

Production Management (ME-419)

Module 3 – Supply Management Inventory Management (EPQ, Discount, SS)

Amin Kaboli

Week 11 – Session 1&2 – Nov 22nd, 2024

Learning Points



3 min

What did you learn the last week?

- Point 1
- Point 2
- Point 3
- ...

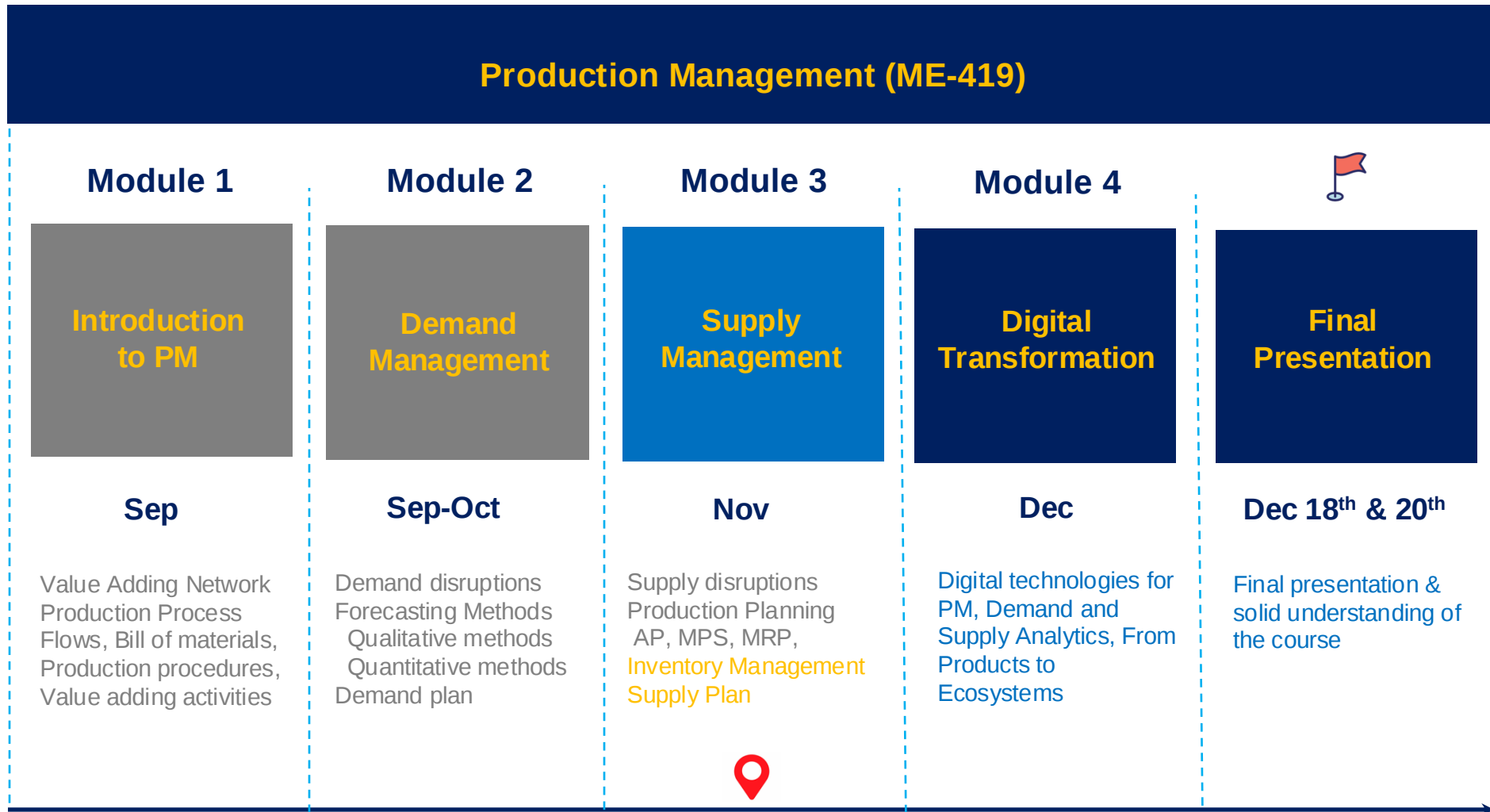


Course Framework



Business plan

Strategic plan
Financial plan



Inventory Management – Decision Variables

How much to buy?



Order Quantity (Q)

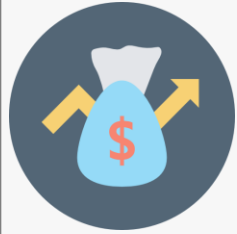
When to buy?



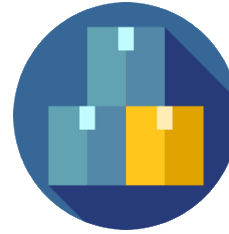
Order Time (T)

Companies make replenishment decisions to manage inventory.

Inventory Management Models



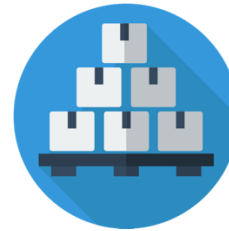
Economic Order Quantity (EOQ)



Safety Stock



Economic Production Quantity (EPQ)



Periodic Review System



Discount Model



Single Period Inventory Model
(Chromas Tree)

Economic Order Quantity (EOQ) - Assumption

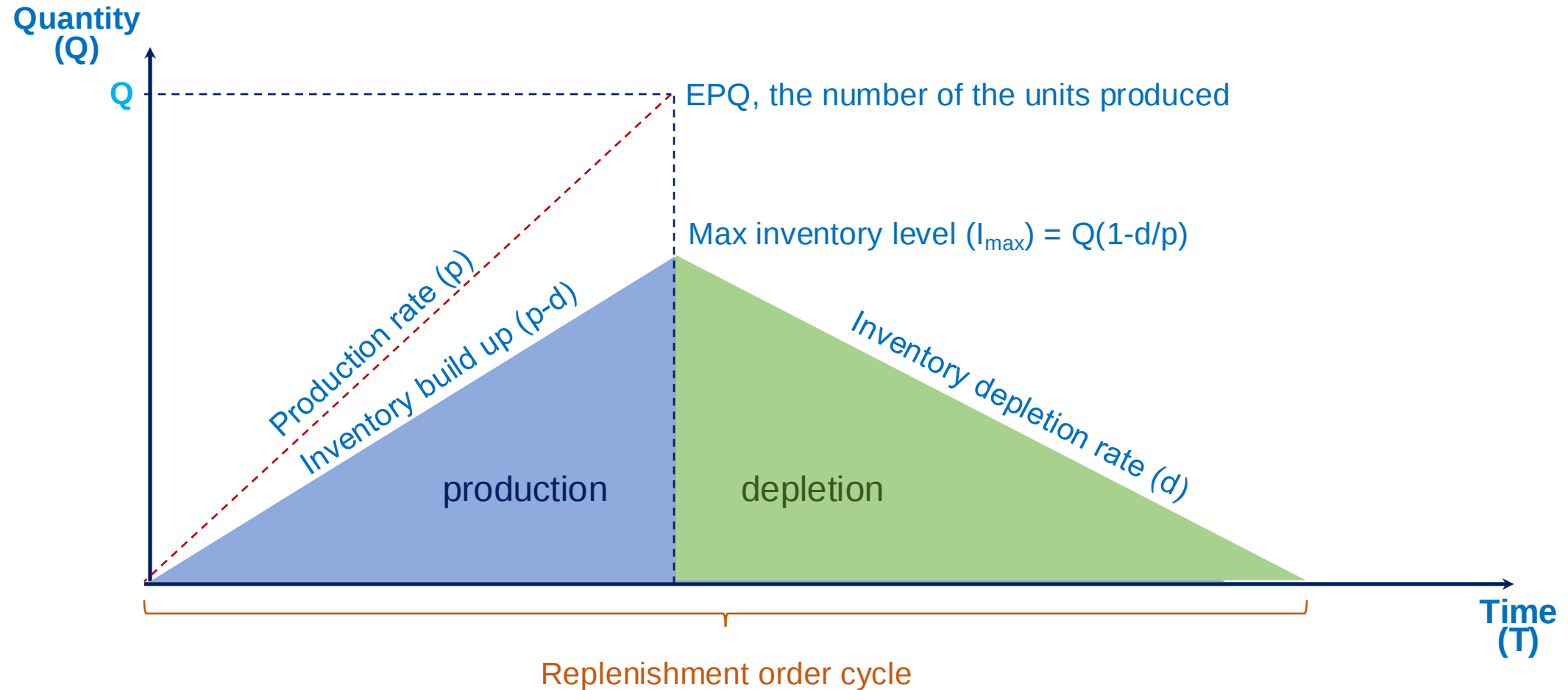
- Demand is **known** and **constant**.
- Lead time is **known** and **constant**.
- Ordering (and set up) costs are **fixed** and **constant**.
- **Unlimited** capacity.
- **Full (NOT partial) shipment.**
- Price is **fixed** and **constant**.

Economic Production Quantity (EPQ) - Assumption

- Demand is **known** and **constant**.
- Lead time is **known** and **constant**.
- Ordering (and set up) costs are **fixed** and **constant**.
- **Unlimited** capacity.
- ~~Full~~ (NOT Partial shipment).
- Price is **fixed** and **constant**.

Economic Production Quantity (EPQ)

- This model allows partial delivery



Total Costs in EOQ

Total costs (TC) = Ordering costs + Holding costs

$$\begin{aligned}\text{Ordering costs} &= \text{Number of orders placed} * \text{cost to place an order} \\ &= (\text{Demand/Quantity ordered}) * S \\ &= (D/Q) * S\end{aligned}$$

$$\begin{aligned}\text{Holding costs} &= \text{Average inventory level} * \text{holding cost per unit} \\ &= (\text{Max-Min})/2 * H \\ &= (Q-0)/2 * H\end{aligned}$$

$$\text{Total costs (TC)} = (D/Q) * S + (Q)/2 * H$$

Total Costs in EPQ

Total costs (TC) = Ordering costs + Holding costs

$$\begin{aligned}\text{Ordering costs} &= \text{Number of orders placed} * \text{cost to place an order} \\ &= (\text{Demand/Quantity ordered}) * S \\ &= (D/Q) * S\end{aligned}$$

$$\begin{aligned}\text{Holding costs} &= \text{Average inventory level} * \text{holding cost per unit} \\ &= (I_{\max})/2 * H \\ &= Q(1-d/p)/2 * H\end{aligned}$$

$$\text{Total costs (TC)} = (D/Q) * S + (Q(1-d/p))/2 * H$$

Calculating EPQ

$$\text{Total costs (TC)} = (D/Q) * S + (Q(1-d/p))/2 * H$$

$$\text{Ordering costs} = (D/Q) * S$$

$$\text{Holding costs} = Q(1-d/p)/2 * H$$

$$(D/Q) * S = Q(1-d/p)/2 * H$$

$$Q^2 = \frac{2DS}{H(1-\frac{d}{p})}$$

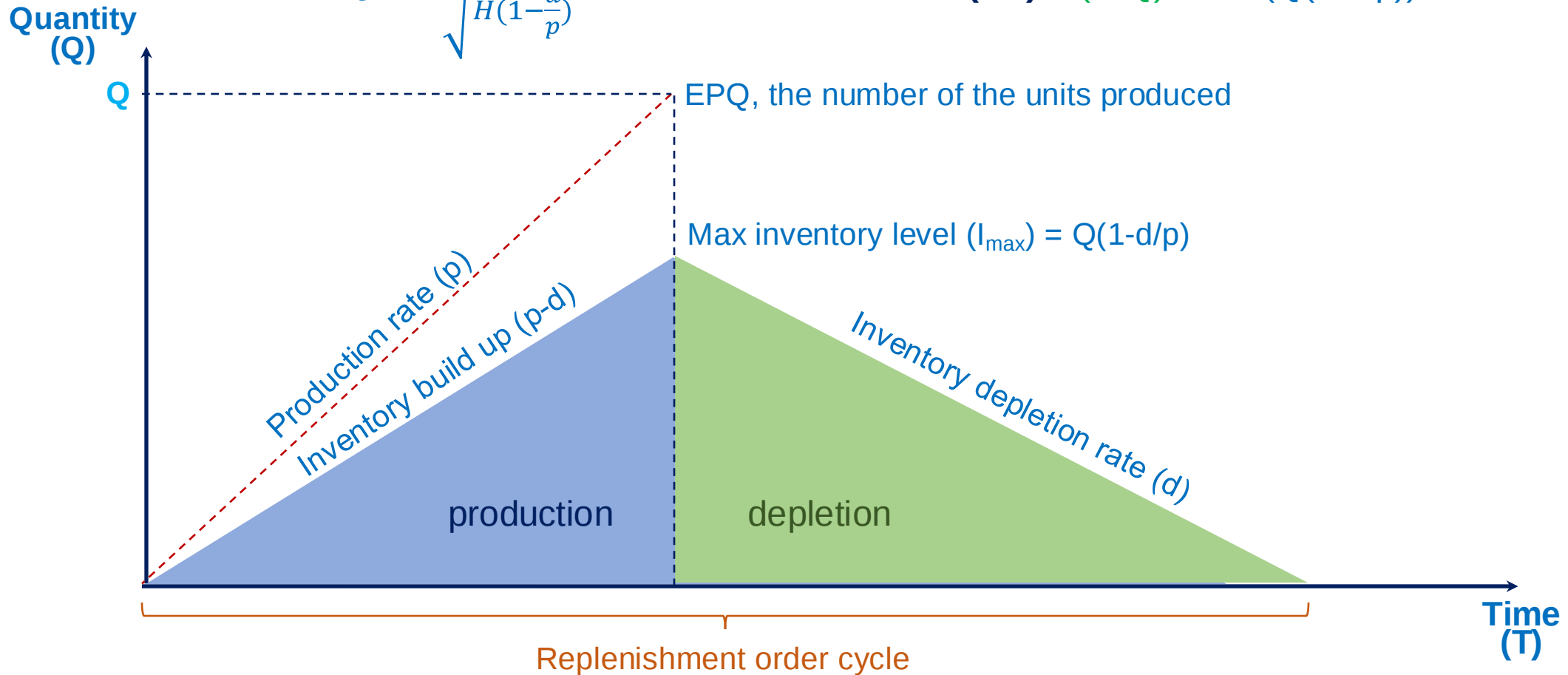
$$Q^* = \sqrt{\frac{2DS}{H(1-\frac{d}{p})}}$$

Economic Production Quantity (EPQ)

- This model allows partial delivery

$$Q^* = \sqrt{\frac{2DS}{H(1-\frac{d}{p})}}$$

$$\text{Total costs (TC)} = (D/Q) * S + (Q(1-d/p))/2 * H$$



Exercise 2: Find EPQ, Total annual costs, Reorder Point



3 min

Annual demand (D): 18'000 units

Demand rate/month (d): 1'500 units

Ordering cost (S): CHF 800

Production rate/month (p): 2'500 units

Annual holding cost (H): CHF 18 per unit

Company operations: 20 days per month



Exercise 3: Calculate ratio of d/p using daily, weekly, annual demand



5 min

Annual demand (D): 10'000 units

Annual Production: 2'5000 units

Company operations: 250 days per year, 50 weeks per year, 5 days per week

Assignment 11: Inventory Management

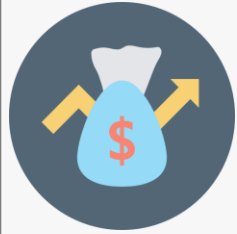


10 min

Task 1: Define what you need to calculate EOQ for your case study

Task 2: Define what you need to calculate EPQ for your case study

Inventory Management Models



Economic Order Quantity (EOQ)



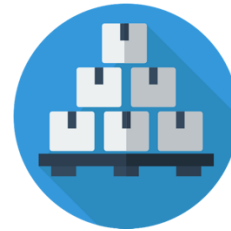
Economic Production Quantity (EPQ)



Discount Model



Safety Stock



Periodic Review System



Single Period Inventory Model
(Chromas Tree)

Economic Order Quantity (EOQ) - Assumption

- Demand is **known** and **constant**.
- Lead time is **known** and **constant**.
- Ordering (and set up) costs are **fixed** and **constant**.
- **Unlimited** capacity.

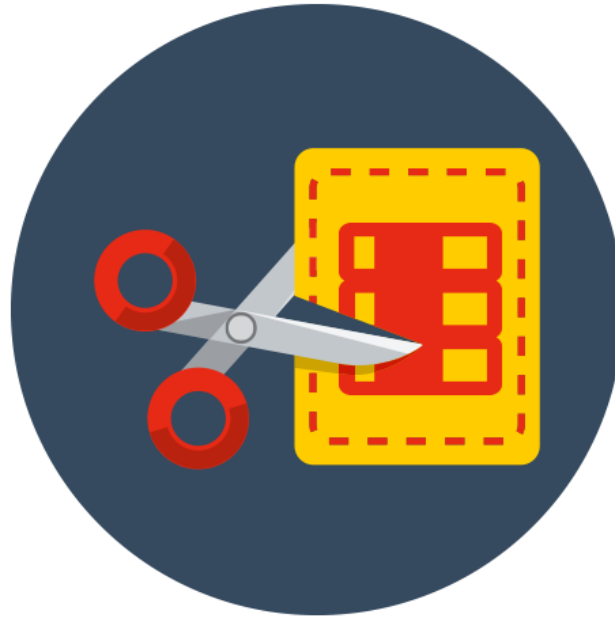
• Full (NOT partial) shipment.

EPQ

• Price is **fixed** and **constant**.

Question: Why Companies Offering Discount?

DISCOUNT



Quantity Discount Model

Total costs (TC) = Ordering costs + Holding costs + Product or Material costs

Ordering costs = Number of orders placed * cost to place an order
= (Demand/Quantity ordered) * S
= $(D/Q) * S$

Holding costs = Average inventory level * holding cost per unit
= (Max-Min)/2 * H
= $(Q-0)/2 * H$

Product or material costs = Price * Demand
= $p_r * D$

Total costs (TC) = $(D/Q) * S + (Q)/2 * H + p_r * D$

Exercise 1: What are the annual total costs?



3 min

Opaline is a small beverage company in Valais, Switzerland. Currently the order quantity for organic apple is 200kg at a time (a two-week supply). Opaline buys fruits from the local farmers. The annual demand for organic apple is 5200 kg. The ordering cost is estimated at CHF 50. The annual holding cost is 30 percent of the unit price. Opaline pays CHF 3.75 per kg for organic apple. What are the annual total costs?



Solution: What are the annual total costs?

Opaline is a small beverage company in Valais, Switzerland. Currently the order quantity for organic apple is 200kg at a time (a two-week supply). Opaline buys fruits from the local farmers. The annual demand for organic apple is 5200 kg. The ordering cost is estimated at CHF 50. The annual holding cost is 30 percent of the unit price. Opaline pays CHF 3.75 per kg for organic apple. What are the annual total costs?

The annual holding cost: $3.75 * 0.30 = 1.125$

TC = $(5200/200)*50 + (200/2 * 1.125) + (3.75 * 5200) = 19'614$



Exercise 2: What are the annual total costs?

Opaline is a small beverage company in Valais, Switzerland. Currently the order quantity for organic apple is 200kg at a time (a two-week supply). Opaline buys fruits from the local farmers. The annual demand for organic apple is 5200 kg. The ordering cost is estimated at CHF 50. The annual holding cost is 30 percent of the unit price. Opaline pays CHF 3.75 per kg for organic apple.

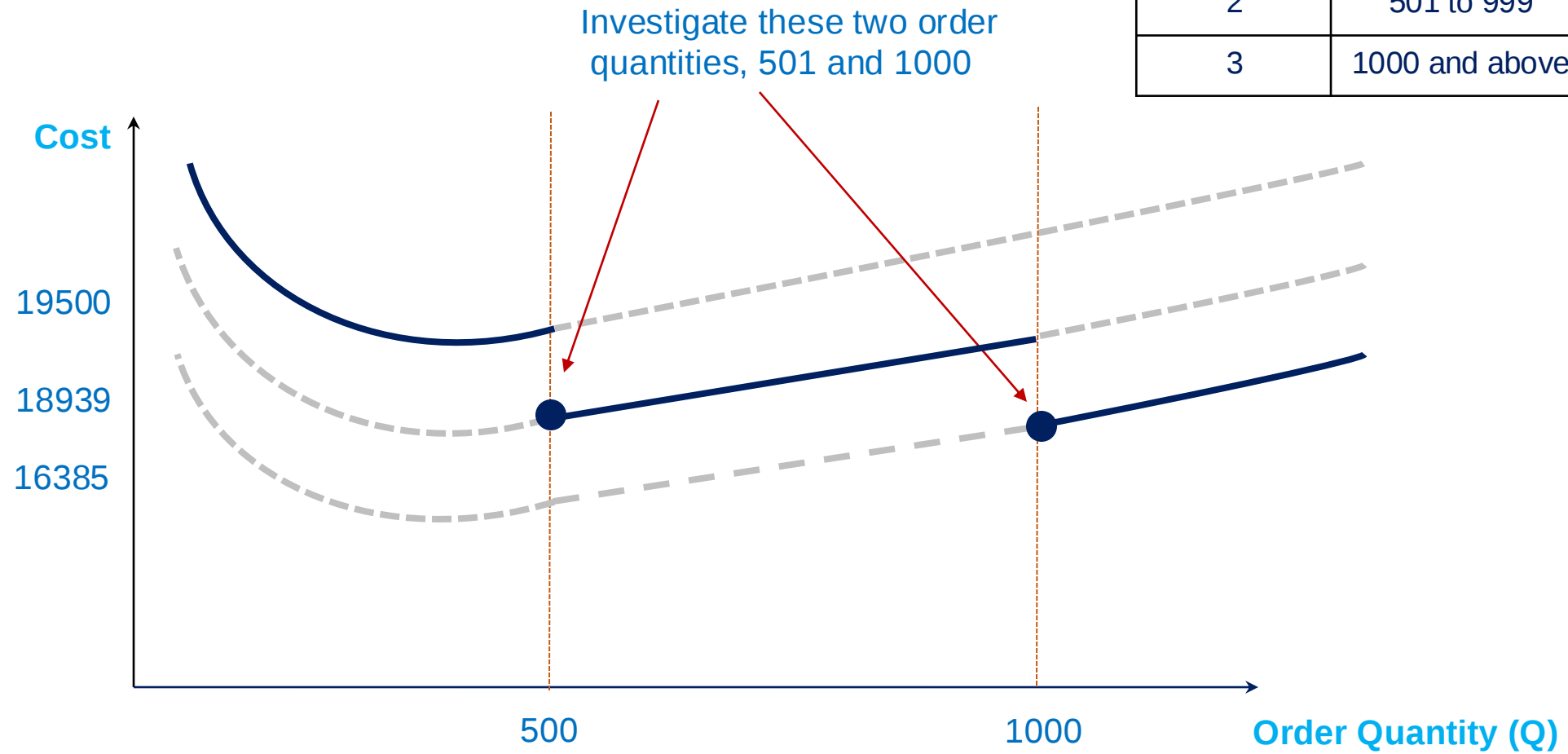
New production manager took an initiative and negotiated with supplier (farmers) and could get some discount on order quantity (price incentives). Prices are as follows:

Discount #	Quantity	Price (CHF)
1	0 to 500	3.75
2	501 to 999	3.5
3	1000 and above	3



Quantity Discount Total Cost Curves

Discount #	Quantity	Price (CHF)
1	0 to 500	3.75
2	501 to 999	3.5
3	1000 and above	3



Solution (I): What are the annual total costs?

1. Calculate Q^* using EOQ, *using cheapest price*:

$$Q^*(1: \text{ with new price}) = \sqrt{\frac{2 \cdot 5200 \cdot 50}{0.9}} = 760.11 \text{ kg}$$

2. Determine whether the order quantity is feasible:

It is not feasible since $501 < 760.11 < 999$

3. Calculate Q^* *with the next higher price*:

$$Q^*(2: \text{ with new price}) = 703.731 \text{ kg}$$

4. Determine whether the order quantity is feasible:

It is feasible since $501 < 703.731 < 999$ and aligned with the price



Solution (II): What are the annual total costs?

Since it is a feasible order quantity, we (re)calculate the total annual costs for this order quantity:

$$TC = (5200/703 * 50) + (703/2 * 1.05) + (3.5 * 5200) = 18'939$$

What if we order 1000 kg instead of 703, do we decrease the annual costs?

$$TC = (5200/1000 * 50) + (1000/2 * 1.05) + (3.5 * 5200) = 16'385$$

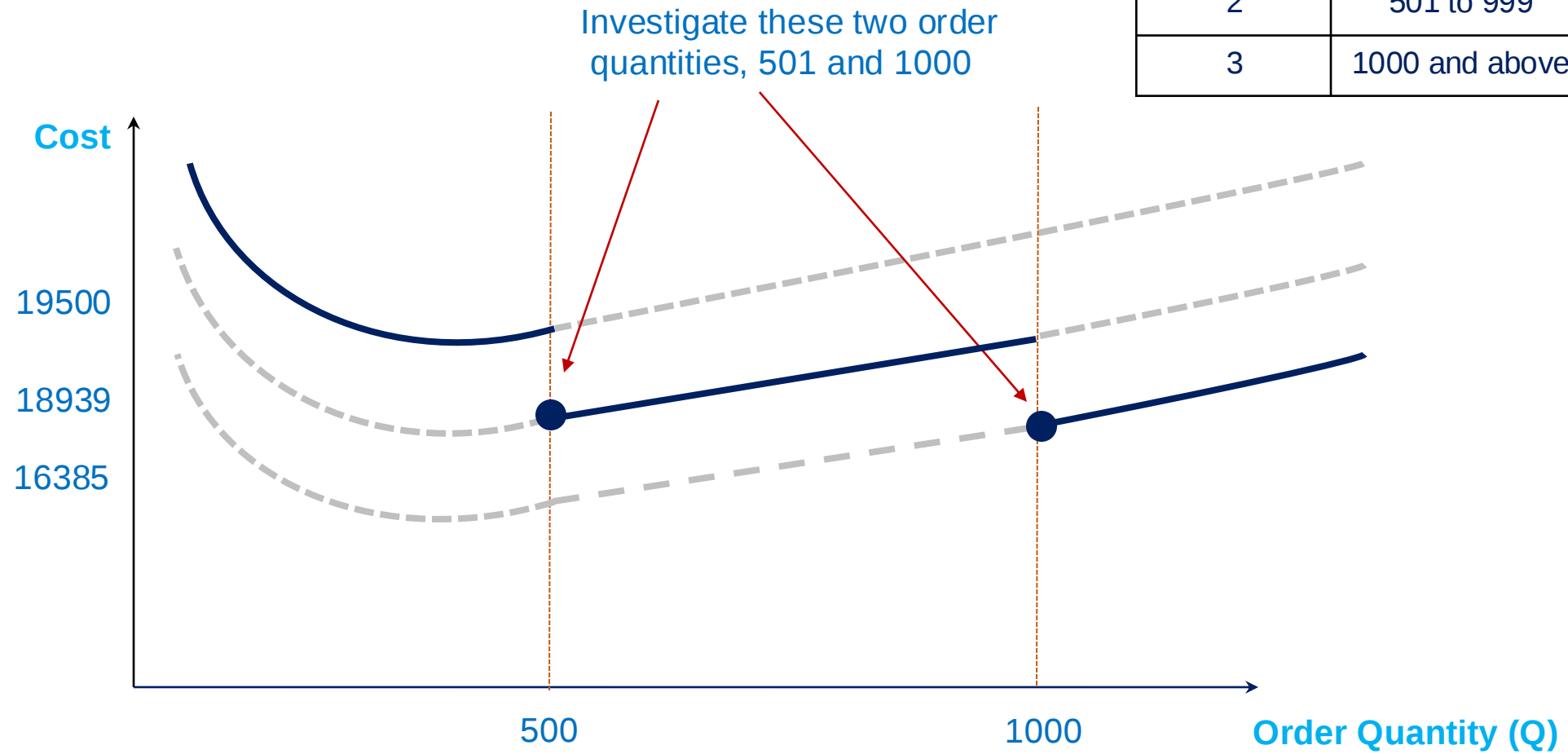
So, the optimal order policy for Opaline is to order 1000kg at a time.

Question: Do they have adequate storage capacity and can accommodate 1000 kg at a time?



Quantity Discount Total Cost Curves

Discount #	Quantity	Price (CHF)
1	0 to 500	3.75
2	501 to 999	3.5
3	1000 and above	3



Question: Why Companies Don't Use Optimal Order Quantity?

Why Companies Don't Use Optimal Order Quantity?

- Demand is not known and uniform.
- Companies have their own order policy depends on;
 - packaging,
 - machine output,
 - transportation optimization
 - ...
- Other reasons?

Assignment 11: Inventory Management



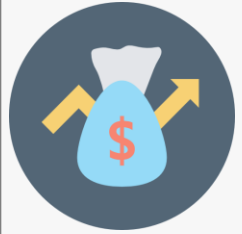
10 min

Task 1: Define what you need to calculate EOQ for your case study

Task 2: Define what you need to calculate EPQ for your case study

Task 3: Negotiate with your supplier (coach) and build a discount model

Inventory Management Models



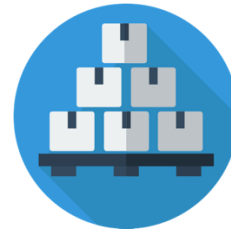
Economic Order Quantity (EOQ)



Safety Stock



Economic Production Quantity (EPQ)



Periodic Review System

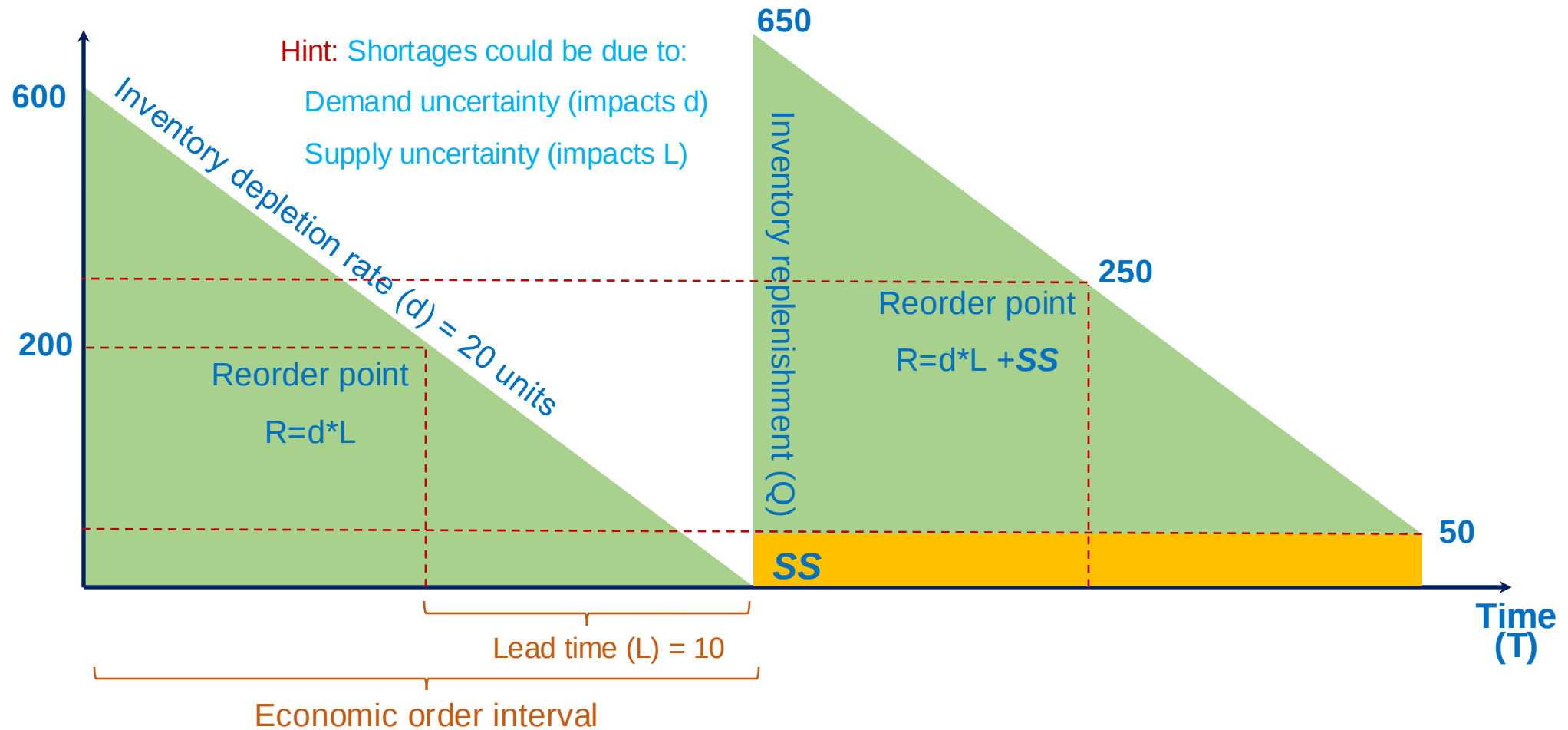


Discount Model



Single Period Inventory Model
(Chromas Tree)

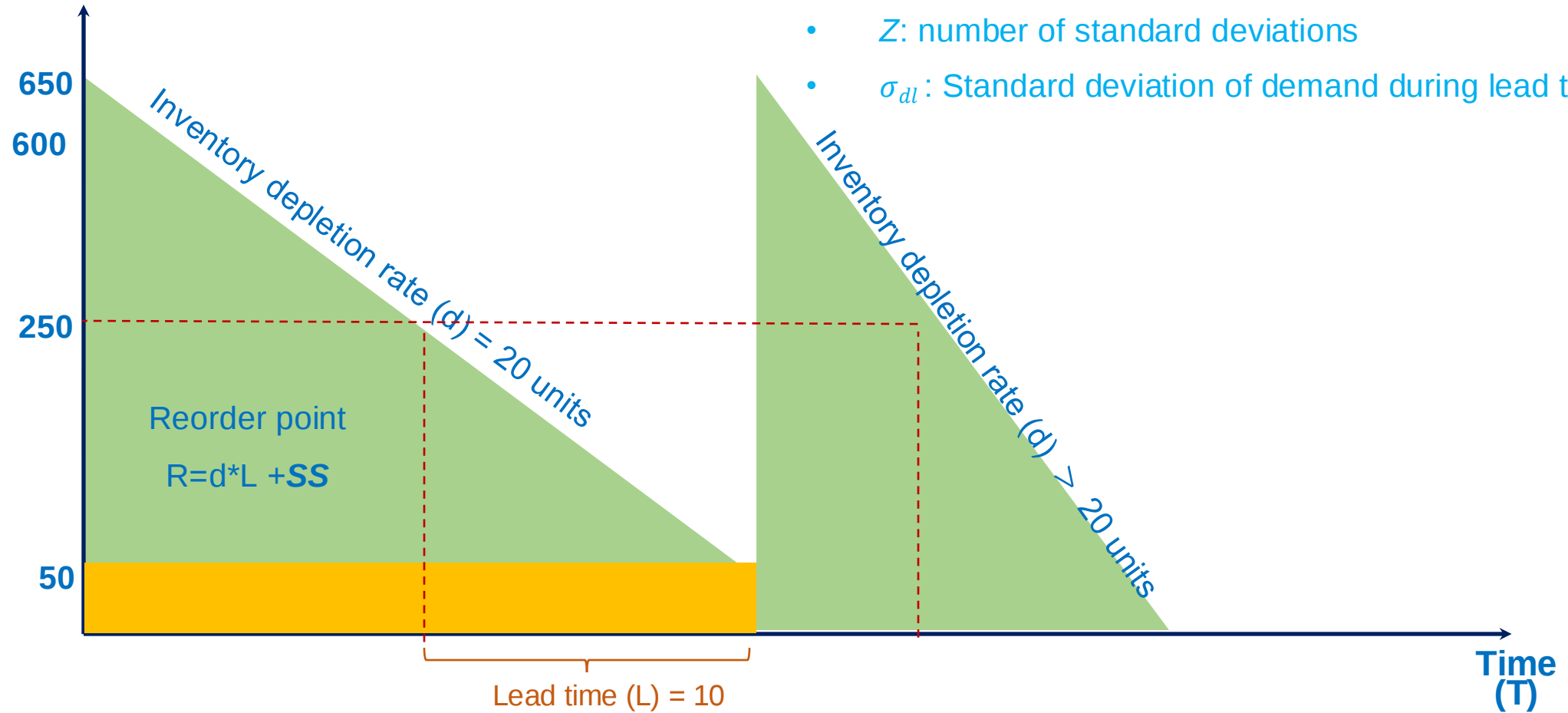
How Safety Stock (SS) Changes the Reorder Point?



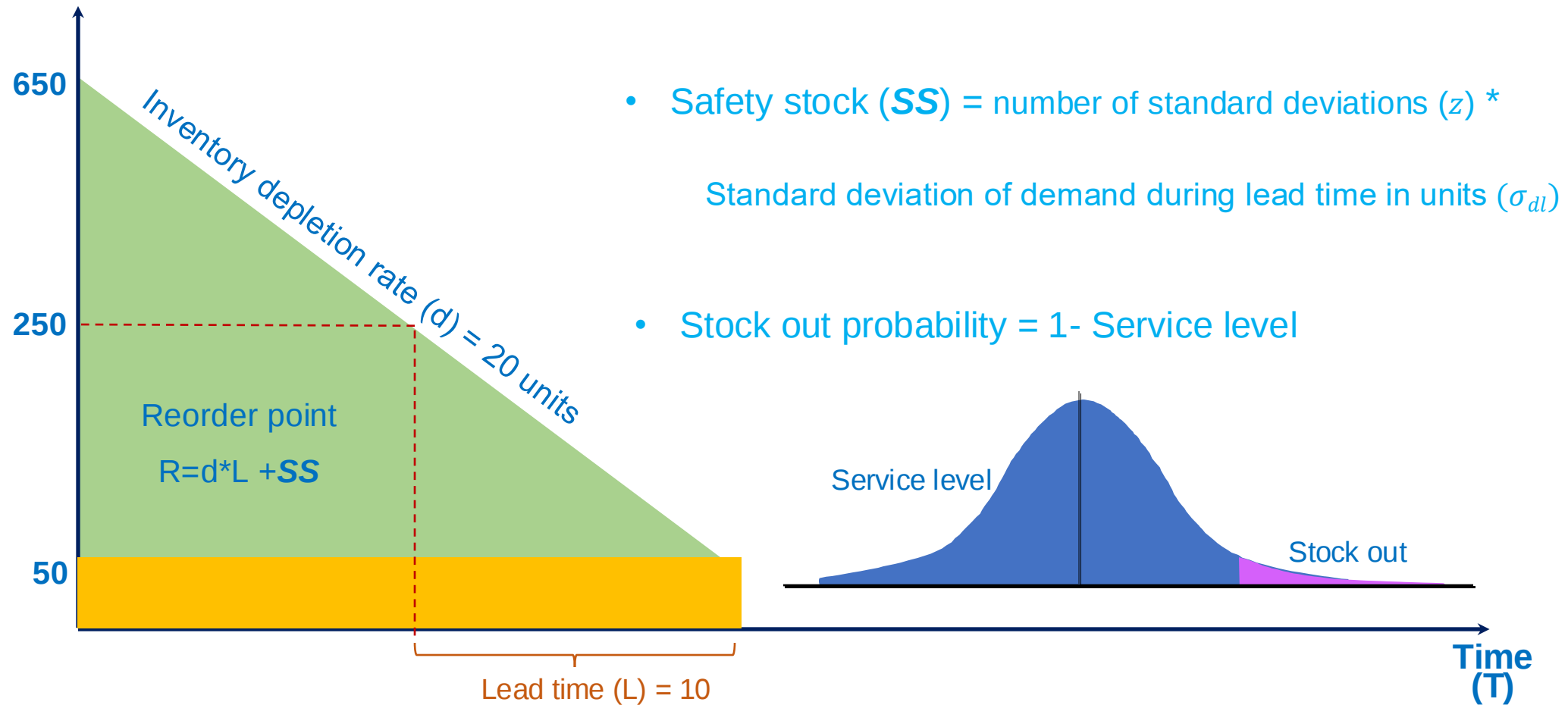
Demand Uncertainty During Leadtime

The stock out risk = 1- Service Level

- SS: Safety stock ($SS = z\sigma_{dl}$)
- Z: number of standard deviations
- σ_{dl} : Standard deviation of demand during lead time in units



Safety Stock (SS) – Known probability distribution



Exercise 1: Determine SS for Satellite at EPFL

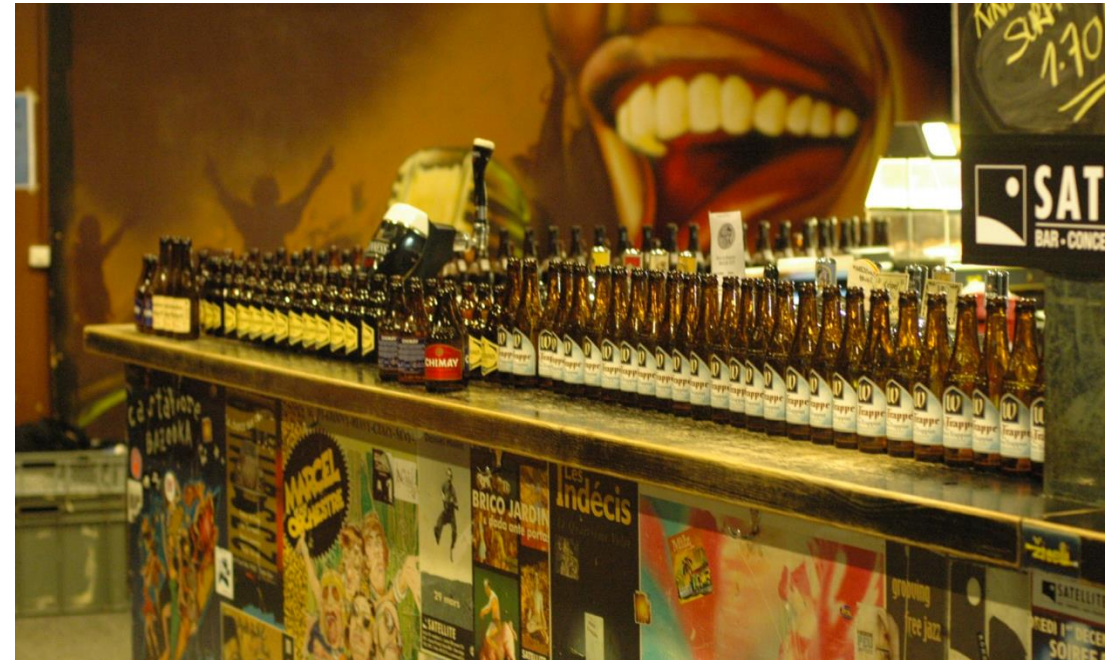


5 min

The managing team of Satellite determined that demand for beer during lead time averages 5000 bottles. The managing team believe that the demand during lead time can be described by a normal distribution with a mean of 5000 bottles and a standard deviation of 300 bottles. They decide to set the service level on 96% and for 4% of time be out of stock.

Step1: Determine the z value to use.

Step 2: Determine the reorder point



Production Management (ME-419)

Coaching Rooms

Amin Kaboli

Week 11 – Session 4 – Nov 22nd, 2024

Please Follow Your coaches to Your Designated Rooms

Coaches



Saria
GCA 330



Joao
GCA 331



Xavier
GRA 332

The Art of Giving and Receiving Effective Feedback



Feedback is a gift



Feedback/comments are
always welcome

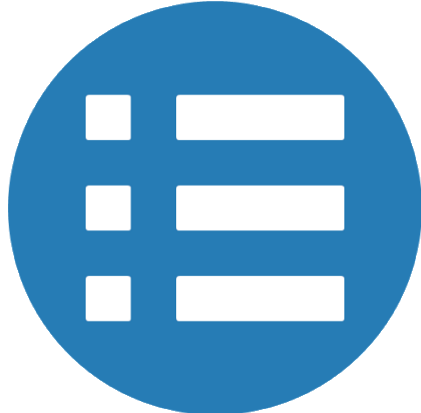
Giving Effective Feedback



Respectful

Ask for permission

May I share my observation



Fact-based

Share facts/ your feelings

What I observed/felt is that ...



Constructive

Stay focused on growth

What I suggest is that ...



Concise

Be to-the-point and short

Max three key points



Open

Be open to any reaction

I respect your feeling ...

Receiving Effective Feedback



Receive the gift

Be open and receptive

I appreciate your feedback



Listen

Listen to listen!

The goal is to listen not to answer, no interruption
(zip it)



Understand

Focus on THE message

The goal is to understand,
ask questions, clarify,
repeat key points, ...



Decide

You always have a choice

*Thank you, I have never
seen it this way*
OR
*Thank you, let me reflect
and get back to you?*



Follow up

Reach a common understanding

There are many ways to
follow up: revise the work,
set up a meeting, ...