

Step 1 of 7 ^

Weekly demand for 10 variants of copier is shown below:

	Mean (D)	Standard Deviation (σ_D)
High Volume Variant (80% demand)	1,000	200
Low Volume Variant (20% demand)	28	20

The following table provides the information related to the Company's current policy.

Cost per unit (in \$)	1,000
High Volume Variant (k_H)	1
Low Volume Variant (k_L)	9
Holding Cost	20%
CSL	95%
Supply Lead Time (L)	4 weeks

No Component Commonality**High Volume Variant:**

Step-1: The weekly demand the variant is normally distributed with mean D_L and standard deviation σ_L , here

$$\sigma_L = \sqrt{L}\sigma_D$$

Step-2: Safety inventory is the inventory that is carried to meet the demand if it exceeds the demand forecasted for that period.

Safety inventory (ss) per variant can be calculated as

$$\begin{aligned} ss \text{ per variant} &= F_s^{-1}(CSL) \times \sigma_{L+T} \\ &= NORMSINV(CSL) \times \sigma_{L+T} \end{aligned}$$

Proceed similarly for low volume variant, as shown below:

Inout Data	
Cost per copier	1000
Holding Cost	0.2
CSL	0.95
F_S^{-1} (CSL)	1.64
Supply Lead Time (L)	4

High Volume Variant: No Commonality	
D	1000
σ_D	200
k_H	1
σ_L	400
ss per outlet	658
Total ss	658
Annual Holding Cost	\$131,588.29

Low Volume Variant: No Commonality	
D	28
σ_D	20
k_S	9
σ_L	40
ss per outlet	66
Total ss	592
Annual Holding Cost	\$118,429.46

	A	B
1	Excel Formulas	
2	Cost per copier	1000
3	Holding Cost	0.2
4	CSL	0.95
5	F_S^{-1} (CSL)	=NORMSINV(B4)
6	Supply Lead Time (L)	4
7		
8	High Volume Variant: No Commonality	
9	D	1000
10	σ_D	200
11	k_H	1
12	σ_L	=(B10*B6^0.5)
13	ss per outlet	=(B5*B12)
14	Total ss	=(B13*B11)
15	Annual Holding Cost	=(B14*B2*B3)
16		
17	Low Volume Variant: No Commonality	
18	D	28
19	σ_D	20
20	k_S	9
21	σ_L	=(B19*B6^0.5)
22	ss per outlet	=(B5*B21)
23	Total ss	=(B22*B20)
24	Annual Holding Cost	=(B23*B2*B3)

The safety inventory of high volume variant is **658 copiers** and total annual holding cost is **\$131,588**.

The safety inventory of low volume variant is **592 copiers** and total annual holding cost of is **\$118,429**.

Combined Aggregated Option

Assume the demand in all regions to be independent and identically distributed with D and σ_D , the aggregate demand is normally distributed with mean D^c and standard deviation σ_D^c , here

$$D^c = kD; \text{ And } \sigma_D^c = \sqrt{k}\sigma_D$$

Using commonality increases the cost by \$25 per copier.

(Assumption: 1 year = 52 weeks.)

	A	B
1	Formualas	
2	Cost per copier	1000
3	Holding Cost	0.2
4	CSL	0.95
5	F_S^{-1} (CSL)	=NORMSINV(B4)
6	Supply Lead Time (L)	4
7		
8	High Volume Variant: No Commonality	
9	D	1000
10	σ_D	200
11	k_H	1
12	σ_L	=(B10*B6^0.5)
13	ss per outlet	=(B5*B12)
14	Total ss	=(B13*B11)
15	Annual Holding Cost	=(B14*B2*B3)
16		
17	Low Volume Variant: No Commonality	
18	D	28
19	σ_D	20
20	k_S	9
21	σ_L	=(B19*B6^0.5)
22	ss per outlet	=(B5*B21)
23	Total ss	=(B22*B20)
24	Annual Holding Cost	=(B23*B2*B3)
25		
26	Complete Commonality	
27	D_C	=(B9*B11+B18*B20)
28	σ_D^C	=SQRT(B11*B10^2+B20*B19^2)
29	σ_L	=(B28*B6^0.5)
30	Aggregate ss	=(B29*B5)
31	Reduction in Safety Stock	=(B14+B23-B30)
32	Annual Holding Cost Savings	=(B31*B2*B3)
33	Annual Increase in component Cost	=(B27*25*52)

Input Data	
Cost per copier	1000
Holding Cost	0.2
CSL	0.95
F_S^{-1} (CSL)	1.64
Supply Lead Time (L)	4

High Volume Variant: No Commonality	
D	1000
σ_D	200
k_H	1
σ_L	400
ss per outlet	658
Total ss	658
Annual Holding Cost	\$131,588.29
Low Volume Variant: No Commonality	
D	28
σ_D	20
k_S	9
σ_L	40
ss per outlet	66
Total ss	592
Annual Holding Cost	\$118,429.46
Complete Commonality	
D_C	1252
σ_D^C	208.81
σ_L	418
Aggregate ss	687
Reduction in Safety Stock	563
Annual Holding Cost Savings	\$112,635.54
Annual Increase in component Cost	\$1,627,600

687 units as safety-stock are required with common component option. The resulted savings in annual holding cost is \$112,636.

Thus, centralization increases the annual cost by \$1,627,600.

Commonality is not justified because the increase in the components cost exceeds the savings made in annual holding cost.

Commonality is justified if the increase in the components cost is equal of less than the savings made in annual holding cost.

d)

Low Volume Variant: Component Commonality

Follow the methodology used in part-b, as shown below:
 savings by the annual demand, as shown below:

$$\begin{aligned}\text{Additional Cost} &= \frac{112,636}{65,104} \\ &= \$1.73\end{aligned}$$

It means that **\$1.73** increase in component cost will justify the commonality.

	A	B
1	Input Data	
2	Cost per copier	1000
3	Holding Cost	0.2
4	CSL	0.95
5	F_s^{-1} (CSL)	=NORMSINV(B4)
6	Supply Lead Time (L)	4
7		
8	Low Volume Variant: No Commonality	
9	D	28
10	σ_D	20
11	k_s	9
12	σ_L	=(B10*B6^0.5)
13	ss per outlet	=(B5*B12)
14	Total ss	=(B13*B11)
15	Annual Holding Cost	=(B14*B2*B3)
16		
17	Low Volume Variant: Commonality	
18	D_c	=(B9*B11)
19	σ_D^c	=(B10*B11^0.5)
20	σ_L	=(B19*B6^0.5)
21	Aggregate ss	=(B20*B5)
22	Reduction in safety stock	=(B14-B21)
23	Annual Holding Cost Savings	=(B22*B2*B3)
24	Annual Increase in Cost	=(B18+25*52)

Input Data	
Cost per copier	1000
Holding Cost	\$0.20
CSL	0.95
F_s^{-1} (CSL)	1.64
Supply Lead Time (L)	4

Low Volume Variant: No Commonality	
D	28
σ_D	20
k_s	9
σ_L	40
ss per outlet	66
Total ss	592
Annual Holding Cost	\$118,429.46

Low Volume Variant: Commonality	
D_C	252
σ_D^C	60
σ_L	120
Aggregate ss	197
Reduction in safety stock	395
Annual Holding Cost Savings	\$78,952.97
Annual Increase in Cost	\$327,600.00

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The safety inventory of low volume variant using component commonality is **197 units** and the resultant savings in annual holding cost by using commonality is **\$78,953**.

Thus, centralization increases the annual cost by **\$327,600**.

Commonality is not justified since the increase in the component cost exceeds the savings in annual holding cost.

e)

Annual savings in the holding cost by using commonality for only low volume variant is \$78,953 and the annual demand is

$$D^C \times \text{Weeks/Year} = 252 \times 52 \\ = 13,104$$

Additional cost required so that the commonality for low volume variant is justified can be calculated by dividing the holding cost savings by the annual demand

$$\text{Additional Cost} = \frac{78,953}{13,104} \\ = 6.03$$

Thus, the additional cost that justifies commonality for low volume variant is **\$6.03**.