

Modelling and Analytics for Supply Chain Management
Professor Kunal Kanti Ghosh
Vinod Gupta School of Management
Indian Institute of Technology, Kharagpur
Lecture 30
Safety Stock and Reorder Level

Hi, good afternoon we welcome you to our session on safety stock and reorder level in the context of inventory management.

(Refer Slide Time: 00:24)

CONCEPTS COVERED

- Safety Stocks
- Reorder Level

SAFETY STOCK

- Safety stock is the additional amount of stock kept on hand to safeguard against the fluctuations in lead time or demand or both these variables at the same point in time
- Safety stock helps to reduce the probability of stock-out

NPTEL Online Certification Courses
IIT Kharagpur

Now, when we want to discuss about safety stock we need to know what is meant by that. So, safety stock is the additional amount of stock kept on hand to safeguard against the fluctuations in lead time, or fluctuations in demand or fluctuations in both these variables at the same point in time. Lead time we have already defined is the time that elapses between

the placement of an order on to the supplier. And the receipt of the goods, from the supplier at the premises of the manufacturer.

Now, these fluctuations in statistics it is measured by the standard deviation of the particular variable. If it is lead time, then will be referring to the standard deviation or variance in lead time. At the measure of the fluctuation of lead time and similarly, if it is fluctuation in demand we have to compute the standard deviation or the variance of demand.

Now, safety stock basically helps to reduce the probability of stock-out and we need to know, what is the optimal amount of safety stock that we must keep in our organisation. So, that the probability of stock-out is as per desired service level.

(Refer Slide Time: 02:40)

SAFETY STOCK

- ❑ A key pre-requisite for this is the establishment of a service level
- A 'service level' is a policy measure set by supply chain managers that help determine the level of safety stock that needs to be kept to protect themselves from stock-out situations

NPTEL Online Certification Course
IIT Kharagpur

SAFETY STOCK

- ❑ Two types of service levels commonly used in inventory control are:
 - ❖ A measure based on the proportion of order cycles in which no stock outs occur, and
 - ❖ A measure based on the proportion of customer demands that are satisfied from the on-hand inventory, also referred to as the 'fill rate'

NPTEL Online Certification Course
IIT Kharagpur

A pre-requisite for this then is a establishment of a service level. Now, you might ask me what is the service level? So, a service level is a policy measure set by supply chain managers, to help them determine the level of safety stock that needs to be kept to protect themselves from stock-out situations. So, basically is the policy level decision and there are two types of service levels commonly used in inventory control.

Number one, is a measure based on the proportion of order cycles in which no stock outs occur. Is a measure based on the proportion of order cycles in which no stock outs occur, and the second definition of service level. Service level is a measure based on the proportion of customer demands that are satisfied from the on-hand inventory. This is also referred to as the fill rate.

(Refer Slide Time: 04:26)

SAFETY STOCK

- There are several methods for determining safety stock but each one of them require thorough analysis of
 - ✓ Historical Lead Time, and
 - ✓ Demand Data

NPTEL Online Certification Courses
IIT Kharagpur

There are several methods for determining the safety stock. But, each one of them require thorough analysis of Historical Lead Time and Demand Data. Until and unless adequate amount of data related to these two entities lead time and demand is available. Safety stock determination will not be accurate.

Today of course with the help of computer systems particularly with the adherent of enterprise resource planning systems, there are various ways in which we can extract relevant data related to lead time and demand. The demand data can be obtained from consumption master files.

Because in any organisation whenever there is an issue that issue transaction is being captured in the data base. And over a period of time we can extract all those issue

transactions to find out average demand and the standard deviation of demand for any particular item. Similarly, this historical lead time though we can we have defined that lead time is the difference in time between placement of purchase order and receipt of the item. This receipt of the item can be obtained from the computer systems based on goods receipt date.

And we know the purchase order date, so we will get the difference between this to (())(06:39). To get an idea or measure of lead time and we will capture all the receipt transactions over a period of time. To get the average lead time and the standard deviation of lead time.

(Refer Slide Time: 07:00)

SAFETY STOCK

- When adequate data is available, then we can fit a statistical distribution to describe demand during lead time²
- Usually, normal distribution is assumed although other continuous distributions may be used

The slide features a background with a stylized tree of icons representing various business and technical concepts. In the bottom right corner, there is a small video inset showing a man in a white shirt and tie speaking. At the bottom of the slide, there are logos for NPTEL and IIT Kharagpur, along with the text 'NPTEL Online Certification Course IIT Kharagpur'.

So, when adequate data is available, we can fit statistical distribution to describe demand during lead time. And normally we assumed normal distribution to fit as the distribution of demand during lead time. Although, any other continuous distributions maybe used.

(Refer Slide Time: 07:36)

SAFETY STOCK

□ The following three situations may be encountered while determining safety stock:

- Demand is variable, Lead time is constant
- Demand is constant, Lead time is variable
- Both demand and lead times are variable

NPTEL Online Certification Course
IIT Kharagpur

While discussing about safety stock, we have to keep in mind the following three situations that may normally be encountered while determining the safety stock. The first one is, the demand is variable while lead time is constant. The second one is demand is constant but the lead time maybe variable. And the third one is both these entities demand and lead times are variable.

(Refer Slide Time: 08:37)

SAFETY STOCK

Demand During Lead Time

Cycle-service level = 85%

Probability of stockout (1.0 - 0.85 = 0.15)

Average demand during lead time

z

Fixing Safety Stock with a Normal Probability Distribution for an 85 Percent Cycle-Service Level

NPTEL Online Certification Course
IIT Kharagpur

Now, as long as the demand during lead time is less than its average value, then everything is in order, and we are not bothered about the safety stock. The safety stock concept comes in, when these variables either demand or lead time values exceed their average values. So, here we see a normal distribution curve and see average demand during lead time.

As long as the in reality the actual demand is less than the average demand during lead time. There is no question of safety stock but, when the demand exceeds this average value, then we have to protect that through its safety stock or the buffer stock.

Now, we have already defined that if the cycle service level is specified. Saying this case, cycle service level is specified at 85 percent. Then the corresponding normal random, standard normal random variate is pointed here, at this point 0.85 corresponding to that whatever Z value is there.

See in that case, if Z value is at this point the probability of stock-out will be 1.0 minus 0.85 is only 15 percent this ratio. So, we have to find out that particular Z value which will give us protection upto this level. And under such condition the amount of safety stock that we have kept is Z multiplied by the standard deviation of the demand during lead time.

(Refer Slide Time: 11:18)

REORDER LEVEL – VARIABLE DEMAND, CONSTANT LEAD TIME

- Let us consider the case when demand is variable and lead time is constant.
- In finding out the reorder level, we will make the following assumptions:
 - The inventory system is reviewed on a continuous basis
 - The inventory system involves a single item
 - Demand for the item is random

The slide features a background with various icons including gears, a tree, and a person. A video inset in the bottom right corner shows a man in a white shirt and tie speaking. The NPTEL logo is visible in the bottom left corner.

REORDER LEVEL – VARIABLE DEMAND, CONSTANT LEAD TIME

- The underlying statistical distribution of demand can be estimated
- Lead time is known and constant
- A fixed cost is incurred every time an order is placed
- The order size can be found out by using the formula for EOQ
- $Q = \sqrt{2DS/iC}$
- D = Annual demand for the item
- S = Ordering cost
- C = Unit cost for the item, Annual interest rate = i

NPTEL Online Certification Courses
IIT Kharagpur

So, we will also determine the reorder level under each of the cases that we have mentioned. Let us take the case of determining the reorder level where the demand is variable and the lead time is constant. In finding out the reorder level we will make the following assumptions. The first assumption is that the inventory system is reviewed on a continuous basis.

The inventory system involves a single item and demand for the item is random. The underlying statistical distribution of demand can be estimated that is also a one assumption. And in this case normally we have assumed that is a normal distribution. Lead time is known and constant and the another assumption is that a fixed cost is incurred every time an order is placed which will basically call the ordering cost. The order size we have already discussed about this in our economic order quantity determination exercise.

That the order size can be find out by using the formula for EOQ which is nothing but, square root of $2DS$ by i into C . Where, D is annual demand for item, S is the ordering cost and C is the unit cost for the item and the annual interest is given by i .

(Refer Slide Time: 13:21)

REORDER LEVEL – VARIABLE DEMAND, CONSTANT LEAD TIME

□ When demand is normally distributed with a known mean and a standard deviation, the reorder level, 'R' is given by,

➤ $R = \bar{d}L + SS = \bar{d}L + Z\sigma_d$ where,

- ❖ \bar{d} = Average Demand
- ❖ L = Lead Time
- ❖ SS = Safety Stock
- ❖ Z = Number of Standard Deviations for a Specified Cycle Service Level
- ❖ σ_d = Standard Deviation of Lead Time Demand

REORDER LEVEL – VARIABLE DEMAND, CONSTANT LEAD TIME

□ The units for average demand and lead time must be consistent i.e., if the demand period is specified in **days**, then the lead time must also be in **days**.

□ If the problem specifies standard deviation of **daily** demand, then the expression of R should be written as;

➤ $R = \bar{d}L + Z\sigma_d\sqrt{L}$ where,

- ❖ \bar{d} = Average **Daily** Demand
- ❖ L = Lead Time in **Days**
- ❖ Z = Number of Standard Deviations for a Specified Cycle Service Level
- ❖ σ_d = Standard Deviation of **Daily** Demand

When demand is normally distributed with a known mean and the standard deviation, the reorder level, R is given by average demand into lead time which is constant, plus the safety stock. Which is nothing but \bar{d} into L plus Z multiplied by σ_d . Where \bar{d} is the average demand, L is a lead time, S is the safety stock and Z is the number of standard deviations for a specified cycle service level.

σ_d is nothing but the standard deviation of lead time demand. Here, we have to remember one thing, that the units for average demand and lead time must be consistent. That is, if the demand period is specified in days, then the lead time must also be in days. If this unit of measures are not the same, then appropriate conversion has to be made.

For example, if the problem specifies standard deviation of daily demand, then the expression for reorder level should be written as $\bar{d}L + Z\sigma_d\sqrt{L}$. Where, \bar{d} is the average daily demand, L is the lead time in days, Z is the number of standard deviations for a specified cycle service level. And σ_d is a standard deviation of daily demand.

(Refer Slide Time: 15:42)

REORDER LEVEL – VARIABLE DEMAND, CONSTANT LEAD TIME

- Demand period is the time span over which the demand has been estimated
- Unit of measure for demand period and lead time must be consistent
- If the units are not the same, then we may need to make some adjustments depending on:
 - > (a) Demand period is less than lead time
 - > (b) Demand period is greater than lead time

(Source: Problems and Solutions in Inventory Management by Shenoy and Rosas, 2018)

NPTEL Online Certification Courses
IIT Kharagpur

REORDER LEVEL – VARIABLE DEMAND, CONSTANT LEAD TIME

- Demand period is less than lead time
- ✓ Consider the following example where the standard deviation of daily demand is 4 units and the lead time is 3 days
- ✓ Assuming the demand for each day is independent, the standard deviation of lead time demand is equal to the square root of the sum of the variances of daily demand

(Source: Problems and Solutions in Inventory Management by Shenoy and Rosas, 2018)

NPTEL Online Certification Courses
IIT Kharagpur

So, you need to know that the demand period which we have basically mentioned here, is the time span over which the demand has been estimated. Unit of measure for demand period and lead time must be consistent. It I am repeating because this is very important assumption and need to be satisfied is a pre-requisite.

If the units are not the same, then we may need to make some adjustments depending on demand period is less than lead time or demand period is greater than lead time. If the demand period is less than lead time. For example, consider the following example where the standard deviation of daily demand is 4 units and lead time is 3 days. Assuming the demand for each day is independent, then in that case the standard deviation of lead time demand is equal to the square root of the sum of the variances of daily demand.

(Refer Slide Time: 17:18)

NUMERICAL EXAMPLE

☐ Solution:
In other words, in this case

➤ $\sigma_d = \sqrt{4^2 + 4^2 + 4^2} = \sqrt{48} = \underline{6.92 \text{ Units}}$

i.e. the standard deviation of the lead time demand is 6.92 units

(Source: Problems and Solutions in Inventory Management by Shenoy and Rosas, 2018)

NPTEL Online Certification Courses
IIT Kharagpur

NUMERICAL EXAMPLE

✓ The daily demand for an item is normally distributed with a mean of 100 units and a standard deviation of 3 units

✓ The procurement lead time is 6 days

➤ Question to be answered:
❖ Compute the standard deviation of lead time demand

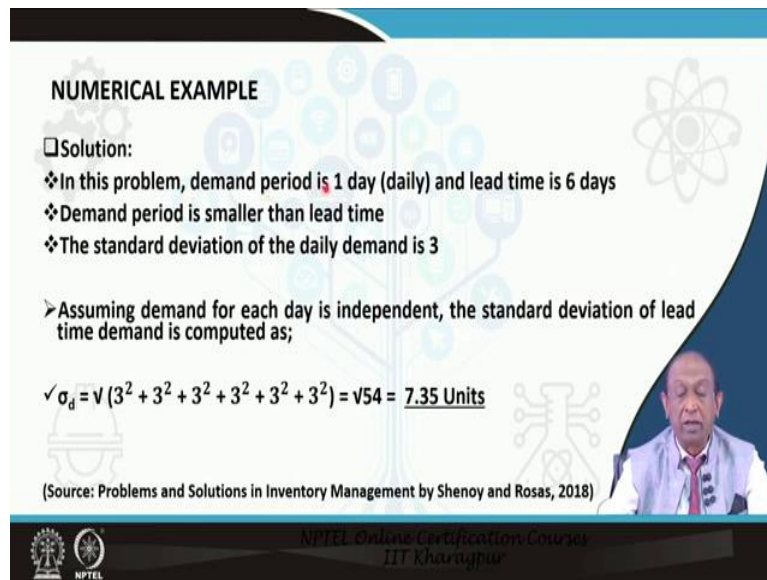
(Source: Problems and Solutions in Inventory Management by Shenoy and Rosas, 2018)

NPTEL Online Certification Courses
IIT Kharagpur

In this case, sigma d will be root over of 4 square plus 4 square plus 4 square. That is root of R of 48 that is 6.92 units, which is the standard deviation of lead time demand. Consider this numerical example that daily demand for an item is normally distributed with a mean of 100 units and a standard deviation of 3 units.

The procurement lead time is 6 days. The questions to be answered is compute the standard deviation of lead time demand. So, lead time is 6 days and we have been given, that the demand distribution particular daily demand distribution is normal with a mean of 100 units and the standard deviation of 3 units.

(Refer Slide Time: 18:39)



NUMERICAL EXAMPLE

□ Solution:

- ❖ In this problem, demand period is 1 day (daily) and lead time is 6 days
- ❖ Demand period is smaller than lead time
- ❖ The standard deviation of the daily demand is 3

➤ Assuming demand for each day is independent, the standard deviation of lead time demand is computed as;

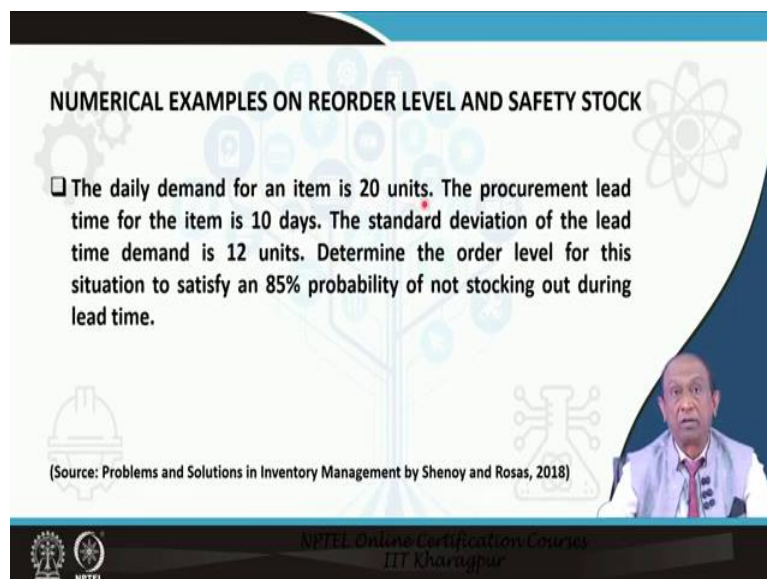
$$\sqrt{\sigma_d} = \sqrt{3^2 + 3^2 + 3^2 + 3^2 + 3^2 + 3^2} = \sqrt{54} = \underline{7.35 \text{ Units}}$$

(Source: Problems and Solutions in Inventory Management by Shenoy and Rosas, 2018)

NPTEL Online Certification Courses
IIT Kharagpur

So, demand period in this case is 1 day because daily demand and lead time is 6 days. So, demand period is smaller than lead time. Hence we have to first compute the standard deviation of daily demand. The standard deviation of daily demand is given is 3. We have to compute the standard deviation of lead time demand, which is nothing but as before root of R of 3 square plus 3 square plus 3 square like this, root over of 54 that is 7.35 units.

(Refer Slide Time: 19:25)



NUMERICAL EXAMPLES ON REORDER LEVEL AND SAFETY STOCK

□ The daily demand for an item is 20 units. The procurement lead time for the item is 10 days. The standard deviation of the lead time demand is 12 units. Determine the order level for this situation to satisfy an 85% probability of not stocking out during lead time.

(Source: Problems and Solutions in Inventory Management by Shenoy and Rosas, 2018)

NPTEL Online Certification Courses
IIT Kharagpur

NUMERICAL EXAMPLES ON REORDER LEVEL AND SAFETY STOCK

- In this problem, the following data are given:
 - Daily demand $d = 20$ units.
 - Lead time $L = 10$ days.
 - The standard deviation of demand during lead time σ_d is directly specified (12 units).
 - $Z = 1.04$
 - Hence we get
 - $R = (20 * 10) + (1.04 * 12) = 213$ units
- The reorder level is 213 units. The safety stock is 13 units.

(Source: Problems and Solutions in Inventory Management by Shenoy and Rosas, 2018)



NPTEL Online Certification Courses
IIT Kharagpur

REORDER LEVEL – VARIABLE DEMAND, CONSTANT LEAD TIME

- Demand period is greater than lead time
 - Consider a situation where the demand period is greater than lead time (e.g., demand is annual and lead time is specified in days).
 - Let $n =$ number of lead time periods that make up the demand period
 - For example, if demand period is expressed in months and lead time is given in weeks, then $n = 4$

(Source: Problems and Solutions in Inventory Management by Shenoy and Rosas, 2018)



NPTEL Online Certification Courses
IIT Kharagpur

Look at this example, the daily demand for an item is 20 units. The procurement lead time for the item is 10 days. The standard deviation of the lead time demand is 12 units. Determine the order level for this situation to satisfy an 85 percent probability of not stocking out during lead time.

So, here you see is a very straight forward problem. Because the standard deviation of lead time demand is given and hence the reorder level is nothing but daily demand \bar{d} . 20 into lead time which is 10 plus corresponding to 85 percent service level the value of Z is 1.04. That you will get it from a normal distribution, standard normal distribution table that multiplied by 12 which is the standard deviation of demand during lead time is given. So, multiply you will get 213 units, so here the reorder level is 213 units. Therefore, the safety stock in this case is only 1.04 multiplied by 12, which is 13 units.

(Refer Slide Time: 21:00)

REORDER LEVEL – VARIABLE DEMAND, CONSTANT LEAD TIME

- ☐ Demand period is greater than lead time
 - Consider a situation where the demand period is greater than lead time (e.g., demand is annual and lead time is specified in days).
 - Let n = number of lead time periods that make up the demand period
 - For example, if demand period is expressed in months and lead time is given in weeks, then $n = 4$

(Source: Problems and Solutions in Inventory Management by Shenoy and Rosas, 2018)

NPTEL Online Certification Course
IIT Kharagpur

Now, let us discuss the case where the demand period is greater than lead time. Consider a situation where the demand period or in some problem it may be given that only. Where the demand period is greater than the lead time. For example, annual demand is given and lead time is specified in days less than of course 365. In that case, let n be the number of lead time periods that make up the demand period. For example, if demand period is expressed in months and lead time is given in weeks, then n equals 4.

(Refer Slide Time: 21:57)

REORDER LEVEL – VARIABLE DEMAND, CONSTANT LEAD TIME

- ☐ If the standard deviation of demand period is given and we need to determine the standard deviation of lead time demand, then we can use the following:
 - $\sigma_d = \sigma_L / \sqrt{n}$ where
 - σ_d = standard deviation of demand
 - σ_L = standard deviation of lead time

(Source: Problems and Solutions in Inventory Management by Shenoy and Rosas, 2018)

NPTEL Online Certification Course
IIT Kharagpur

NUMERICAL EXAMPLES ON SAFETY STOCK

- The demand for an item in a month is normally distributed with a mean of 100 units and a standard deviation of 3 units. If the lead time is 1 week, compute the standard deviation of the lead time demand.

(Source: Problems and Solutions in Inventory Management by Shenoy and Rosas, 2018)



NPTEL Online Certification Courses
IIT Kharagpur

NUMERICAL EXAMPLES ON SAFETY STOCK

- In this problem, the demand period is 1 month and lead time is 1 week.

- Since demand period is greater than the lead time, we use
- $[\sigma_d = \sigma_L / \sqrt{n}]$ to obtain the standard deviation of lead time demand.
- Here $n = 4$
- Therefore, $\sigma_L = (3 / \sqrt{4}) = 1.5$ units
- The standard deviation of lead time demand is 1.5 units
- (Source: Problems and Solutions in Inventory Management by Shenoy and Rosas, 2018)



NPTEL Online Certification Courses
IIT Kharagpur

So, under such a situation if the standard deviation of demand period is given and we need to determine the standard deviation of lead time demand, then will use the following expression. $\sigma_d = \sigma_L / \sqrt{n}$ where, σ_d is the standard deviation and σ_L is the standard deviation of lead time. Look at this example, the demand for an item in a month is normally distributed with a mean of 100 units and a standard deviation of 3 units.

So, monthly demand distribution is given. If the lead time is 1 week, compute the standard deviation of the lead time demand. Very simple will use this formula $\sigma_d = \sigma_L / \sqrt{n}$, $n = 4$. So, $\sigma_L = 3 / \sqrt{4} = 1.5$ units, so the standard deviation of lead time demand is 1.5 units. Here, I have denoted this one, demand standard deviation of demand during lead time by σ_L .

(Refer Slide Time: 23:21)

REORDER LEVEL – CONSTANT DEMAND, VARIABLE LEAD TIME

- ❑ Now we will consider the case where the replenishment lead time is variable and the demand is constant
- ❑ Reorder level may be determined under the following assumptions:
 - ✓ The inventory system is reviewed on a constant basis
 - ✓ The inventory system involves a single item
 - ✓ Demand for the item is known and constant
 - ✓ Lead time is random but the distribution governing the lead time is known (normally distributed)

(Source: Problems and Solutions in Inventory Management by Shenoy and Rosas, 2018)

REORDER LEVEL – CONSTANT DEMAND, VARIABLE LEAD TIME

- ❑ When the demand is constant and lead time is variable, the reorder level (R) is given by,
 - $R = d\bar{L} + Z * d * \sigma_L$ where,
 - ❖ d = Daily Demand
 - ❖ \bar{L} = Average Lead Time
 - ❖ Z = Standardized Normal Variate
 - ❖ σ_L = Standard Deviation of Lead Time

(Source: Problems and Solutions in Inventory Management by Shenoy and Rosas, 2018)

Now, will discuss a situation where the demand is constant but variable lead time. Lead time is variable. So, here also reorder level may be determined under the following assumptions that the inventory system is reviewed on a constant basis. The inventory system involves a single item. Demand for item is known and constant. Lead time is random but the distribution governing the lead time is known which is normally distributed.

So, in this case when the demand is constant and lead time is variable, the reorder level is given by d into \bar{L} plus Z into constant demand d multiplied by σ_L . Where, σ_L is the standard deviation of lead time Z is standardized normal variate depending on the service level, we have to find the value of Z . \bar{L} is the average lead time, d is the daily demand.

(Refer Slide Time: 24:40)

NUMERICAL EXAMPLES ON REORDER LEVEL AND SAFETY STOCK

□ Hospital SSKM performs 10 heart surgeries each day with one stent for each surgery. The hospital procures stents from England. The procurement lead time is normally distributed with a mean of 10 days and a standard deviation of 3 days. If the hospital management wants a 95% probability of not stocking out during lead time, compute the safety stock and the reorder level for stents.

(Source: Problems and Solutions in Inventory Management by Shenoy and Rosas, 2018)

NUMERICAL EXAMPLES ON REORDER LEVEL AND SAFETY STOCK

□ In this problem,

- d is 10 stents (constant).
- L is 10 days.
- $Z = 1.64$.
- $\sigma_L = 3$ days
- $R = (10 * 10) + (1.64 * 10 * 3) = 149$ stents

□ The safety stock is 49 units and the reorder level is 149 stents.

(Source: Problems and Solutions in Inventory Management by Shenoy and Rosas, 2018)

So, let us look at this example, hospital SSKM performs 10 heart surgeries each day with one stent for each surgery. The hospital procures stents from England. The procurement lead time is normally distributed with a mean of 10 days and a standard deviation of 3 days. If the hospital management wants a 95 percent probability of not stocking out during the lead time.

Compute the safety stock and the reorder level for stents. So, you see this problem demand d is 10 stents which is constant, demand is constant. Lead time mean is 10 days, Z is 1.64 depending on this 94, 95 percent service level. σ_L is given in this problem as 3 days because lead time is variable, demand is constant.

The reorder level can be found out using the formula that I have discussed before d bar into L bar plus Z into σ_L into d which is 149 stents. So, the safety stock this portion if you

compute 1.64 into 10 into 3 works out to be 149. So, safety stock is 49 units and the reorder level is 149 units.

(Refer Slide Time: 26:22)

REORDER LEVEL – VARIABLE DEMAND, AND VARIABLE LEAD TIME

□ We will now consider the case where both demand and lead times are variable. Assuming that the demand and lead times are normally distributed, the reorder level, R, is given by

➤ $R = \bar{d} \cdot \bar{L} + Z \cdot \sqrt{\bar{L} \sigma_d^2 + \bar{d}^2 \sigma_{LT}^2}$

➤ \bar{d} = Average demand per period
➤ \bar{L} = Average replenishment time
➤ σ_d = Standard deviation of demand per period
➤ σ_{LT} = Standard deviation of lead time

(Source: Problems and Solutions in Inventory Management by Shenoy and Rosas, 2018)

NPTEL Online Certification Course
IIT Kharagpur

And the last case where both the demand is variable and the lead time is variable. In that case the reorder level R, is given by this expression, \bar{d} into \bar{L} plus Z multiplied by root over of \bar{L} into σ_d square plus \bar{d} square into σ_{LT} square. Where, σ_d is standard deviation of demand per period.

So, this is in quantity σ_{LT} is expressed in terms of days so in order to convert it to quantity, we multiplied by \bar{d} . We add these two variances and take the square root of that to get the resultant variance and this is the formula over through which will determine R.

(Refer Slide Time: 27:19)

NUMERICAL EXAMPLES ON REORDER LEVEL AND SAFETY STOCK

□ The daily demand experienced by small home computer assembler is normally distributed with a mean of 20 units and a standard deviation of 6 units. The assembler sources the RAM for the computer from a supplier in the local market. The lead time for supply of the RAM chips is also normally distributed with a mean of 3 days and a standard deviation of 1 day. If the assembler desires to ensure a 90% probability of not stocking out during lead time, compute (i) Reorder level, R and (ii) Safety stock, SS

(Source: Problems and Solutions in Inventory Management by Shenoy and Rosas, 2018)

NPTEL Online Certification Course
IIT Kharagpur

Look at this example the daily demand experienced by small home computer assembler is normally distributed with a mean of 20 units and the standard deviation of 6 units. The assembler sources the RAM for the computer from a supplier in the local market. The lead time for supply of RAM chips is also normally distributed with a mean of 3 days and a standard deviation of 1 day. If the assembler desires to ensure a 90 percent probability of not stocking out during lead time, compute reorder level R and safety stock.

(Refer Slide Time: 28:10)

NUMERICAL EXAMPLES ON REORDER LEVEL AND SAFETY STOCK

➤ Here, both the demand and lead time are variable.

➤ The value of z for a probability of 0.90 is $Z = 1.28$

➤ Substituting the values in $R = \bar{d} * L + Z * \sqrt{L\sigma_d^2 + \bar{d}^2\sigma_L^2}$

➤ $R = (20 * 3) + 1.28 * \sqrt{(6^2 * 3) + (1^2 * 20^2)} = 60 + 28.8 = 88.8$ units

➤ The reorder level is 89 units while the safety stock is 29 units to maintain a desired cycle service level of 90%.

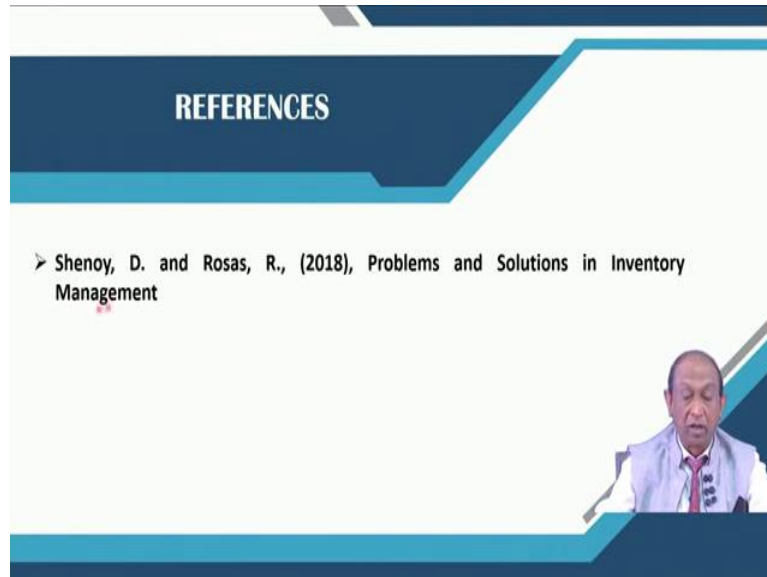
(Source: Problems and Solutions in Inventory Management by Shenoy and Rosas, 2018)

NPTEL Online Certification Course
IIT Kharagpur

So, in this problem both demand and lead time is variable. The value of z for a probability of 0.90 is 1.28. We substitute that required values in the expression for R and we get R equals, 20 into 3 plus Z value of 1.28 multiplied by square root of this expression. L bar which is 3

into $\sigma d \sqrt{6} + \bar{d}$ into σLT square. And we get R as 88.8 units, which can be rounded off to 89 units. So, the reorder level is 89 units while the safety stock is 29 units to maintain a desired cycle service level of 90 percent.

(Refer Slide Time: 29:25)



The reference or the source for all these problems and solutions is given in this book. Problems and Solutions in Inventory Management by Shenoy and Rosas, 2018. This is the reference given and thank you for your pleasant listening. Thanks.