Safety Stock & Reorder Point Calculation

In supplier & inventory mgmt, a critical balance must be struck between having enough stock to meet customer demand and not overstocking, which ties up cash. Two essential tools in achieving this balance are SAFETY STOCK and the REORDER POINT (ROP):

- **SAFETY STOCK**. is extra inventory maintained to buffer against uncertainties in demand and supply.
- **ROP**. is the inventory level at which a new order must be placed to replenish stock before running out.

1. SAFETY STOCK.

Safety Stock serves as a protective buffer to ensure you can still fulfill customer orders even if demand exceeds expectations or supplier deliveries are delayed or process disruptions occur. Without safety stock, a company risks stockouts, which can lead to lost sales, dissatisfied customers, and damage to brand reputation.

Safety Stock formula:

$$\text{Safety Stock} = Z \cdot \sigma_{LT}$$

Where:

- Z is the Z-Score, corresponding to the desired level of service. Represents the number of standard deviations needed to cover the probability of avoiding stockouts.

Verteilungstabellen

Standardnormalverteilung

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998
3.5	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998
3.6	0.9998	0.9998	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.7	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.8	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999

Examples:

- 90% servicelevel: $Z = 1{,}28$
- 95% servicelevel: $Z = 1{,}65$
- 99% servicelevel: $Z = 2{,}33$

The higher the service level, the more safetystock you need, hence increasing holding cost.

- σ_{LT} is the standard deviation of demand during lead time, which accounts for variability in either demand or lead time, or both.

Demand

1. x_1
2. x_2
3. x_3
⋮
n. x_n

$$\sigma_D = \sqrt{\sum_{i=1}^{n} \frac{(x_i - \bar{x})^2}{n}}$$

$$\boxed{\sigma_{LT} = \sqrt{LT} \cdot \sigma_D}$$

This formula applies when lead time is constant. If lead time is variable, the formula adjusts to include lead time variability, which we'll explore later.

Example 1. Calculating Safety stock

Let's assume you're managing a product with following characteristics:

1) Average daily demand 50 units
2) Standard deviation of daily demand 5 units
3) Lead time 10 days
4) Desired service level 95% (Z-score 1'65)

Safety Stock? Step 1. Standard dev. of demand during lead time

$$\sigma_{LT} = \underbrace{\sqrt{10 \text{ days}}}_{\sqrt{LT}} \cdot \underbrace{5 \frac{\text{units}}{\text{day}}}_{\sigma_D} \cong 15'81 \text{ units}$$

Step 2. Calculate the safety stock

$$\text{Safety Stock} = Z \cdot \sigma_{LT} = 26'09 \text{ units}$$

Interpretation: we need to hold 26 units of stock to achieve 95% of service level.

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2. ROP. is the inventory level at which you should place a new order to replenish the stock before running out. The ROP ensures, that by the time new stock arrives, you still have enough on hand to meet demand during the lead time.

ROP formula: $ROP = \text{Demand during lead time} + \text{Safety stock}$

2.1. Demand during lead time:

$$\text{Demand during lead time (DLT)} = \text{Average daily demand} \cdot \text{Lead time}$$

Example 2. Calculate ROP.

Same data as in Example 1:

- Average daily demand 50 units
- Lead time 10 days
- Safety Stock 26 units

Step 1. Calculate $DLT = 50 \frac{\text{units}}{\text{day}} \cdot 10 \text{ days} = 500 \text{ units}$

Step 2. $ROP = DLT + \text{Safety Stock} = 526 \text{ units}$

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3. Incorporating lead Time variability

In real world situations, Lead time might also fluctuate due to production or shipping delays. When this happens, the calculation for safety stock must account for both demand variability and lead time variability.

The updated formula: $$\text{Safety Stock} = Z \cdot \sqrt{(LT \cdot \sigma_D^2) + (D^2 \cdot \sigma_{LT}^2)}$$

Where: · σ_D is the stand. dev. demand

· σ_{LT} is the stand. dev. lead time

· D is the average daily demand

· LT is the average lead time.

Example 3.1. Calculation with the lead-time variability.

- Average daily demand 50 units
- Std deviation of daily demand 5 units
- Average lead time 10 days
- Std deviation of lead time 2 days
- Desired service level 95% (Z score 1'65)

Step 1. Calculate total variability during lead time

$$\sigma_{LT} = \sqrt{(LT \cdot \sigma_D^2) + (D^2 \cdot \sigma_{LT}^2)} =$$

$$= \sqrt{(10 \cdot 5^2) + (50^2 + 2^2)} = \ldots = 101'24 \text{ units}$$

Step 2. Calculate safety stock

Safety Stock = 1'65 · 101'24 = 167'04

Step 3. Calculate the new re-order point

ROP = DLT + Safety Stock = 500 units + 167 = 667 units

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4. Practical considerations

While it is important to maintain enough stock to avoid stockouts excessive safety stock can lead to increased holding cost.

- Storage cost . more stock requires stock space.
- Insurance . additional insurance to protect the inventory.
- Obsolescence . holding too much inventory can lead to products becoming outdated or spoiled.

CONCLUSION : Trade. off between service level vs. inventory cost.

thigher service levels require more safety stock, which increases costs . Businesses must find the right balance btw. maintaining high service levels and controlling inventory-related expenses.

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5. what to do?
   - Improve demand forecasting.
   - Building reliable supplier relationships.
   - Using technology.

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key takeaways.

1) safety stock accounts for variability in demand and lead time, ensuring stock is available to meet unexpected demand or delays.
2) Reorder point. is the inventory level at which a new order should be placed to avoid stockouts.

3) Both calculations rely on factors like average demand, lead time, and desired service levels, and should be updated as these factors change.