Production Management (ME-419)

Module 3 – Supply Management

Inventory Management (EPQ, Discount, SS)

Amin Kaboli

Week 11 – Session 1&2 – Nov 21st, 2025

Course Framework

Business plan
Strategic plan
Financial plan

Production Management (ME-419)

Module 1	Module 2	Module 3	Module 4	
Introduction to PM	Demand Management	Supply Management	Next-Gen Production	Final Presentation
Sep	**Sep-Oct**	**Oct-Nov**	**Dec**	**Dec 19th**
Value Adding Network Production Process Flows, Bill of materials, Production procedures, Value adding activities	Demand disruptions Forecasting Methods Qualitative methods Quantitative methods Demand plan	Supply disruptions Production Planning AP, MPS, MRP Capacity Planning Inventory Management Supply Plan	Latest trends in Production Management Orchestrating supply chain effectively From linear to circular models	Final presentation & solid understanding of the course

Learning Points

3 min

What did you learn the last week?

- Point 1
- Point 2
- Point 3
- …

Inventory Management – Decision Variables

How much to buy?

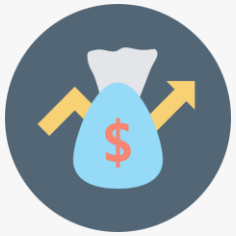
When to buy?

Order Quantity (Q)

Order Time (T)

Companies make replenishment decisions to manage inventory.

Inventory Management Models

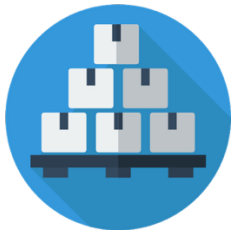


Economic Order Quantity (EOQ)

Economic Production Quantity (EPQ)

Discount Model

Safety Stock



Periodic Review System

Single Period Inventory Model (Chromas Tree)

Economic Order Quantity (EOQ) - Assumption

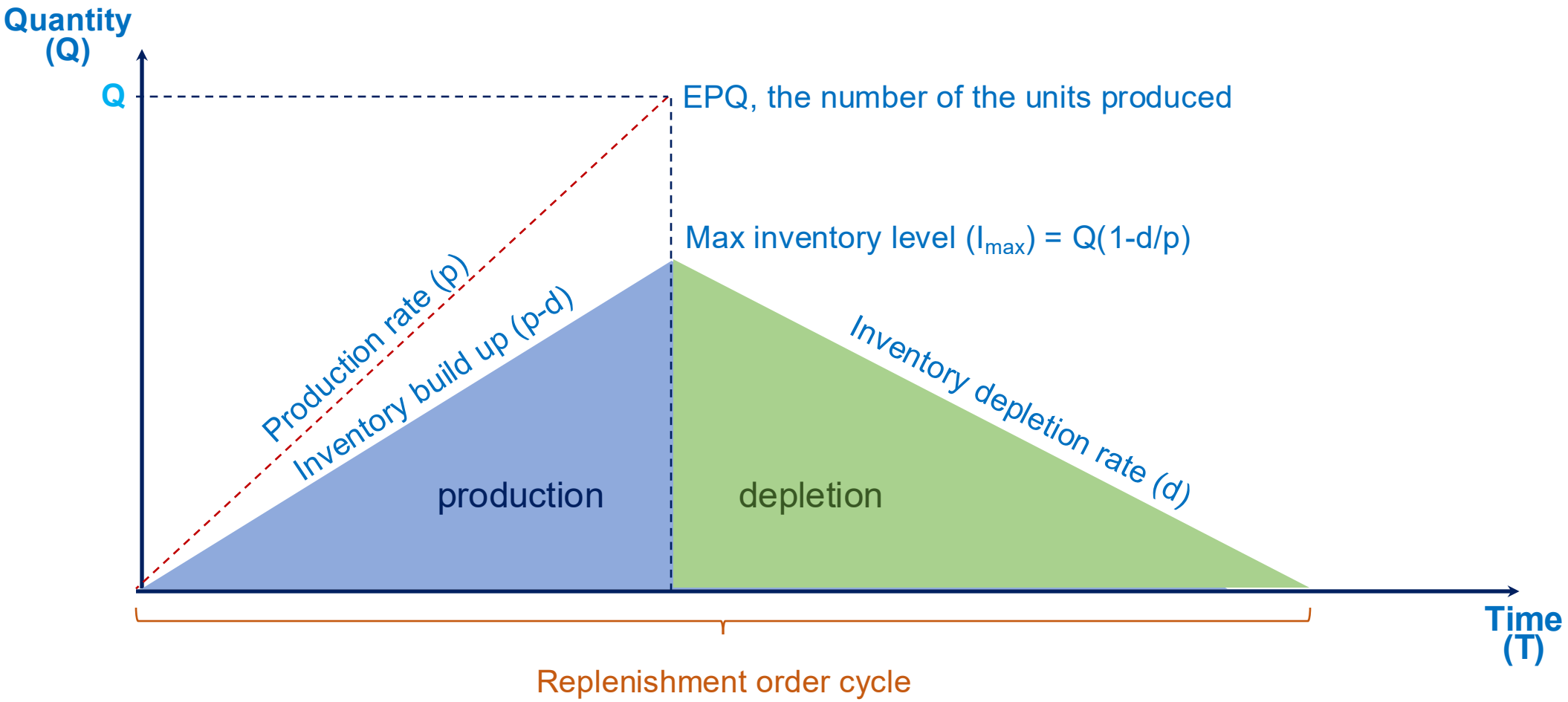
- Demand is known and constant.
- Lead time is known and constant.
- Ordering (and set up) costs are fixed and constant.
- Unlimited capacity.
- Full (NOT partial) shipment.
- Price is fixed and constant.

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

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

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

Total Costs in EPQ

Total costs (TC) = Ordering costs + Holding 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

= $\mathbf{(I_{max})}$/2 * H

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

Total costs (TC) = (D/Q) * S + (Q(1-d/p))/2 * H

Calculating EPQ

Total costs (TC) = (D/Q) * S + (Q(1-d/p))/2 * H

Ordering costs = (D/Q) * S

Holing costs = **Q(1-d/p)**/2 * H

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

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

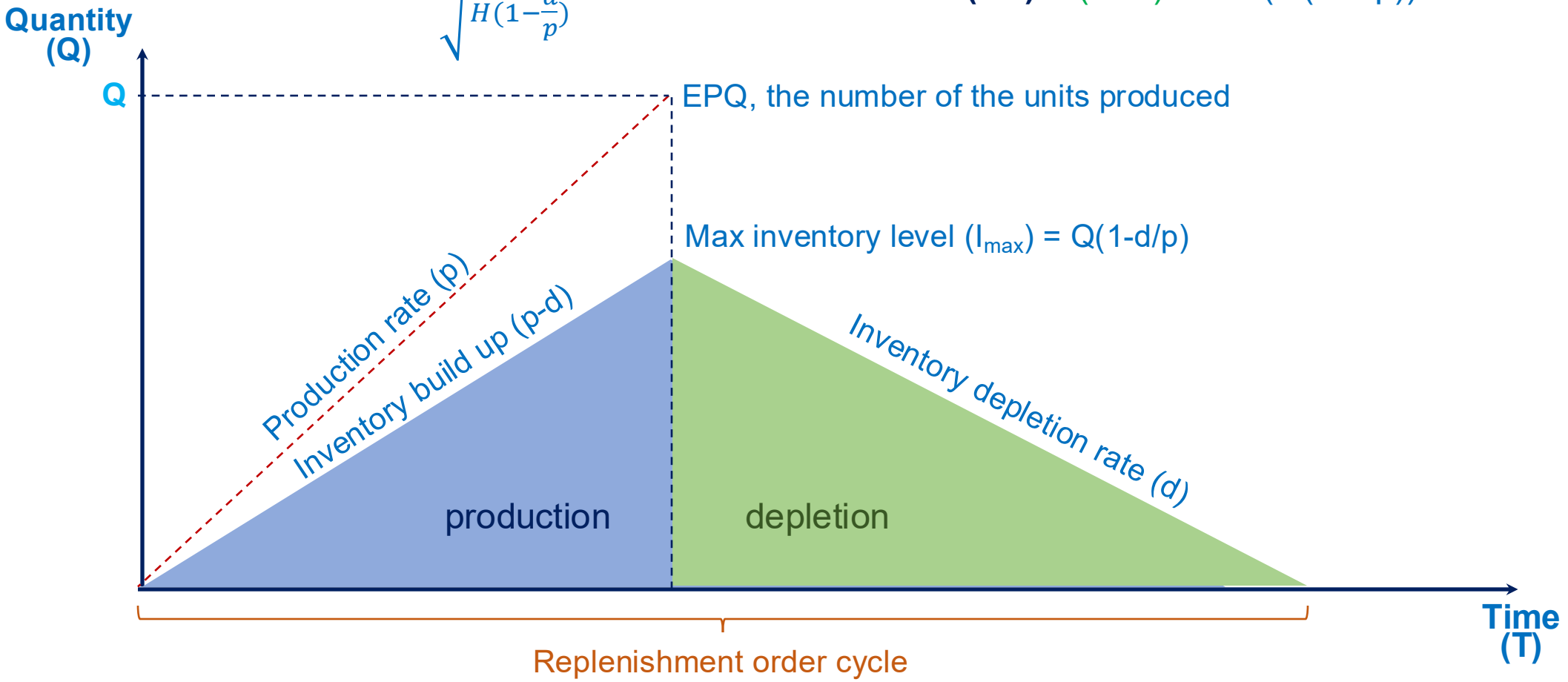
$$\mathbf{Q^*} = \sqrt{\frac{2DS}{H(1-\frac{d}{p})}}$$

Economic Production Quantity (EPQ)

- This model allows partial delivery

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

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

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

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

Average daily demand: *d* = 10000 units /250 = 40 units per day
Daily production: *p* = 25000 units /250 = 100 units per day
Daily ratio: 40/100 = 0.4

Average weekly demand: *d* = 10000 units /50 = 200 units per week
Daily production: *p* = 25000 units /50 = 500 units per week
Daily ratio: 200/500 = 0.4

Average annual demand: *d* = 10000 units
Daily production: *p* = 25000 units
Daily ratio: 10000/25000 = 0.4

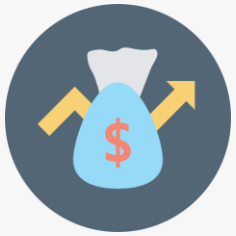
Assignment: Inventory Management

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

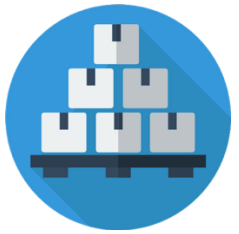
Inventory Management Models



Economic Order Quantity (EOQ)

Safety Stock

Economic Production Quantity (EPQ)



Periodic Review System

Discount Model

Single Period Inventory Model (Chromas Tree)

Question

Why Companies Offering Discount?

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.

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?

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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
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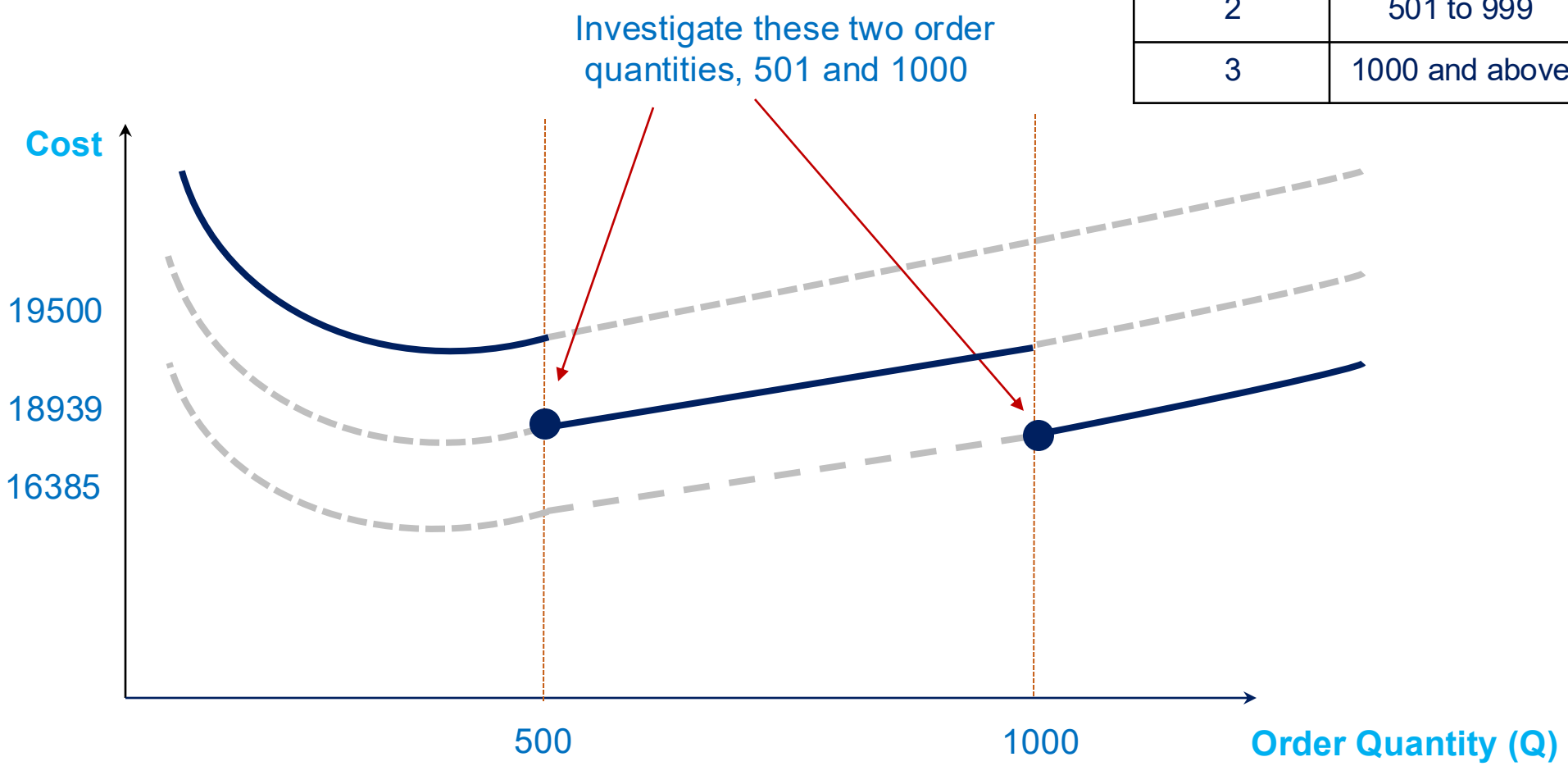


Solution (I): What are the annual total costs?

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

Q*(1: with new price) = $\sqrt{\frac{2*5200*50}{0.9}}$ = 760.11 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: with new price) = 703.731 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?

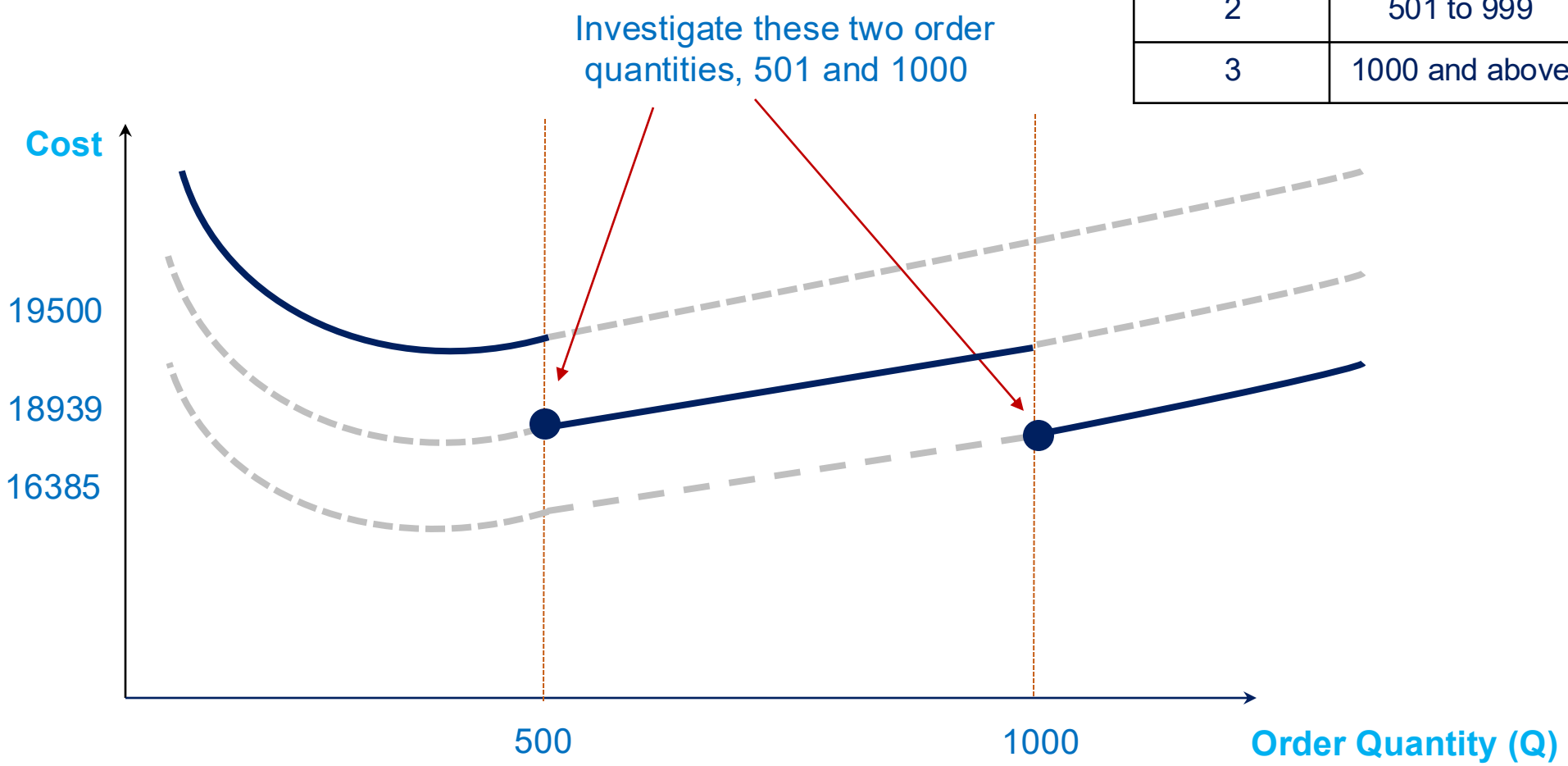
TC = (5200/1000 * 50) + (1000/2 * 1.05) + (3.5 * 5200) = 16’385

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

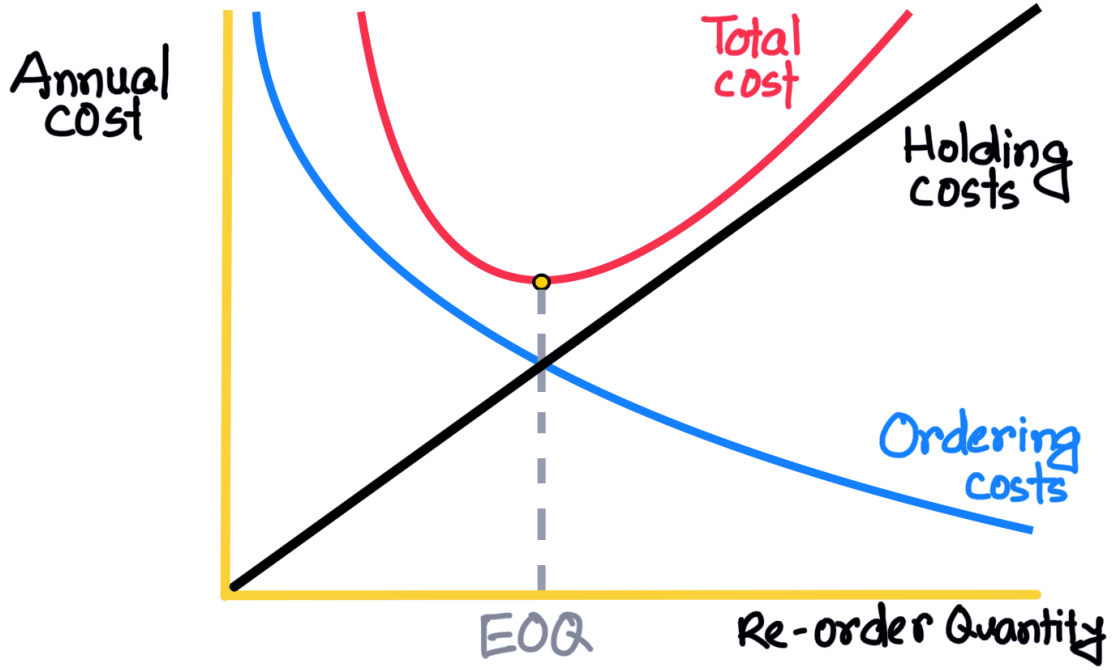
Question: Do they have adequate storage capacity and can accommodate 1000 kg at a time?

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

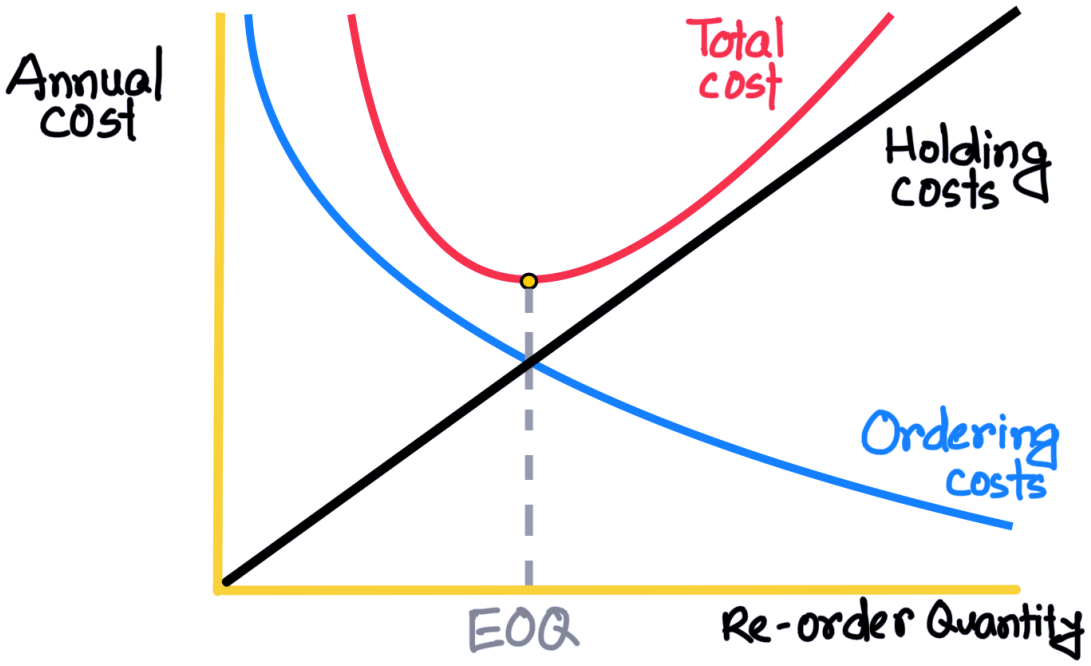


Question



Why Companies Don’t Use Optimal Order Quantity?

Question: 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: Inventory Management

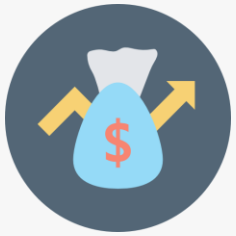
10 min

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

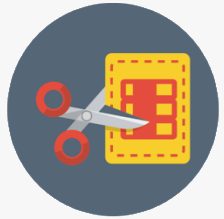
Task 3: Negotiate with your supplier (coach) and build a discount model

Inventory Management Models



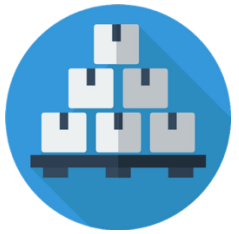
Economic Order Quantity (EOQ)

Economic Production Quantity (EPQ)



Discount Model

Safety Stock



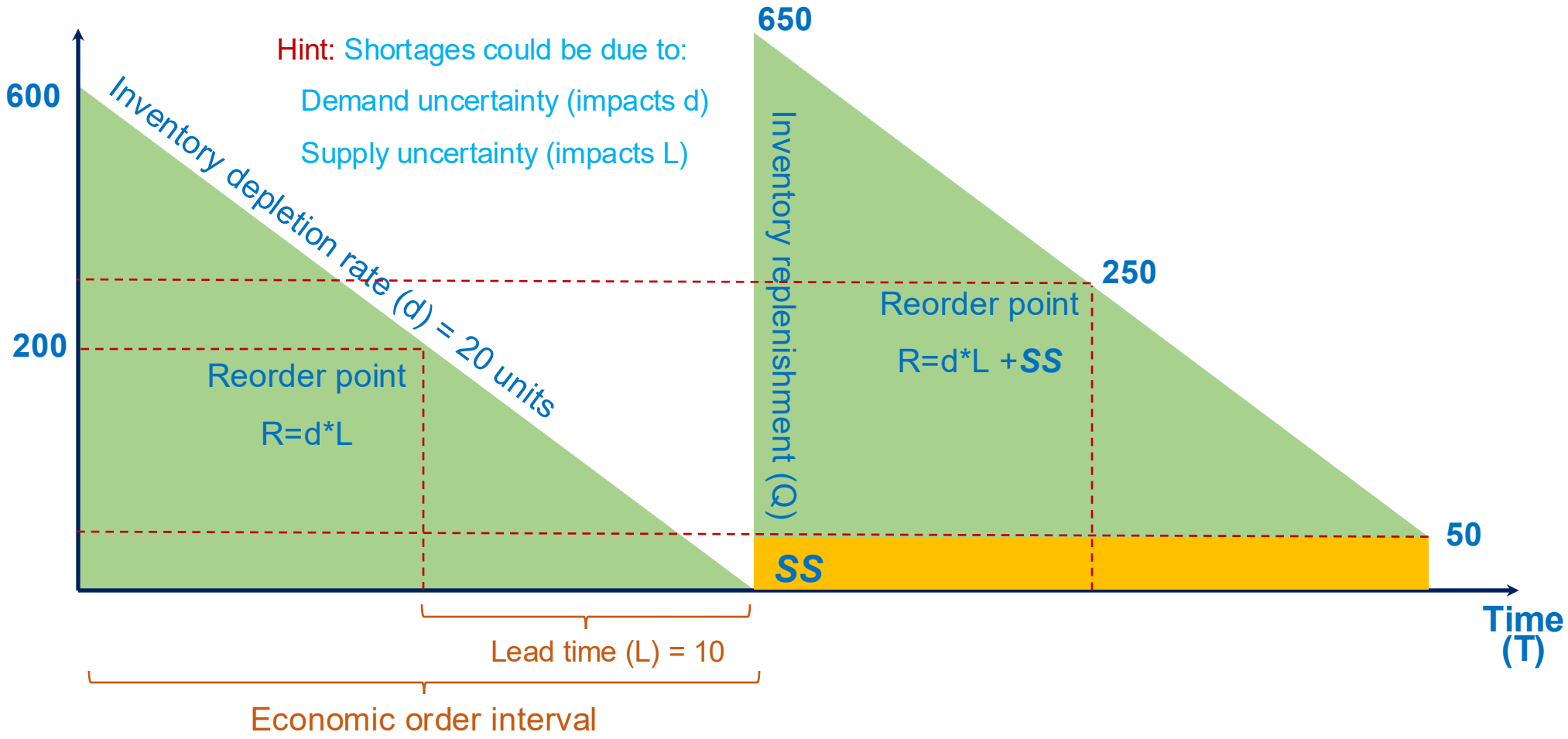
Periodic Review System

Single Period Inventory Model (Chromas Tree)

Question

Who keeps some kind of safety buffer in life (money, food, time, energy) just in case something unexpected happens?

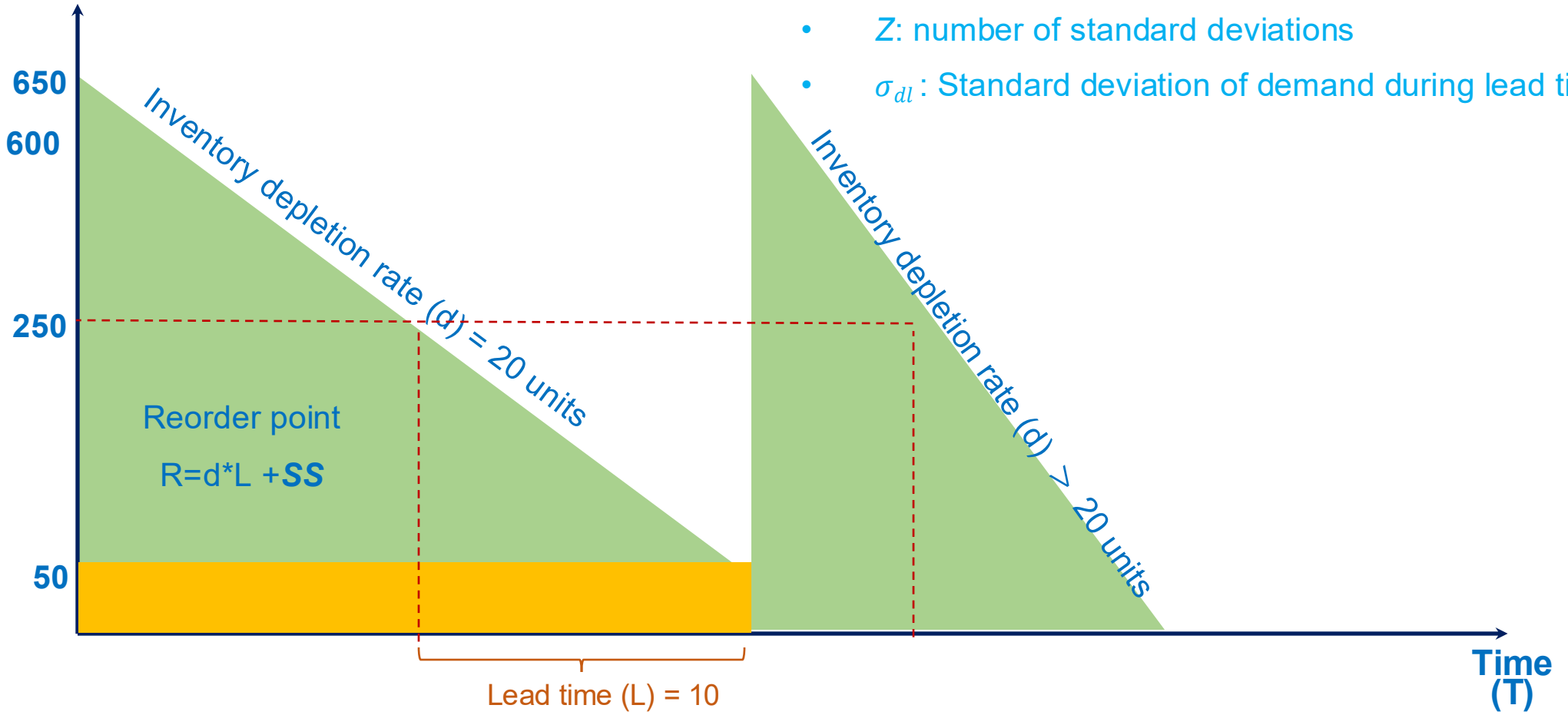
How Safety Stock (SS) Changes the Reorder Point?



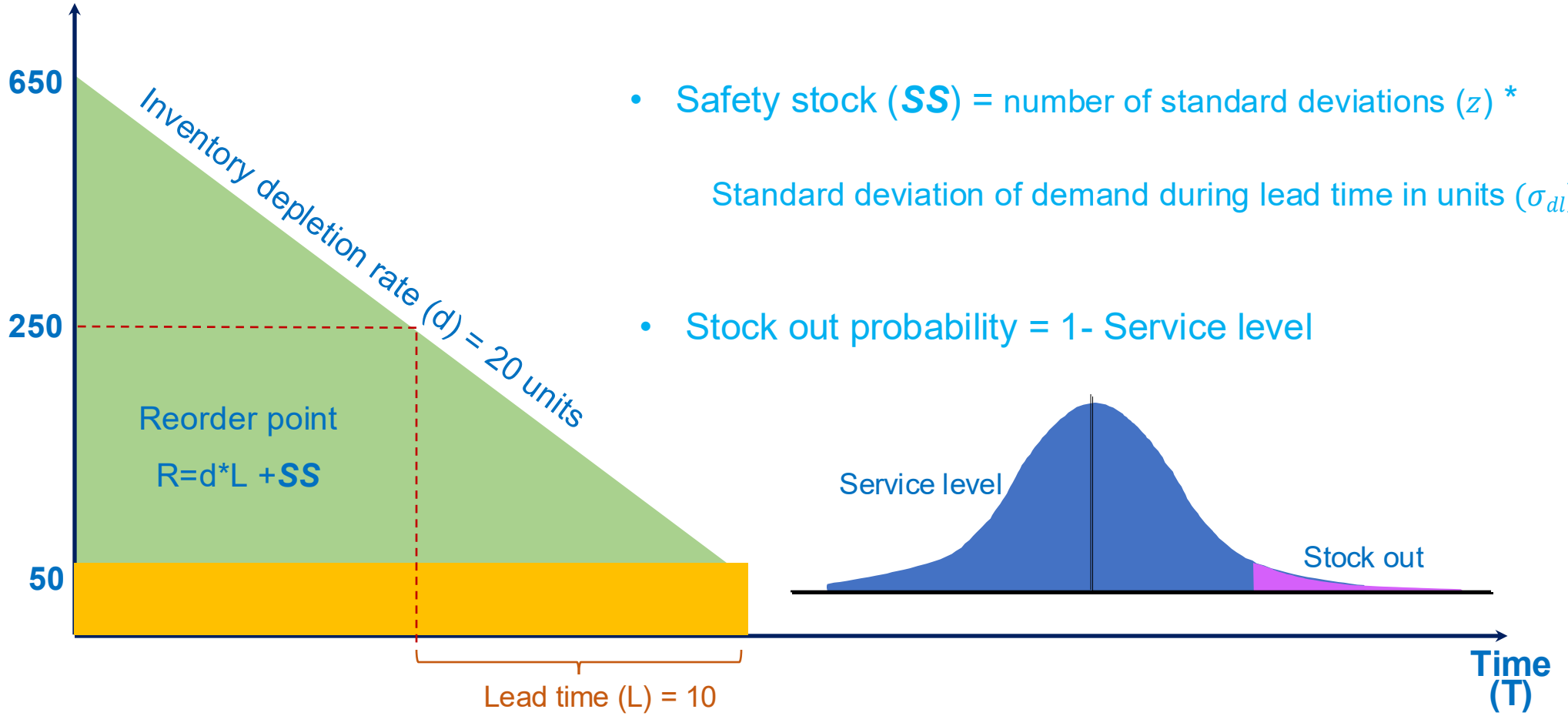
Demand Uncertainty During Leadtime

The stock out risk = 1- Service Level

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



Safety Stock (SS) – Known probability distribution



- Safety stock (***SS***) = number of standard deviations (z) *

  Standard deviation of demand during lead time in units (σ_{dl})

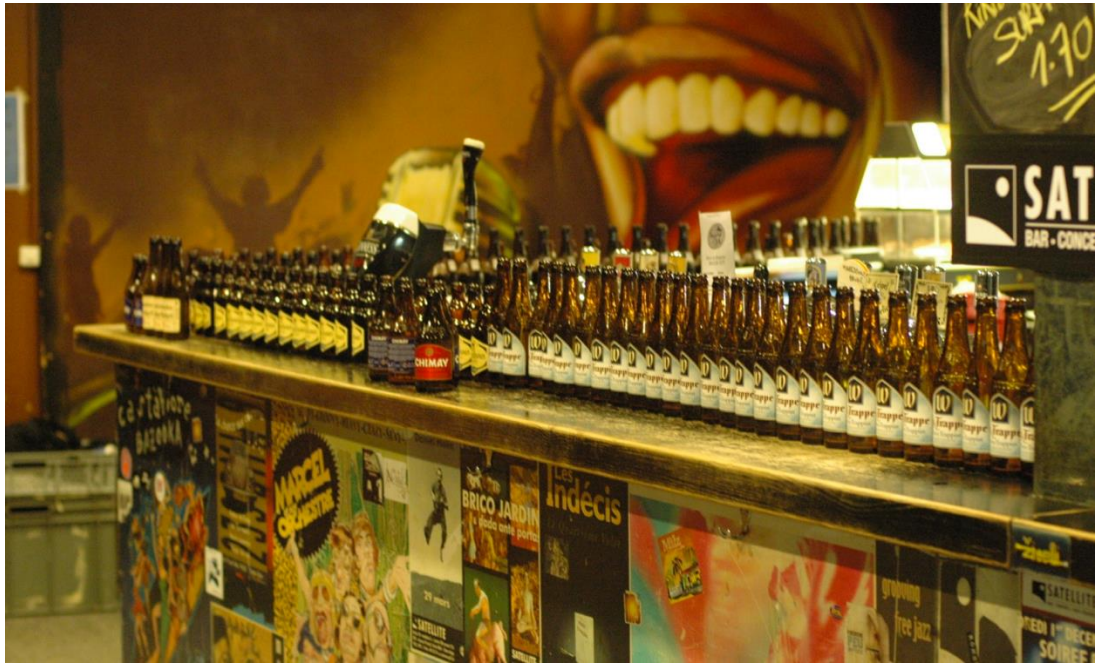
- Stock out probability = 1- Service level

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



Solution: Determine SS for Satellite at EPFL

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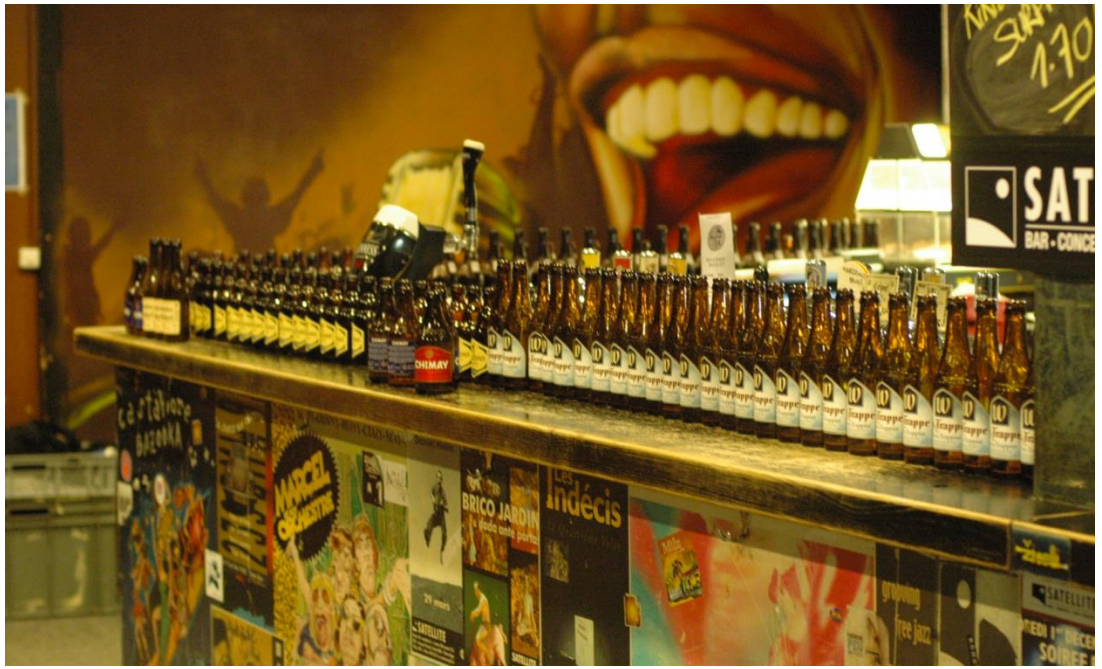
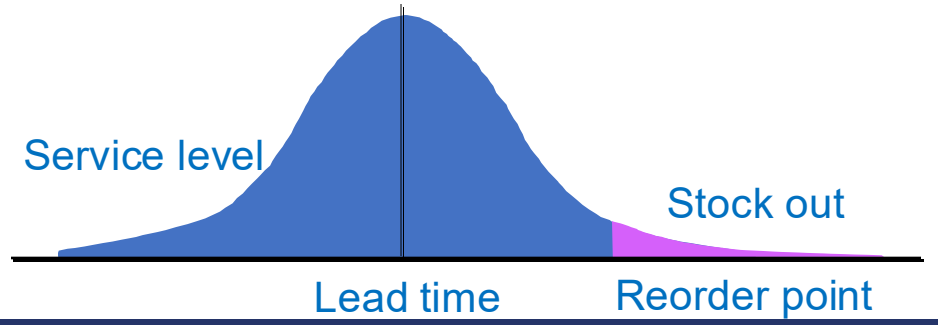


Step1: Determine the z value to use.
Step 2: Determine the reorder point

Service level = 1- Probability (stockout)
96% = 1 – 0.04

Excel function: NORMSINV (0.96) = 1.75
SS = 1.75 * 300 = 525

R = 5’000 + 525 = 5’525



Solution: Determine SS for Satellite at EPFL

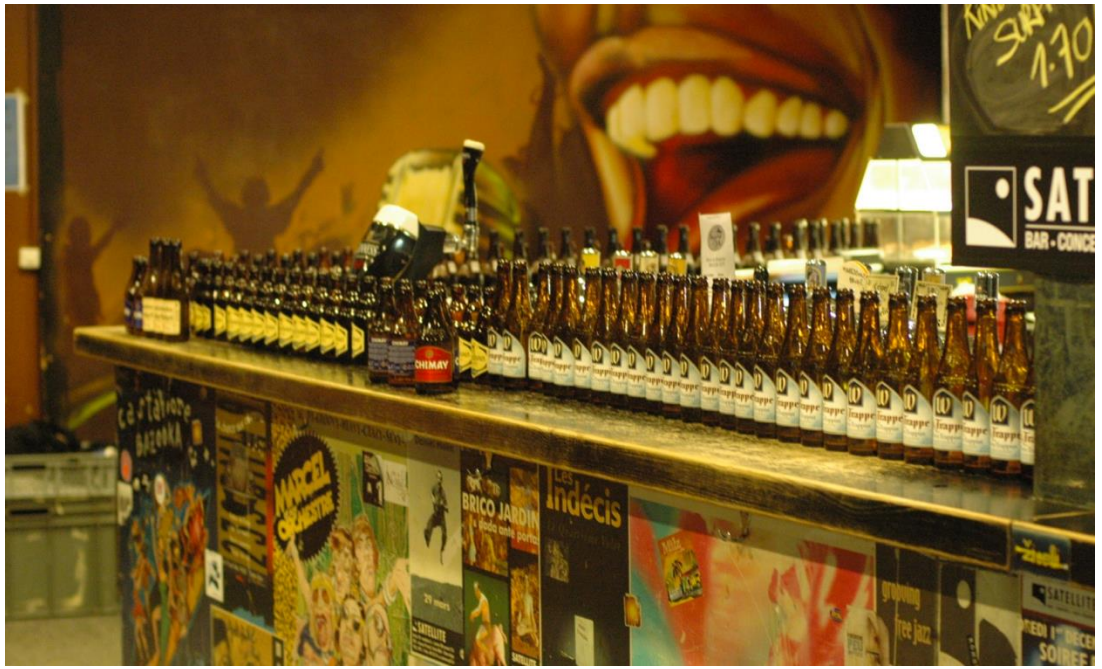
The managing team of Satellite determined that demand for beer during lead time averages 3750 bottles. The managing team believe that the demand during lead time can be described by a normal distribution with a mean of 3750 bottles and a standard deviation of 525 bottles. They decide to set the service level on 98% and for 2% of time be out of stock.

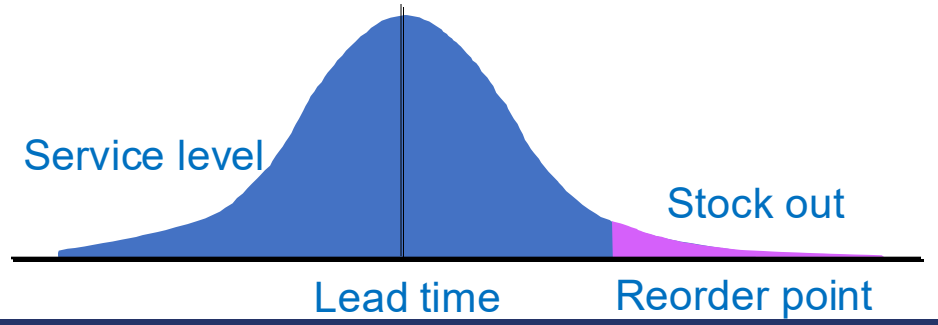
Step1: Determine the z value to use.
Step 2: Determine the reorder point

Service level = 1- Probability (stockout)
98% = 1 – 0.02

Excel function: NORMSINV (0.98) = 2.05
SS = 2.05 * 525 = 1078

R = 3’750 + 1078 = 4’828





Assignment: 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

Task 4: Define Safety Stock for your product (Finished Good)
Consider following service levels (95%, 90%, 85%)

Production Management (ME-419)

Coaching Rooms

Amin Kaboli

Week 11 – Session 4 – Nov 21st, 2025

The Art of Giving and Receiving Effective Feedback

Feedback is a gift

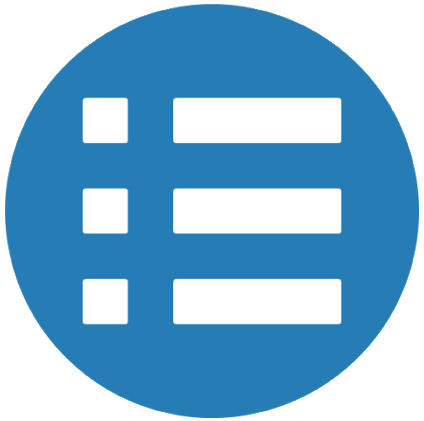
Feedback/comments are always welcome

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, …