How Long Should the Forecasting Horizon Be?

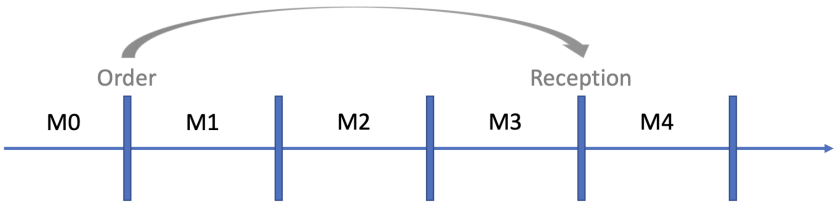
As a demand planner, you can only focus on a limited forecasting horizon. How long should it be?

> *Forecasts should only be made to help you make the right supply chain decisions.*

Source: https://commons.wikimedia.org/wiki/File:Conquistadores_654.jpg

Let's imagine that you are a supply planner. Your main supplier is quoting you a lead time of 3 months, and you make monthly orders.

Technically, you make your order on the first day of the current month (here, M1). Order receptions happen at the very start of a month (they can't be used to fulfill orders of the previous month). In other words, you'll do the order on the very first day of M1 and will receive it on the very first day of M4.

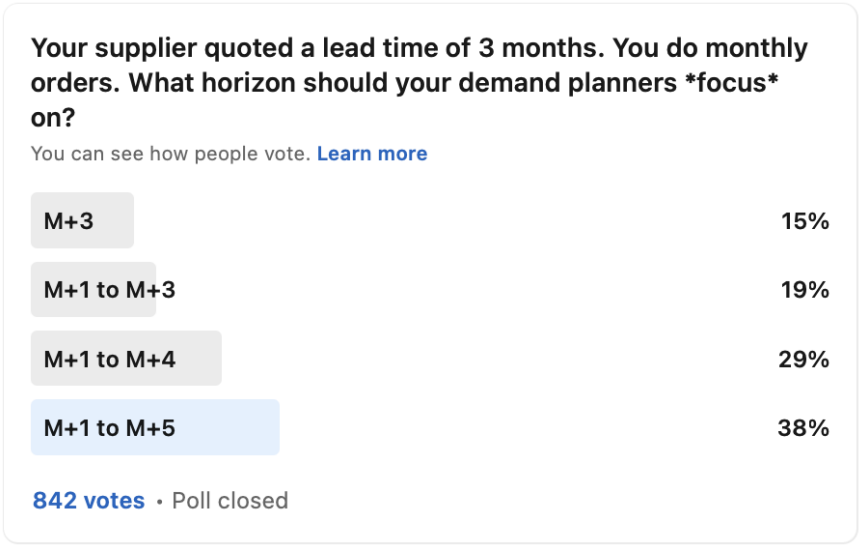


You want your supply chain's demand planners to support you by providing a useful demand forecast.

Should you ask them to **focus** on:

- Forecasting M+1?
- Forecasting M+2?
- Forecasting M+3?
- Forecasting M+4?
- Forecasting M+1 to M+3?
- Forecasting M+1 to M+4?
- Forecasting M+1 to M+6?

I ran a poll on LinkedIn and got these answers:



I agree with 38% of the voters: you should focus on a horizon of 5 months (maybe slightly more). I guess this answer would be counterintuitive for many planners, as 34% would only be interested in M3 maximum.

In order to explain my choice of the horizon (M1 to M5), let's first take a look at the theory and then illustrate it with an example.

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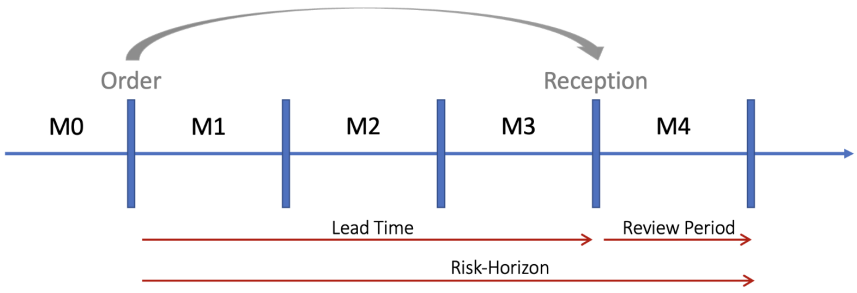
Theory: Inventory Optimization, Lead Times, and Review Periods

Inventory optimization theory teaches us that periodic inventory replenishment policies should be protected over a risk-horizon* of L+R (Lead Time + Review Period).

> **Risk-horizon: Maximum amount of time you need to wait to receive an order (from your supplier). During this period your inventory is at risk of being depleted. In a periodic replenishment policies, we have risk-horizon = lead time + review period. I introduced this concept in my book, Inventory Optimization.*

Our earlier example would be 4 months: 3 months of lead time plus a review period of 1 month.



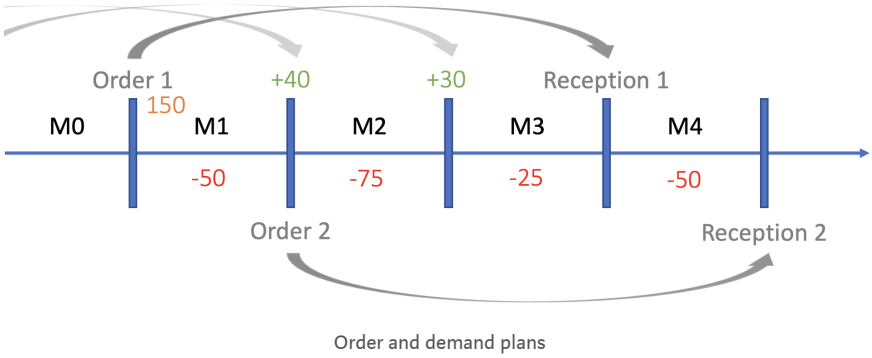
Lead Time, Review Period and Risk-Horizon

This is a counterintuitive answer to the question. Most supply planners would focus on the M+3 forecast or the cumulative M+1 to +3 forecast, but not the cumulative M+1 to +4 forecast.

Example

Let's move to an example; we'll later discuss M5 and M6.

Let's imagine the following order and demand plans as highlighted in the Figure below. The upcoming order receptions are in green, the demand forecasts in red. At the time of making the order (just at the start of M1), we had an inventory level of 150 units.

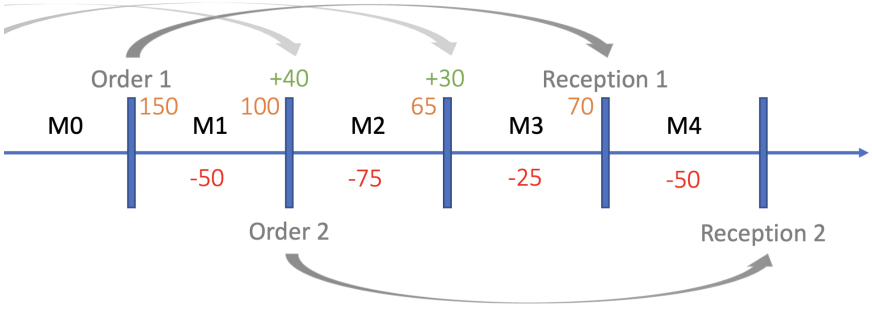


Order and demand plans

Let's imagine that we want to **finish** each month with an inventory level of 100 units *before* we receive a new order. *By defining our inventory target this way, it will correspond to the definition of safety stocks.*

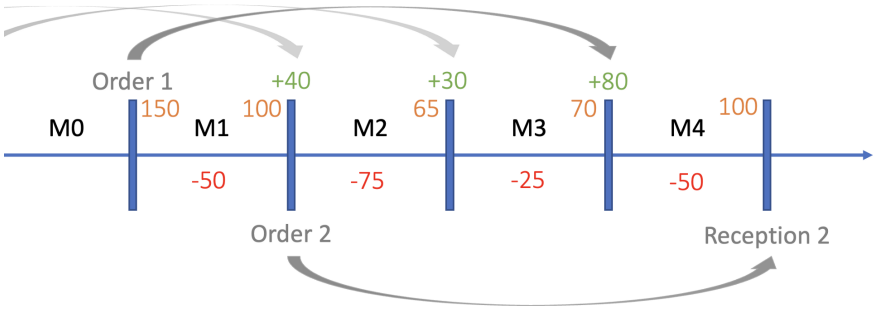
Example. At the end of M1, we expect to have an inventory of 150–50=100 units (= starting position - expected demand). Then we'll receive our previous order of 40 units and reach 140 units to start M2.

Looking at the Figure below, we compute that by the end of M3, we expect to be left with an inventory of 70 pieces. *That's 30 pieces lower than our target of 100 units.*



With a lead time of 3 months, Order 1 (that we are making now) won't arrive in time to change anything within the next 3 months. The only thing we can impact is the stock level at the end of M4.

As shown in the Figure below, by ordering 80 pieces now, we'll ensure that the stock position at the end of M4 will be 100 units (starting = 70+80; consumption = 50; stock remaining = 100).



We need to order 80 units now to reach our stock target at the end of M4.

Which Forecast is the Most Important?

Looking at the Figure above, we realize that changing the forecast of any of M1 to M4 will change the amount we should order.

Example: If your demand planner updates the M2 forecast by changing the expected demand from 75 pieces to 100 pieces, you should also react by increasing your order by 25 units.

It means that **any period from M1 to M4 is equally important to determine your order amount**.

Looking Further Ahead

Let's recap the story so far.

> *We need to make our monthly order to our supplier which quoted a lead time of 3 months. We realized that, in order to decide how much to order now, we had to pay attention to the demand forecast for the coming 4 months.*

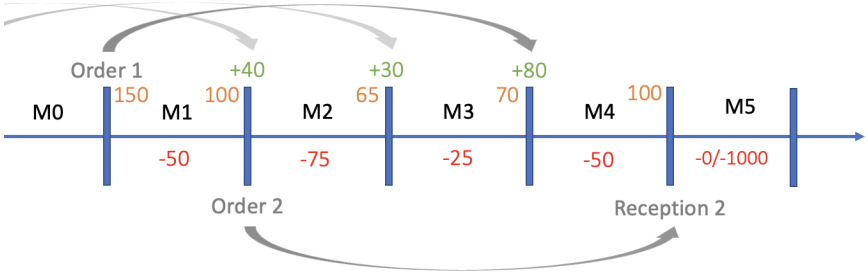
But, actually, this is not the full picture.

Optimal Service Level and Risks

The science of inventory optimization teaches us that we need to optimize service levels based on profitability and risks. Basically, you need to balance the risk and the cost of over- and under-stocking.

Let's imagine two simple (extreme) scenarios:

- Scenario #1: the expected demand in M5 is 1000 pieces.
- Scenario #2: the expected demand in M5 is 0 pieces.



Scenarios 1 and 2 (look at M5)

We initially assumed that we wanted to finish M4 with a safety stock of 100 pieces. Obviously, if we do not expect any sales after M4 (scenario 2), finishing M4 with an inventory of 100 pieces wouldn't be a wise decision. On the other hand, if we expect to sell a thousand pieces in M5 (scenario 1), we could allow a bigger safety margin for M4 (as the risk of obsolete or long-term leftovers is low).

Collaboration

By providing an even more long-term view to your supplier, you can help them to reduce the lead time, reduce their cost, and increase their stock availability.

Going Further #1: Probabilistic Forecasting over the Lead Times

In a recent article, I showed that probabilistic forecasts are (much) more relevant and **useful** than point forecasts.

- **Point Forecast**: associate the future with a single expected outcome, usually an average expected value (not to be confused with the *most likely* outcome). Example: *We forecast to sell 1000 units next month.*
- **Probabilistic Forecast**: allocates a probability for different events to happen.

If you want to properly assess how much inventory you need (and optimize safety stocks and service levels), you'll need to get a probabilistic view of what can happen over this risk-horizon.

Basically, we should look at the demand distribution over L+R rather than just a point forecast over L+R.

Probabilistic Forecasting and Inventory

Optimization

Forecasts should only be made to help you making the right supply chain decisions.

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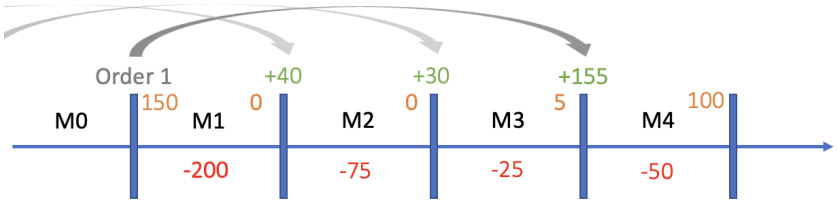
Pay attention that the demand distribution over M1 to M4 is usually not the same as the sum of the demand distribution over M1, M2, M3, and M4. But that's another story.

Going Further #2: Lost Sales vs. Backorders

Inventory policies with backorders (*all excess demand is kept until stock is available*) differ from policies with lost sales (*all excess demand is lost*).

- **Lost Sales:** Your clients (usually) cancel orders when you are out of stock. You need to pay attention to any shortage that might happen over the risk-horizon. So you need to have a detailed picture of what could happen during **each separate month** (in top of having a good forecast over the total horizon).



Lost Sales: If M1 demand increases by 150 units (to 200 pieces), the impact on the order is only an increase of +75 units as the excess demand of M1 and M2 is lost.

Lost sales are common in B2C/FMCG, making it particularly difficult for demand planners to estimate the *real* demand.

Capturing Unconstrained Demand in Supply Chains

The article below is a summary of one of my LinkedIn posts. If you are interested in such ...

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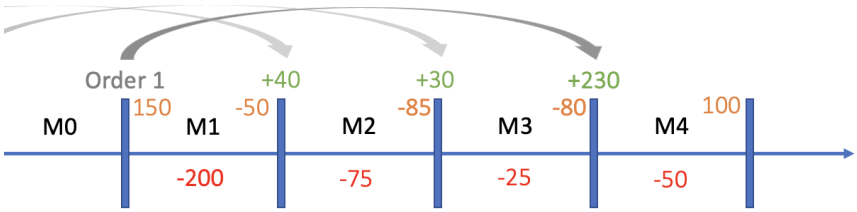
- **Backorders**: In case of inventory shortages, your clients will keep their orders open and wait for stock to be available again. In such

a case, there is no impact on the order requirement if you miss any inventory over the risk-horizon: the total demand won't be impacted. You can then focus on the cumulative forecast from M1 to M4 rather than each month's forecast separately.



Backorders: If M1 demand increases by 150 units (to 200 pieces), the impact on the order is an increase of +150 units (80+150=230) as all the excess demand is back-ordered.

- **Hybrid**: In most supply chains, some clients will keep their order open (or reorder) and some will just go to the competition. To optimize your order quantity, you will have to estimate the likelihood of lost sales occurring over the risk-horizon.

Conclusion

In conclusion, the best practice is to focus on forecasting demand over the risk-horizon (lead time plus review period) plus a few periods (to understand the risks of having too much/too little inventory and collaborating with your supplier).

Call to action

If you are managing a demand planning process, I would advise you to revise the forecasting KPIs you are tracking. Looking simply at M+1 or M+2 will not be enough.

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☞ **Let's connect on LinkedIn!**

Acknowledgments

Stefan de Kok

About the Author

Nicolas Vandeput is a supply chain data scientist specialized in demand forecasting and inventory optimization. He founded his consultancy company SupChains in 2016 and co-founded SKU Science

—a fast, simple, and affordable demand forecasting platform—in 2018. Passionate about education, Nicolas is both an avid learner and enjoys teaching at universities: he has taught forecasting and inventory optimization to master students since 2014 in Brussels, Belgium. Since 2020 he is also teaching both subjects at CentraleSupelec, Paris, France. He published *Data Science for Supply Chain Forecasting* in 2018 (2nd edition in 2021) and *Inventory Optimization: Models and Simulations* in 2020.