Forecast Accuracy KPIs

Forecast accuracy measurement is important for a number of reasons including the investigation of existing or potential problems in the supply chain and ensuring that the forecasting system is under control. It is also an important component in safety stock calculation.

Forecast Accuracy - A short introduction

Forecast Accuracy is a measure of how close the Actual Demand is to the Forecasted quantity.

- Forecast Accuracy is the converse of Error
- Accuracy (%) = 1 – Error (%)

However, we truncate the Impact of Large Forecast Errors at 100%.

- If Actual equals Forecast, then Accuracy = 100%
- If Error > 100% → 0% Accuracy (i.e. We constrain Accuracy to be between 0 and 100%)

For example :

	SKU A	SKU B	SKU C	SKU D
ACTUAL	25	50	75	74
FORECAST	75	0	25	75
ABSOLUTE ERROR	50	50	50	1
ERROR %	200%	100%	67%	1%
ACCURACY %	0%	0%	33%	99%

Error Metrics

Measuring accuracy starts with some measure of forecast error. A number of different forecast error measures can be used :

a) **BIAS** : Bias can be described as a tendency to either over-forecast (forecast is more than the actual), or under-forecast (forecast is less than the actual), leading to a forecasting error.

Forecast bias = ∑(Forecast - Sales)

b) **BIAS% :** Bias% is simply the absolute percentage of Forecast Bias error and is calculated as :

Forecast bias % = ∑(| Forecast- Sales |)/ ∑Sales

c) **MAPE** : The **Mean Absolute Percentage Error (MAPE)** is one of the most commonly used KPIs to measure forecast accuracy. MAPE is the sum of the individual absolute errors divided by the demand (each period separately). It is the average of the percentage errors.

MAPE = 1/n ∑((| Forecast - Sales |)/ Sales)

d) **MAD** : The **Mean Absolute Deviation** is the average of the absolute errors across products or time periods.

MAD = 1/n ∑ (| Forecast - Sales |)

e) **WAPE :** also referred to as the **MAD/Mean ratio**, means **Weighted Average Percentage Error.** It is the sum of Absolute errors divided by the sum of the Actuals:

WAPE = (∑ | Forecast - Sales |)/ (∑ Sales)

Illustration of different error metrics :

	Sales	**Forecast**	**Bias**	**Bias %**	**MAD**	**MAPE**	**WAPE**
SKU 1 ~Channel Group 1	28	14	-14	50%	14	50%	50%
SKU2~ Channel Group 1	81	112	+31	138%	31	38%	38%
SKU3~ Channel Group 1	222	196	-26	88%	26	12%	12%

Aggregation Levels

One of the biggest factors affecting what results the forecast accuracy metrics produce is the selected level of aggregation in terms of number of products or over time. Forecast accuracies are typically better when viewed on the aggregated level.

However, when measuring forecast accuracy at aggregate levels, one needs to be careful about how one performs the calculations. It can make a huge difference whether one applies the metrics to aggregated data or calculate averages of the detailed metrics.

In the below example, we have a group of three products, their sales and forecasts from a single week as well as their respective MAPEs. As we can see , the resulting group-level MAPE is much lower than when calculating the average of the individual products' respective MAPE results.

	Sales	**Forecast**	**MAPE**
SKU 1 ~Channel Group 1	28	14	50%
SKU2~ Channel Group 1	81	112	38%
SKU3~ Channel Group 1	222	196	12%
PM : Group Level	331	322	3%

So which number is correct? The answer is that both are, but they should be used in different situations and never be compared to one another.

For example, when assessing forecast quality from a safety stock perspective, one could easily argue that the low forecast error of 3% on the aggregated level would in this case be quite misleading. However, if the forecast is used for business decisions on a more aggregated level, such as planning picking resources at a distribution center , the lower forecast error of 3% may be perfectly relevant.

There are two types of aggregations Period level and Grain level

- The period level aggregation is like viewing the accuracy at week, month, quarter, year.

The error metrics considered in this module are following:-

1. Absolute Deviation

2. Bias
3. Bias Percentage
4. MAPE
5. MAD Mean Ratio
6. MSE
7. RMSE
8. Sum Of Bias / Sum Of Sales
9. Sum Of Error/ Sum Of Sales

Formulas are defined below

Metric Type	**Period Level Aggregation**	**Period Level Formula**	**Grain Level Aggregation**	**Grain Level Forumula**
Bias	Average	average (forecasted values - actual value) across periods	Average	average(X) across grains. X will be determined by period level aggregation
Bias	Sum	sum (forecasted value - actual value) across periods	Sum	sum(X) across grains. X will be determined by period level aggregation
Bias	Median	Median (forecasted values - actual value) across periods	Weighted Average	Sum(Weight *X)/Sum(Weight) across grains. X will be determined by period level aggregation
Bias			Median	Median(X) across grains. X will be determined by period level aggregation

Bias %	Average	Average((forecasted values - actual value)/(sales))across periods	Average	average(X) across grains. X will be determined by period level aggregation
Bias %	Median	Median((forecasted values - actual values)/(sales))across periods	Weighted Average	Sum(Weight *X)/Sum(Weight) across grains. X will be determined by period level aggregation
Bias %			Median	Median(X) across grains. X will be determined by period level aggregation
Sum of Bias/Sum of Sales	-	Sum of bias across periods across grains / sum of sales across periods across grains	-	Sum of bias across periods across grains / sum of sales across periods across grains
MAPE	Median	median (abs(actual value - forecasted values) / actual value) across periods	Average	average(X) across grains. X will be determined by period level aggregation
MAPE	Average	average (abs(actual value - forecasted values) / actual value) across periods	Weighted Average	Sum(Weight *X)/Sum(Weight) across grains. X will be determined by period level aggregation

MAPE			Median	Median(X) across grains. X will be determined by period level aggregation
MAD-Mean Ratio	Average of AD / Average of Sales	average (abs(actual value - forecasted values)) across periods/ average(actual value) across periods	Average	average(X) across grains. X will be determined by period level aggregation
MAD-Mean Ratio			Weighted Average	Sum(Weight *X)/Sum(Weight) across grains. X will be determined by period level aggregation
MAD-Mean Ratio			Median	Median(X) across grains. X will be determined by period level aggregation
MSE	Average	(Sum((actual value-forecast value)^2))/(no. of periods)	Average	average(X) across grains. X will be determined by period level aggregation
RMSE	Average	Sqrt((Sum((actual value- forecast value)^2))/(no. of periods))	Average	Sqrt(sum(X^2)/(# of Grains)) across grains. X will be determined by period level aggregation

Sum of Error/Sum of Sales	-	Sum of abs(actuals-forecast) across periods across grains / sum of sales across periods across grains	-	Sum of abs(actuals-forecast) across periods across grains / sum of sales across periods across grains
Absolute Deviation	Average	average (abs(actual value - forecasted values)) across periods	Average	average(X) across grains. X will be determined by period level aggregation
Absolute Deviation	Sum	sum (abs(actual value - forecasted values)) across periods	Sum	Sum(X) across grains. X will be determined by period level aggregation
Absolute Deviation	Median	Median (abs(actual value - forecasted values)) across periods	Weighted Average	Sum(Weight *X)/Sum(Weight) across grains. X will be determined by period level aggregation
Absolute Deviation			Median	Median(X) across grains. X will be determined by period level aggregation

Lag

The longer into the future one forecasts, the less accurate the forecast is going to be.

Typically, forecasts are calculated several months into the future and then updated, for example, on a weekly basis. So, for a given week we calculate multiple forecasts over time, meaning we have several different forecasts with different time lags. The forecasts should get more accurate when you one gets

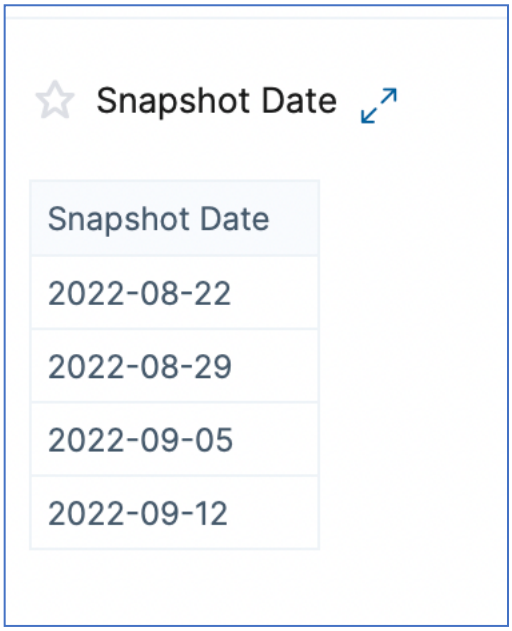
closer to the week that they are forecasting, meaning that the forecast accuracy will look very different depending on which forecast version you use in calculating it.

The forecast version used when measuring forecast accuracy is the forecast for which the time lag matches when important business decisions are made. In retail distribution and inventory management, the relevant lag is usually the lead time for a product. If a supplier delivers from the Far East with a lead time of 12 weeks, what matters is what your forecast quality was when the order was created, not what the forecast was when the products arrived

Note: For Pulmuone the error metric is calculated as (|Forecast- Actuals|)/ Forecast

Dashboard to review the Forecast Accuracy by Snapshot (Forecast Version) and Lag

Aera had generated the forecast starting from week of 2022-08-22 for User Validation. No historical snapshots were generated to measure the accuracy.



Forecast Accuracy is measured on the basis of various lags and so far we have:

Lag Summary

LAG	Snapshot Date
0	2022-08-22
0	2022-08-29
0	2022-09-05
0	2022-09-12
1	2022-08-22
1	2022-08-29
1	2022-09-05
1	2022-09-12
2	2022-08-22

Below dashboard provides the Forecast Accuracy KPIs based on the selected filters:

By default we selected all the forecast snapshots (forecast versions) to view the dashboard. Please use the filter Lag to view the forecast Qty and accuracy by report as per below: