Management Internship Report

(8th May 2018 – 7th September 2018)

Project Title: Forecast and Inventory Analytics

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Under the guidance of
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Contents

1. About the Company

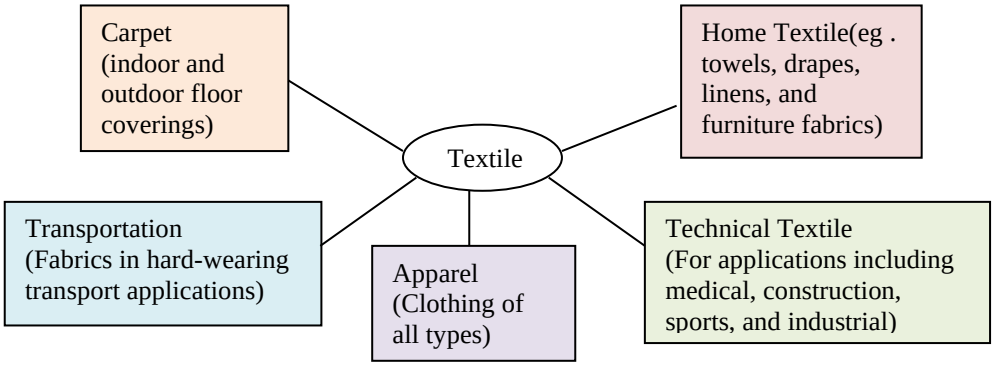
Archroma is a global color and chemicals company headquartered in Reinach near Basel, Switzerland. The company was founded in 2013 as a spin-off of Clariant which in turn is a spinoff of Sandoz. It operates over 35 countries with 25 production sites. Its three business divisions are – Textile Specialties (70%), Paper Specialties (25%), and Emulsion Products (5%).

1.1 Divisions and products

Textile— textile chemicals and dyes; special chemicals for pretreatment, dyeing, printing, and finishing of textiles.

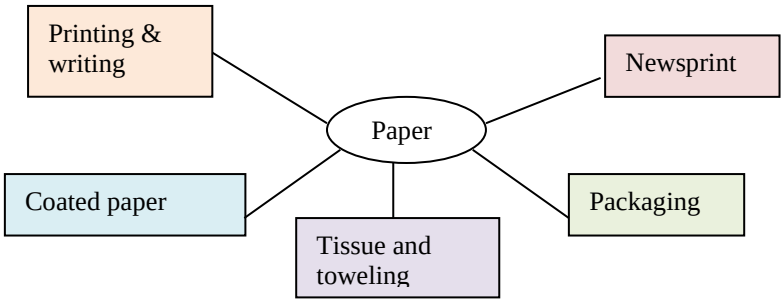
Key Products – Drimaren, Foron, Advanced Denim, Nuva, Nylosan, NanoSphere, Coldblack

Key markets –



Paper—Paper Solutions Business provides expertise in the management of whiteness, coloration, special coatings, and strength for all kind of papers.

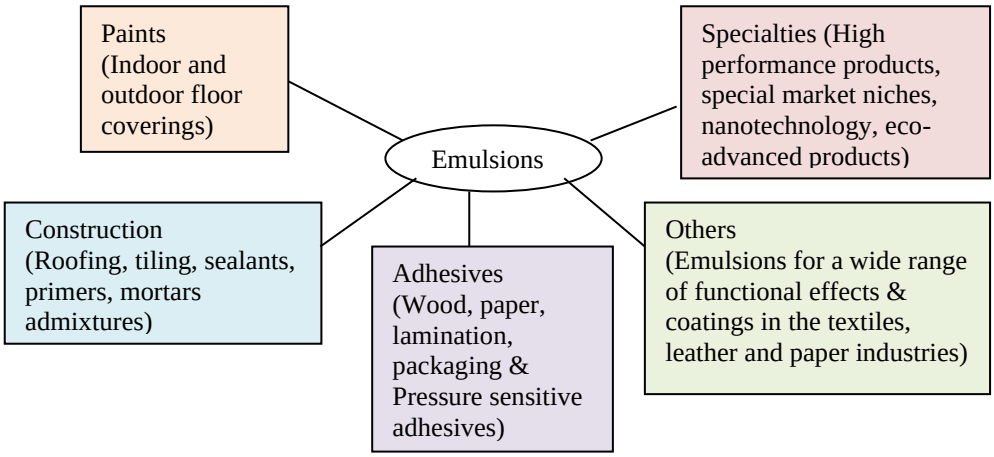
Key products – Dyes, Optical brightening agents, surface and coating chemicals, process chemicals.



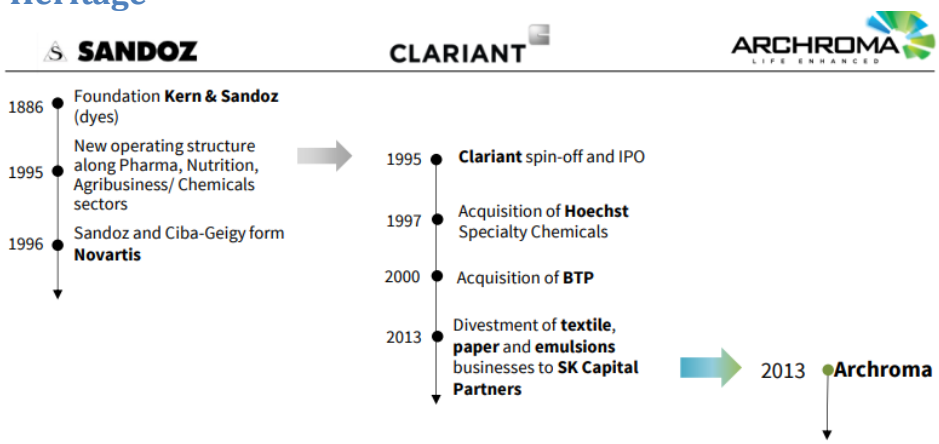
Emulsions— specialty emulsions to paints, adhesives, construction and the textile, leather and paper sectors.

Key products- Mowilith, Mowicoll, Appretan, Printofix, Melio, Cartaseal, Cartacol, Cartacoat

Key markets:



1.2 Heritage

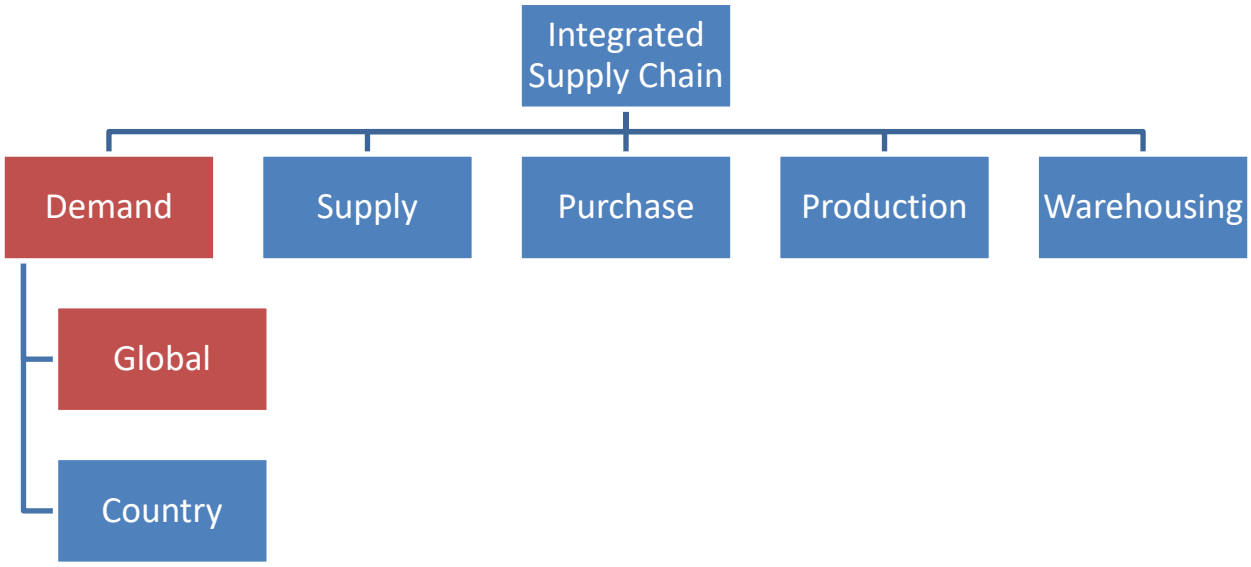


1.3 Archroma presence worldwide

1.4 Standards/commitments

- Bluesign
- Oeko-Tex®
- GOTS
- TSCA
- FDA
- BfR
- REACH

2. Work profile of department in the MIP organization



In the supply chain department, there are 5 departments: Demand, Supply, Purchase , Production and warehousing . The Demand department is further split into a global department and country department. Country departments work on data related to a specific country. Global department works on data related to all the countries. The major responsibilities of global demand planning department are as follows:

- Forecast Accuracy Calculation
- Generating Statistical Forecast
- Reviewing statistical Forecast
- Inventory – Forecast Analysis
- ABC-XYZ Analysis
- Decisions on warehouse space reduction / expansion
- Generating inputs for Material Requirement Planning
- Forecast Evolution Index

3. Concepts

3.1 ABC- XYZ categorization

ABC categorization: ABC analysis categorizes inventory items into 3 categories A being the most important / valuable and less in number and C being least in value and high in number. Importance of item can be based on several metrics like sales volume, sales value, profit margin, contribution margin, unit price, costs etc.

A – top 20% that contribute about 80% of the chosen metric

B – contribute 15% of the chosen metric

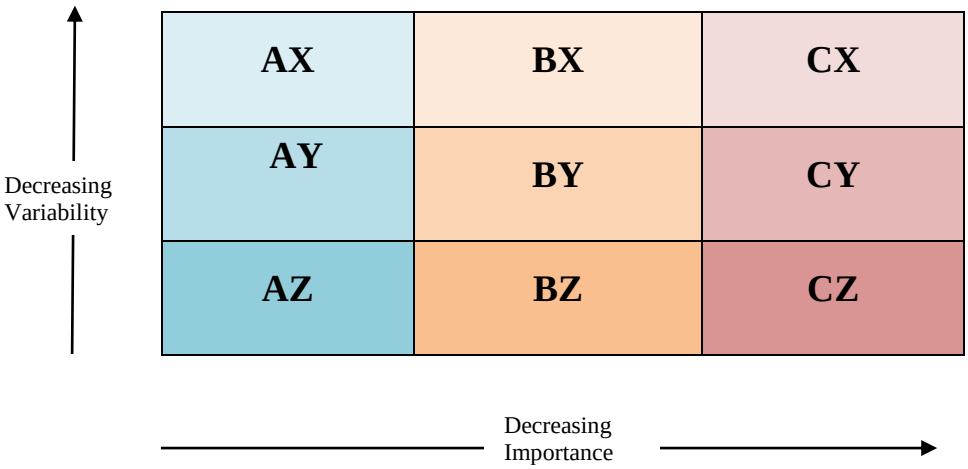
C – 5% of the chosen metric

XYZ categorization: Categorizes items based on ease of forecasting ability. For this coefficient of variation is calculated which is Std. deviation / mean.

X – Stable category. The coefficient of variation lies between 0 to 0.5

Y – The demand is variable. Coefficient of variation lies between 0.5 to 1

Z – The demand is erratic. Coefficient of variation is greater than 1



- AX: Very important items, but relatively easy to forecast.
- CX: Relatively unimportant items that are relatively easy to forecast.
- AZ: Very important items that are hard to forecast.
- CZ: Relatively unimportant items that are hard to forecast.

Importance of ABC –XYZ analysis:

ABC analysis helps to focus effectively on selective items that are most important rather than focusing on all the items. Hence if slight improvement is made in terms of inventory costs in A category, it will affect the overall costs more than if improvement is made in B or C category. This categorization helps us to analyze each category separately e.g. If the forecast accuracy of AX items is low it means that we can improve it since X items are easy to forecast. It also tells that we should improve the accuracy because the category (A) is important. Also, this categorization can help us to select a forecast method specific to each category E.g. We can use simple moving average or ARIMA for products belonging to AX, BX, and CX category, seasonal ARIMA for Y category and CROSTON method for Z category.

3.2 Forecast accuracy

Forecast accuracy indicates how close the forecasted values are to the actual values of sales. Forecast accuracy is calculated for each country. Since the forecasts are done monthly, for each month the forecast accuracy of a country is calculated. The formulae used for calculation of forecast accuracy are as follows:

$$WeightedError = \frac{(AbsDeviation)}{\max(DQ, Stat)} * wt$$

Weighted error: weighted forecast error for a product

DQ: 3M aggregate Delivery Qty of product @country

Stat: 3M aggregate Statistical Forecast of the product @country

AbsDeviation: Absolute difference between DQ and Stat

Wt: DQ of product @ country/Total DQ @ country

The first step is to calculate weighted error of forecast for each product for which a country has given a forecast. Weighted error is error fraction multiplied by the ratio of delivery quantity of product to total delivery quantity of all products for country. Hence the products that are delivered in high quantity will have more effect on the error.

$$ForecastAccuracy = 1 - \sum WeightedError$$

ForecastAccuracy: Forecast accuracy at country level

WeightedError: Weighted Error at PPC level calculated using the WeightedError formula

The weighted error of each product delivered to the country is aggregated and summed. This sum is subtracted from 1 to get forecast accuracy of the country.

Example: For example, a country forecasts for 3 products and these products are delivered in the following quantities:

PPC (A)	**DQ (B)**	**Stat (C)**	**Dev (D)=(C-B)**	**Abs Dev (E)=Abs(D)**	**Max (F)=max(B,C)**	**Error (G)= E/F**	**Wt (H)= B/sum(B)**	**Weighted Error (I)=G*H**
12XXX	1000	1500	500	500	1500	0.33	0.21	0.0693
23XXX	1700	1000	-700	700	1700	0.411	0.36	0.1479
34XXX	2000	2400	400	400	2400	0.166	0.43	0.0713
Total	4700	4900	200	1600	5600	0.907	1.00	0.2885

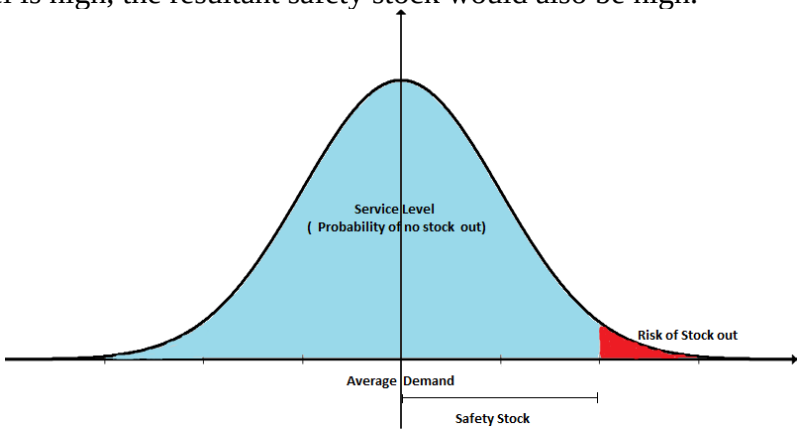
ForecastAccuracy = 1- sum(I)

=1-0.2885

=0.711 or 71.1%

3.3 Cycle Stock, Safety Stock , lead time ,service level

Lead time: The total time taken for a product to get manufactured and delivered to the customer.
Cycle Stock: Average demand during the lead time is cycle stock
Safety Stock: Safety stock is inventory that is carried to prevent stockouts.
Service Level: It is the probability that all orders will be filled from cycle stock during lead time.
If the service level is high, the resultant safety stock would also be high.



Formulae for calculating safety stock

Safety stock based on demand variability:

$$\text{Safety stock} = Z \times \sqrt{PC/T_1} \times \sigma_D \text{ , where:}$$

Z = Z-score
PC = performance cycle, another term for total lead time
T_1 = time increment used for calculating standard deviation of demand
σ_D = standard deviation of demand.

Safety stock based on lead time variability:

$$\text{Safety stock} = Z \times \sigma_{LT} \times D_{avg} \text{ , where:}$$

σ_{LT}=standard deviation of lead time
D_{avg}= average demand.

Safety stock based on demand variability and lead time variability both independent of each other:

$$\text{Safety stock} = Z \times \sqrt{(PC/T_1 \times \sigma_D^2) + (\sigma_{LT} \times D_{avg})^2}$$

Safety stock based on demand variability and lead time variability dependent on each other

$$\text{Safety stock} = (Z \times \sqrt{PC/T_1} \times \sigma_D) + (Z \times \sigma_{LT} \times D_{avg})$$

4. Project

The entire project is divided into sub projects/tasks as follows:

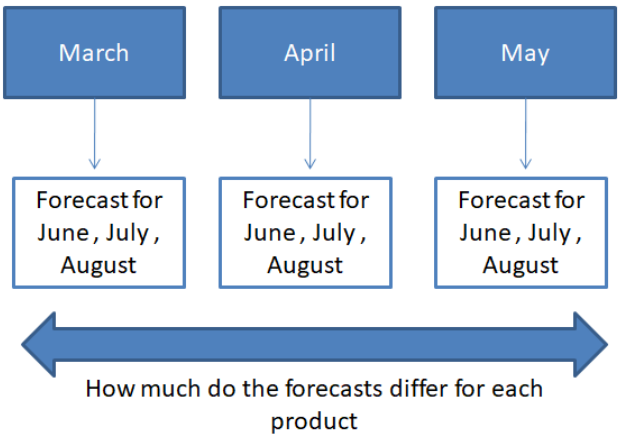
4.1 Forecast Evolution Index

Suppose lead time of a product is x days i.e after placing the order , it takes x days to finally complete and deliver the order .For these x days, any change in the order cannot be accommodated by production department.

Hence the forecast for that product needs to be made before this period and it should remain unaltered or frozen during lead time.

- Generally, lead time in chemical industry is 30 to 90 days. In order to account for changing forecasts in these 30-90 days, we have identified products that suffer the most from variable forecasts from one month to another. For these products certain steps can be taken by the production department to respond to changes in forecasts.

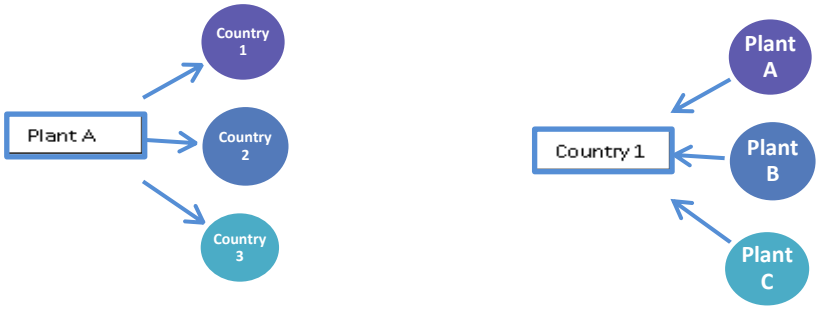
The objective of this part is to identify those products at country and division level which show high variation in terms of their 3-month aggregate forecasts. This analysis was done in May on basis of forecast data of June, July, and August available for months May, April, and March. For each of the months aggregated forecasts for June July and august was calculated.



The absolute and percentage difference of the aggregate forecasts for the 3 months was calculated for all the products at country and division level. All the products along with their 3-

month aggregate sales (February, March, and April) were ranked according to the absolute difference in the forecasts. Top 10 products for each country were filtered for each division.
In future this analysis can be done in any month by just using the same code.

4.2 Global Network Analysis

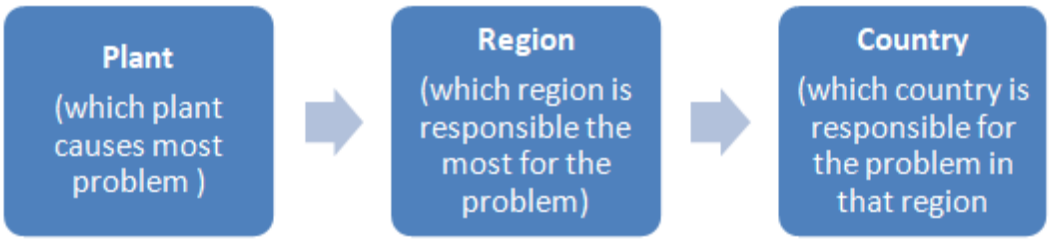


The organization has various hub countries from where the products are shipped to other countries. Each plant's inventory at hub countries for each product is analyzed and the country which is responsible for excess inventory at that plant for that product is found out. Excess inventory occurs when the forecasts exceed the actual sales. Holding huge amounts of inventory leads to increased carrying costs. Hence this excess inventory must be reduced.
The global network analysis has been done in 2 ways:

- Plant-wise
- Country-wise

Plant-wise

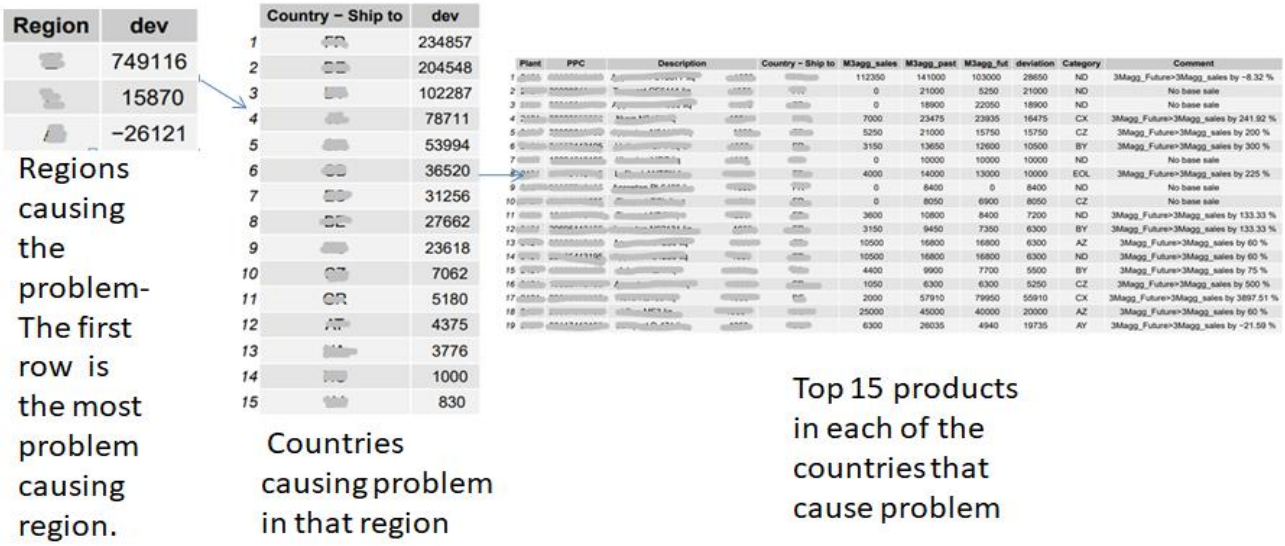
Plant wise analysis is done in hierarchical manner as follows:



Deviation= Past Forecast-Past Sales

This deviation is calculated for each product and then aggregated at plant and region level and then at plant and country level. The past forecast and sales can be aggregated at 3 months or 6 months. Hence both types of analysis are done 3 months and 6 months

Example for 3M analysis:



Comments are also added for better understandability of data. If the % difference between past sales and future forecasts is high, then the forecast for future must be adjusted.

Age analysis

The Key Age ASIP column provides us with information regarding the age of the item in inventory at a plant in terms of days. eg. – 360 age means that it has been 360 days since the item was initially stocked at the plant.

Top 10 products with age 180-90 at plant XYZ were identified as follows:

	Plant	PPC	Description	Key Age ASIP	Inv_Vol	Inv_Value
1	[illegible]	[illegible]	[illegible]	120-180	27500	22326
2	[illegible]	[illegible]	[illegible]	90-120	21150	73708
3	[illegible]	[illegible]	[illegible]	90-120	19950	61937
4	[illegible]	[illegible]	[illegible]	120-180	17550	46244
5	[illegible]	[illegible]	[illegible]	120-180	15960	34861
6	[illegible]	[illegible]	[illegible]	90-120	11550	20941
7	[illegible]	[illegible]	[illegible]	90-120	11250	27196
8	[illegible]	[illegible]	[illegible]	120-180	11000	12024
9	[illegible]	[illegible]	[illegible]	120-180	11000	25042
10	[illegible]	[illegible]	[illegible]	90-120	10825	41989

Top 10 products in the inventory with age between 720-180 were identified for a plant XYZ as follows:

	Plant	PPC	Description	Key Age ASIP	Inv_Vol	Inv_Value
1	[illegible]	[illegible]	[illegible]	180-360	78840	168337
2	[illegible]	[illegible]	[illegible]	360-720	29260	147226
3	[illegible]	[illegible]	[illegible]	180-360	21981	93044
4	[illegible]	[illegible]	[illegible]	180-360	13250	23987
5	[illegible]	[illegible]	[illegible]	360-720	12600	23497
6	[illegible]	[illegible]	[illegible]	180-360	12000	9277
7	[illegible]	[illegible]	[illegible]	180-360	11990	55174
8	[illegible]	[illegible]	[illegible]	360-720	11000	19209
9	[illegible]	[illegible]	[illegible]	180-360	10560	18836
10	[illegible]	[illegible]	[illegible]	180-360	10000	31046

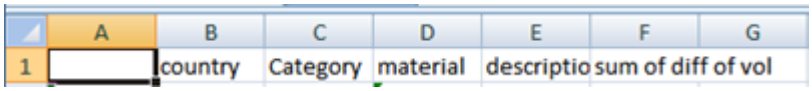
4.3 Top 15 products with increasing trend country wise

Metric: sum of consecutive difference between inventory vol of the products in different weeks.

Example:

Product	Inventory Vol wk1	Inventory Vol wk2	Inventory Vol wk3	Inventory Vol wk4	Metric
A	100	140	178	210	(140-100)+ (178-140)+ (210-178)=110
B	100	100	70	90	(100-100)+ (70-100)+ (90-70)= -10

Here product A has a more positive increasing trend than product B. Hence must be ranked above B. This is done for all the products country wise. After ranking, top15 from each country are displayed. The results are exported into excel files with the following columns:



The excel has top 15 products for each country in the same file.

4.4 Top 15 with most varying inventory country wise

Metric used: standard deviation and absolute difference

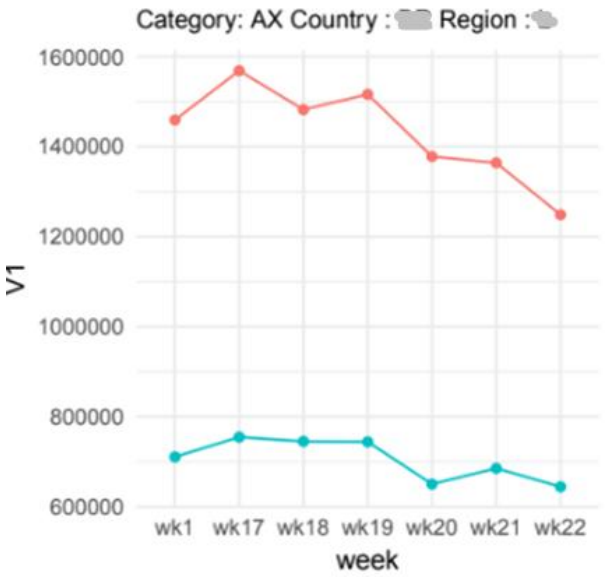
Similar to normal difference between consecutive volumes, absolute difference and standard deviation can be taken. If standard deviation or absolute difference is high, then it implies that the volumes of the product are not stable.

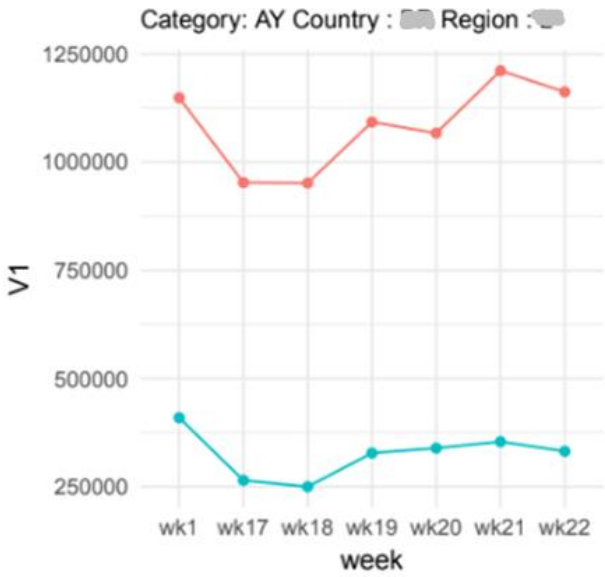
4.5 Visualizing inventory trends

Visualization is utilized for regional reporting to business and supply chain heads.

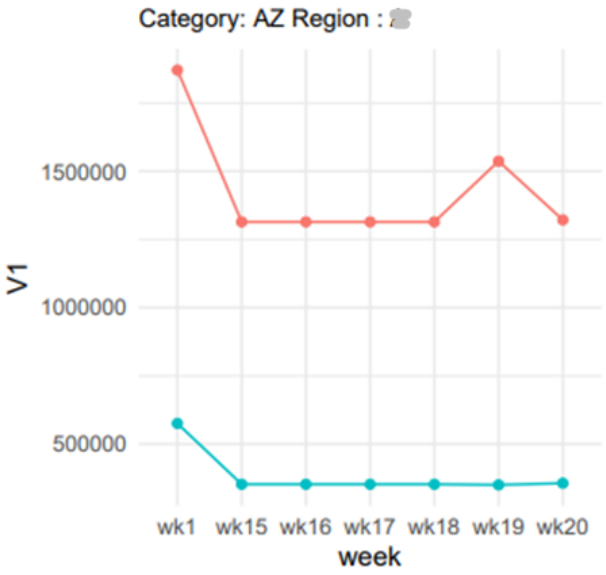
Apart from categorization into ABC-XYZ categories, the items are also categorized into different product groups as finished products, intermediaries, raw materials, traded goods (TG buy/sell), traded goods BASF.

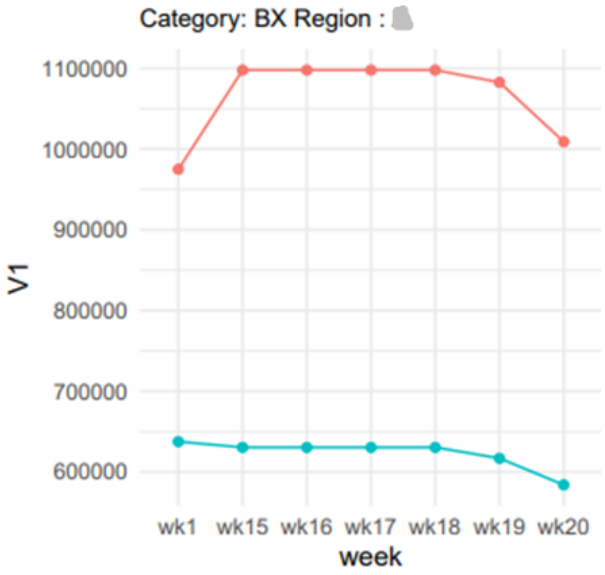
Country and division wise category trends



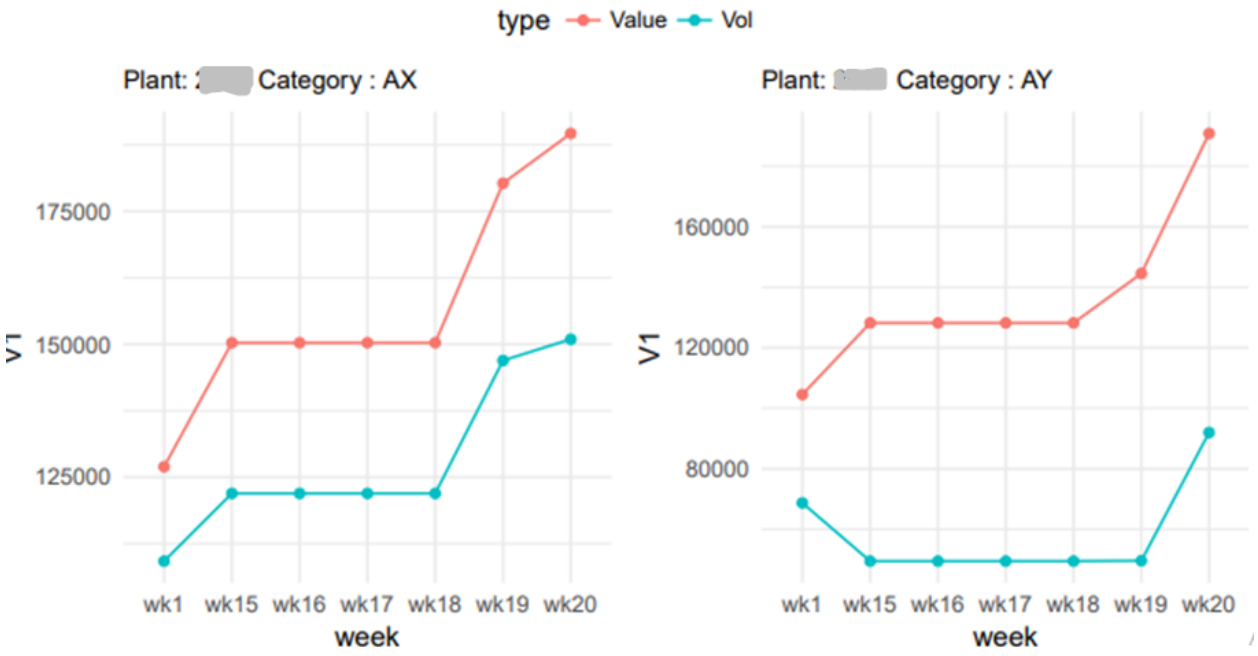


Region wise category trends

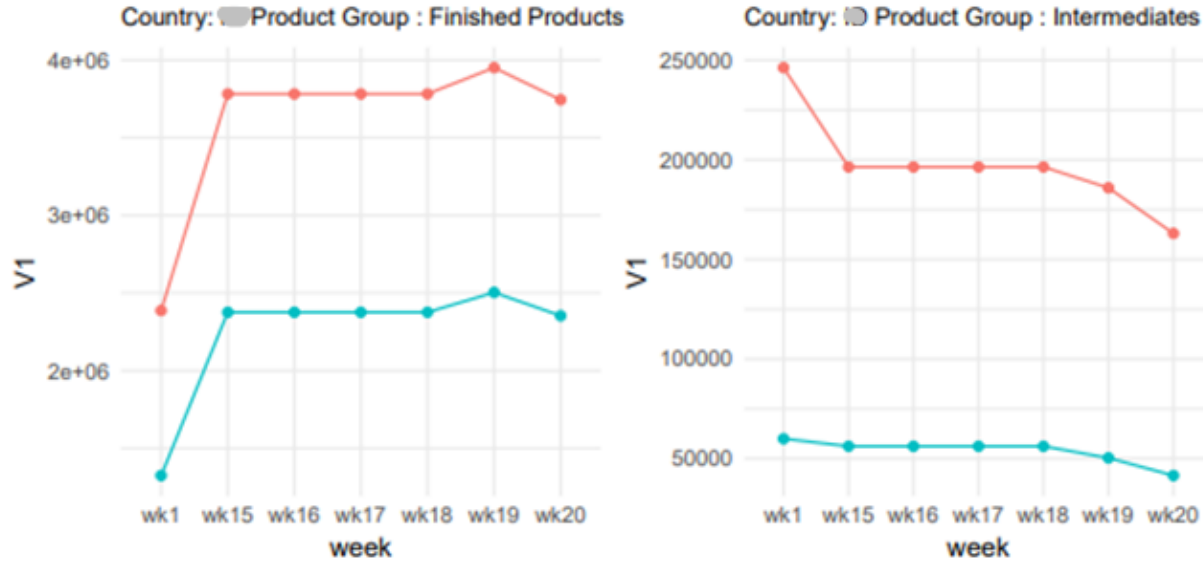


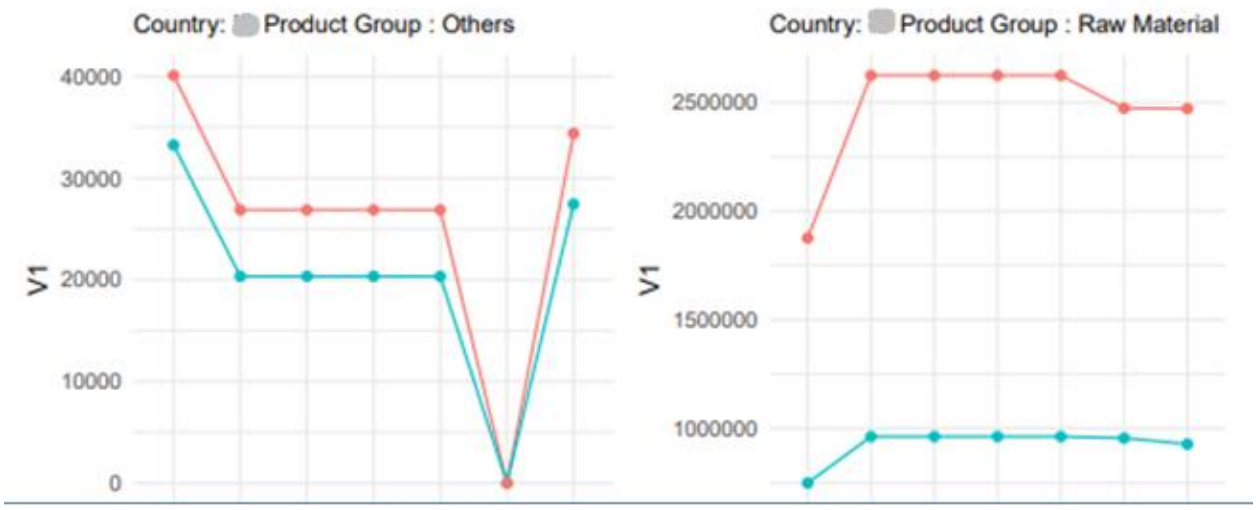


Plant wise category trends

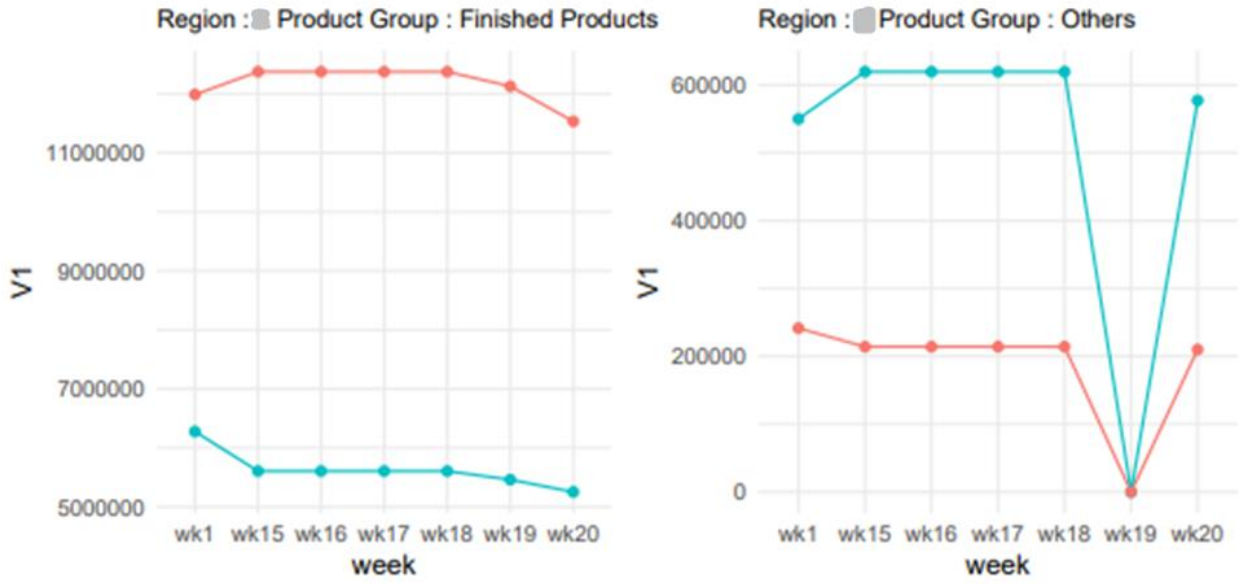


Country wise product groups

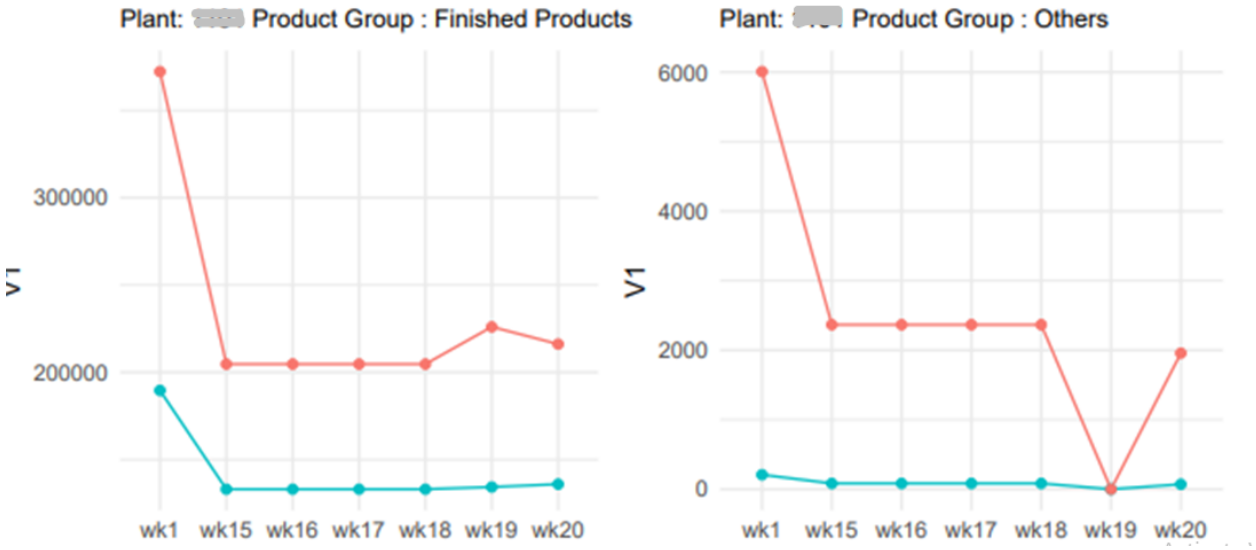




Region wise product groups



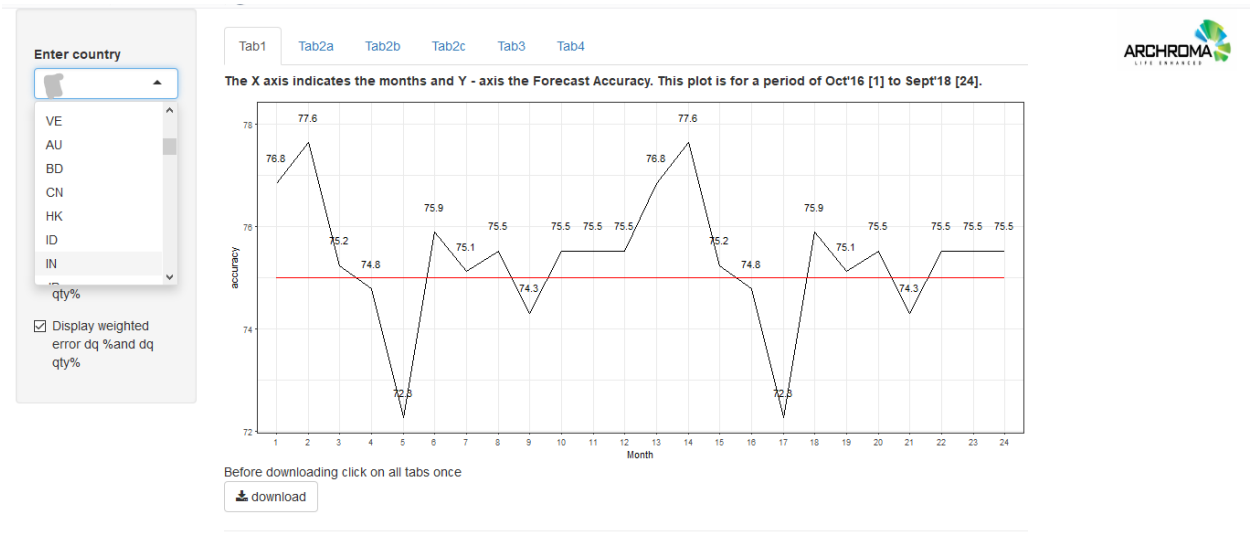
Plant wise product groups



4.6 Forecast Accuracy App

The app gives a complete view of the forecast accuracy of a country. It has been developed in R using shiny package. The app has 6 tabs for different purposes.

Tab1:



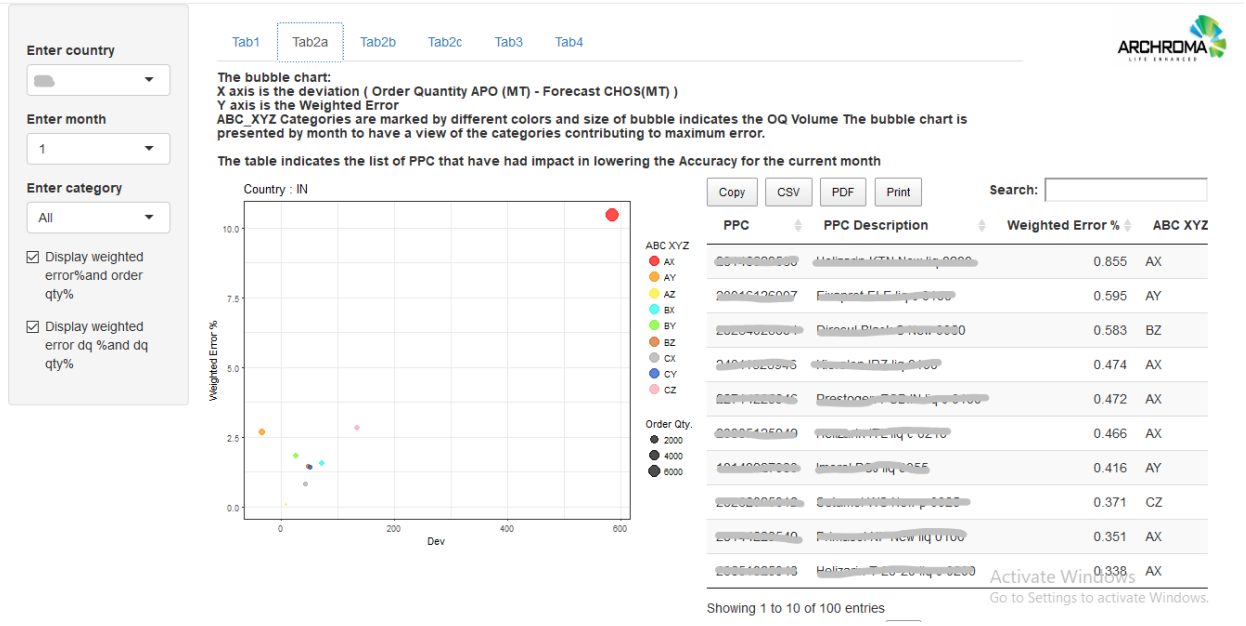
The first tab includes the overall Forecast accuracy trend for country over 24 months (past 2 years) that is selected through dropdown menu in the sidebar. The red line shows the target accuracy of 75%.

X axis is the month and Y axis is the forecast accuracy for the country calculated using forecast accuracy formulae in section 3.2

The values in the screenshot are not the actual values instead these are dummy values that have been repeated for 12 months.

Tab 2a

In this tab we are able to identify categories and products that have had large, weighted error in forecast in any month for the selected country.



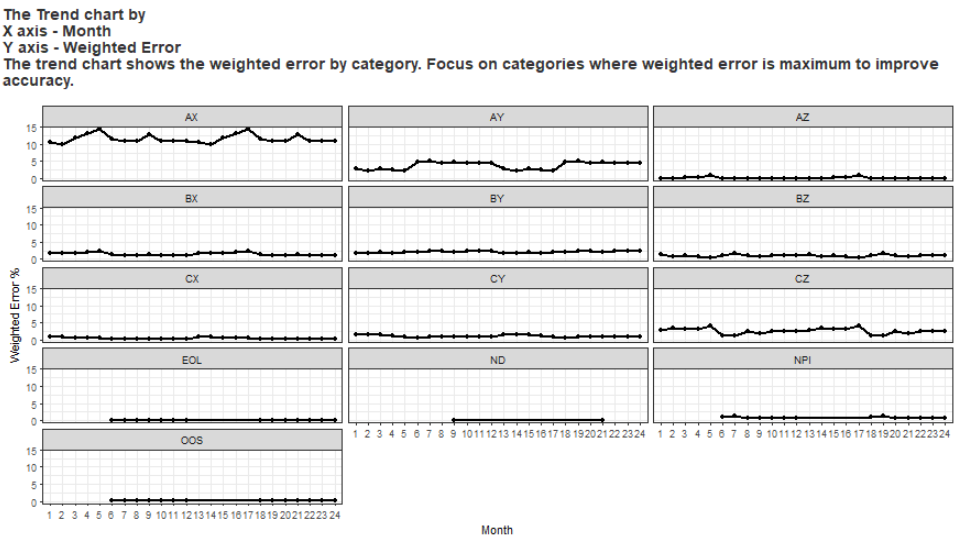
The plot in the second tab changes according to the selected month from the drop-down menu.

This bubble plot has weighted error % as y axis and deviation on x axis. All the observations(products) have been grouped by category. This helps to identify which categories have high weighted error and which have positive or negative deviation.

On the right side the table shows list of top 10 products that have large difference between forecast and actual sales in the month that is selected in the dropdown menu.

In the sidebar on the left there is a check box that enables to hide or show some columns in the table like weighted error % of each product. This option is made available so that the table does not become overwhelmed with numbers especially for those who are not analysts.

The third dropdown enables to select a category for the table i.e if `AX` category is selected then top 10 products of only AX category will be shown. If `All` is selected then top 10 irrespective of categories are shown.



The second plot on the tab shows weighted error in forecast trend for each of the categories of products.

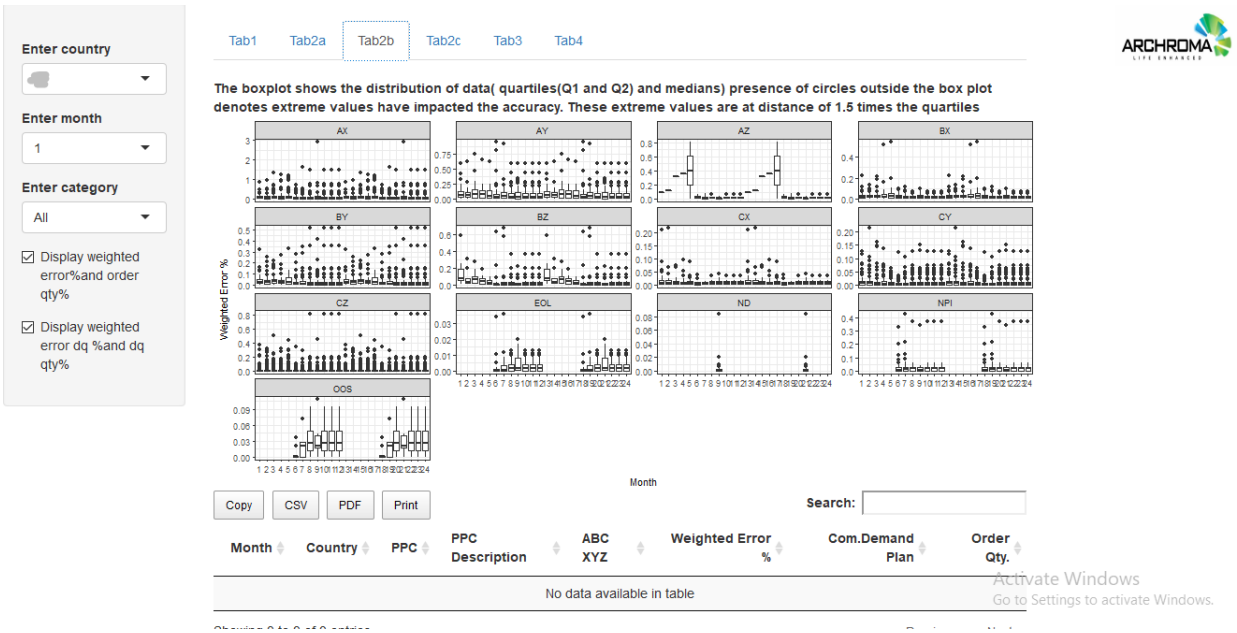
There are 12 categories in all: AX, AY, AZ, BX, BY, BZ, CX, CY, CZ and NPI, EOL, OOS, ND.

ABC analysis categorizes inventory items into 3 categories A being the most important / valuable and less in number and C being least in value and high in number. XYZ categorization categorizes items on the basis of ease of forecast ability. X – Stable category. Y – The demand is variable. Z – The demand is erratic. Hence AX would mean Very important items, but relatively easy to forecast. Apart from these there are other categories too. NPI is new product introduction. ND is not defined which is mostly for raw materials. EOL is end of life products.

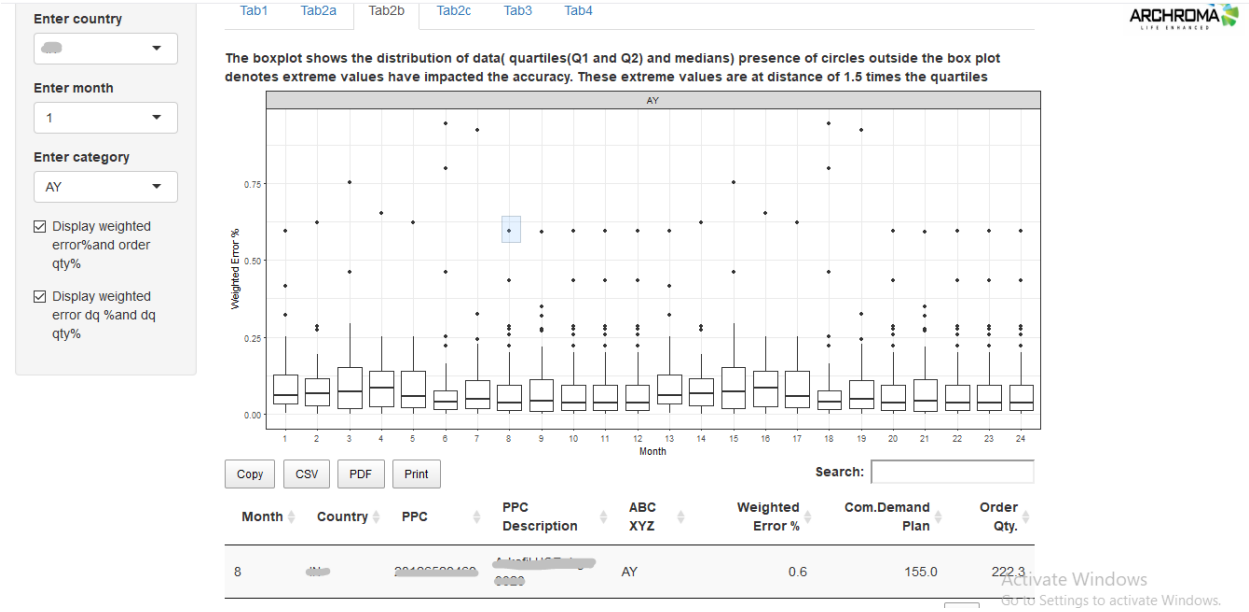
This helps us to find out which categories have a trend of increasing weighted error in their forecasts at a single glance.

Tab 2b

This tab helps to identify products that have impacted the weighted error adversely. The points outside the box plot denote extreme values which are 1.5 times the interquartile range (IQR).

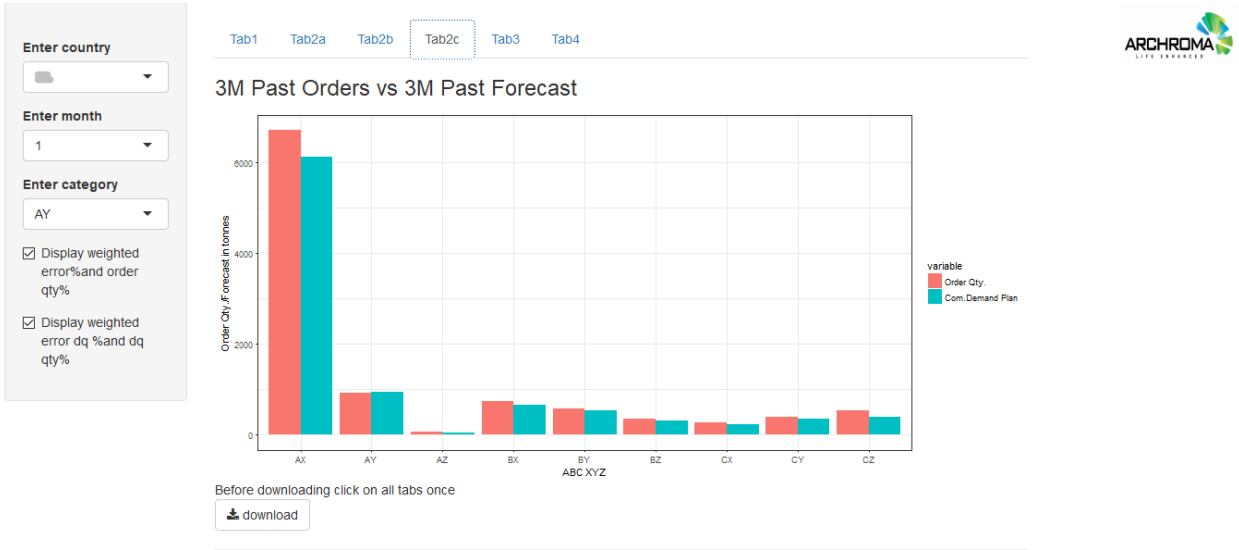


In the `Enter category ` dropdown if a particular category is selected then only the boxplot for that category is shown. Here AY category has been selected.



The boxplot is interactive i.e, if a rectangular region is selected in the plot then all the points lying in that region would be shown in the table under the plot along with their error , qty demanded and qty predicted in a month.

Tab 2c



Tab 3

This tab focuses on future forecasts and difference between future forecasts and past orders.

OrderQtyMT: 3-month past orders

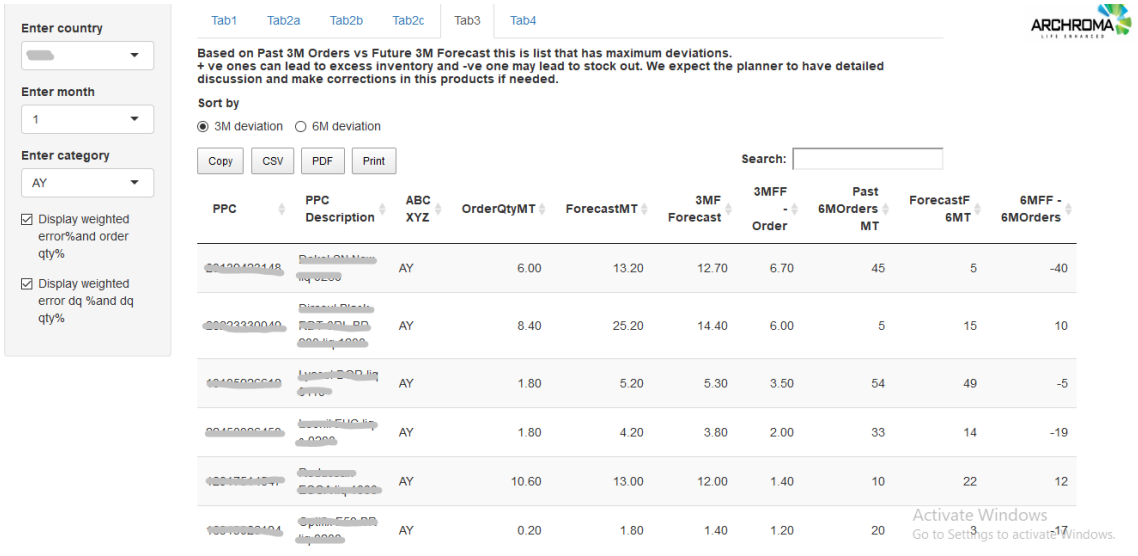
ForecastMT: 3-month past forecast

3MF Forecast: 3-month future forecast

3MFF- Order: 3-month future forecasts – 3-month past orders

6-month past forecast, orders and future 6-month forecast are also part of the table.

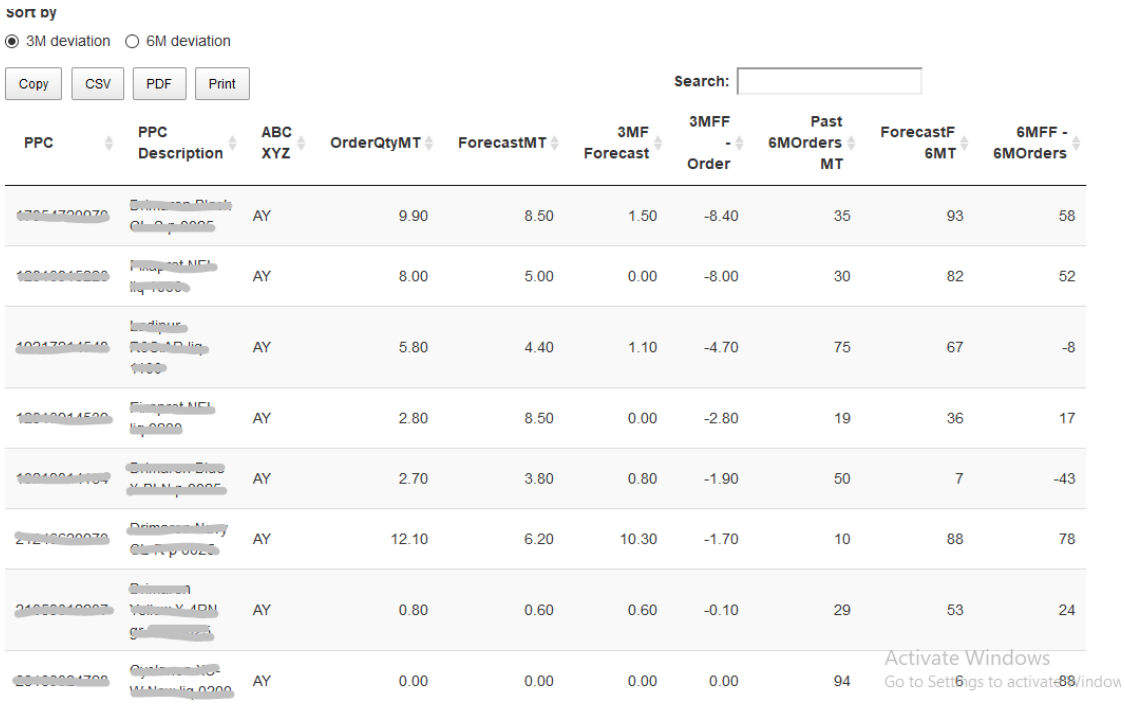
The products with highest positive difference between forecasts and past orders for the country are listed in the first table of this tab as follows:



These products can lead to excess inventory in future.

There is an option to either show the products according to 3-month deviation or 6 month deviation.

The next table in this tab lists top products for the country where the forecasts lag behind the sales. These products can suffer from stockouts



Sort by

3M deviation 6M deviation

Copy | CSV | PDF | Print

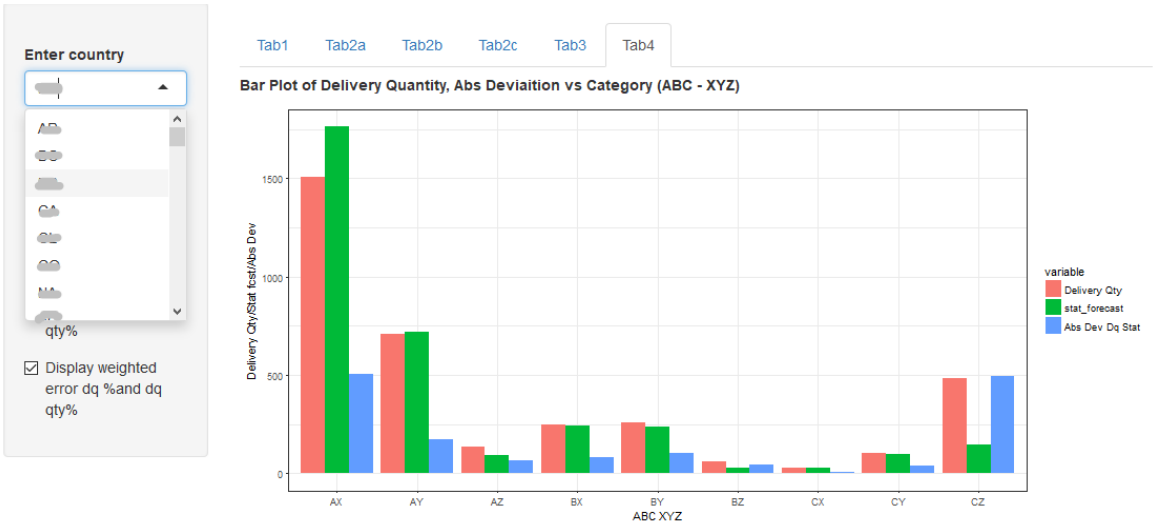
Search:

PPC	PPC Description	ABC XYZ	OrderQtyMT	ForecastMT	3MF Forecast	3MFF - Order	Past 6MOrders MT	ForecastF 6MT	6MFF - 6MOrders
[redacted]	[redacted]	AY	9.90	8.50	1.50	-8.40	35	93	58
[redacted]	[redacted]	AY	8.00	5.00	0.00	-8.00	30	82	52
[redacted]	[redacted]	AY	5.80	4.40	1.10	-4.70	75	67	-8
[redacted]	[redacted]	AY	2.80	8.50	0.00	-2.80	19	36	17
[redacted]	[redacted]	AY	2.70	3.80	0.80	-1.90	50	7	-43
[redacted]	[redacted]	AY	12.10	6.20	10.30	-1.70	10	88	78
[redacted]	[redacted]	AY	0.80	0.60	0.60	-0.10	29	53	24
[redacted]	[redacted]	AY	0.00	0.00	0.00	0.00	94	6	-88

Tab4

This tab focuses on the performance of current month's statistical forecast.

The following plot shows Delivery qty, statistical forecast and aggregated deviation for each category in a country.



Deliver_qty: total qty of products in a category shipped to the country selected.

Stat_forecast: forecasts are done for individual products. stat_forecast is the aggregate sum of the individual forecasts in each category.

Abs dev dq stat: for each product the absolute difference between statistical forecast and delivery qty is calculated and then is aggregated at country and category level.

From the above plot we can say that statistical forecast performs better for AX category than CZ category for the selected country because as compared to the quantity delivered, the total absolute deviation is very less in AX category.

The tab has 2 tables.

The first one lists top 10 products where statistical forecast has done well in the past.

For this, first top 50 products with largest delivery qty are chosen and for those 50 products top 10 products with lowest weighted error are displayed.

Below are listed PPC where statistical forecast has done well in the past month

Show 10 entries Search:

APO New PPC	PPC Desc	ABC XYZ	Delivery Qty	Statistical	Abs Dev Dq Stat
[redacted]	[redacted]	AY	34	34	0
[redacted]	[redacted]	AX	17.6	16.9	0.8
[redacted]	[redacted]	AX	36.3	37.1	0.8
[redacted]	[redacted]	AZ	24.3	25.5	1.2
[redacted]	[redacted]	AX	30.4	28.4	2
[redacted]	[redacted]	AX	32.6	35.4	2.7
[redacted]	[redacted]	AY	49.7	52.4	2.7
[redacted]	[redacted]	BX	20.8	18.1	2.7
[redacted]	[redacted]	AX	39.9	43.1	3.2
[redacted]	[redacted]	AY	27.1	23.9	3.1

Showing 1 to 10 of 10 entries Previous 1 Next

The next table lists products where statistical forecast has not done well and for these products manual inputs would be recommended for the selected country. For this table, first the top 50 products with largest delivery qty are chosen and for those 50 products top 10 products with highest weighted error are displayed.

Below are listed PPC where manual inputs would be recommended.

Show 10 entries Search:

APO New PPC	PPC Desc	ABC XYZ	Delivery Qty	Statistical	Abs Dev Dq Stat
[redacted]	[redacted]	CZ	154.6	0	154.6
[redacted]	[redacted]	CZ	123.7	0	123.7
[redacted]	[redacted]	AX	154.8	245.5	90.7
[redacted]	[redacted]	CZ	36.6	0	36.6
[redacted]	[redacted]	AX	102.2	66.7	35.5
[redacted]	[redacted]	AX	85.3	135.2	49.9
[redacted]	[redacted]	AZ	43.1	15.1	28.1
[redacted]	[redacted]	AX	63	104.4	41.3
[redacted]	[redacted]	BZ	30	7.3	22.7
[redacted]	[redacted]	CZ	24.7	2.5	22.2

Showing 1 to 10 of 10 entries Previous 1 Next

Download functionality

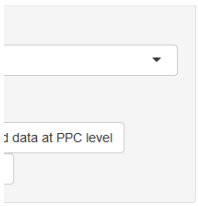
All the plots and tables in the app can be downloaded together in form of a pdf document for that country.

4.7 Statistical Forecast vs Delivery Quantity and Sales Forecast vs Order Quantity

Order quantity is monthly customer demand. Delivery quantity is the quantity that has been shipped and delivered to the customer.

Sales Forecast is done by country planner and is based on sales and marketing data. Statistical forecast is done by a consultant on the basis of customer data.

For each of the ABC-XYZ category for each country the following table is generated:



Tab 1 Plot Tab3

Show 15 entries Search:

ABC XYZ	Agg_DQ	Agg_stat	Agg_Abs_dev_dq	weighted_error_dq	Agg_OQ	Agg_Fcst	Agg_Abs_dev_oq	weighted_error_oq
[illegible]	6,899,986	6,252,435	1,456,068	12.75	7,524,260.00	6,914,520	1,668,680	13.02
[illegible]	1,676,197	1,447,708	538,644	4.60	1,875,892.00	1,982,510	736,012	4.75
[illegible]	24,075	17,609	16,383	0.12	26,055.00	24,224	11,079	0.07
[illegible]	616,975	608,519	117,960	0.98	673,495.00	668,155	185,968	1.34
[illegible]	575,399	467,931	273,064	2.13	645,399.00	545,105	315,626	2.18
[illegible]	164,245	197,678	153,317	0.89	218,875.00	162,978	110,837	0.77
[illegible]	73,184	66,030	16,553	0.14	74,414.00	62,325	18,019	0.15
[illegible]	242,064	205,726	94,717	0.77	288,249.00	206,725	133,654	1.05
[illegible]	214,549	80,793	199,901	1.64	279,181.00	110,966	227,540	1.76
-	10,486,674	9,344,428	2,866,606	24.02	11,605,820.00	10,677,507	3,407,415	25.10

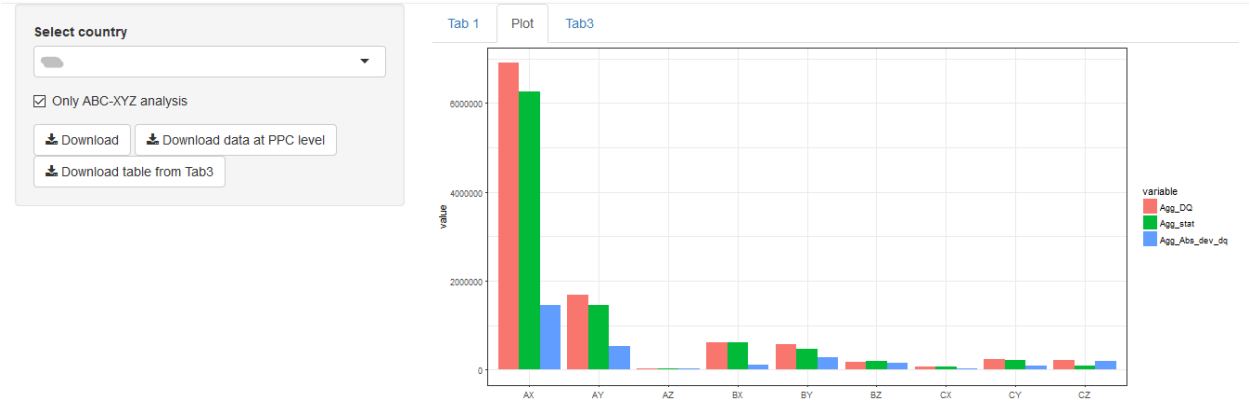
Showing 1 to 10 of 10 entries Previous 1 Next

The first three numerical column are the same columns that were used to plot the bar chart in Accuracy App in tab 4. The same is repeated for Sales Fcst vs OQ. For calculation of weighted error, weighted error formula mentioned in section 3.2 has been used for both Statistical Forecast vs DQ and Sales Forecast vs OQ.

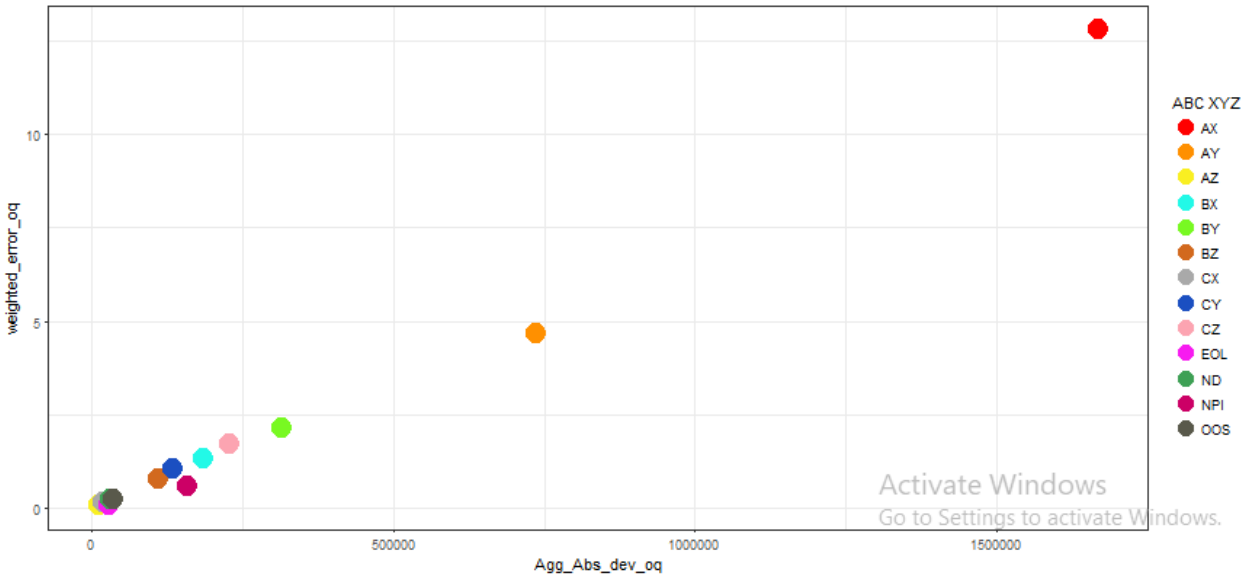
For each category in a country weighted error for both the forecasts is calculated. If the statistical forecast error is lesser than Sales Forecast error then in that case, statistical forecast works better for the category and must be used.

There is a checkbox as well that enables to perform calculations only for ABC-XYZ categories (excluding other categories such NPI, ND etc.)

The next tab includes two plots. The first one is similar to the plot in Tab4 of country-wise inventory app as shown below:



The second one is a bubble plot that has weighted error on Y axis and absolute deviation on x axis. The products are grouped into categories and the aggregate error and deviation are plotted.



The next tab includes a table that lists all the countries and their aggregate accuracies of sales forecast and statistical forecasts. So, on a country level we get an idea whether the statistical forecast is performing well or sales forecast or both.

Tab 1 Plot Tab3

Show 10 entries Search:

C1	accuracy_dq	accuracy_oq	Agg_OQ
[illegible]	35	84.54	14606514
[illegible]	72.7	74.23	11818070
[illegible]	61.41	72.32	8609201
[illegible]	71.06	76.21	5575464
[illegible]	64.59	63.04	5089137
[illegible]	41.79	59.67	4982990
[illegible]	48.89	60.51	4846910
[illegible]	50.27	67.28	4143959
[illegible]	56.04	55.51	2897496
[illegible]	42.29	54.9	2470888

Showing 1 to 10 of 87 entries Previous 1 2 3 4 5 … 9 Next

4.8 Country wise inventory app

This app allows to perform inventory analysis interactively.

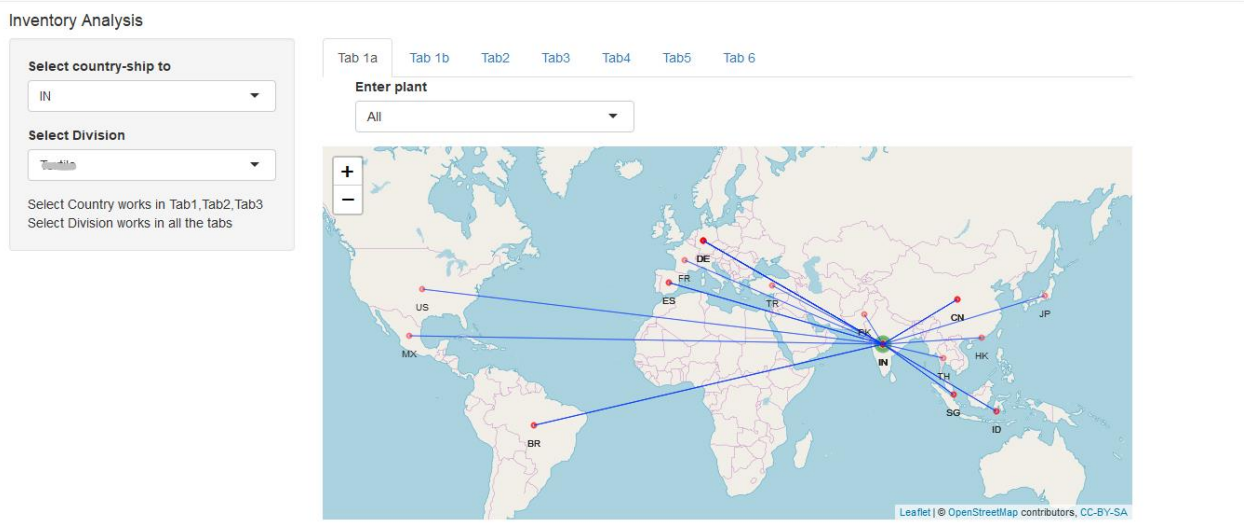
The app has 7 tabs for the following purposes:

Country-wise analysis is done in the first 4 tabs.5th tab is for region-wise analysis

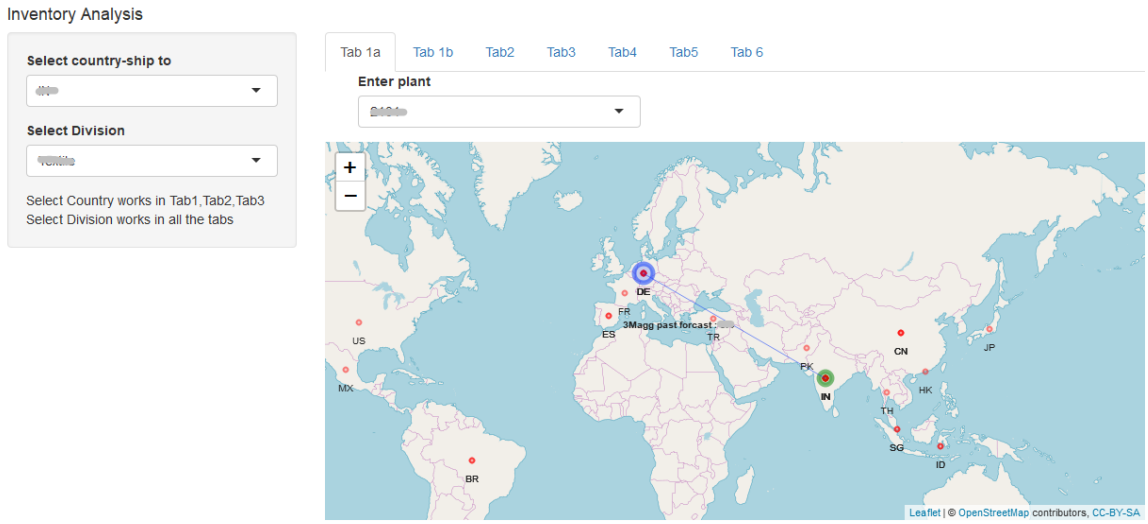
Tab 1a	Forecasts given by selected country to different plants
Tab 1b	Top `n` plants where maximum forecast is given by the selected country
Tab 2	Top products according to deviation for selected country and the plants from where these are shipped to selected country
Tab 3	Category wise Inventory Value and Volume for selected country and division
Tab 4	Region wise analysis
Tab 5	Products produced at Single plant and shipped to multiple countries
Tab 6	String search

Tab 1a

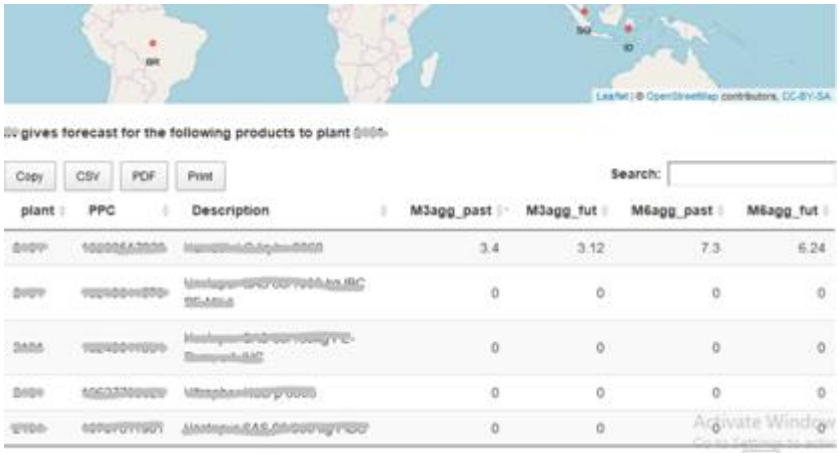
This tab includes a map showing the locations from where the selected country imports the products. From the side bar menu country and division can be selected. To show all the countries of plants from where the products are shipped to selected country, `All` option can be selected in plant's dropdown menu



If a specific plant is chosen from the dropdown menu, then a link between the plant and the selected country is shown along with the past 3 month forecast that the selected country has provided to the plant.



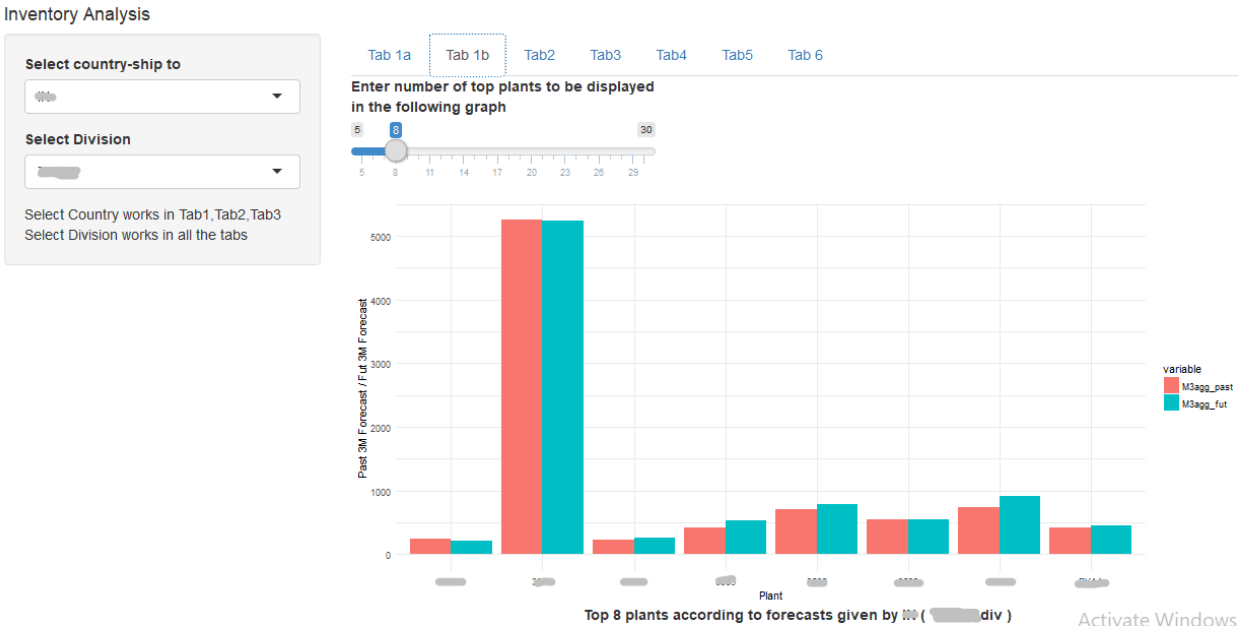
As the dropdown inputs change a table below the map also gets updated. This table provides information about products that are shipped from the selected plant to selected country. The information includes past 3 M/6M forecast and Future 3 M /6 M forecast .



This list provides us with the products on which the focus must be shifted. For example, in the above case, we need to focus only on the first product for selected plant and country. The products identified from this table can be analyzed further in tab 2.

Tab 1b

This tab depicts top ‘n’ plants based on forecasts given by the selected country. ‘n’ can be selected through slider input as shown. Both future and past forecasts are plotted in the graph.



Tab 2

This tab includes a table of the products that have highest deviation (Forecast – Sales). It has information about the products’ past forecast, future forecast, and past sales. Deviation is calculated on the basis of 3 month past forecast and sales. Deviation_fut is difference between future forecast and past sales.

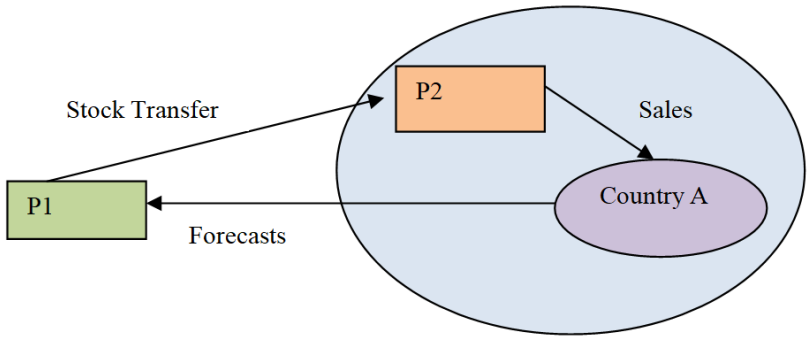
Tab 1a | Tab 1b | Tab2 | Tab3 | Tab4 | Tab5 | Tab 6

Top products ( ) according to deviation in

Copy | CSV | PDF | Print | Search:

PPC	Description	M3agg_past	M3agg_sales	M3agg_fut	M6agg_past	M6agg_sales	M6agg_fut	deviation	deviation_fut
		410	318.4	450	770	762.2	900	91.6	131.6
		96	38.55	90	156	145.75	180	57.45	51.45
		100	51.24	105	179	146.16	210	48.76	53.76
		83	35.2	60	213	122	120	47.8	24.8
		40	0	0	40	0	0	40	0
		74	41.2	81	92	118.4	162	32.8	39.8
		61.6	31.3	54	112.6	83	108	30.3	22.7

Stock transfer problem – The countries provide forecast to a plant, but the sales based on that forecast are made and recorded at another plant after stock is transferred from original plant to this plant. This is depicted in the following diagram:



On clicking on a PPC, following table appears that shows where the forecasts for the product are given by the country and where the sales occur.

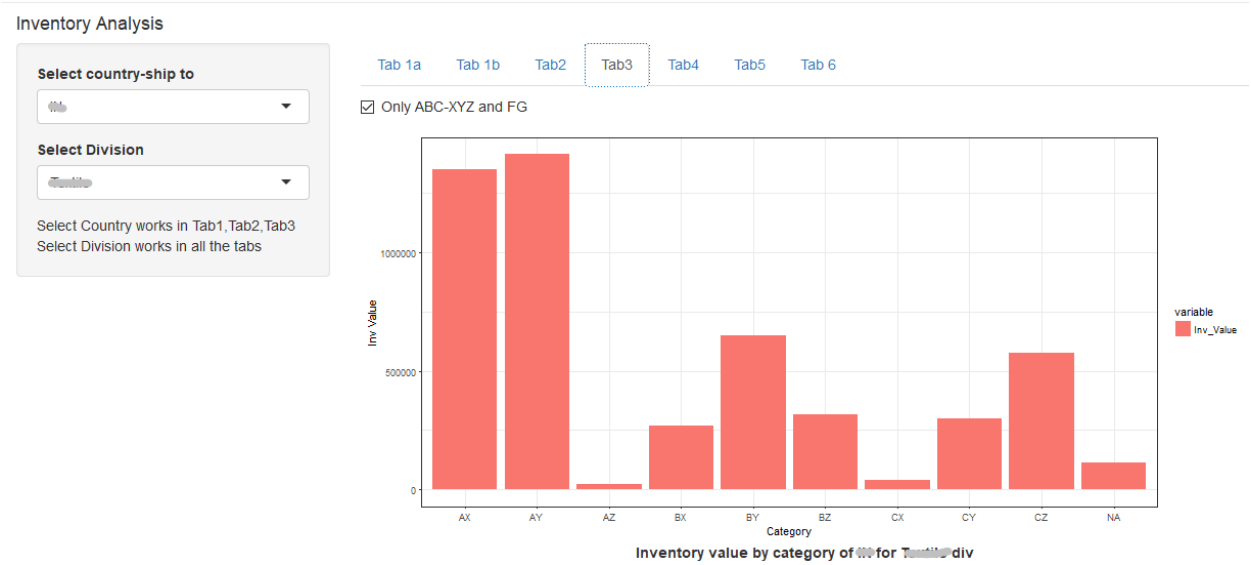
For the selected product , forecasts and sales are done at the following plants

Copy | CSV | PDF | Print | Search:

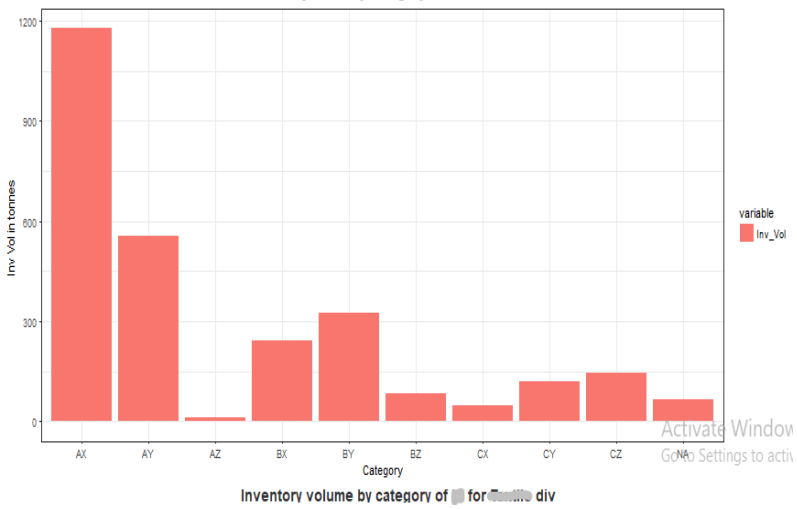
PPC	plant	M3agg_past	M3agg_sales	M3agg_fut	M6agg_past	M6agg_sales	M6agg_fut	deviation	deviation_fut
		0	318.4	0	0	762.2	0	-318.4	-318.4
		0	0	0	0	0	0	0	0
		410	0	450	770	0	900	410	450
28120329489	-	410	318.4	450	770	762.2	900	91.6	131.6

Tab 3

This tab includes two bar charts. First one is Inventory Value vs categories and second one is inventory volume vs categories for the selected country and division.

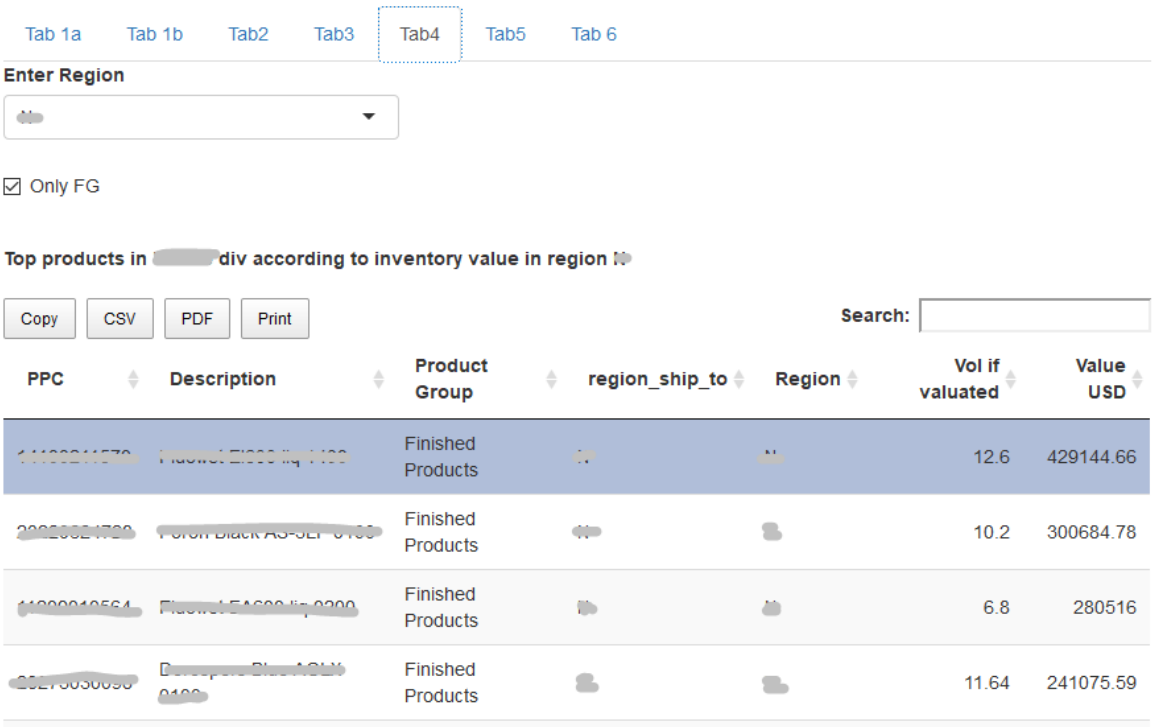


There is a checkbox on top of the bar chart that allows us to either include all the product groups and categories or to include only ABC- XYZ categories and Finished goods.

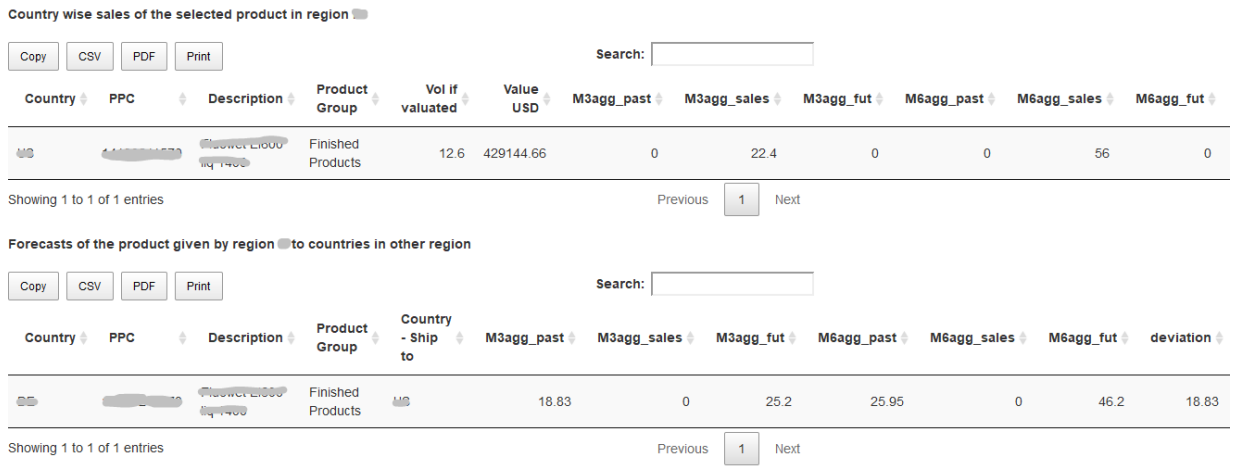


Tab 4

Tab 4 is for region wise analysis. On selecting a region say, North America, the products with highest inventory in the North America due to forecasts given by all countries in North America are listed. This helps to identify how much inventory in a region is caused by the region itself.



On clicking on any product from the first table, following tables get generated. The first one shows in which country the sales of the products are made. The second one shows which country/countries give how much forecast for the selected product to countries in other region.



The last table is a summary table that aggregates the above two tables and calculates the past and future deviation.

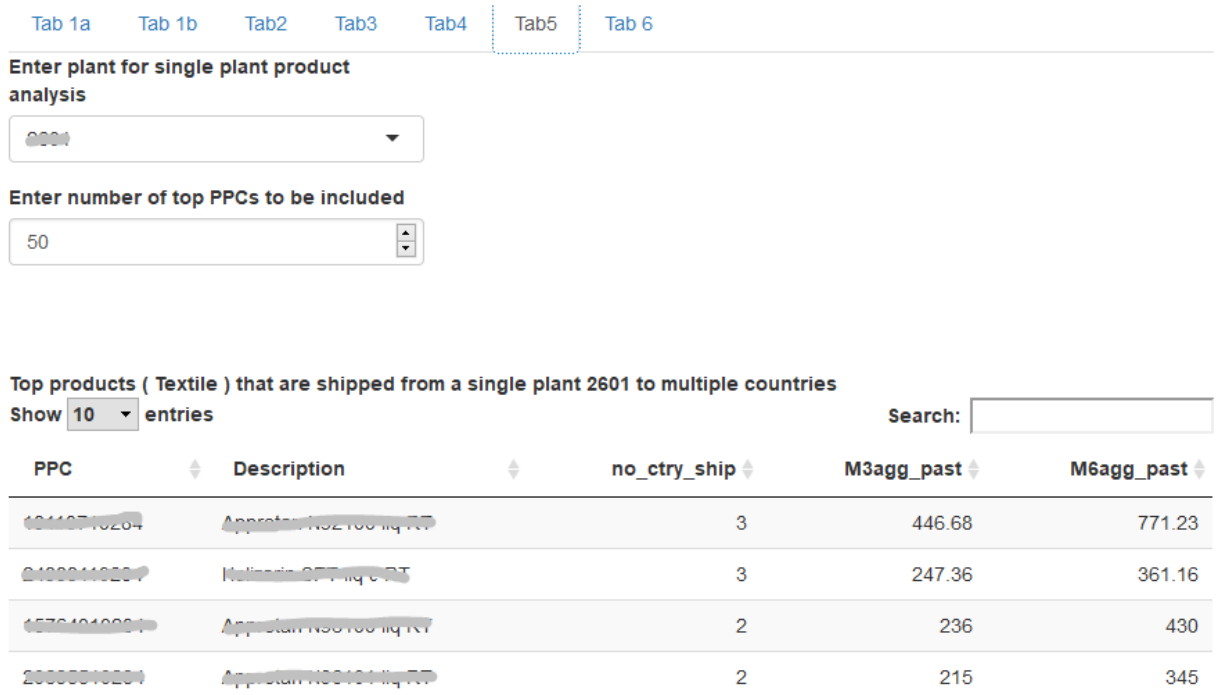
Total deviation and deviation-future for the selected product in region

Copy CSV PDF Print Search:

PPC	Description	M3agg_past	M3agg_sales	M3agg_fut	M6agg_past	M6agg_sales	M6agg_fut	deviation	deviation_fut
[redacted]	[redacted]	18.83	22.4	25.2	25.95	56	46.2	-3.57	2.8

Tab 5

This tab focuses on those products that are produced at a single plant and are shipped to multiple countries. These products must be given special attention because if these are not produced in sufficient quantities then many countries would be affected all at the same time.



Through the drop-down menu plant for analysis can be selected. In order to find produced at single plant and shipped to many countries following steps have been taken:

1) Find out top ‘n’ products produced at the plant that have the maximum sales. The probability that a product would be produced only at that plant is high if it’s sales from that plant is high.
2) For each of these top ‘n’ products find if they are only produced in the selected plant and if they are shipped to more than one country.
3) Arrange the products according to their past 6 months sales.

Inventory of the product at selected plant

Show 10 entries Search:

PPC	Description	Plant	Country	Product Group	Vol if valuated	Value USD
[redacted]	[redacted]	[redacted]	[redacted]	Finished Products	82.08	55859.43

Showing 1 to 1 of 1 entries Previous 1 Next

Inventory of the product at plants where the product is shipped from

Show 10 entries Search:

PPC	Description	Plant	Country	Product Group	Vol if valuated	Value USD
[redacted]	[redacted]	[redacted]	BR	Finished Products	0.72	1360.56
[redacted]	[redacted]	[redacted]	CN	Finished Products	71.7	103698.7
[redacted]	[redacted]	[redacted]	DE	Finished Products	0.96	1309.73
[redacted]	[redacted]	[redacted]	ES	Finished Products	9.03	10013.84
[redacted]	[redacted]	[redacted]	ID	Finished Products	12.6	28723.71
[redacted]	[redacted]	[redacted]	JP	Finished Products	0.56	1656.65

On clicking the product in the first table, the inventory of the product at the selected plant and the inventory of the product at countries where it is shipped to are displayed as shown in the above snapshot.

Forecasts and sales of the product

Show 10 entries Search:

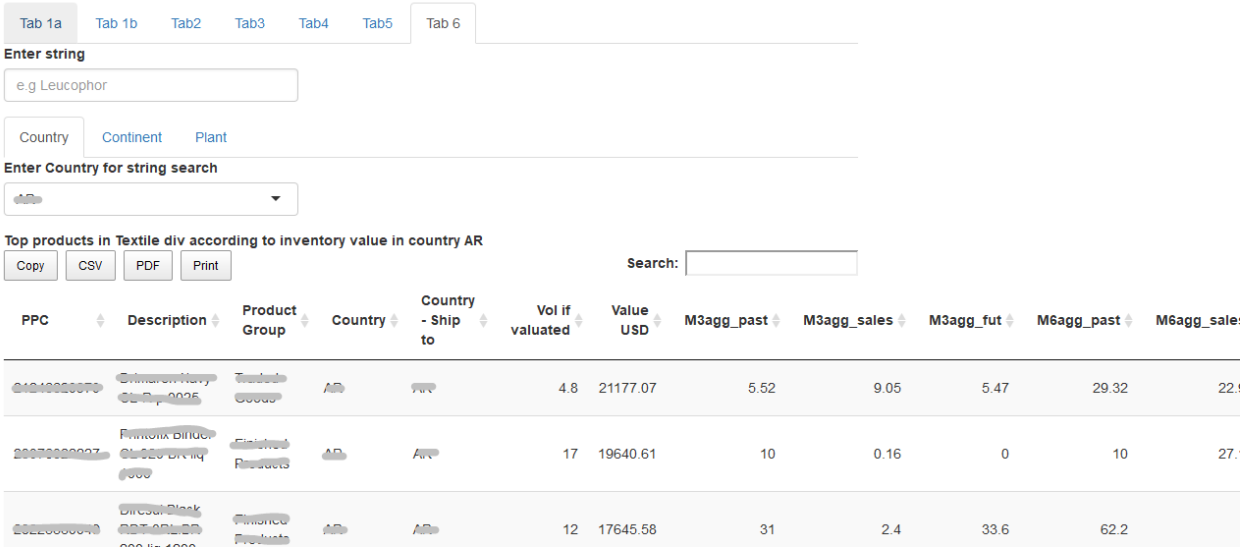
PPC	Description	Country - Ship to	M3agg_past	M3agg_sales	M3agg_fut	M6agg_past	M6agg_sales	M6agg_fut
[redacted]	[redacted]	BD	24	15.96	30	45	43.68	60
[redacted]	[redacted]	BG	0.06	0.18	0.12	0.16	0.24	0.24
[redacted]	[redacted]	BR	0.3	0.3	0	0.3	0.54	0
[redacted]	[redacted]	CN	146.32	103.62	154.68	271.2	251.82	313.04
[redacted]	[redacted]	DE	0.98	0	0	2.37	0	0

The last table includes the forecasts and sales of the product country wise.

Tab 6

This tab is for analysis of products country, continent, and plant wise based on the product's description. On entering a string in the text input, e.g., Leucophor, all the products that include

the word Leucophor in the product description are filtered and appear in the table along with their inventory value, volume, sales, and deviation.



5. Key Learnings:

- ABC- XYZ analysis and its importance, introduction to forecasting methods
- How to interpret the results obtained after execution of code
- How to generate informative and intuitive plots
- How to change visual representation of data depending upon the audience
- Various R packages and commands –
  - dplyr: to manipulate data by joining, adding new variables, sorting, selecting variables, filtering rows etc.
  - ggplot2: to make plots like trendline chart, scatter plot, box plot etc.
  - gganimate – to make animated plots
  - R markdown: to make the execution of code interactive
  - Grid and grid extra packages
  - Shiny - for wrapping up everything into an app
  - mailR – for email automation

- How to generate outputs in different formats – PDF, Excel, GIF, HTML
- How accuracy and error of forecasts are calculated

6. References

http://kourentzes.com/forecasting/2016/10/15/abc-xyz-analysis-for-forecasting/

http://web.mit.edu/2.810/www/files/readings/King_SafetyStock.pdf

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