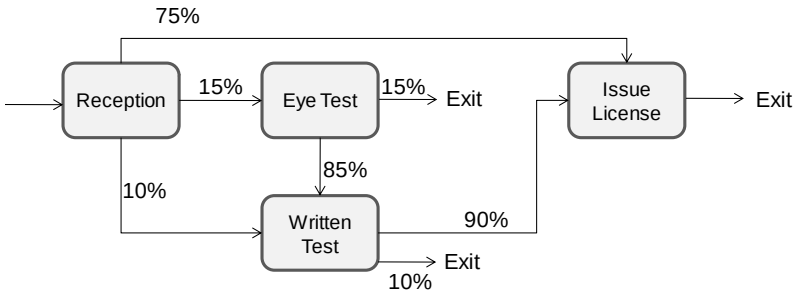
Operation Management 2024/2025
Master in Management (MIM)
Regular Period Exam – October 22, 2024
Duration: 1h30 minutes

SOLUTIONS

GROUP I (7.0 points)

Q1. (3 points) The local Department of Motor Vehicles issues new licenses and renews licenses. (See the diagram below.) The office receives 100 customers per hours. All customers first see a receptionist. The receptionist directs them in one of three directions. 75% go directly to Issue License (staffed by 10 workers) where a new photo and license are done. 15% are required to take an eye test (staffed by one worker) and 10% must first take a multiple-choice electronic written test (on one of the five computers). Only 85% of people pass the eye test and the remaining 15% exit. The customers who pass the eye test proceed on to the Written Test. 10% of the people who take the written test fail it, while 90% pass the test and then proceed to Issue License.



Data on each station are provided in the following table:

	Workers/machines	Activity time (min)
Reception	1	0.4
Eye Test	1	5
Written test	5	15
Issue License	10	6

(1.5 point) a) What is the implied utilization of "Eye test"?		
1		80%
2	X	125%
3		66.7%
4		150%

(1.5 point) a) What is the flow rate of "Written test"?		
1	X	22.75 customers/hour
2		95 customers/hour
3		90 customers/hour
4		85 customers/ hour

Flow rate: 100 customers/hour

	workers	Processing Time (min)	Capacity per hour	Flow rate (hour)	Utilization =Demand/capacity	
Reception	1	0.4	(60/0.4)= 150	100	(100/150)*100= 66.7%	
Eye test	1	5	(60/5) =12	=100*0.15=15	15/12 = 125%	
Written Test	5	15	(60/15)*5= 20	= 0.15*0.85*100+ 0.10*100 = 22.75	(22.75/20) =113.75%	
Issue License	10	6	(60/6)*10= 100	= [0.10*100+0.15* 0.85*100]*0.9+ 0.75*100 = 95.475	95.475/100= 95.475%	

Q2. (2 points) MIGROS is a Swiss supermarket chain. The following table shows the financial data (year 2023) for MIGROS:

Inventories ($MM)	6,000
Sales (net $MM)	89,000
COGS ($MM)	80,000

Assume that MIGROS has an average annual holding cost rate of 20% (i.e. it costs the retailer $2 to hold an item that it procured for $10 for one entire year), and operates 365 days a year.

MIGROS has a COGS= $80,000 MM = flow rate, R. Inventory, I = $6,000 MM. Therefore, flow time T = I/R = 6,000/80,000 = 0.075 years, or 27.375 days.

Q2a. (1.0 point) How many days, on average, does a product stay in MIGROS 's inventory before it is sold?		
1		5.47 days
2	X	27.34 days
3		30.33 days
4		13.32 days

Q2b. (1.0 point) What is MIGROS 's annual inventory turns?		
1	X	13.3 inventory turns
2		27.4 inventory turns
3		12 inventory turns
4		15.5 inventory turns

R =1/T = I/R = 1/0.075 years=13.3

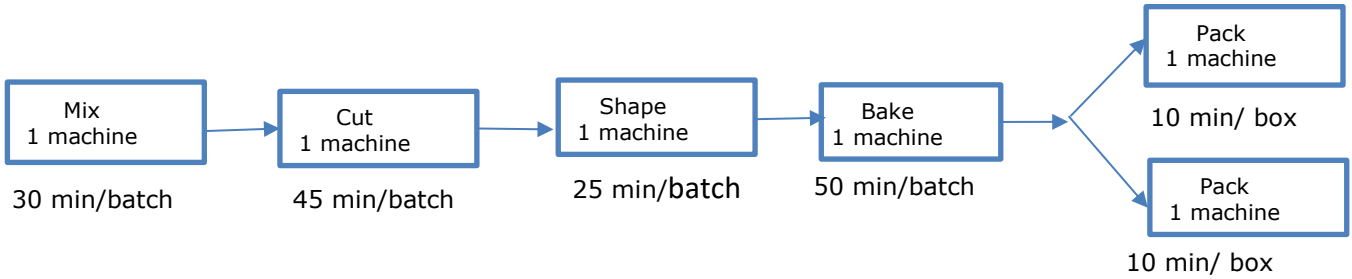
Q3. (1 point) Which of the following is not an objective of lean operations?

1		Reduce space and inventory
2	X	Reduce the size of the work force
3		Reduce variability
4		Improve employees communication

Q4. (1 point) Which of the following statements regarding a pull system is TRUE?		
1		Large lots are pulled from upstream stations
2		Work is pushed to the downstream stations when it is actually needed
3		Manufacturing cycle time is increased
4	x	Materials is moved only when the next stage wants it

Group II (4.0 points)

CAKE+ is a manufacturing company that produces several kinds of Christmas cakes. The production process for Portuguese Christmas Kings Cake (Bolo Rei) is shown in the figure below. There are five operations (phases) in sequence. The product only needs to go through one of the machines in the packing phase. Christmas Kings Cakes are packaged in boxes of 20 cakes. Each batch includes 6 boxes.



Assume that: the company works 8 hours per day, 5 days per week; the yield in each phase is 100%; there are no stoppages and stock cannot be accumulated between the different phases of the process. Currently, the company produces 40 batches/week.

a) **(1.0 point) Identify the bottleneck of the process. Justify your answer.**

b) **(1.0 point) Identify the appropriate flow unit. What is the throughput time for the flow unit identified?**

c) **(0.5 point) What is the capacity utilization of the of the "Shape" operation?**

d) **(1.5 point) Suppose that the weekly demand increases to 60 batches/week. Assuming that the company wants to satisfy all this demand, which changes should be performed in the process? Justify your answer.**

a) **(1.0 point) Identify the bottleneck of the process. Justify your answer.**

Data: 2400 minutes/week; actual output = 40 batches/week

Mix: 30 min/batch ⇒ 80 batches/week

Cut: 45 min/batch ⇒ 53.3 batches/week

Shape: 25 min/batch ⇒ 96 batches/week

Bake: 50 min/batch ⇒ 48 batches/week ⇒ Bottleneck

Pack: 10 min/box⇒ (10*6)= 60 min/batch ⇒ 40 batches/week⇒*2 machines =80 batches/week

b) (1.0 point) Identify the appropriate flow unit. What is the throughput time for the flow unit identified? Flow unit = 1 batch

throughput time = 30+45+25+50+60 = **210 minutes**

c) (0.5 point) What is the capacity utilization of the of the "Shape" operation?

Capacity utilization = actual output/design capacity = **40/96 *100= 41.7%**

d) (1.5 point) Suppose that the weekly demand increases to 60 batches/week. Assuming that the company wants to satisfy all this demand, which changes should be performed in the process? Justify your answer.

60 batches/week.

The company need to buy a cutting machine and a bake machine

Group III (9 points)

Q1. (3.0 points) ICE.Co is an ice-cream shop that sells artisanal ice-cream with a various number of flavours. The weekly demand for the limon ice-cream is normally distributed with a mean of 175 liters and a standard deviation of 25 liters. The unit cost of a liter of limon ice-cream is 0.75 euros, and store sells this ice-cream for 1.5 euros per liter. At the end of week unsold ice-cream is reduced in price by 65% and always sold to a company. Note: $\Phi(1.645) = 0.95$.

a) (1 point) How many liters of limon ice-cream should be purchased to ensure an in-stock probability of 95%?

Data: c = 0.75 euros/liter; p = 1.5 euros/liter; v = 0.35*1.5 = 0.525 euro/kg;
μ=175 liters and σ=25 liters
Overage Cost, Co = c-v = 0.75-0.525 = 0.225
Underage Cost, Cu = p - c =1.5-0.75 = 0.75
F(1.645) = 0.95, thus z = 1.645
In-stock probability = P(D ≤ Q) = 0.95 ⇒ P(Z ≤ (Q-175/25)) = 0.95 ⇒ Q = 175 + 1.645* 25 = 216.1 ⇒ Q = 216 liters

b) (1 point) How many liters of limon ice-cream should be purchased to maximize the expected profit?

Critical Ratio = Cu/(Cu + Co) = 0.75/(0.75+0.225) = 0.7692

F(0.74) = 0.77, thus z = 0.74
Q = μ + z * σ = 175 + 0.74 * 25 = **193.5 liters**

c) (1 point) Assume that the owner of ICE.Co decides to purchase 200 liters of limon ice-cream to sell next week. Determine the expected profit.

μ=175 liters and σ=25 liters
Q = 200 liters
z = (Q-175/25) = 1.0 ⇒ L(1.0) = 0.3069

Expected lost sales =L(z)×σ = L(1.0) = 0.0833*25 = 2.08
Expected lost sales = μ − Expected sales

Expected sales = μ -Expected lost sales = 175-2.08= **172.92**
Expected leftover inventory = Q - Expected sales =200-172.92 = **27.08 liters**

Expected profit = [(p-c) × Expected sales] - [(c-v) × Expected leftover inventory]
0.75*172.92-0.225*27.08 = **123. 60 euros**

Q2. (3.0 points) GOODHEALTH is a Portuguese company that produces medical devices, among them the blood pressure monitor BL00M1, which has an annual demand of 60,000 units. At its manufacturing plant in Lisbon the company produces the blood pressure monitor BL00M1 at a rate of 1,600 units per week. The holding cost per unit per year is 35 euros, and the setup cost is 150 euros per production run. The company currently produces lots of 12,000 blood pressure monitors in each production run. Assume that the company works 250 days per year, 50 weeks. Assume that GOODHEALTH operates 50 weeks a year, 5 days per week.

a) Taking into account the lot size used by GOODHEALTH:
a1) (1 point) How many blood pressure monitor are in inventory when the production stops?

d = 1,200 units/week, p = 1,600 units/week
Imáx = Q(1-d/p) = (12,000)*(1-1,200/1,600) = 3,000 blood pressure monitors

a2) (1 point) Determine the annual holding cost.

Annual holding cost = (Q/2)(1-d/p)*H = (12,000/2)*(1 -1,200/1,600)*35= 52,500 euros/year

a3) (1 point) What is the inventory level 8 weeks after the beginning of a production run?

T = Q/D = 12,000/60,000 = 0.2 years = 10 weeks

t1 = Q/p = 12,000/1,600 = 7.5 weeks

I (8 weeks) = Imáx-(t-t1)*d =2,400 I (8 weeks) = (T-t)*d =(10-8)*1200 =2,400

Q3. (3 points) ROADCYCLE is a Danish store that sells different types of electric bicycles, among them, the BIKEE1 whose annual demand is 40,000 units. Currently, ROADCYCLE purchases BIKEE1 from a Portuguese supplier at a price of 250 euros The order cost is equal to 75 euros and the yearly holding cost per BIKEE1 is 35% of its purchase price. The lead time of the supplier is normally distributed with a mean of 3 weeks and a standard deviation of 2 weeks. The owner of the store wants to adopt a reorder point policy and ensure a 99% service level. Assume that the company works 5 days per week, 50 weeks per year.

a) (1.0 point) What safety stock should be carried for BIKEE1?

a) D = 40,000 bikes/year ⇒ d = 800 bikes /week; P = 275 euros/ bike ;
μ_{LT} = 3 weeks σ_{LT} = 2 weeks; $Z_\alpha = Z_{0.99} = 2.326$

SS = $Z_\alpha \times \sigma_{dLT}$= $Z\alpha \times \sigma_{dLT}$ =2.326 × 1,600 = 3,721.6 bikes = **3,722 bikes**

$$\sigma_{dLT} = \sqrt{d^2 \times \sigma_{LT}^2} = 800 \times 2 = 1{,}600 \text{ bikes}$$

a) Assuming that the safety stock established by the owner of ROADCYCLE for BIKEE1 is 4,000 units.

b1) (1.0 point) What should the reorder point be?

SS = 4,000 bikes

ROP= μ_{LT}*d + SS = 800*3 + 4,000 = **6,400 bikes**

b2) (1.0 point) Determine the annual holding cost.

Q =261.86 =262 bikes

Annual holding cost =(Q/2+SS)*h =[(262/2)+4,000]*35 = **144,585 euros**