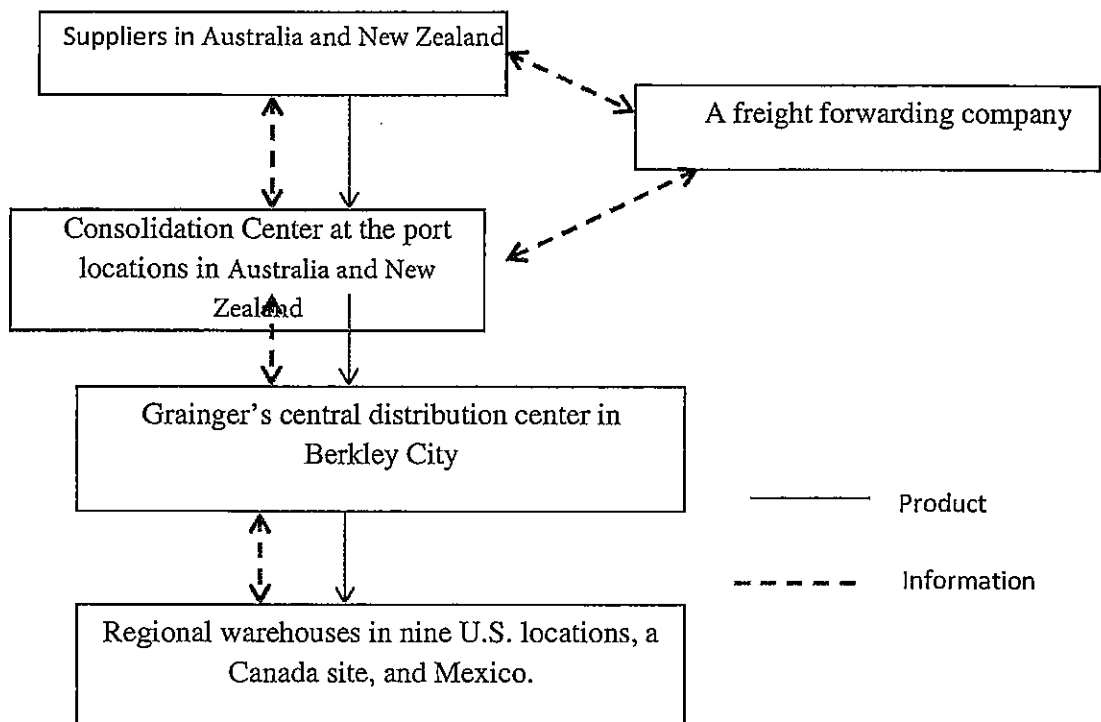


# **Practice Exam 3**

Q1. (15 credits) S. Walsh, Inc. is a leading supplier of maintenance, repair, and operating motors to businesses and institution all over the world. Walsh works with over 250 suppliers in the Australia and New Zealand region. These suppliers produce motors to Walsh’s specifications and ship to the United States using ocean freight carriers from four major ports in Australia and New Zealand. The contracts that Walsh has with Australian and New Zealand suppliers currently specify that the supplier owns the motors and is responsible for all costs incurred until the motors are delivered to the shipping port. Walsh works with a freight forwarding company that coordinates all shipments from australian and New Zealand suppliers.

Currently, suppliers first ship motors on pallets to consolidation centers operated by the freight forwarding company at the port locations. At the consolidation centers, motors are packed in 40-foot containers. From any port location in Australia or New Zealand, containers are shipped to U.S. entry ports in either San Francisco or San Diego After passing through customs, the containers are shipped by rail to Walsh’s central distribution center in Berkley City. The containers are unloaded and quality is checked in BerkleyCity. From there, individual items are sent to regional warehouses in nine U.S. locations, a Canada site, and Mexico.

- a. Draw a figure to describe the supply chain of Grainger. Indicate clearly all flows of product and all flows of information. (9 credits) [Lecture 1]



- Formulate 3 different types of logistics costs for **Walsh Inc.**. (3 credits) [Lecture 1]
- b. Costs for planning and scheduling of staff  
 Costs for inventory management of product in storage  
 Costs for shipping the products in the North America  
 Costs for hiring a freight forwarding company  
 Cost for purchasing from suppliers  
 Cost for tax payment at U.S. entry ports
- c. Formulate 3 logistics decision problems that might occur in this supply chain of Walsh. (3 credits) [Lecture 1]
- Selection of a freight forwarding company  
 Selection of suppliers  
 Selection of the location of the central distribution center  
 Selection of regional warehouses  
 Selection of shipping modes in the North America

Q2. (15 Credits)

Quality Parts Company supplies parts for a computer manufacturer located a few miles away. Demand for parts from the computer company is 15 units per hour. Each part has to go through a system with three main stages (Milling, Lathing, Assembly) in order to be completed. At the Milling stage, there are two identical machines operating in parallel. The production time of each machine follows a normal distribution with a mean of 6 minutes and a standard deviation of 5 minutes. At the Lathing stage, 16 products are processed in a batch at a single machine. The set-up time is 15 minutes per batch. Each product takes 3 minutes. At the Assembly stage, there is an assembly line with the capacity of 30 jobs per hour.

- a. What is the productive utilisation at the Assembly stage? (5 credits) [Lecture 2]

Solution: Arrival rate:  $\lambda = 15$  units per hour  
 The capacity at the Milling stage:  $\frac{60}{6} \times 2 = 20$  units per hour

The capacity at the Lathing stage:  $\frac{60}{3 \times 16 + 15} \times 16 = 15.238$  units per hour

Since the arrival process is the bottleneck, the arrival rate at the Assembly stage is 15 units per hour. The capacity at the Assembly stage is 30 units per hour.

The productive utilisation at the Assembly stage is  $15/30 = 0.5$

- b. What is the corresponding Work-in-Progress in the system? (5 credits) [Lecture 2]

$$\text{The corresponding WIP is given by } 2 \times \frac{15}{20} + 16 \times \frac{15}{15.238} + \frac{15}{30} = 17.75 \text{ units}$$

- c. Suppose that the demand is increased to 18 units per hour. What is the minimum batch size at the Lathing stage in order to fulfill the demand requirement? (5 credits)[Lecture 2]

Define  $x$  as the minimum batch size.

To meet the demand requirement, we have

$$\frac{60x}{3x+15} \geq 18 \Leftrightarrow x \geq 45$$

The minimal batch size is 45.

Q3. (15 Credits) Karl opens a drive-thru with one cashier. Customers will enter the “place order” line to meet the cashier. Currently, it takes the cashier on average 4 minutes to complete an order, following a negative exponential distribution. During an hour, 12 customers arrive on average (the number of arrivals is Poisson distributed).

- What is the average number of customers in the drive-thru area? (5 credits) [page 219-222]
- What is the probability that at most 3 customers are waiting? (5 credits)[page 225-230]
- The manager estimates that every minute a customer spends waiting in line, it costs € 1 due to customers’ dissatisfaction, and loss of future business. To improve the service, the manager sends the cashier to a strict training class. After the class, the cashier can take an order in exactly 3 minutes. What is the expected cost saving per hour caused by the training? (5 credits) [page 232-233]

- a. Choose M/M/1 model

$$\lambda = 12 \text{ per hour, } \mu = 15 \text{ per hour}$$

$$L_s = \frac{\lambda}{\mu - \lambda} = 4 \text{ customers}$$

b.  $P_{n \leq 4} = 1 - P_{n > 4} = 1 - \left(\frac{\lambda}{\mu}\right)^5 = 0.672$

c. In the current system,  $W_q = \frac{\lambda}{\mu(\mu - \lambda)} = \frac{4}{15} \text{ hour} = 16 \text{ minutes}$

After the training,  $\mu = 20$  per hour .

We use the M/D/1 model.

$$W_q = \frac{\lambda}{2\mu(\mu - \lambda)} = 2.25 \text{ minutes}$$

The expected cost per hour is  $12 \times (16 - 2.25) = \text{Euro } 165 \text{ per hour.}$

#### Question 4 (20 points)

Case: JUMP INC.

Jump Inc. is a producer of recreational and military parachutes. With its production location in Flint, Michigan it is one of the largest producers of parachutes worldwide. Jump Inc. sells to customers worldwide, but its main customer base is in Europe and the US. Parachute Inc. distinguishes two main product groups RecreParachute® and ProParachute®. RecreParachute is the brand available to consumers and ProParachute is available to institutional customers such as the army and the navy.

RecreParachute parachutes come in five different shapes, three different wingspans and eleven colors. Jump Inc. sells their parachutes only to certified retailers, which in turn sell the parachute to the consumer. ProParachute parachutes are always designed together with the institutional customer as the army might require a different parachute for different missions. The demand for RecreParachute parachutes shows a strong seasonal pattern, with demand peaking in the beginning of April as parachuting in the Northern hemisphere is restricted from April until September due to the weather. Jump Inc. prides itself for being never out of stock, which is greatly valued by its customers. The demand for ProParachute parachutes is less predictable.

As RecreParachute parachutes are not subject to any fashion and the seasonal pattern is predictable Jump Inc. knows the amount of each parachute it should have on stock during the year without running out of stock. When the stock of a type of RecreParachute parachute comes below a certain level a production order is given for this specific type. The process for ProParachute parachutes is less simple and involves intensive communication between Jump Inc. and a customer. Once the design and technical aspects of the ProParachute parachute are agreed upon the purchasing department buys all the required materials needed for this product line.

The production process starts with getting the right fabric from the warehouse. A worker places the fabric on a light table which allows him to spot any flaws in the woven pattern. The next step is to feed the fabric to a laser cutter which cuts out the different pieces for a parachute. Depending on the model this can vary between 30 and 100. Now the parts are sewed together by hand using nylon tape to reinforce the seams. The different parts have holes that allow the flow of air between the layers to stabilize the descent. The parachutes are stored in a warehouse and have to wait on average 2 weeks before being transported to yet another quality control center where the stitches are checked for flaws. Every 2.5 cm of stitching needs to have between 7 and 10 stitches or else it could break during flight. The corners of the parachute are now reinforced with triangular patches made from woven nylon and steel wire. These patches will serve as the contact points for the 60 lines that connect the parachute to the jumper's harness. Now the lines can be attached by using a knot that can only be applied manually. This process takes 2 hours per parachute. The strings are attached to the harness and the parachute folded in a backpack. Each backpack is put into a wooden crate and transported to the warehouse. Depending on the type of product it will be sent to the RecreParachute warehouse or the ProParachute storage facility.

- a. In the case above one or several Customer Order Decoupling Point(s) can be distinguished. Explain for each CODP how you characterize it (e.g. MTO, MTS) and where it is positioned in the process. (4 points) [page 175]

ProParachute - Engineer to order. Parachutes are designed, materials are purchased and products are produced bases on a specific customer order

The CODP lies at the design department

RecreParachute - Make to Stock. All production orders are initiated by stock levels of final product (re-order point)

The CODP lies at the final product warehouse

**For each CODP discuss two forces which caused the current position of the CODP. (4 points)[page 175]**

b.

ProParachute:

Customer specific products - all parachutes are tailor made

Irregular demand - Prarachute inc. never knows when a ProJump order comes in

RecreParachute:

Desired short leadtime due to seasonality

High delivery reliability as customers value Parachute inc. never being out of stock

Also demand is easy to forecast and stable

- c. An external consultant advised Parachute Inc. to adopt a 'Fixed Position lay-out'. The production manager of Jump inc. disagrees with the consultant and argues that there is nothing wrong with the current lay-out. Explain which lay-out type Parachute Inc. has and discuss whether the advice of the consultant should be followed or not. (4 points) [page 180]

**Current Lay-out:** most likely a product layout

**Explanation:** when considering the likeness of the products low routing variability (each parachute undergoes the same sequence of process steps) it is highly likely that the machines are arranged in the sequence of the consecutive process steps.

**Advice Consultant: ~~GOOD~~ / BAD**

Explanation: A fixed position lay-out is only suitable for large projects as all the resources are required to come to the 'product' rather than the product flows through the resources. In the case of a parachute it is highly inefficient to do so.

**d. The same consultant advises Jump Inc. to start processing the orders for RecreParachutes parachutes in the same way as ProJump parachutes. This, he argues will allow Parachute Inc. to benefit from economies of scale. Discuss whether the consultant provides Parachute Inc. with good or bad advice. (3 points) [page 99]**

**Advice Consultant: ~~GOOD~~ / BAD**

Explanation: When looking at the forces which caused the CODP of Jump Inc. to be positioned at MTS it seems rather strange to expose the customers to a very long lead time (design, purchasing and production) customers will be dissatisfied as it is highly likely they will miss the parachuting season if they order their product to late. The pros of completely designing your own parachute might be outweighed by the cons of the long lead time. For Parachute Inc. it will also be inefficient as they cannot balance their capacity in the light of seasonal demand. That means in winter the factory can be closed.

**e. Quality is very important for Jump Inc.; in the chapter 'Quality management and six sigma' p 310 six dimensions of quality are mentioned e.g. (1) performance and (2) perceived quality. Mention the other four dimensions of quality and discuss which two dimensions are the most important for Jump Inc. (5 points) [page 314]**

**1: Features**

**2: Reliability / Durability**

**3: Serviceability**

**4: Aesthetics**

**Explanation of the two most important dimensions:**

**1: Performance:** Relying on your parachute to function properly is likely to be the single most important quality aspect

**2: Reliability / Durability:** Similar to the answer above only now over a period of time

**Question 5 (10 points)**

- a. According to Jacobs en Chase types of sourcing can differ greatly. The book mentions several of these types one of which is 'vendor managed inventory' ('VMI'). Explain the concept of VMI. (1 point) [page 436]

When a customer allows a supplier to manage an item or a group of items for them. The supplier may replenish these items as they seem fit

- b. The 'triple bottom line' consists out of three core elements, mention and shortly discuss these three elements. (3 points) [page 27, exhibit. 2.1]

1: Social: pertains to fair and beneficial business practices toward labor, the community, and the region in which a firm conducts its business

2: Economic: the firm's obligation to compensate shareholders who provide capital via competitive returns on investment

3: Environmental: the firm's impact on the environment and society at large

- c. Mention and discuss three causes of the 'Bullwhip effect'. (6 points) [page 436-437]

**Order synchronization**

Customers order on the same order cycle, e.g., first of the month, every Monday, etc.

**Order batching**

Retailers may be required to order in integer multiples of some batch size, e.g., case quantities, pallet quantities, full truck load, etc.

**Trade promotions and forward buying**

Supplier gives retailer a temporary discount, called a trade promotion.

Retailer purchases enough to satisfy demand until the next trade promotion

**Reactive and over-reactive ordering**

Each location forecasts demand to determine shifts in the demand process.

Responding to a "high" demand observation

Unfortunately, it is human to over react

**Shortage gaming**

If supplier production is less than orders, orders are rationed

to secure a better allocation, the retailers inflate their orders, i.e., order more than they need



**Question 6 (15 points)**

The lean-philosophy has its roots within the Ford car corporation. Unsurprisingly many applications of lean are found in the automotive industry. An important research question is whether the lessons learned in the automotive industry can also be applied in other sectors. Recently many hospitals start to apply the lean philosophy. Although they see the benefits of lean they seem to struggle with some aspects.

- a. Discuss four tools of lean which are suitable for a hospital. Further, discuss one aspects of lean which is hard (or impossible) to implement. (4 points) [Chapter 12]

<p><b>Suitable in hospitals</b></p> <p>Value Stream Mapping (process focus)</p> <p>5S</p> <p>5 Why's</p> <p>Visual Control (Jidoka)</p> <p>Leveled Scheduling (Heijunka)</p> <p>SMED; Transfer batches</p> <p>Continuous Improvement (Kaizen)</p> <p>Fool-proofing (Poka-Yoke)</p> <p><b>Not applicable in hospitals</b></p> <p>Pull (Kanban)</p> <p>One-piece flow</p> <p>Cellular Manufacturing</p>
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COLLO is a B2B company that delivers pigments for the plastics industry. An important quality aspect within the plastics industry is color consistency. For example a batch of yellow Playmobile® blocks should have exactly the same color as its previous or subsequent batch.

The color of the pigments provided by COLLO is often measured with a light spectrograph. The color yellow is represented by a value of 580 nanometer (nm). The operations manager of COLLO received an order which specifies that the spectrograph value should be between a value of 575nm and 585nm.

By means of sampling the production process it is determined that the x-bar chart in SPC (Statistical Process Control) on the *central line* (CL) have a spectrograph value of 576nm with an *upper & lower control limits* (UCL and LCL) which can have a spectrograph value of 2nm higher or lower than the CL.

b. Determine the *Process Capability Index* for this pigment (show your calculation) and use this index to determine what the operations manager should do in short and in long term. (4 points) [page 323]

**Process Capability Index:**

For COLLO it applies that USL = 585nm; LSL = 575nm ; X-bar = 576nm and 3s = 2nm. It follows that  $Cpk = \text{Min}\{ (585-576)/2; (576-575)/2\} = \text{Min}\{ 4,5 ; 0,5\} = 0,5$

This indicates that the process has no high capability of providing products within the required specification limits.

**Short term:**

Direct investigation into what causes the problem of this deviation as this is unacceptable, recall of the batch as it might harm the relationship with the customer. Mixing of batches to smoothen the problem. Trying to bring x-bar nearer to specification and after that reduce variability

**Long term:**

Purchasing of more precise machinery.

ChairPoint is a manufacturer of office furniture such as chairs, tables, desks, and book cases. In comparison to their competition ChairPoint is seen as a 'discounter'. Their goal is to be the cheapest producer in every product range.

The Operations Strategy of ChairPoint is "to provide standard basic office furniture at the lowest possible costs". The table below represents the "costs of quality" (conform the "quality is free" concept by Crosby) of ChairPoint over the year 2013.

Cost element	Cost (Euro)
Scrap and rework	70000
Complaints management 1 full-time employee	45000
Warranty payments	65000
Annual "quality-day" for all the factory workers	10000
2 full-time Quality inspectors	110000

Quality-audit by external consultants	35000
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Consider yourself as the Supply Chain Manager of ChairPoint. Your human resources (HR) colleague introduced the plan to give all supply chain employees within ChairPoint a quality improvement training. The costs of this training are attributed to your "cost of quality" budget and amount up to approximately Euro 40000.

- c. Four types of cost of quality are distinguished in the chapter "Quality Management and Six Sigma". Mention these four types of costs and explain which cost element in the table above relate to these types. (4 points) [page310-311]

<b>Appraisal Costs</b>
2 full-time Quality inspectors
Quality-audit by external consultants
<b>Prevention Costs</b>
Annual "quality-day" for all the factory workers
<b>Internal Failure</b>
Scrap and rework
<b>External Failure</b>
Complaints management 1 full-time employee
Warranty payments

- d. Do you agree with the plan of your HR colleague? Why (not)? (3 points) [page 310]

<p>Within the concept "cost of quality", the costs mentioned can be classified as follows:</p> <p>Failure cost: Scrap + Complaints + Warranty = 70000 + 45000 + 65000 = 180000 and Control cost: Awareness + Inspection + Audit = 10000 + 110000 + 35000 = 155000.</p> <p>Clearly, this organization has more failure cost than control cost which according to the concepts for "cost of quality" is to be considered as sub-optimal.</p> <p>The P&amp;O proposal is to add additional training cost of 40000.</p> <p>The difference between the control cost and failure costs is 25000. By adding 40000 to the control cost the cure seems worse than the problem. Only if the 40000 extra results in a decline of failure cost &gt;15000 there is a break even.</p>
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Q7. (10 credits)

The logistics manager of Super Value has decided to determine in a mathematical way the location of their distribution centre in the Ireland. From this distribution centre, trucks transport groceries with a certain delivery frequency to the stores in Dublin, Cork, Galway and Limerick to fulfil the demand of the customers of these stores. Information on the delivery frequency per store and the x- and y-coordinates of each city are given in the table below

City	Delivery frequency	X-coordinate	Y-coordinate
Dublin	1 truck each working day	-10	-10
Limerick	1 truck per week	30	20
Cork	4 trucks per week	5	-20
Galway	1 truck each 2 weeks	25	45

Note that 5 working days per week.

- a. Determine the optimal (x,y)-coordinates for the location of the Distribution Centre. (5 credits) [page 465-473]

The following answer uses the total number of trucks each 2 weeks, i.e., 21 trucks as the total weight. Students can use the total number of trucks each week, i.e., 10.5 trucks.

$$C_x = \frac{-10 \times 10 + 2 \times 30 + 8 \times 5 + 1 \times 25}{21} = 1.19$$

$$C_y = \frac{-10 \times 10 + 2 \times 20 - 20 \times 8 + 1 \times 45}{21} = -8.33$$

- b. With the same delivery frequency for all the cities, what is the minimal number of trucks for Limerick in order to make the x-coordinate no less than 5.8? (5 credits) [lecture 7]

Denote z as the number of trucks per week for Limerick

$$C_x = \frac{-10 \times 10 + 2z \times 30 + 8 \times 5 + 1 \times 25}{19 + 2z} \geq 5.8 \Leftrightarrow z \geq 3$$

Thus, the minimal number of trucks per week is 3