PGDM/PGDM-IB, 2018-20

Process Analysis and Improvement (DM- 342/IB-317)

Trimester-III, End-Term Examination: March 2019

Time Allowed: 2 ½ hours Max Marks: 50

Roll No:

Instruction: Students are required to write Roll No on every page of the question paper. Writing anything except the Roll No will be treated as Unfair Means. In case of rough work please use the answer sheet.

Section A

Please attempt any THREE questions. Each question carries 5 marks. **Please be brief.**

A1. The Toyota Production System identifies inventory as the biggest waste. Do you agree? Why? *Name* two characteristics in TPS that help significantly reduce this waste.

A2. Consider the Xootre example. The production process comprised three stations: station 1 (12 min), station 2 (10 min), and station 3 (8 min). The data in parentheses are the respective processing times. Each station is manned by one worker. What is the cycle time? What is the flow rate? Keeping the number of stations and the flow time the same, what is the best flow rate possible in this case? Assume that demand is not a constraint.

A3. Besides teaching, members of a business school faculty are also expected to create and disseminate new knowledge in the form of research publications. While number of papers published by an individual in a given period is important, the quality of the papers is also important. How will you define research productivity for a faculty member? How will you use quartile analysis to improve the average research productivity?

A4. In a large hospital, there are 10 births per day. 80% of the deliveries are easy and require mother and baby to stay for 2 days; 20% of the cases are more complicated and require a 5 day stay. What is the average occupancy of the department?

A5. Consider a two-stage process. The processing time for stage 1 is 3 min (constant), while that for stage 2 is normally distributed with a mean of 9 min and standard deviation of 2 min. What is the probability that the flow rate of the process will be 20 units per hour?

Section B

Please attempt any TWO questions. Each question carries 10 marks.

B1. Infusion US is a start-up that offers powerful and energizing infusions in a non-hospital setting for athletes (just electrolytes, ☺). The service process includes five activities that are conducted in the sequence described below. (The time required for each activity is shown in parentheses).

Activity 1: Welcome and explain procedure (7 min)

Activity 2: Take vitals, insert IV, and take blood (13 min)

Activity 3: Mix infusion treatment (12 min)

Activity 4: Infusion (30 min)

Activity 5: Debrief (5 min)

Three nurses (S1, S2 and S3) offer the services in a worker paced line. The assignment of activities to the nurses is given below.

S1 – Activity 1 and Activity 2

S2 – Activity 3

S3 – Activity 4 and Activity 5

Assume the demand to be unlimited and that the process admits patients at the rate of the bottleneck.

a. Which nurse is the bottleneck of the process? (2 marks)
b. What is the utilization of nurse 2? (2 marks)
c. What is the cycle time in minutes? (2 marks)
d. What is the average labour utilization across all three nurses? (2 marks)
e. What are the direct labour costs associated with serving one patient? Assume wages @ $30/h for nurses 1 and 2, and $60/h for nurse 3. (2 marks)

B2. Line balancing is a critical aspect of an assembly line. Consider an assembly line comprising 11 operations, as listed in the table below. Please note that combination of tasks at one station of the line is possible.

Sequence	Task	Task time (min)
1	A	20
2	B	10
3	C	5
4	D	10
5	E	15
6	F	5
7	G	10
8	H	30
9	I	10
10	J	5
11	K	30

a. Assume that the process is capacity constrained (there is enough demand), and that each task is performed by one worker. What is the maximum capacity of this line? (2 marks)

b. Create a balanced line that achieves the maximum capacity while maximizing the labour utilization, without disturbing the sequence of the tasks. How many stations will you need (draw a schematic diagram of stations and assigned tasks)? (2 marks)
c. What will be the average labour utilization of the line (created in part b)? (2 marks)
d. If shuffling of tasks were allowed, would your line differ from the one created in part b? Illustrate with a diagram of the new line. (2 marks)
e. What will be the average labour utilization now? (2 marks)

B3. Dr Peters is a physician employed by a large primary care practice in Wynnewood, PA. The practice in which he works is open 260 days a year. Physicians have 30-minute appointment slots starting at 8 am all the way up to 6 pm. The practice is looking for improvement opportunities and wants to get a sense of the Overall People Effectiveness (OPE) of their physicians. The data collected so far suggests that:

- Dr Peters, because of his German parents, spends 30 work days a year on vacation at Germany.
- He also loses 2h of potential work time each day due to electronic medical record-keeping (he blocks these 2 hours in his schedule, so no appointments are available during this time).
- Dr Peters has a really busy schedule, so 75% of his appointments are booked.
- About half of the patients Dr Peters sees are coming for their annual check-up. Such exam appointments are made a long time in advance. About one out of every six patients does not show up for his or her appointment.
- Though the appointment slots are 30 minutes per slot, Dr Peters only spends, on average, 23 minutes with the patient (or doing work related to the patient after the patient has left the office). Of those 23 minutes, about 5 minutes could easily be done by one of Dr Peters's assistants.

a. How many patients does Dr Peters see on a typical day when he is at work? (5 marks)
b. What is his OPE? (Assume that his maximum availability is 260 days in a year) (5 marks)

Section C

With respect to the case 'Middletown General Hospital Emergency Department' please answer the following questions.

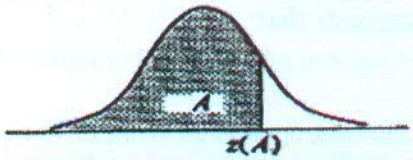
1. C1. In 2011, what was the average number of observation patients in the hospital? What was the average number of admitted patients in the hospital?
2. Using the 2011 patient flows, how large should the ED observation unit be to achieve a target utilization of 80%?
3. In 2011, what was the profit flow in dollars/day resulting from patients who entered the hospital (on observation or admitted status) through the ED? (Flow conservation?)
4. Assume that an observation unit of your recommended size is built and running and that the hospital experiences the same flow rates as it did in 2011. Ignoring the fixed costs of constructing and equipping the room, what would be the benefit (in dollars/day) to the hospital for having the observation unit relative to the status quo? Also assume that all of the

inpatient beds that were formerly filled by observation patients can now be filled by inpatients, who stay on average 5.8 days and net the hospital $3,500 each.

5. Is there a financial business case to be made for building the ED observation unit, taking into account the costs (fixed and variable) and the revenues? You may answer this question using the payback period.

(5 x 3 marks)

Entry is area A under the standard normal curve from $-\infty$ to $z(A)$



z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

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Middletown General Hospital Emergency Department Observation Unit Analysis Exercise

Dr. Nate Greene, director of the Middletown General Emergency Department (ED), looked out over the patients on mobile beds lined up in the hallway. He could barely meet their eyes, understanding fully how upsetting a lack of privacy and impressions of substandard care are to vulnerable people in need. Unfortunately, overcrowding in the ED was commonplace due to a scarcity of inpatient beds in the main hospital. There was no place for these patients to go until an inpatient bed opened up.

"There has to be a better way to manage this, at least for the sickest patients," he muttered to himself. Greene knew that day the ED had already moved 10 patients into the hospital on observation status, and he wished he could call those back and send some of his sickest patients upstairs instead. "If I had a safe place to hold observation patients down here in the ED, it would make a world of difference," he thought.

Middletown General Hospital is a tertiary care hospital with 400 inpatient beds. In 2011, the Middletown Hospital Emergency Department (ED) saw about 200 patients each day. On average, 150 were discharged after being seen, but about 50 stayed overnight. About 20% of these patients were on "observation" status, meaning that an admission decision had not been made, pending test results or the results of an overnight observation stay. The remaining 80% were admitted directly. All patients who stayed overnight (whether admitted or on observation status) were put into an inpatient bed. That is, there was no separate observation area. The average admitted patient stayed 5.8 days and represented about $3,500 in profits to the hospital. The average patient under observation occupying an inpatient bed netted the hospital about $3,300 in profits.

Observation patients stayed on observation status for an average of 1.2 days before being either discharged or admitted (upgraded to inpatient status). Eighty percent of observation patients were discharged, and 20% were upgraded to inpatient status. After admission, observation patients stayed an average of 5.8 days before discharge and netted the hospital $3,500. See **Figure 1**.

In January of 2012, Greene had become convinced that an ED observation unit would be an attractive way to board observation status patients without using an inpatient bed. Observation beds are less costly

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to staff than inpatient beds due to the more stringent code requirements associated with an inpatient stay. In addition, in Certificate of Need[1] states regulators make increasing observation bed capacity much easier than increasing licensed inpatient bed capacity.

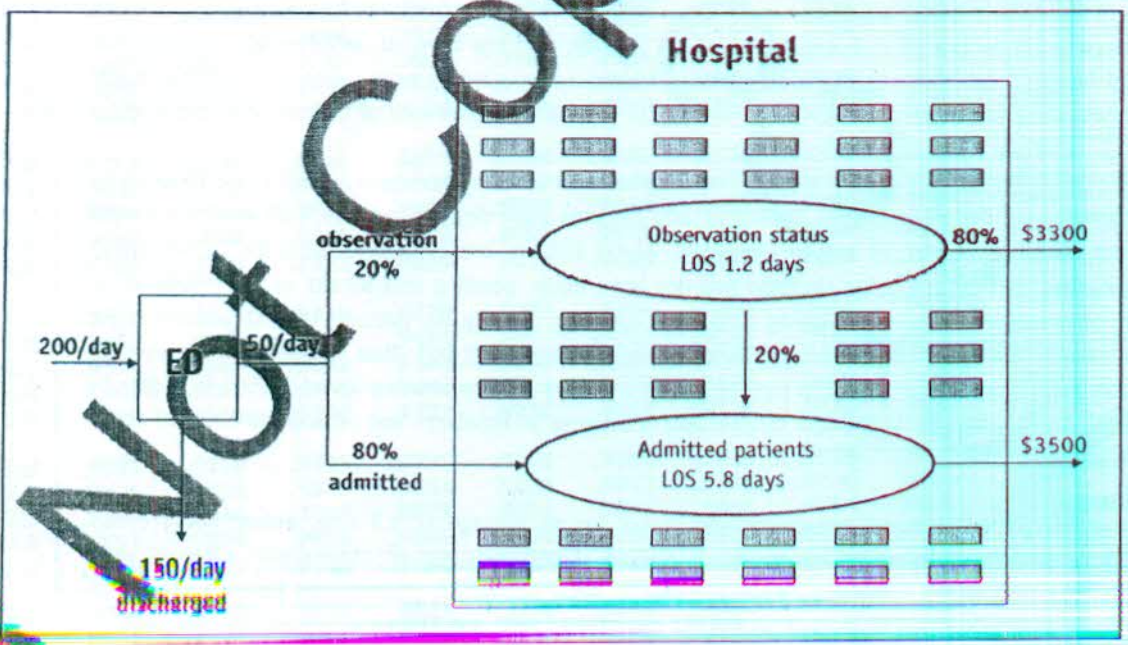
While it was obvious that the extra space provided by an observation unit would alleviate congestion, Greene knew that it would never be built unless he could make a sound economic case for it to the hospital administration. He made some rough calculations and estimated that if an observation unit was available, the average profit per observation patient who was discharged without being admitted would be $3,700. He also estimated the fixed investment required to construct (and equip) an ED observation unit to be $5 million plus $60,000 per bed.

Weary of compiling numbers and trying to make sense of them in the scraps of time he was able to steal between shifts in the ED, Greene decided to give the project to a group of business students from a local university who had been assigned to him as part of a project course.

"Team, I need a business case. You can assume that all vacated beds will be backfilled by new admitted patients, and that all of those new patients come in on admitted status and so represent $3,500 in profits to the hospital," he said. "What I want to know is whether an observation unit makes economic sense for Middletown."

Figure 1

Middletown General Patient Intake Flow Chart



[1] In Certificate of Need states, a hospital must prove the need for additional capacity to a state agency before being allowed to carry out the expansion. The intent is to make capacity competition and reduce overbuilding.

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