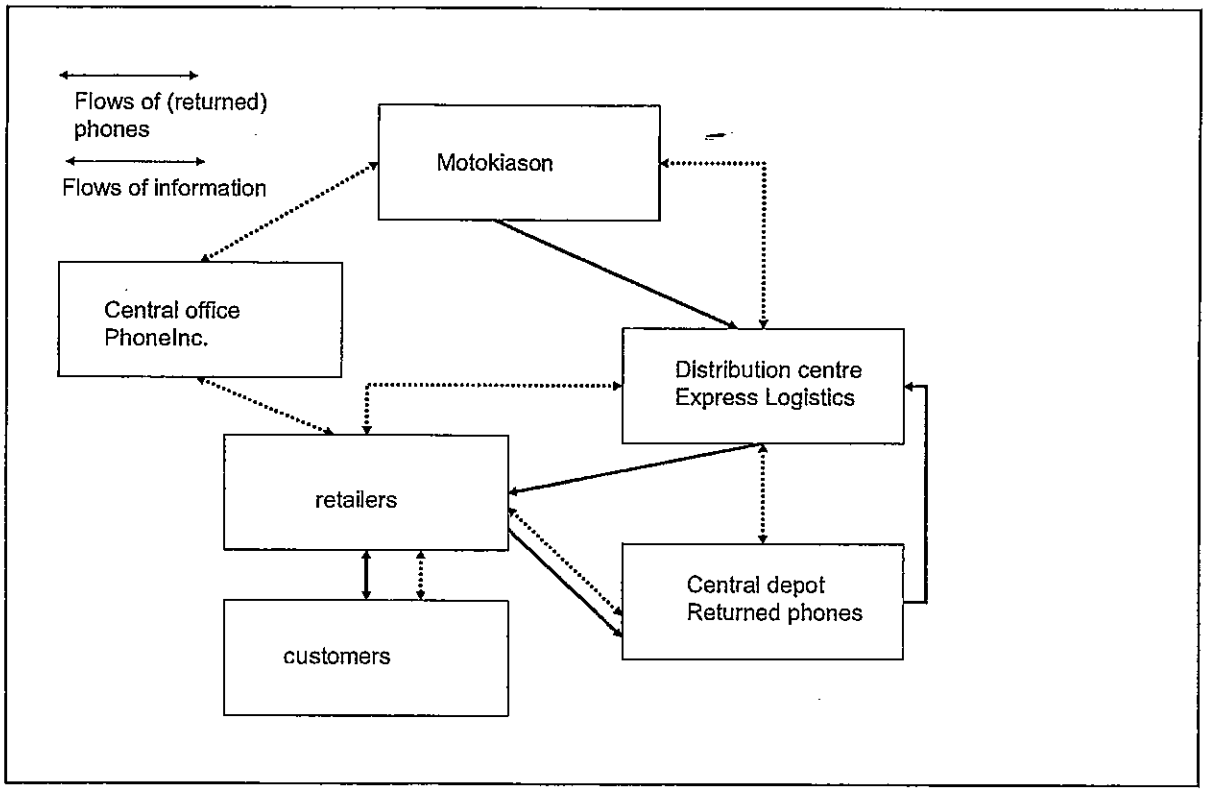
Practice Exam 1

Question 1 (20 credits)

Thecompany PhoneInc. has 25 stores (which are called "The Shop4Phones") throughout the country where customers can buy their mobile phones. In the coming years, the company wants to expand its business to the rest of Europe and it might be expected that the volume will double. Usually, in a supply chain of mobile phones, phones are transported from factories to a wholesaler. This wholesaler distributes the phones to the various retailers. However, the PhoneInc. preferred to be no longer dependent on the wholesaler. Furthermore, one of the major suppliers (Motokiason) of the PhoneInc. figured out that a lot of information was lost if all contacts go through a wholesaler. Therefore, both companies agreed to eliminate the wholesaler and have direct contact with each other. Motokiason guarantees the PhoneInc.that it can always offer mobile phones of Motokiason. Motokiason takes care of all logistics activities of their phones. The transport and distribution of the mobile phones is outsourced to a third party logistics provider, Express Logistics. The Shop4Phones can check electronically on the website of the central office of the PhoneInc.on the assortment of Motokiason and place their orders once a week. The central office of the PhoneInc.submits the orders to the factory of Motokiason in the south of Sweden near the port of Göteborg. There is one transport per week with mobile phones from Sweden to the distribution centre of Express Logistics. In this distribution centre the mobile phones are sorted over the various Shop4Phones. Delivery vans transport the mobile phones to the Shop4Phones. Transportation requests for various Shop4Phones are not combined into one trip. From an environmental point of view customers are encouraged to return their used and broken phones to the Shop4Phones. There is one central depot in the Netherlands, namely in Nijmegen, where returned mobile phones are collected. Express Logistics also needs to manage the flow of returned mobile phones from the Shop4Phones to this central depot. At this depot phones are sorted by brand and once a week delivery vans of Express Logistics need to transport the returned mobile phones of Motokiason from the central depot back to the distribution centre of Express Logistics.

a. **Draw a figure to describe the supply chain of the PhoneCorporation and Motokiason. Indicate clearly all flows of mobile phones and all flows of information.** (10 *credits*) ***[Lecture 1]***



b. **Formulate 5 logistics decision problems in this supply chain of mobile phones.** (5 *credits*) ***[Lecture 1]***

Selection of third party logistics provider,
Forecasting of number of mobile phones to be sold,
Planning of transport from Mobile Express to the retailers,
Forecasting of the number of returned mobile phones,
Planning of production of mobile phones.

c. **Indicate 3 aspects of the current distribution structure, which could be improved and in which way, to deal effectively with the two growth scenarios of the coming years.** (5 *credits*) ***[Lecture 1]***

Transport: which mode of transportation will be used? Combination of transport requests of various shops and/or combination of delivering new phones to shops and to pick-up old phones.
Distribution Centre: new DC required or can it be done from the Netherlands, which layout in the current DC to handle doubling of volume
Information systems: international ordering system

Question 2 (15 credits)

Consider a university library that is open from 9.00 until 17.00 five days a week. Two types of customers can be distinguished, namely: faculty and students. On average, 80% of the customers are students. A single service desk is available for both types of customers willing to borrow books. All books available for borrowing are stored in a warehouse. A single employee is available at this service desk to handle requests. From observations it can be concluded that on average 40 customers arrive per hour. 60% of the customers (both faculty and students) need to borrow 1 book, 25% of the customers need 2 books, 10% of the customers need 3 books and the rest of them need 7 books. After arriving at the library, students first need to use one of the 5 computers to search for the desired book(s). The search process takes on average 3 minutes per book. Thereafter, students can go to the service desk to hand over their request. Faculty members already performed this search task at their university room. Those customers, therefore, directly go to the service desk after arriving at the library. The employee behind the service desk first checks in approximately 1 minute per

book if the desired book(s) is/are available. Thereafter, (s)he enters the warehouse to pick the desired book(s). The time to collect the desired book(s) clearly depends on the number of books to be picked from the warehouse and follows a normal distribution with a mean of (60 + 30*number of books) seconds and a standard deviation of 30 seconds. During this time the customer waits at the service desk until the employee returns. The employee needs to perform some administrative tasks before the customer can leave with the book(s). The time required to perform those tasks follows a normal distribution with a mean of 1 minute per book and a standard deviation of 10 seconds. 20% of the students and 10% of the faculty have some questions to be answered by the employee in, on average, 5 minutes. After receiving the books and/or the answers to the questions the customer leaves the library.

a. **What is the utilisation rate of the computers used in the search process? Support your answer with calculations.** (*7 credits*) ***[Lecture 2]***

First, calculate the average number of books per customer.
0.6*1+0.25*2+0.1*3+0.05*7 = 1.75 books
Then, the number of students arriving at the computers: 80% of 40 per hour = 32 students
Average time per student at a computer: 3 minutes per book * 1.75 = 5.25 minutes per student
Design capacity per computer: 60/5.25 = 11.43 students
5 computers can handle 57.142857 students
Utilisation of the computers: 32/57.142857 = 0.56 or 56%

b. **What is the minimum required number of employees at the service desk to prevent the service desk from being a bottleneck? Support your answer with calculations.** (*8 credits*) ***[Lecture 2]***

Search process at the computers is no bottleneck. So all customers arriving per hour need to get service at the service desk.
First, calculate average time to collect books from the warehouse: 60 + 30*number of books = 112.5 seconds = 1.875 minutes
Average time of a student at the service desk: 1*1.75 (checking) + 1.875 (collecting) + 1.75 (administration) + 0.20*5 (20% information) = 6.375 minutes
Average time of faculty at the service desk: 1*1.75 (checking) + 1.875 (collecting) + 1.75 (administration) + 0.10*5 (10% information) = 5.875 minutes
80% students and 20% faculty:
Average time of a customer at service desk: 0.80*6.375 + 0.20*5.875 = 6.275 minutes
One employee can help 60/6.275 = 9.56 customers per hour
40 customers arrive.
Thus, we need at least 5 employees to prevent the service desk from being a bottleneck.

Question 3 (10 credits)

Customers call in their orders at the call centre of a small internet retailer. If a customer's call cannot be answered directly, the call will be placed in an electronic queue. The retailer is searching for a new communication company that can handle these calls. Two communication companies, Green and TeleFour, have made an offer. Yellow will use one employee who can handle an average of 10 calls per hour, following a negative exponential distribution. The cost charged by Green equals €20 per hour. TeleFour uses an automated computer system that can offer service to exactly 11 calls per hour. The computer system handles the calls one by one. TeleFour will charge €60 per hour for the system. On average every 10 minutes a calls arrives at the call centre (the number of arrivals is Poisson distributed). Time spent by customers in the system (time between placing the call and actually leaving the system after placing the order) is considered a cost in the amount of €4 per minute per customer.

Determine which of the two companies (Green or TeleFour) gives the lowest expected total costs (including the costs of customers being in the system) and give the exact cost difference between the companies per hour. ***[page 232-233 Formulae]***

Option Green: M/M/1 system with $\begin{matrix}\lambda=6\\ \mu=10\end{matrix}$ and $W_S = \frac{1}{\mu-\lambda} = 0.25$ hour per person = 15 minutes per person.

Total costs customer spending time in the system per hour = expected number of people arriving per hour * average time in system per person * 4 euro per minute = 6*15*4 = 360 euro per hour.

Total Costs Green= 20 euro per hour + 360 = 380 euro per hour

Option TeleFour: M/D/1 system with $\begin{matrix}\lambda=6\\ \mu=11\end{matrix}$ and

$W_S = W_q + \frac{1}{\mu} = \frac{\lambda}{2\mu*(\mu-\lambda)} + \frac{1}{\mu} = \frac{6}{110} + \frac{1}{11} = \frac{8}{55}$ hour per person = 8.73 min. per person.

Total costs customer spending time in the system per hour = 8.73*6*4 = 209.45 euro per hour Costs TeleFour = 60 euro + 209.45 = 269.45 euro per hour.

TeleFour gives the lowest costs and should win the bid. The costs difference is: 110.55 euro per hour.

Question 4 (20 credits)

CASE BATHCO

BathCo. manufactures synthetic baths. The company strives for a large market share in the West European market for quality baths. Key words for BathCo's are customer focus, flexibility and quality.

The baths are supplied in various colors and shapes and are made from synthetic sheets. These sheets are purchased from at a large chemical company and have a delivery lead time of 2 to 3 Months. Sheets are ordered in a certain size and color. Wineco's purchasing department can only choose from certain standard sizes of sheets. Upon delivery sheets are stored in the warehouse.

The planning department determines which types of baths will be made in a certain month. This is done by checking how many baths of a particular type and color are in stock is in the warehouse for end products and by estimating whether this is sufficient for the expected demand in the next month. If a certain type of bath must be produced, the sawing department is ordered to saw a batch of sheets with a certain size from standard sheets stocked in the warehouse. Remaining pieces can be put back into stock in the warehouse. Then, the sheets are moved to the forming division, where the bath gets the desired shape. This department uses molds to shape the baths, which are rather expensive. For every type of bath a different mold is used. The changeover from one from to the other requires changing the mold, which takes a lot of time. During changeover, there is no production. With one mold all colors of that type of bath can be made and there is no changeover between those colors. After forming the baths are temporarily stored on the shop floor before going to the finalizing department. Finalizing comprises of hardening by adding extra materials on the non-visible side of the baths, drying, drilling holes and packaging. This department uses trolleys on which the baths are clamped during the process stages. For each type of bath a limited number of trolleys is available. The capacity of the drying room is so large that always trolleys with different types need to be dried together. The finalizing department has as a consequence always different types of baths in process and that the in the intermediate storage after the forming department always different types have to be available. After packaging, the baths are moved to the warehouse for end products to await delivery to the customer, wholesaler or installer. Delivery usually takes in small quantities.

The company places great emphasis on short delivery times and a high delivery reliability. Sometimes, in order to realize those, a production run will be interrupted in the forming department, including a long changeover from one mold to another. However, since a year, BathCo experiences capacity problems in the warehouse and in the forming department. On the one hand, many slow moving baths with very low demand are stocked and some of these baths are probably even obsolete, while on the other hand there are many rush orders in the forming department.

In response to these problems the Chief Executive of BathCo proposes to stock baths directly after forming and only start finalizing and packaging once a specific bath is ordered.

a. What is the type of process that BathCo has in the current situation? Why? (2 credits)
[page 175-177]

(assembly) Line because the products all follow the same sequence in production

b. Where is the Decoupling Point located in the current situation and how can it be characterized? (2 credits) *[page 175-177]*

The stock of finished products, so it is Make to stock production

c. What might be the main constraint within the process that determines the current location of the Decoupling Point? Why? (2 credits) *[page 175-177]*

The large changeover times, and therefore relatively large lead times. The large changeover make it almost impossible to have make to order production

d. What is the most likely layout in the current finalizing Department? Why? (2 credits) *[page 180]*

product layout because the products all follow the same order step by step.

e. How can the Decoupling Point in the proposed situation be best characterized? Why? (2 credits) [page 175]

Assemble-to-order, because from existing parts an order is made using different parts.

f. Do you agree that the new situation solves the two problems mentioned in the case description? Give arguments. (6 credits) *[page 175-177]*

First problem relates to storage capacity: that will be solved as there is no production of less demanded products, so less obsolescence of products. Still the wrong colors might be stocked and be slow movers.
Second problem relates to the rush orders and thus to not having the right products stored. In the new situation (as ideally (!!) in the old situation) there is interruption of the forming department as that department is producing to intermediate stock. On the other hand, the finalizing department is only producing rush orders and might need more capacity to cope with peaks in demand. So, the delivery problem is probably not directly solved. Moreover, still for the intermediate storage a good forecast is required.

g. **A student just graduated from IB&M remembers that Jacobs and Chase devote a whole chapter to Lean production. Rather than having the formed baths stored, he aims at introducing all principles underlying Lean production. What would be the two main problems to work on if Wineco aims at implementing Lean production? Explain shortly why these problems might be a limiting factor in implementing Lean production in this company. (4 credits)** *[Chapter 12*

1. The huge changeover times in the forming department which are caused by the specific molds.
2. the capacity/batching at the drying operation
3. Availability of trolleys
4. Good forecasting

These problems cause batching and thus waiting time and (intermediate storage) to happen which is all considered to be waste.

Question 5 (10 credits)

a. Describe the three dimensions that determine how a company chooses for a specific type of strategic sourcing. (5 credits) *[page 434/440]*

Specificity: refers to how common the item is and, in a relative sense, how many substitutes might be available Commonly available products can be purchased using a relatively simple process
Transaction costs: costs associated with making a purchase: ordering, selecting, billing, price setting, etc.
Contract duration: length of the relationship

b. What is Vendor Managed Inventory and under what circumstance (value of the dimensions) will a company make a choice for that type of sourcing? (5 credits) *[page 436]*

Vendor managed inventory - the supplier manages an item or group of items for a customer.
VMI will be chosen if a product specific for a customer (so no advantage of keeling stock ventrally), if the transaction costs are low and if the relationship is stable and long (so more trust).
See Exhibit 8.1(page 224 of the book)

Question 6 (15 credits)

a. What Stemming from its origin at Toyota, it is no surprise that the Lean philosophy is widely applied in the automotive industry. In studying Lean, one of the key issues, both in academia and in practice, is to which extent the various aspects of Lean (methodology, concepts and tools) are also applicable in other industries.
Consider the outlet of a Dutch supermarket like Albert Heijn, CoOp or Jumbo where customers come to do their daily shopping.
Which aspects of Lean would be applicable to this setting? Name at least three.
Also name one aspect of Lean that might be very hard (or impossible) to implement in this setting? (5 credits) *[Chapter 12]*

Virtually all aspects of Lean are usable in supermarkets; like the objective of removing waste, the different role of managers and good thinking on the workfloor, good relations with strategic suppliers, value stream mapping, 5S, Poka-yoke, Kanban, Kaizen, Jidoka et cetera.
Probably less usable are "single piece flow" and Mixed Modeling /Heijunka. Suppliers are not dedicated to a single supermarket outlet (nor to a single supermarket chain) like the Toyota suppliers are (remember "Toyota city"). Heijunka might also proof to be difficult, especially when looking at the flow of customers: you cannot entirely control the demand from customers which is lumpy (e.g. weekend shopping).

b. What Steel Inc.is a company that works business-to-business (B2B) and is specialized in manufacturing steel components to be used in communication devices. Since such devices are quite sensitive, the customers of Steel Inc. have strict specification with respect to the components delivered to them by Steel Inc. For one of Steel Inc.'s components, the BB52, it is the weight that matters most.
The Steel Inc.Supply Chain Manager is looking into an order from a customer that has ordered a batch of BB52's that should have a weight between 1.240 and 1.260 kilogram.
From samples taken from the BB52 production process it can be observed that the SPC X-bar control card has a Central Line of 1.248 kilograms and the Upper and Lower Control Limits are 8 grams higher and lower than that, respectively.

Determine the Process Capability Index for this batch of BB52's and use this to determine what the Supply Chain Manager of Steel Inc. should do, both in the short term and in the long term. (5 credits) ***[page 323]***

For the BB52's it applies that USL = 1.260; LSL = 1.240; X-bar = 1.248 and 3s = 8. It follows that Cpk = Min{ (1260-1248)/8 ; (1248-1240)/8} = Min{ 1.5 ; 1.0} = 1.0.
This indicates that the process is (only just) capable of providing products within the required specification limits.
On the very short term no immediate action is required as far as the X-bar chart is concerned. However, some additional information on the Range chart might be required.
An improvement that the SC Manager might be looking at for the short term is to ensure that the central line is exactly inbetween the specification limits (i.e., at 1.250 rather than the current 1.2480).
For the longer term, it might be worthwhile to investigate ways to improve the capability.

c. An office furniture manufacturer (which employs 1000 people) is planning to adopt the Lean philosophy including all ideas of Total Quality Management.
Following are some characteristics of its present production system:

i. **There is a quality assurance department of 50 people, including 30 inspectors;**
ii. **Rejected products discovered at the end of final assembly are sent by conveyor to a rework area staffed by 120 people;**
iii. **All purchased raw materials and parts are inspected on the receiving docks using acceptance sampling;**
iv. **All direct labors are paid by how much they produce, which is measured daily.**

What changes would you suggest and why? (Name three different changes and their motivation.) (5 credits) ***[Chapter 12]***

Some points for improvement would be:

- In an Lean/TQM environment, quality management is the concern of everybody in the organization rather than for a specialized department as is currently the case;
- Obviously with so many people working in the rework area, there must be major issues with quality. Within Lean, quality problems are considered waste and must be removed, rather than erecting an entire department to handle such problems;
- TQM is about quality at the source (" you cannot inspect quality into a product; you have to build it in") whereas this organization seems to depend on inspection only (i.e., is reactive rather than proactive);
- Checking incoming items might not be bad; however within the Lean/TQM concept it is expected that suppliers do their own quality control and that joint systems are in place so that quality control for incoming materials is simply not needed anymore;
- Within Lean, the workers are concerned with quality and the management with productivity. By making payment based on items produced only, there is no incentive for producing quality. The payment scheme should be changed in order to encourage quality work rather than the quantity of the work.

Question 7 (10 credits)

When placing a new warehouse for mobile phones, Motokiason wishes to consider four sites. Important data related to the positive weights of each factor and the scores per site are given in the following table.

Location Factor	Weight (W_i)	Scores Amsterdam	Scores The Hague	Scores Utrecht	Scores Rotterdam
1. Warehouse utilization	20	8	6	4	7
2. Average time per trip from warehouse to retailers	15	7	5	7	5
3. Employee preferences	15	1	7	8	3
4. Accessibility to major highways	10	7	4	9	5
5. Land costs	10	2	3	1	4
6. Quality of life	15	5	6	9	5
7. Taxes	15	3	5	5	4

a. **Which is the best site? Assume that a higher score is more desirable than a lower one. Support your answer with calculations.** (*5 credits*) ***[page 465/473]***

		Amsterdam	The Hague	Utrecht	Rotterdam
1. warehouse utilization	20	8	6	4	7
2. average time per trip from warehouse to retailers	15	7	5	7	5
3. Employee preferences	15	1	7	8	3
4. accessibility to major highways	10	7	4	9	5
5. land costs	10	2	3	1	4
6. Quality of life	15	5	6	9	5
7. Taxes	15	3	5	5	4
		490	535	615	485

Utrecht is best site

b. **For what range of values for the weight "warehouse utilization" (currently $W_1 = 20$) does the site given as the answer to question a) remain the best site? Assume that all other weights and all scores keep their current values. Support your answer with calculations.** (*5 credits*) ***[Lecture 7]***

Weight warehouse utilization = w_1

Amsterdam: $w_1*8+15*7+15*1+10*7+10*2+15*5+15*3 = 330 + 8w_1$
The Hague: $6w_1 + 415$
Rotterdam: $7w_1 + 345$
Best site was Utrecht: $4w_1 + 535$

$4w_1 + 535$ needs to be larger than all values for other cities
So, $4w_1 + 535 > 330 + 8w_1$; $w_1 < 51.25$
$4w_1 + 535 > 6w_1 + 415$; $w_1 < 60$
$4w_1 + 535 > 7w_1 + 345$; $w_1 < 63.3$

If range of values for this weight: $0 \leq w_1 < 51.25$ than Utrecht is the best site

Appendix: a few formulas

Calculating WIP:

$L = \lambda W$

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

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

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

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

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

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