PGDM/IB, 18-20

Supply Chain Analytics (DM-444/IB-420)

Trimester-IV, End Term Examination, September 2019

Time allowed: 2 hr 30 min Max Marks: 50

Section A

Attempt all questions (total marks: 30)

1. Anthony's Lobsters is a small seafood restaurant in Newport, Road Island. The place is famous for its lobsters, and customers flock in every day to try it. The arrival rate of the customers is 70/hour with a standard deviation of 60. Anthony's Lobsters has only one chef, but he is very efficient, and the restaurant can satisfy around 90 customers/hour with a standard deviation of 40.
   a. What is the current utilization? (2 marks)
   b. What is the expected time an order waits in the queue (in minutes)? (2 marks)
   c. What is the expected flow time (total time in the system) in minutes? (2 marks)
   d. What is the expected number of orders in process? (2 marks)
   e. What is the expected number of orders waiting in the queue? (2 marks)

   (CILO 2)

2. Bharatiya Ghar (BG) is an Indian real-estate development company that has just finished building a hotel in Goa. BG's hotel has 150 luxury rooms, and the company needs to decide on the long-term price levels to be charged for the hotel rooms. In particular, BG considers a potential price level of ₹10000 per room per day. Based on the analysis of the market research and past occupancy data, the company estimates that if it uses the ₹10000 price level, the daily demand D for rooms at the hotel will be distributed as a Poisson random variable with parameter lambda = 147. The company assumes that if demand for rooms on a particular day exceeds 150, all extra room requests (above 150) will be lost to other hotels.

   a. Suppose the demand on a given day turns out to be 153. What is the total revenue that BG will receive on that day? (1 mark)

   b. What is the algebraic expression for the daily total revenue BG will receive, R, as a function of the daily demand D? (2 marks)

   c. Suppose that Excel's Random Number Generation tool has generated the following sequence of 5 random values from the Poisson distribution with parameter 147: 171, 148, 156, 157, 140. These values reflect 5 random daily demand values. What is the sample standard deviation of the BG's **daily total revenue** values corresponding to these demand values? (3 marks)

   d. Use Excel to set up and run a simulation of the total daily revenue R using n = 100 simulation trials and the random seed of 123. Based on the results of this simulation, what are the estimates for the expected value and the standard deviation of the total daily revenue? (4 marks)

   (CILO 1)

3. Power Cycle makes meters that gauge the speed and power with which cyclists ride their bikes. An electronic sensor, connected to the bicycle's pedal, communicates via Bluetooth to the rider's iPhone or Android phone.

   Power Cycle buys the device's Bluetooth interface from an outside vendor that has offered the following terms.

   i. The vendor will deliver 50,000 interfaces to Power Cycle 60 days from now.
   ii. Power Cycle has the option to buy another 50,000 interfaces for delivery 120 days from now.
   iii. If it wants to buy the 2nd set of 50,000 interfaces, Power Cycle must let the supplier know at least 30 days before delivery; that is, by 90 days from now.
   iv. Power Cycle will pay £5 per unit for the interfaces.

   The supplier incurs a fixed cost of £125,000 for ***each*** production run, plus a per-unit cost of £2 for each interface produced. The manufacturer believes that there is a 60% chance that Power Cycle will request the 2nd set of 50,000 interfaces, and it wants to decide which of the following options it should choose: 1) Enter into the contract, produce 50,000 units now, and produce a 2nd set of 50,000 units only if Power Cycle requests them later. 2) Enter into the contract, produce 100,000 units now, and bear the risk that Power Cycle does not reorder. If the supplier chooses option 2 and Power Cycle orders only 50,000 units in total, the leftover 50,000 units will have no salvage value for the supplier.

   a. Structure the supplier's choices using a decision tree. Make sure you explicitly define all of the elements of the tree: decisions, events, cash flows and probabilities associated with decisions and events, and payouts associated with the final outcomes. (6 marks)
   b. What are the maxi-min, maxi-max, and expected value maximizing decisions for the supplier? What are the monetary values associated with those choices? (4 marks)

(CILO 3)

Section B (20 marks)

When a natural disaster strikes, normal supply chains are disrupted and many vital supplies cannot reach those affected through the normal routes. To handle the first few days after the disaster, many specialized Non-Governmental Organizations (NGOs) work hard to secure vital supplies such as food, blankets, and medicines, and deliver these to people in the affected areas. To do so, they set up temporary supply networks, which only operate as long as needed.

Suppose you are working with one such NGO to set up a temporary network to distribute disaster-kits in the aftermath of a hurricane. You have secured kits from your central supply facility that will be flown in regularly. The kits need to be delivered once per week (as long as needed) to eight (8) temporary shelters, which are located a few hours' drive from the airport.

To simplify the operations, you aim to set up a logistics and distribution centre (DC) to control all distribution. All incoming shipments will be transported from the airport directly to the centre by the military, and from the DC you will plan how the kits are delivered to the shelters.

You are choosing between five (5) locations for the DC. The distances between the five (5) potential locations and the eight (8) shelters are shown in the table below. Assume the outbound transportation cost to be $1/mile.

Distances in **miles**								
	Shelter 1	**Shelter 2**	**Shelter 3**	**Shelter 4**	**Shelter 5**	**Shelter 6**	**Shelter 7**	**Shelter 8**
DC 1	0.61	3.32	9.5	6.52	7.77	1.92	8.52	9.75
DC 2	6.04	0.51	1.34	6.06	0.22	6.33	4.61	3.28
DC 3	4.99	2.41	2.33	3.95	8.84	7.94	7.87	0.94
DC 4	5.58	8.8	6.32	8.54	5.15	6.06	9.42	2.16
DC 5	7.87	9.64	0.7	5.92	2.7	0.26	0.5	3.4

The weekly demand at each shelter has been estimated as follows:

Demand in **thousands**							
Shelter 1	**Shelter 2**	**Shelter 3**	**Shelter 4**	**Shelter 5**	**Shelter 6**	**Shelter 7**	**Shelter 8**
14	8	25	22	20	17	18.5	23

The capacity of the DC will be limited to 150,000 kits per week. The relevant data is given in the Excel file, sheet 'Section B'.

[Hint: You need to build a facility location model in your spreadsheet. To check your spreadsheet, try setting each decision variable (the flow on each of the 40 arcs and the five binary open-or-not variables) = 1. Your total cost should be $198,590. If this is not the case, check your model!]

a. You are considering opening only one DC. Which of the five DC's should you open to minimize total transportation cost? (5 marks)

b. Due to road conditions, the shelters furthest away from the centre may suffer from late and unreliable deliveries. As a result you are thinking about opening more than one DC.

   Assuming the military is ok with delivering your supplies to more than one DC, what is the optimal number of DCs? (5 marks)

c. Suppose it costs $300,000 per week to set up and run a DC. What is the optimal number of DCs? Assume the same transportation costs as in the previous parts of this question. (5 marks)

d. When you see the optimal solution from part c (above), you realize that under that solution, much of the demand is more than 2 miles away from a DC. How does the optimal solution change if we require that at least 60% of demand should be less than 2 miles from a DC? (5 marks)

   (Note: for this part, you will need to enforce the demand constraints more exactly and make them binding; use equality sign) **(CILO 2)**