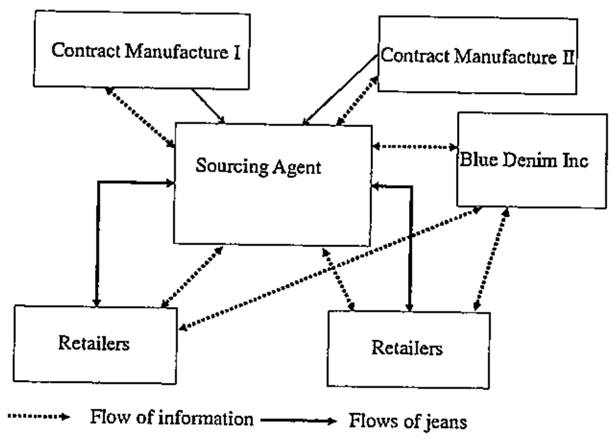
Practice Exam 4

Question 1 (15 credits)

Blue Denim Inc. began to produce and sell denim jeans in the early 1970s in the United Kingdom and has achieved enormous growth. Blue Denim Inc's success was the result of a unique approach in a product market dominated by strong brands and limited variety. Blue Denim Inc is convinced that a good relationship with the independent retailers is vital to its success. The Blue Denim Inc's representatives meet with each independent retailer three to four times each year in order to present the new collections and to take sales orders. Because the number of accounts for each representative is so large, contact is often achieved by holding a presentation in a hotel for several retailers. The representatives take orders from retailers for six-month delivery. After Blue Denim Inc receives an order, the retailer has only one week in which to cancel because of the need to place immediate firm orders in Hong Kong to meet the delivery date. The company has had a long-standing policy of not holding any inventory of jeans in the United Kingdom.
After an order is taken and confirmed, the rest of the process up to delivery is administered from the Blue Denim Inc office in Willesden. The status of orders can be checked from a Web site maintained by Blue Denim Inc. The actual orders are sent to a sourcing agent in Hong Kong who arranges for manufacturing the jeans by two contract manufacturers in Mainland China. After fabrication, the contract manufacturer will transport the jeans to the warehouse of the sourcing agent. Then, the agent will directly ship the completed jeans to the retailer. Blue Denim Incworks closely with the Hong Kong sourcing agent to ensure that the jeans are made properly and that the material used is of the highest quality.

a. **Draw a figure to describe this supply chain of Blue Denim Inc. Indicate clearly all flows of jeans and all flows of information. (9 credits)** ***[Lecture 1]***

a.



b. Formulate three different types of logistics costs in this supply chain of jeans. (3 credits) ***[Lecture 1]***

Costs for logistics aspects of purchasing the raw materials for jeans.
Costs for the planning of the distribution of jeans
Costs for the scheduling of staff at the warehouse in Hong Kong
Costs for planning and scheduling of the material handling systems in the warehouse

c. Formulate 3 logistics decision problems that might occur in this supply chain of jeans. (3 credits) ***[Lecture 1]***

Selection of contract manufacturers
Selection of the sourcing agent
Planning of production of jeans
Planning of distribution of jeans over various retailers in the warehouse
Scheduling of ships and/or flights who deliver jeans

Question 2 (15 credits)

Consider a production process consisting of the following three stations in a serial production line. Each product has to go through these three stations (punching, grinding, assembly) in order to be completed. At the punching station, 10 products are processed in a batch at a single machine. The set-up time is 5 minutes per batch. Each product takes 1.5 minutes.
At the grinding station, there are three identical machines operating in parallel. The production time of each machine is 5 minutes on average. At the assembly station, there are two automatic machines in parallel with the capacity of 20 jobs per hour for each machine. Demand for production is 25 units per hour.

a. **What is the departure rate of the production process? (5 credits)** ***[Lecture 2]***

The arrival rate is 25 per hour.
The capacity of the punching station is given by

$$\frac{60}{10\times1.5+5}\times 10 = 30 \text{ per hour}$$

The capacity of the grinding station is given by

$$\frac{60}{5}\times 3 = 36 \text{ per hour}$$

The capacity of the assembly station is given by

$$20\times 2 = 40 \text{ per hour}$$

The arrival process is the bottleneck.
The departure rate is 25 per hour.

b. **Suppose that the demand is increased to 35 units per hour. What is the productive utilisation at the assembly station? (5 credits)** ***[Lecture 2]***

When the demand is increased to 35 units per hour, the punching station becomes the bottleneck.
The departure rate from the punching station is 30 per hour.

Since the capacity of the grinding station is larger than 30 per hour, the departure rate from the grinding station is 30 per hour.

The arrival rate at the assembly station is the same as the departure rate from the grinding station.

The productive utilization at the assembly station is given by
30/40=0.75

c. **Suppose that the demand is increased to 30 units per hour. Is it possible to make the amount of Work-in-Progress in the system no more than 12 by adjusting the batch sizes at the punching station? Support your statement with calculation. (5 credits)** ***[Lecture 2]***

Denote the batch size at the punching station is z.

The throughput time is given by
1.5z+5+8 minutes

WIP=30 $\times \frac{1.5z+13}{60} \leq 12$
By solving the inequality, we obtain z ≤ 7.333

But, note that the above formula is true if the arrival is the bottleneck.
Then, we need to make sure
$\frac{60z}{1.5z+5}$>30. Then, we obtain z>10.

Thus, it is impossible to make WIP no more than 12.

Question 3 (15 credits)

In a service station, the inter-arrival time of vehicles is 4 minutes in a Poisson distribution. For simplicity, we assume that there is only one lane and one staff, who can take the payment from a driver at the rate of 18 per hour in a negative exponential distribution.

a. **In how much time would you expect to wait in line, make the payment, and leave on average? (5 credits)** ***[page 225-230]***

λ = 60/4=15 per hour
μ = 18 per hour

It is an M/M/1 model

and we should use the formula of Ws

$W_s = \frac{1}{18-15} = \frac{1}{3}$ hour = 20 minutes

b. **What is the probability that when you arrive, there will be less than three vehicles ahead of you? (5 credits)** ***[page 225-230]***

We need to compute the probability that there is less than three vehicles in the the system.

So, we should compute $P_{n<3} = P_{n\leq 2} = 1 - P_{n>2}$

$P_{n>2} = (\frac{15}{18})^3$=0.579
$P_{n<3} = 0.421$

c. **To improve the quality of service, the administration has decided to experiment with the use of a debit card for the collection of tolls. It will take exactly two and half minutes to verify the debit card and complete the payment. Compared with the original system, how much waiting time can be reduced by using debit cards? (5 credits)** ***[page 225-230]***

For the debit card system, it is an M/D/1 model.

μ = 60/2.5=24 per hour

Solution I:

The waiting time is given by
$W_q = \frac{15}{48(24-15)} = \frac{5}{144}$ hour

The waiting time of the original system is given by
$W_q = \frac{15}{18(18-15)} = \frac{5}{18}$ hour

The reduction of the waiting time is given by $\frac{5}{18} - \frac{5}{144} = 0.243\ hour$ =14.58 minutes

Solution II:
$W_s = \frac{48-15}{48\times(24-15)} = 0.076\ hour$

The waiting time in system is reduced by 0.333- 0.076=0.257 hour = 15.42 minutes

Question 4 (20 credits)

PEPE is a small but important Dutch pipe tobacco producer. PEPE is renowned for its high quality and refined taste and operates mainly in the European market. Tobacco leaves are purchased from many different countries all over the world. As harvest times differ from country to country PEPE purchases tobacco leaves throughout the year. PEPE mainly purchases its leaves from independent farmers, but sometimes from auctions or broker companies. Buying consistent quality and sufficient quantity is often a great challenge for PEPE. Factors complicating the purchasing of tobacco leaves are for example weather and growing conditions in the supplying country, but also the lack of proper storage facilities and transport play a role. Besides tobacco leaves, PEPE purchases flavoring agents, preservatives, and packaging material. These products are all purchased within The Netherlands and can be obtained quickly and easily in the right quality.

The tobacco leaves are shipped to The Netherlands and stored in PEPE's raw material warehouse. On average PEPE has sufficient stock to produce for 2 – 4 months. Due to the nature of the purchasing process, as described above, PEPE strives to keep the stock of raw materials at an even level. The warehouse of PEPE is designed in such a way that tobacco leaves can be kept fresh for 12 months.

PEPE takes pride in their specific tobacco blends. Customers, therefore, cannot compose their own blend of tobacco. In order to comply with the different tastes of customers PEPE offers ten specific blends. Two types of customers can be distinguished: large retail chains and independent tobacco shops. Independent tobacco shops can only order standard packages, whereas the large chains are allowed to order customized packages. For PEPE it is often unclear how much and when the large chains will order a specific blend. In order to deliver quickly (as expected by customers) PEPE strives to have a stock of at least 2000kg of unpacked tobacco which can be used for custom packages and 1000kg of standard-packed tobacco of each blend. Once the stock levels of one of the blends gets below the 2000kg (unpacked tobacco) or 1000kg (standard packages of tobacco) a replenishment order is given.

The production process of PEPE starts with cutting and mixing the different leaves in order to obtain a specific blend. Each blend is produced in batches of 250kg. In order to prevent flavor contamination all machines have to be cleaned between batches of different blends. After this stage flavoring agents and preservatives are added to the batch. This is an important step as these determine the taste and quality of the final product. After this stage a thorough quality check is performed. After this check the tobacco is sent to the tobacco warehouse.

The packaging line is constantly working on packaging the standard packages of tobacco. However once an order for a custom type package is received the packaging line starts processing these packages. The packaging process consists of filling tins of either 50g, 100g, 250g, or a custom package; placing a sticker; wrapping and placing the packages in a box. Filled boxes are transported to the finished goods warehouse where they either await transport to a large retail chain or to be ordered by an independent tobacco shop.

a. **In the case above one or several Customer Order Decoupling Point(s) can be distinguished. Explain for each CODP how you recognize it, how you characterize it and where it is positioned in the process.** (4 points) *[page 175-177]*

MTS (Independent tobacco shops) CODP is with the finished goods warehouse; production is activated by the stock levels of final product. Product delivery is activated by a customer order.

ATO (large chains, custom package) CODP is with the tobacco warehouse: unpacked tobacco is produced once the stock levels of unpacked tobacco fall below a certain point. Packaging is activated by a customer order.

b. **For each CODP discuss two forces which caused the current position of the CODP.** (4 points) ~~[page 175-177]~~

MTS (1) quick delivery, (2) low variety

ATO (2) quick delivery, (2) specific demand, difficult to predict demand
Explanation needs to relate to the case text

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

Current Lay out: Product Layout

Explanation:
It is the most likely that the resources are arranged in such a way that they follow the completion of the product (no routing variety).

Advice Consultant: bad

Explanation:
'fixed position' is only used for large projects such as the construction of large immovable objects (e.g. aircraft). The resources have to move to the product rather than the other way around. There would be no benefit from moving the resources to the product in the PEPE case.

d. **The same consultant advises to reduce the production batch size from 250kg to 100kg. This will, according to the consultant, make PEPE more capable in coping with fluctuating demand. Discuss whether this is a good advice and motivate your answer.** (3 points) *[page 175-177]*

Advice Consultant: bad

Explanation:
Production is already shielded from fluctuating demand through the position of the CODP. Reducing batch sizes will not contribute in that sense. All fluctuations are buffered by stock.

e. **Batch size reduction can help to increase flexibility. However, it has an important downside. Within Lean theory a specific tool exists to counter this downside. Discuss the most important <u>downside of batch size reduction and discuss which lean tool helps in countering it.</u>** <u>(2 points)</u> *[Chapter 13]*

Downside of reducing batch size:
Reducing bath size increases the total amount of batches, which will increase the amount of setup times. Therefore, less value added time is available.
Lean tool:
SMED (Single minute Exchange of Dies) is one method of reducing setup times. However in the case of MONTE-C the main component of the setup time is cleaning.

f. **In the chapter 'Global Sourcing and Procurement' four supply chain strategies are mentioned (based on Hau Lee's uncertainty framework). Explain which supply chain strategy fits best with the tobacco leaf supply chain and which supply chain strategy fits best with the packaging material supply chain. Give the explanation for both supply chain <u>strategies.</u>** <u>(3 points)</u> <u>*[page 439, exhibit 13.4]*</u>

Tobacco leaf supply chain: <u>'risk hedging strategy'</u>

Explanation:

Due to the high degree of uncertainty in this chain a <u>'risk hedging strategy'</u> will fit best.

Packaging material supply chain: <u>'efficient supply chain strategy'</u>

Explanation:
Due to the low degree of uncertainty in this chain an <u>'efficient supply chain strategy'</u> will fit best

Question 5 (10 credits)

a. **According to Jacobs & Chase the costs within a supply chain can significantly increase by the <u>'Bullwhip Effect'. What is the 'Bullwhip Effect'?</u>** <u>(2 points)</u> <u>*[page 436-437]*</u>

The phenomenon that small fluctuations at the customer end of a supply chain are amplified to extreme fluctuations at the supplier side of the supply chain.

b. <u>**Discuss three causes of the 'Bullwhip Effect'.** (3 points)</u> <u>*[page 436-437]*</u>

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

c. **Define the three components of the Triple Bottom line and explain the two most important trade-offs within the Triple Bottom line by giving two real-life examples.** (5 points) *[page 27, exhibit 2.1]*

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

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

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

Trade-offs: (1) Economic and environmental, (2) Economic and Social

Example (1): E.g. Shell and Niger delta, BP and Gulf of Mexico, Unilivver and Palm oil plantations in Indonesia, Ecologic produce which is more expensive etc.

Example (2): Clothing industry and the Bangladesh incident, Nike and child labor, Max Havelaar fair-trade logo

Question 6 (15 credits)

As the Lean-philosophy originated with Toyota it is not surprising that it is commonly applied in the automotive industry. When looking at lean research one of the most important research questions is whether lean is applicable in other contexts than the automotive industry.
The organizers of the Amsterdam Music Festival (AMF) - one of the biggest electronic music fair in the world - are considering using lean in their processes (e.g. contracting the artists, renting exhibition and concert space, supporting the artists with all the logistics behind their performance, publicity, ticket sales, etc.). However, they are not sure from which Lean aspects / tools they can benefit from.

a. **Discuss three Lean aspects / tools which can be used by the organizers of ADE. Also discuss one Lean aspect / tool which is difficult or impossible to be used by the organizers of ADE.** (5 points)

Several Lean aspects / tools can be used by AMF.
For example:
- Jidoka / Visual Control to make sure all equipment is in the right place (both for building up a concert as well as clearing it up);
- Value Stream Mapping for all processes; *[page 407-410]*
- 5S for organizing ticket sales booths;
- Kaizen for organizational aspects, a feedback-mechanism and continuous improvement;*[page 409]*
- Poka-yoke for the ticket-selling website, in order to prevent mistakes in the web design.*[page214-216]*

Concepts as Heijunka, one-piece-flow and Kanban are less suitable.

LEAFY GREENS is a producer of "boerenkool" (kale). LEAFY GREENS harvests, washes cuts, and packs the "boerenkool" in 500g bags. In order to comply with Dutch law a 500g bag cannot contain more than 510g and no less than 496g.

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) has a value of 502g with *upper & lower control limits* (UCL and LCL) which can have a value of 6g higher or lower than the CL.

b. Determine the *Process Capability Index* for "boerenkool" (show your calculation) and use this index to determine what the operations manager should do in short term and in long term. (5 points) *[page 323]]*

Process Capability Index:
For LEAFY GREENS applies that USL = 510g; LSL = 496g ; X-bar = 502g and 3s = 6g. It follows that Cpk = Min{ (510-502)/6; (502-496)/6} = Min{ 1,3 ; 1} = 1

This indicates that the process can just provide products within the required specification limits.

Short term:

Momentarily there is no problem, no immediate action is necessary. However, specifications are rather tight considering the LCL.

Long term:

Reducing variability is necessary as a higher standard deviation will immediately result in problem. Installing a more precise portioning and weighing system could help reducing the variability.

For weighing vegetables and fruit in the supermarket in the Korenbeurs all customers have to use a scale which produces a sticker with the price and a bar code. To the annoyance of the customers who want to continue with their shopping, the scale provides the error message "item cannot be weighed, please remove item" up to four times before functioning properly. After assessing this situation for a while, a GSCM student advises the supermarket to apply the DMAIC methodology.

c. Explain the DMAIC methodology by explaining each of the letters in the acronym. Discuss for each component of the DMAIC methodology how they would look like in the supermarket scale case. (5 points) *[page 314]*

Define, Measure, Analyze, Improve, Control (DMAIC)

Supermarket scale case:
Define: customers quickly want to continue with their shopping, waiting for a scale does not comply with customer requirements.

Measure: How many people are waiting? How long are they waiting? How does the error log of the scale look like? Which errors are displayed? How many errors occurred? How much time do employees spend on resetting the scale? Etc.

Analyze: There seems something wrong with the weighing mechanism. Sensor error? Software error? Mechanical problem? Will cleaning the scale help? Etc.

Improve: Call a mechanic of the scale supplier, clean the scale, check cables, replace scale Etc.

Control: Preventive maintenance, have a stock of components, performance agreement with supplier Etc.

Question 7 (10 credits) *[Lecture 7]*

Computers will be transported by CareForTransport from a supplier in China to the distribution centre of CompNow in Amersfoort, The Netherlands. CareForYou has to decide which of the following modes of transportation will be chosen to make sure that the computers are delivered in Amersfoort against minimum total costs:

1. A ship is used to transport the computers from Hong Kong to the port of Rotterdam. Thereafter, the computers are transported by truck from Rotterdam to the distribution centre of CompNow in Amersfoort.
2. A plane is used to transport the computers from Hong Kong to the airport of Amsterdam. Thereafter, the computers are transported by truck from Amsterdam to the distribution centre of CompNow in Amersfoort.

The following information is known:

- Value per computer is 560 euro
- Weight per computer is 12 kg
- Optimal order quantity of computers at supplier in Hong Kong: 1500 pieces
- Interest rate (i.e., inventory costs) is 15% per year
- Transit time per ship from Hong Kong to Amersfoort via the port of Rotterdam is on average 27 days (exact number of days depend on the number of ports being visited on the way to the Netherlands)
- Transit time per plane from Hong Kong to Amersfoort via Amsterdam equals 5 days
- Distance Rotterdam – Amersfoort equals 80 km and
- Distance Amsterdam – Amersfoort equals 50 km
- Fixed costs of a truck equal 1500 euro independent of the distance to be travelled.
- Costs per kilometre per computer travelled by a truck in the Netherlands: 0.25 euro
- On the way back, the truck will be used for transportation requests of other companies and as a result we do not need to consider the costs for travelling back.
- Costs per kilo to be transported per plane: 0.85 euro
- Fixed costs per transport per plane: 22,000 euro
- Costs per computer to be transported per ship: 1.70 euro
- Fixed costs per transport per ship: 11,000 euro
- Assume that a year has 365 days.

How many days should the transit time per ship be exactly to make it more profitable to choose the ship as mode of transportation instead of a plane? Support your answer with calculations.

Fixed costs of a truck are not included, because of the fact that those costs are identical for Amsterdam (plane) and Rotterdam (ship).

Denote the days of the transit time per ship as z.

The total cost by ship is given by
TCs =11000
+1.7x1500
+80x0.25x1500
$+\frac{z}{365} \times 0.15 \times 560 \times 1500$

The total cost by plane is given by
TCp =22000
+0.85x12x1500
+50x0.25x1500
$+\frac{5}{365} \times 0.15 \times 560 \times 1500$

We require TCs < TCp
We obtain z<41.21

The transit time by ship should be no longer than 41 days.

Appendix: a few formulas

Calculating WIP:

L = λW

$$\text{WIP} = \sum_{i=1}^{n} \rho_i X_i$$

M/M/1 formulas

$$L_s = \frac{\lambda}{\mu - \lambda}$$

$$W_s = \frac{1}{\mu - \lambda}$$

$$L_q = \frac{\lambda^2}{\mu(\mu - \lambda)}$$

$$W_q = \frac{\lambda}{\mu(\mu - \lambda)}$$

$$P_{n>k} = \left(\frac{\lambda}{\mu}\right)^{k+1}$$

M/D/1 formulas

$$L_s = \frac{\lambda(2\mu - \lambda)}{2\mu(\mu - \lambda)}$$

$$W_s = \frac{2\mu - \lambda}{2\mu(\mu - \lambda)}$$

$$L_q = \frac{\lambda^2}{2\mu(\mu - \lambda)}$$

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

Statistical Quality Control

X-bar Chart:

$$UCL_{\overline{X}} = \overline{\overline{X}} + A_2\overline{R}$$

$$LCL_{\overline{X}} = \overline{\overline{X}} - A_2\overline{R}$$

R-Chart:

$$UCL_R = D_4\overline{R}$$

$$LCL_R = D_3\overline{R}$$

P-chart: $$UCL = \overline{p} + 3\sqrt{\frac{\overline{p}(1-\overline{p})}{n}}$$

$$LCL = \overline{p} - 3\sqrt{\frac{\overline{p}(1-\overline{p})}{n}}$$

Process capability: $$C_p = \frac{USL - LSL}{6\sigma}$$

$$C_{pk} = \min\left\{\frac{USL - \overline{X}}{3\sigma}; \frac{\overline{X} - LSL}{3\sigma}\right\}$$

Center-of-Gravity formulas

$$C_x = \frac{\sum_i d_{ix} W_i}{\sum_i W_i} \qquad C_y = \frac{\sum_i d_{iy} W_i}{\sum_i W_i}$$