PGDM / PGDM (IB), 2020-22

Process Analysis & Improvement

DM-341 / IB-342

Trimester – III, End-Term Examination: April 2021

Time allowed: 2 Hrs 30 Min

Roll No: _____

Max Marks: 50

Instruction: Students are required to write Roll No on every page of the Answer Sheet. All other instructions on the question paper / notifications should be followed meticulously.

Section A

There are eight questions in this section. The marks for each question are given. Please attempt any combination of questions of total worth 30 marks (exact). **Please be brief**.

A1. 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?

(CILO 2; 5 marks)

A2. Consider the baggage check-in of a small airline. Check-in data indicate that from 9 a.m. to 10 a.m., 255 passengers checked in. Moreover, based on counting the number of passengers waiting in line, airport management found that the average number of passengers waiting for check-in was 35. How long did the average passenger have to wait in line?

(CILO 2; 5 marks)

A3. 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.

(CILO 1; 5 marks)

A4. 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. Since the stage 2 processing time is a random variable, the flow rate of the process will also vary.

a. What is the maximum flow rate of this process?
b. What is the probability that the flow rate of the process will be 20 units per hour?

(Given: for a normal distribution, $P(-3 < Z < 3) = 0.9973$) (CILO 3; 5 marks)

A5. Consider a two-stage process. The processing time for each stage is 5 min. However, each stage can produce defectives with a probability of 50%. In case of a defective, each stage takes extra 5 min to rework. Assuming that the rework produces an OK piece, what is the expected (mean) flow rate of this process?

(CILO 3; 5 marks)

A6. 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.

(CILO 2; 5 marks)

A7. 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)

(CILO 3)

A8. As an equipment provider for several Olympic cyclists, Carbon Bike Frames (CBF) operates a very expensive wind tunnel facility near San Diego, CA. The wind tunnel is used to find the best compromise between ergonomics and aerodynamics for the cyclist. Presently, more and more cyclists are interested in CBF's services, so the company considers building a second facility. However, given the enormous costs of the wind tunnel, they also want to explore a more effective use of the current facility. An initial data collection reveals that:

- The standard fitting time for a cyclist is 2h. On average, the wind tunnel is used for 7 fitting procedures a day (new customers or customers who want a *refit*). The wind tunnel is available 24 hours a day.
- CBF offers a free second session should the customer not be entirely satisfied with their bike fit (internally also known as "rework sessions"). About 2 out of 5 customers come back for such a "*refit*," which takes the same amount of time as the initial fit. Assume that a *refit* customer is completely satisfied after the refit.
- 20 minutes (in addition to the standard time) of the each fitting procedure is spent on setting up the bike on a stationary trainer and getting the athlete ready. Almost all of this could happen outside the wind tunnel, i.e. while another fitting procedure is still going on.
- About one day out of 10, the wind tunnel is down for maintenance or repair.

a. How many new fits are conducted on a typical day when the wind tunnel is in use (assume the wind tunnel is open that day)? Remember that of the 7 fitments done on a day, some are refitment cases and a refitment case is always 'OK'. (5 marks)
b. What is the OEE of the wind tunnel? The value-add time is what is spent on new fitments. Rework time does not add value. Recall that the wind tunnel can be used 24h a day. (5 marks)

(CILO 3; 10 marks)

Section B

This section is of 20 marks. Attempt the questions given at the end.

Dr. Nate Green, 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 General 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). 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 to staff than inpatient beds due to the more stringent code requirements associated with an inpatient stay. In addition, existing regulation makes 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."

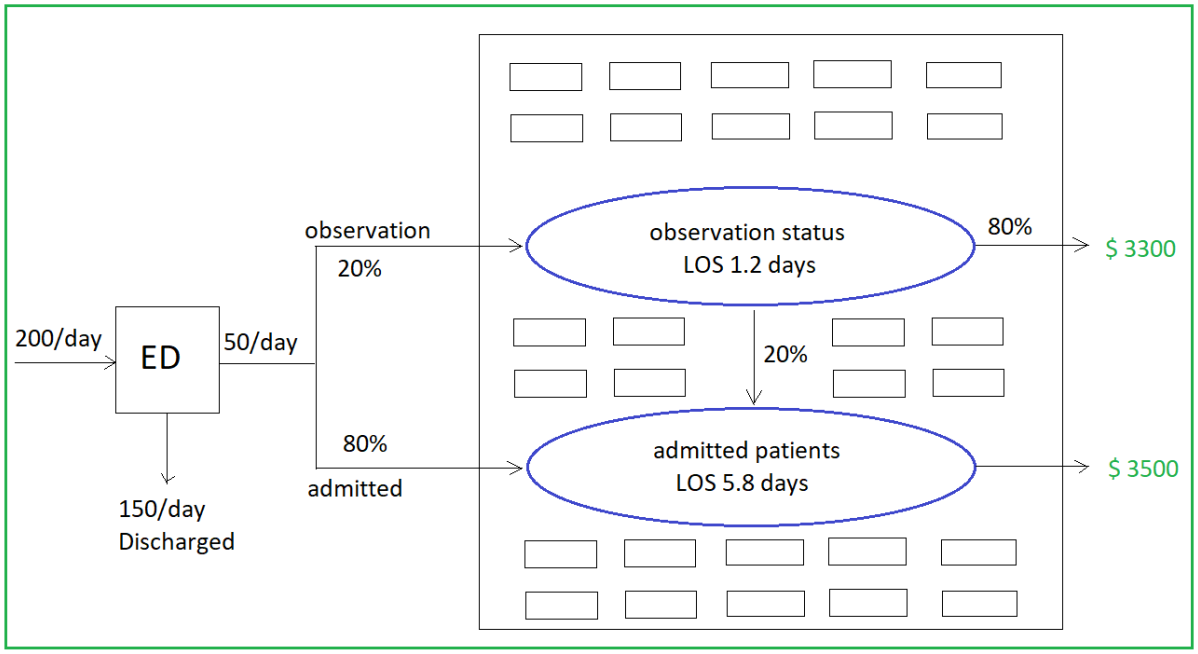

Figure 1. Middletown General Patient Intake Flow Chart (Emergency Department).

LOS: length of stay

1. In 2011, what was the average number of observation patients in the hospital at any point in time? What was the average number of admitted patients in the hospital at any point in time? You may use Little's Law to work out these numbers. (3 marks)

2. Using the 2011 patient flows, how large should the ED observation unit be to achieve a target utilization of 80%? In this question you are required to find out the number of beds in the proposed ED observation unit. The answer to this question is related to the first answer to the previous question. (2 marks)

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? To answer, use the fact that 50 patients entered the hospital through the ED every day. (5 marks)

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 additional profits (in dollars/day) to the hospital for having the observation unit as compared to the present status? Also assume

that all of the inpatient beds that were formerly filled by observation patients (for 1.2 days) can now be filled by inpatients, who stay on average 5.8 days and net the hospital $3,500 each. (5 marks)

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 profits? You may answer this question using the payback period. (5 marks)

(CILO 2; 20 marks)