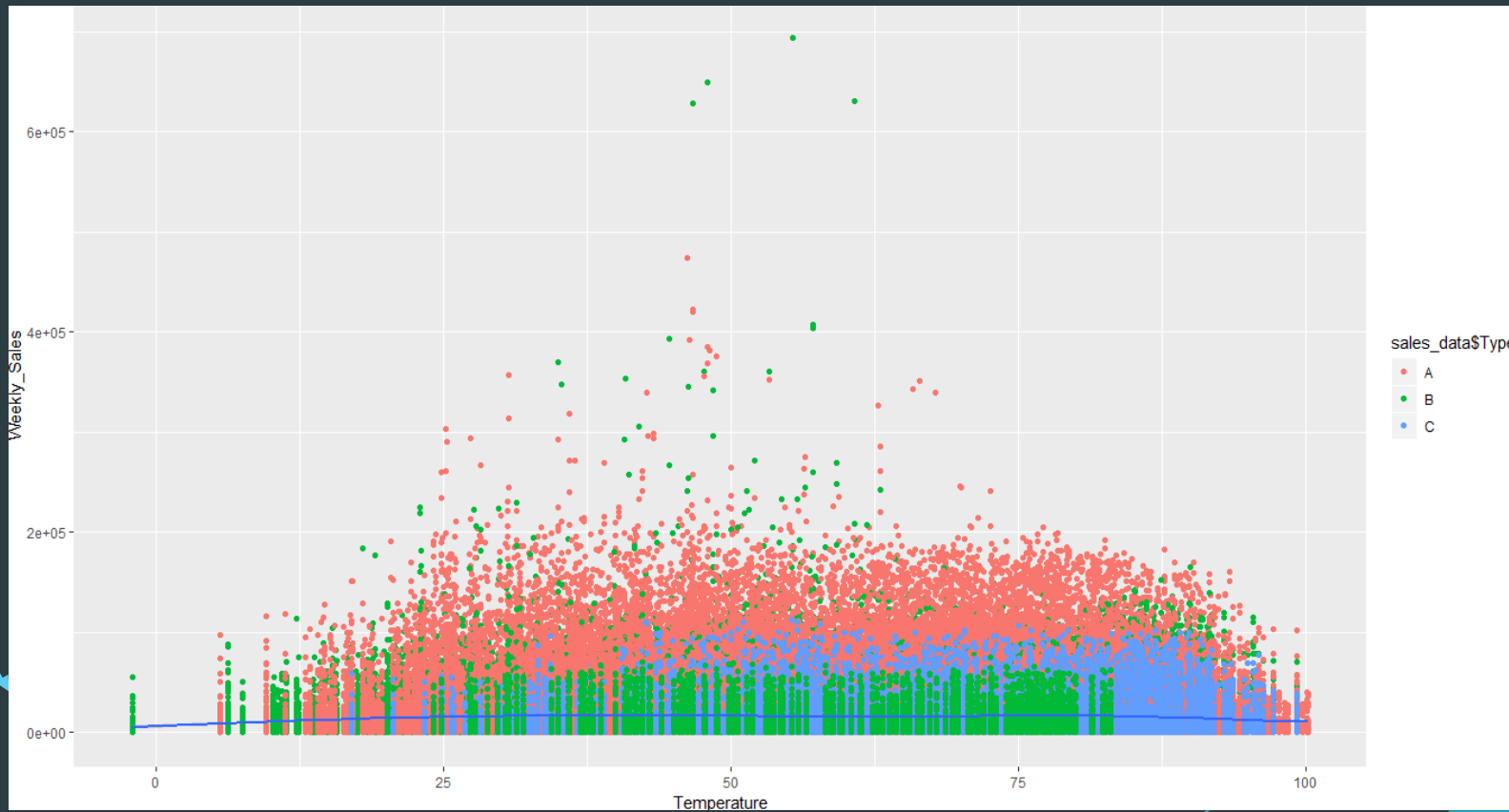Weather factor

Macro Economic variables

Consumer Price Index influence across stores

Store type A sales are not affected much by CPI. Typically Type A stores are bigger in size and have essential commodities
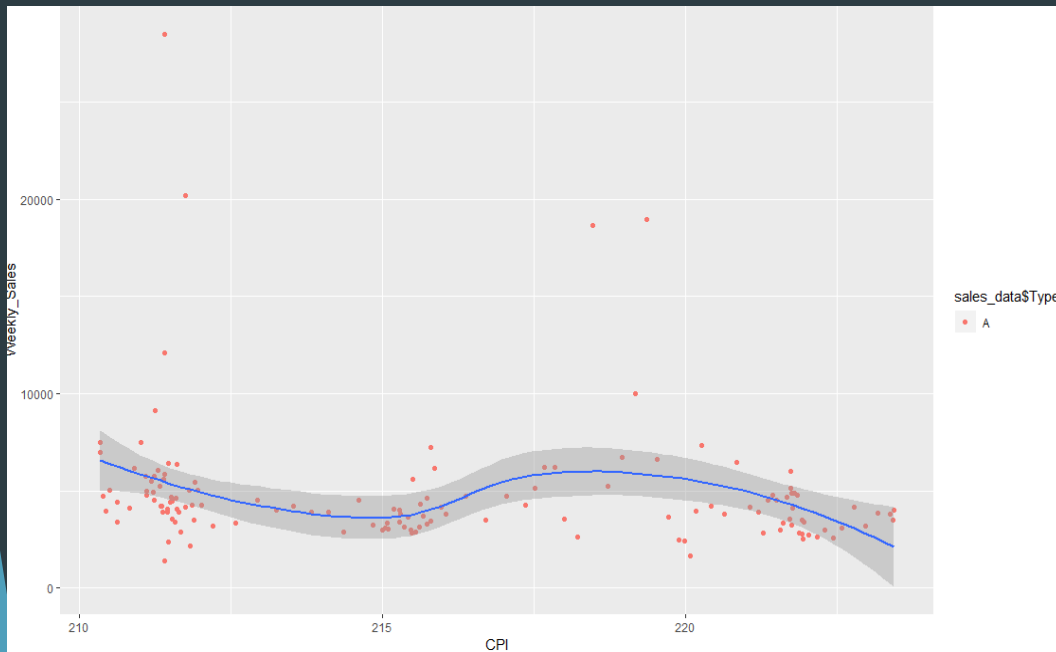
Temperature influence across stores

Minimal influence

Sample analysis - Single department of store 'A'

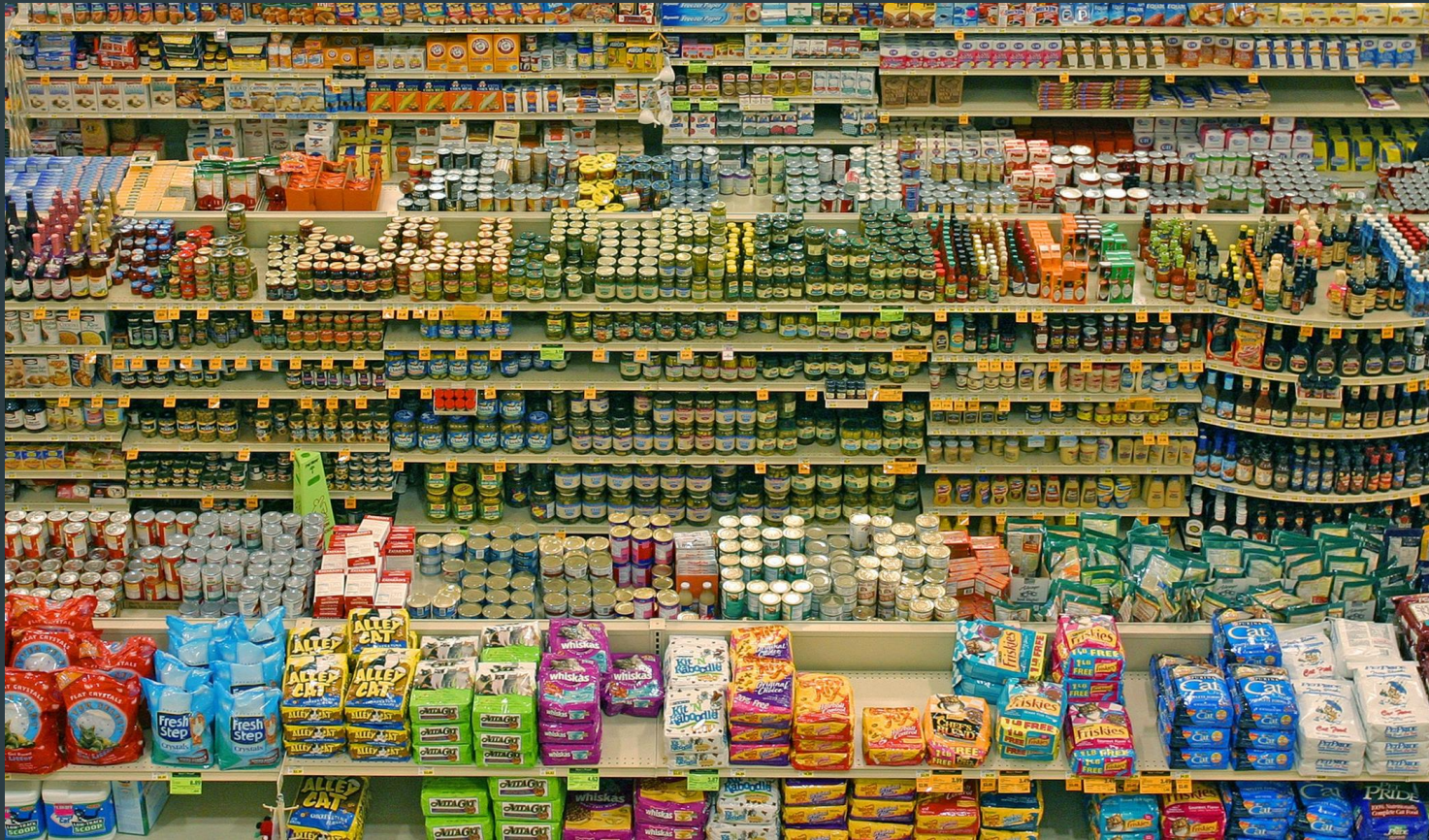Fuel price plays a factor in forecasting sales for this department and store

CPI influence in Store type of 'A'


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Regression with ARIMA(0,0,0) errors

Coefficients:
        intercept  markdown1  markdown4  markdown5  fuel_price     cpi     Temp
         11.3587      0e+00      0e+00      0e+00      0.0741   -0.0039   -0.013
s.e.      2.5332      1e-04      1e-04      1e-04      0.0934    0.0129    0.002
            week      month    Holiday       Dec3       Dec4      Jan1      Oct3      Oct4
         -0.0197     0.0893     0.0001     0.5604     0.3369   -0.4728    0.3428    0.5668
s.e.      0.0185     0.0795     0.0923     0.2027     0.2030    0.1951    0.1922    0.1934
```

Christmas eve and October last weeks have impact in sales in this department

Insights for inventory management

- Department 1 needs to plan for optimal stocking in Christmas eve and October last month.

- Safety stocks needs to understand the lead time from supplier apart from forecast to derive at the value.

- Overall external variables needs to be studies at granular level rather than at higher level.

FACTORS THAT INFLUENCE FOR OPTIMIZING INVENTORY

▶ DEMAND ESTIMATION

▶ LEAD TIME

▶ SAFETY STOCK

▶ RE-ORDER POINT(ROP)
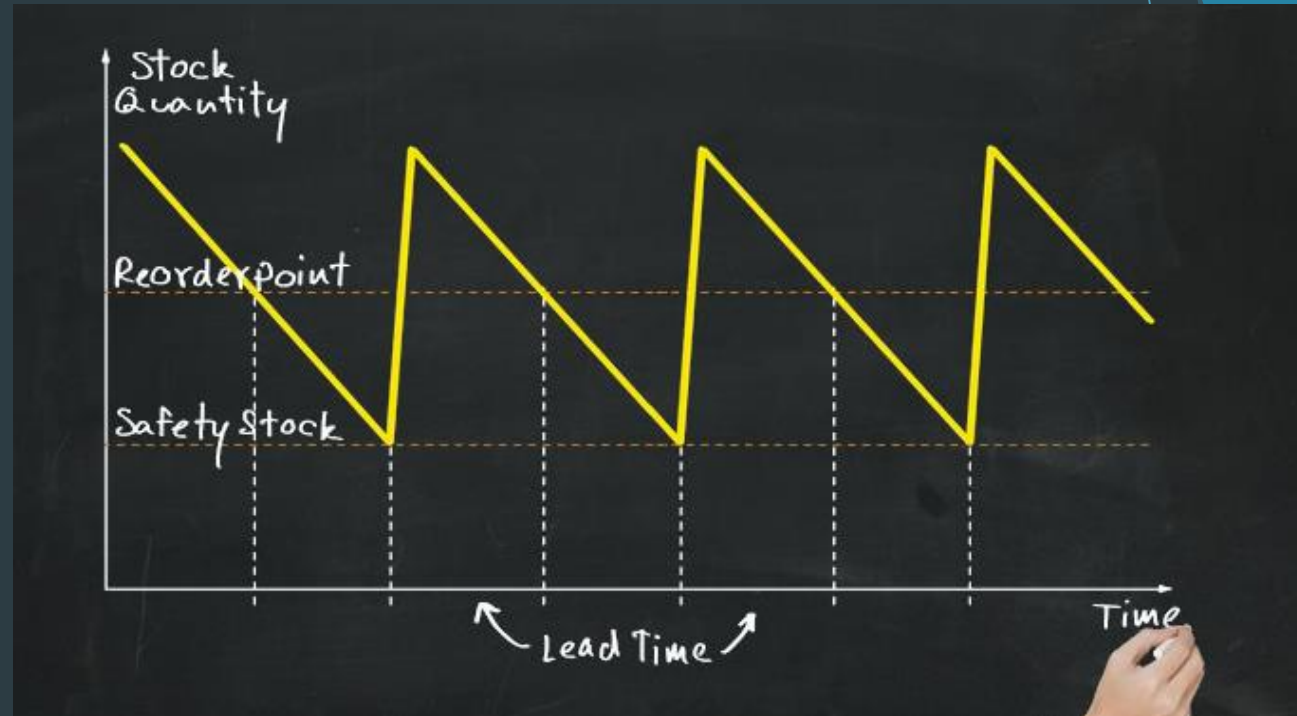
DEMAND ESTIMATION: Demand for the future Periods, which can be calculated through Forecasting.

Lead Time: It is a time interval between placing an order and receiving it.
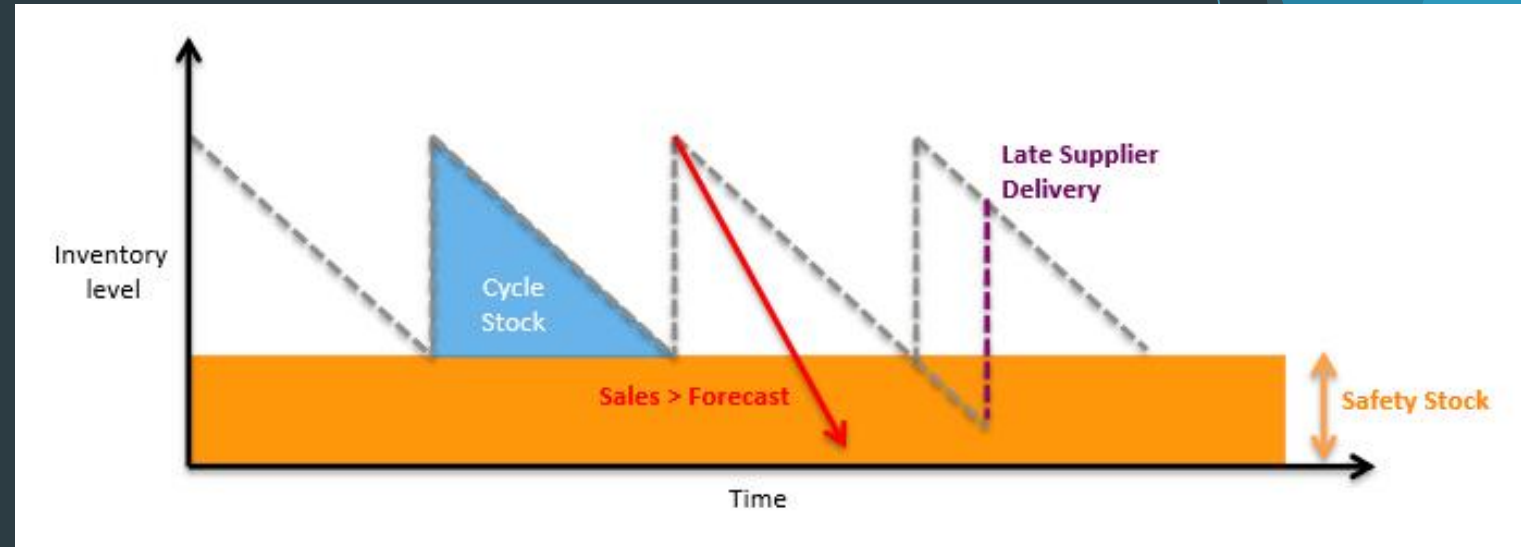
Safety Stock: It is most important factor to maintain the good service level, that makes inventory to prevent from stock-out and back order situation.

ROP: Its is to find an optimal point to open the purchase order by having lead time and Safety Stock into consideration.

Why Safety Stock?

- Offset errors due to forecast

- Maintain service level

Calculating Safety Stock

- Simple Safety Stock Calculation with lead time, order cycle and forecast period are same.

- $ss = z * \sigma_d$

  - $Z \rightarrow Z-$
    $Score, Service\ factor\ of\ required\ service\ level$

 - $\sigma_d \rightarrow Standard\ deviation\ of\ demand$

- Safety Stock Formula including both demand and Varying lead time

- $SS = Z * \sigma_d * \sqrt{LT} + \varepsilon_0$

  - $Z \rightarrow Z-$
    $Score, Service\ factor\ of\ required\ service\ level$

  - $\sigma_d \rightarrow Standard\ deviation\ of\ demand$

  - $LT \rightarrow Average\ Lead\ Time$

  - $\varepsilon_0 \rightarrow Forecast\ Error$

act_sales	fore_sales	demand_fct	demand_act	demand_err	mean_err	safety_stock
434	406.0302903	81.20605805	86.8	27.96970974	7.29203337	1051
575	560.6774554	80.09677935	82.14285714	14.32254455	7.29203337	1051
575	560.2643568	80.03776525	82.14285714	14.73564323	7.29203337	1051
553	534.9887552	76.42696503	79	18.01124476	7.29203337	1051
514	486.3794738	69.48278198	73.42857143	27.62052617	7.29203337	1051
384	434.0721391	62.01030558	54.85714286	-50.0721391	7.29203337	1051
371	399.7684727	57.10978181	53	-28.7684727	7.29203337	1051
426	396.3767778	56.62525396	60.85714286	29.62322225	7.29203337	1051
418	405.8139786	57.97342552	59.71428571	12.18602136	7.29203337	1051

RE-ORDER POINT(ROP)
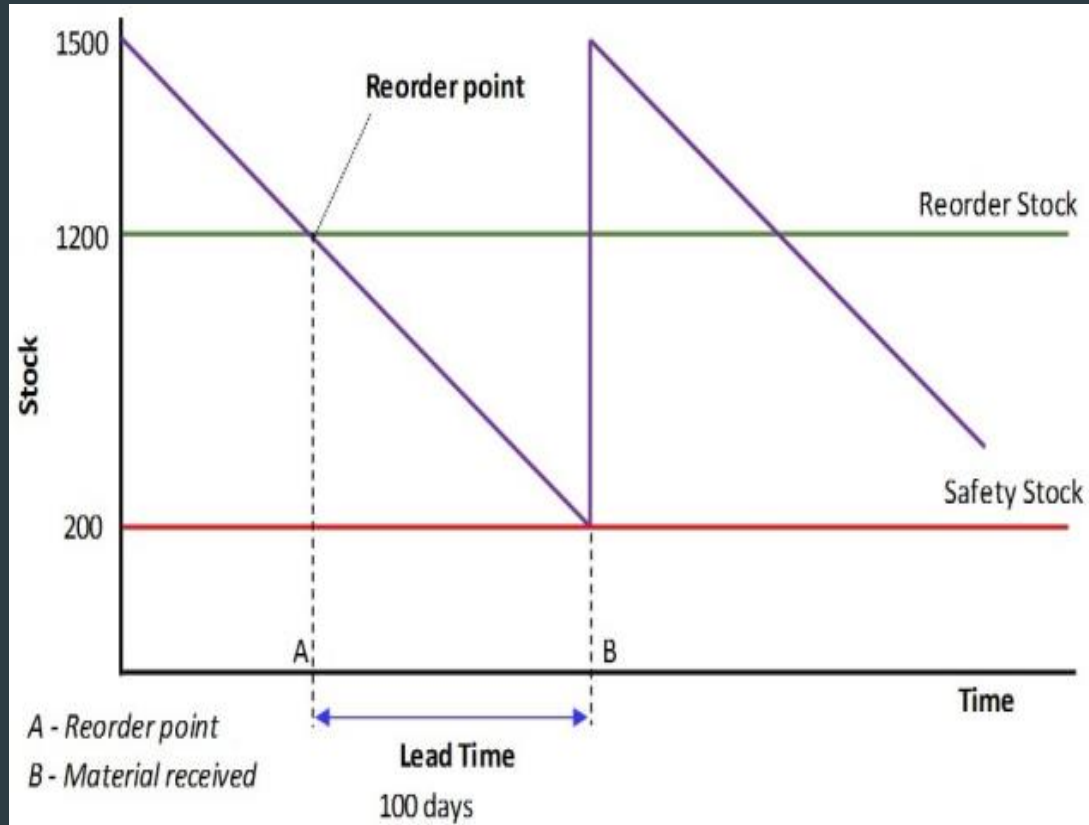
- It is a process most commonly used in supply chain and logistic which is when stock is always ordered when it falls below a certain level, typically below the specified safety stock level.

$$ROP = D * LT + SS$$

$D \rightarrow Avg\ Demand$ **in lead time**

$LT \rightarrow LeadTime$

$SS \rightarrow Safety\ Stock$

INVENTORY OPTIMIZATION

- Proper inventory tracking at SKU level.
- Reduction of excess inventory.
- Reduction of stock-outs scenario.

OPERATIONAL EFFICIENCY

- Estimate safety stock.
- Proper identification of order cycle and reorder quantities.

COST OPTIMIZATION

- Lower Holding cost.
- Lower Spoilage discount.

Solution benefits

Customer Propensity Model

- Personalized customer marketing
- Customer data at retail outlet level
- Operates in non-contractual settings

Customer Propensity model answers

- Who are my probable customers who will visit my store in the next 'X' days ?.

- How can I get my targets for the next promotion campaigns ?.

- Who are my high-profile customers and what categories they buy in general ?.

THANKS