COMM 225: POM, WINTER 2012 - REVIEW QUESTIONS,

(THIS DOCUMENT INCLUDES SELECTED QUESTIONS FROM PAST MID TERM & FINAL EXAMS)

TOPIC: STATISTICAL PROCESS CONTROL

Q 3.1: A certain molded part is examined for conformity in diameter, and for the presence of excessive flashing. Equal-sized samples are taken at 15-min intervals throughout the eight-hour working day. For each sample, the mean and the range of the diameters are recorded, and a notion is made if any of the sampled parts have excessive flashing.

Sample	Mean	Range	Sample	Mean	Range	Sample	Mean	Range
1	1.975	0.2	6	2	0.3	11	2.05	0.1
2	2.025	0.3	7	1.925	0.2	12	1.975	0.1
3	1.9	0.3	8	1.975	0.2	13	1.975	0.3
4	1.95	0.1	9	2	0.2	14	2.025	0.2
5	2.1	0.2	10	2.025	0.2			

- The sum of the mean and range of the 14 samples shown above are 27.9 and 2.9 respectively.
- The fifteenth sample is: {2.00, 2.00, 1.90, 2.10, 2.40, 2.10, 1.95, 2.00}

(a) Calculate the control for the appropriate process control charts limits using all the information you have. Explain if the process appears to be in control?

(b) Every-day 32 samples were taken. Last week the number of samples for which there was a notion of excessive flashing was 2, 4, 2, 2, 3, 3, and 8. The 8 looks higher than the rest. Use an appropriate control char, based on these seven data, to determine whether the presence of excessive flashing is out of control. Sketch the control chart, showing the upper and lower control limits.

Q 3.2: The following table lists the number of defective 40-watt light bulbs found in samples of 100 light bulbs selected over 25 days from a manufacturing process. Construct an appropriate chart to monitor the process and plot the data using the 3-sigma limit. Comment on the process.

Day	Defective	Day	Defective	Day	Defective	Day	Defective	Day	Defective
1	3	6	4	11	2	16	2	21	2
2	2	7	4	12	4	17	3	22	2
3	5	8	5	13	4	18	1	23	3
4	8	9	6	14	4	19	4	24	5
5	3	10	1	15	0	20	0	25	3

Q 3.3: An advertising agency tracks the complaints, by week received, about the billboards in its city:

Week	1	2	3	4	5	6
No. of Complaints	4	5	4	11	3	9

(a) What type of control chart would you use to monitor this process and why?
(b) What are the 3-sigma control limits for this process? Assume that the historical complaint rate is unknown. Is the process mean in control, according to the control limits?
(c) Assume that the historical complaint rate has been 4 calls a week. Is the process mean in control, according to the control limits?

Q 3.4: As a part of an insurance company's training program, participants learn how to conduct a fast but an effective analysis of client's insurability. The goal is to have participants achieve a time less than 45 minutes. There is no minimum time, but the quality of assessment should be acceptable. Test results for three participants were, Jerry, a mean of 37 minutes and a standard deviation of 2.5 minutes; Armand, a mean of 39 minutes and a standard deviation of 3 minutes; and Lau, a mean of 37.5 and standard deviation of 2.5 minutes. Which of the participants would you judge to be capable and why?

TOPIC: SERVICE DESIGN

Q 5.1: Fore and Aft Marina is a new marina planned for a location on the Ohio River near Madison, Indiana. Fore and Aft expects a mean arrival rate of 7 boats per hour. Fore and Aft is evaluating the following two options:

- Option A: One dock with a mean service rate of 12 boats per hour.
- Option B: Two docks with a single queue. Each dock is capable of serving on average 10 boats/ hour.

Calculate the following for both the options (Option A and Option B)

a) What is the average time a boat will wait for service?
b) What is the probability that more than 2 boats are waiting for services?
c) What is the probability that a boat has two wait before getting the services.

Q 5.2: A warehouse has three loading docks. Trucks wait in a single line until signaled to enter in the next available dock. Currently every dock requires a team of two persons who can load a truck on average in 10 minutes. Trucks arrive at the rate of 12 per hour.

a) Determine the expected queue length as well as the average time before a truck is assigned to a dock.
b) Determine the probability that a truck get the dock without waiting in the queue.
c) It is estimated that each truck waiting in the system costs $30/hour. The warehouse manager is evaluating the following two options listed below. Which option would you recommend i.e. current system, option 1 or option 2? Justify your answer by actual calculations. (Assume warehouse operates 10 hours per day and 300 days per year)

    - Option 1: One Automated Loading System (fixed service time), Loading Rate: 20 trucks per hour, Total Cost = $35000/year
    - Option 2: One Semi-automated loading System, Loading Rate: 15 trucks per hour, Total Cost = $18000/year

Q 5.3: The Chattanooga Furniture store gets an average of 50 customers per shift. Marilyn Helms, the manager, wants to calculate whether she should hire 1, 2, 3 or 4 salespeople. She has determined that average waiting times will be 7 minutes with one salesperson, 4 minutes with two salespeople, 3 minutes with three salespeople, and 2 minutes with four salespeople. She has estimated the cost per minute that customer wait at $1. The cost per salesperson per shift (including fringe benefits) is $70. How many sales people should be hired?

Q 5.4: A hockey arena experiences the highest volume of ticket sales on Fridays from 10:00 a.m. to 6:00 p.m. Currently, there are three ticket windows serving their own line in front of each window. A consultant hired recently carried out a time study and found that the verbal communication between the customer and the salesperson takes three minutes on the average. The same study also revealed that there were no customers in the system 20% of the time. Based on Poisson arrival rates and negative exponential service times, answer the following questions. Show all work.

(a) What is the arrival rate per hour at each line?
(b) How long on the average must a customer wait before the start of the service by the salesperson?
(c) What is the average length of each queue?

(d) What is the probability of finding at most two customers waiting in each queue?
(e) After studying the sales operations, the same consultant proposed having a single queue to be served by three sales persons.
(f) What is the arrival rate for this configuration?
(g) What is the probability of finding no customers in the system?
(h) How long on the average must a customer wait before the start of service by the salesperson?
(i) Calculate the total amount of customer waiting time saved on Fridays if the consultant's proposal is accepted.

Q 5.5: Customers arrive at the lobby of the exclusive and expensive Ritz Hotel at the rate of 40 per hour (Poisson distributed) to check in. The hotel normally has three clerks available at the desk to check guests in. The average time for a clerk to check in a guest is four minutes (exponentially distributed). Clerks are paid $12 per hour and the hotel assigns a good will cost of $2 per minute for the time guest must wait in the line.

(a) Determine the current waiting time for guests before getting the services.
(b) Determine if the present check-in system is cost effective; if it is not, recommend what hotel management should do.

Q 5.6: Customers arrive at the drive-up window of a fast food restaurant at the rate of 25 per hour. The employee working the window can serve one customer every 2 minutes. Assume Poisson arrivals and exponential service rates.

(a) What is the average utilization of the employee?
(b) What is the average number of customers in line?
(c) What is the average number of customers in the system?
(d) What is the average time spent waiting in line?
(e) What is the average time waiting in the system?
(f) What is the probability that exactly 2 cars will be waiting in line?

If the manager decides to train the employees to reduce the service time variability as much as possible, what would be the change in the above performance measures? Use appropriate model to do the calculations.

Q 5.7: The manager of an amusement park wants to hire a repair team for the bumper car section. On average 2 cars breakdown every hour. The loss of revenue due to breakdown is $40/hour. The average repair (service) time is 30 minutes for a team of size 1, 20 minutes for a team of size 2, and 15 minutes for a team of size 3.

(a) Assuming that each repair person costs $20/hour, how many people should be hired?
(b) Suppose that the director of the amusement park has asked the manager to go with the repair team size of 2. However, to keep the cars in working condition, more than one repair team may be needed. How many teams should be hired?

Q 5.8: The manager of a regional warehouse must decide on the number of loading docks to request for a new facility in order to minimize the sum of dock costs and driver-truck costs. The manager has learned that each driver-truck combination represents a cost of $300 per day and that each dock plus loading crew represents a cost of $1,100 per day.

(a) How many docks should be requested if trucks arrive at the rate of four per day, each dock can handle five trucks per day assuming both rates are Poisson?
(b) An employee has proposed adding new equipment that would speed up the loading rate to 5.71 trucks per day. The equipment would cost $100 per day for each dock. Should the manager invest in the new equipment?

TOPIC: SALES AND OPERATIONS PLANNING

Q 6.1: Wetski Water Ski (WWS) is the world's largest producer of water skis. As you might suspect, water skis exhibit a highly seasonal demand pattern, with peaks during the summer months and valleys during the winter months. The company likes to zero out its inventory at the end of a year so that it can start fresh each January. The company currently uses a level production strategy but would like to evaluate other options. Given the following costs and quarterly sales forecasts, create a production plan and *calculate the cost of the plan for three strategies: (a) Level production, (b) Chase demand, (c) Mixed strategy: Produce 50,000 in period 1, and 134,000 in periods 2 through 4. Which plan would you recommend to WWS?* (Note: No backordering is allowed.)

Quarter	Sales Forecast
1	50,000
2	150,000
3	200,000
4	52,000

- Beginning workforce: 50 employees
- Production per employee: 1,000 skis/quarter
- Inventory carrying cost: $3 per ski/quarter
- Regular production cost: $50 per ski
- Hiring cost = Firing cost: $500/worker

Q 6.2: *Formulate a linear programming model for the Wetski Water Ski (WWS) (Refer to the Q6.1 above) that will satisfy demand at minimum cost (Define the variables and write the objective function, and constraints).*

Q 6.3: The linear programming model for the above problem was solved using the Excel Solver. The output (with some missing cell entries) is shown below. *Determine the total cost of the optimal production plan and compare it with three production strategies of Q6.1* (fill up the relevant missing cells in the Excel Solver output only if required).

Beginning Workforce:	50	Production Cost:	$50.00		Firing Cost:	$500
Units/Worker	$ 1,00	Inventory Cost:	$3.00		Hiring Cost:	$500
Beg Inv.	0					

Qtr.	*Demand*	*Production*	*Inventory*	*Workers Needed*	*Workers Hired*	*Workers Fired*	*Demand Constraint*	*Production Constraint*	*Workforce Constraint*
1	50,000						50,000		50
2	150,000			150			150,000	150,000	
3	200,000						200,000		200
4	52,000			52			52,000	52,000	
Total	452,000								

Total Production Cost: **Total Inventory Cost:**

Total Hiring & Firing Cost: **TOTAL COST:**

TOPIC: SUPPLEMENT TO LINEAR PROGRAMMING

Q 6.1S: A jewelry store makes necklaces and bracelets from gold and platinum. The store has developed the following linear programming model for determining the number of necklaces and bracelets (x1 and x2) to make in order to maximize profits.

$$Maximize\ Z = 300x_1 + 700x_2 \quad \text{(Total Profit in \$)}$$

Subject to

$$3x_1 + 2x_2 \leq 18 \quad \text{(Gold in ounces)}$$
$$2x_1 + 4x_2 \leq 20 \quad \text{(Platinum in ounces)}$$
$$x_2 \leq 4 \quad \text{(Demand for bracelets)}$$
$$x_1, \quad x_2 \geq 0$$

(a) Solve this model graphically.

(b) The maximum demand for bracelets if 4. If the store produces the optimal number of bracelets and necklaces, will the maximum demand for bracelets be met? If not, by how much will it be missed?