Operations management: Homework 1

Pettersson

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1.

a. Example of process

An example of a process is to bake bread.

b. Components of process

Components of the process:

- Input: Flour, yeast, water, electricity, labor, capital (oven, fridge, bowl with lid), labor
- Output: 1 loaf of bread Bread

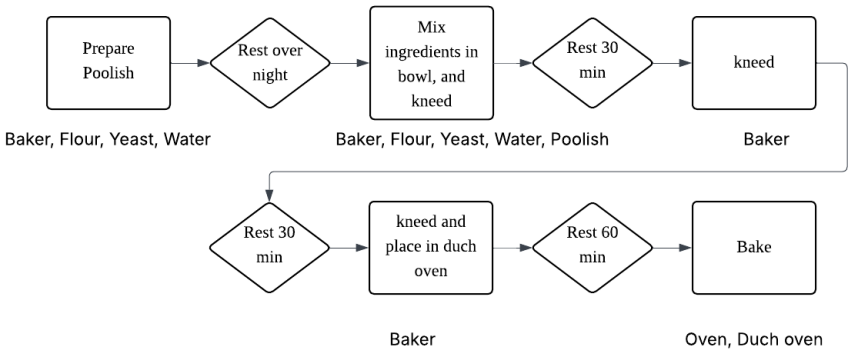

Figure 1: Bread process

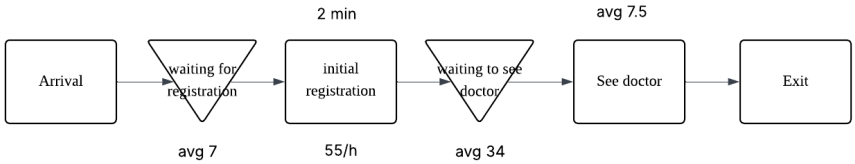

Figure 2: ER, process

2.

a. Process diagram

b. Average Flow time

The total average time (Flow Time, T) is the sum of the average times spent in each stage. By Little's Law (Time = Inventory / Throughput Rate) for the waiting stages. The throughput rate (R) is 55 patients/hour.

Flow time T calculated for each step:

- Waiting for registration: $T = I/R = 7patients/55 = 0.1273h$
- Initial registration: $T = 2min = 0.033h$
- Waiting for doctor: $T = 34patients/55 = 0.6182h$
- Average time with doctor: $T = 0.9 * 5 + 0.1 * 30 = 7.5min = 0.125h$
- Total: $T = 0.1273 + 0.033 + 0.6182 + 0.125 = 0.9038h$

c. Average number of patients being examined by doctors

This is the inventory of patients in the "See Doctor" activity ($I_{doc\_activity}$). We use Little's Law (Inventory = Rate × Time).

- $I_{doc\_activity} = R \times T_{doc\_activity}$
- First, convert activity time to hours: $7.5 \text{ min} \div 60\frac{\text{min}}{\text{hr}} = 0.125 \text{ hr}$
- $I_{doc\_activity} = 55\frac{\text{patients}}{\text{hr}} \times 0.125 \text{ hr} = \mathbf{6.875} \text{ patients}$

On average, 6.875 patients are being examined by doctors.

d. Average number of patients in the ER

This is the total inventory in the system (I_{total}). This can be found by applying Little's Law to the entire process.

- $I_{total} = R \times T_{total}$
- First, convert total time to hours: $54.23 \text{ min} \div 60 \frac{\text{min}}{\text{hr}} = 0.9038 \text{ hr}$
- $I_{total} = 55 \frac{\text{patients}}{\text{hr}} \times 0.9038 \text{ hr} = \mathbf{49.71}$ patients

Alternatively, we can sum the inventory at each stage:

- $I_{reg\_activity} = R \times T_{reg\_activity} = 55 \frac{\text{patients}}{\text{hr}} \times (2 \text{ min} \div 60 \frac{\text{min}}{\text{hr}}) = 1.83$ patients
- $I_{total} = I_{reg\_wait} + I_{reg\_activity} + I_{doc\_wait} + I_{doc\_activity}$
- $I_{total} = 7 + 1.83 + 34 + 6.875 = 49.71$ patients

3.

a. Number of DVD copies needed

To meet demand, the number of copies must equal the average number of DVDs rented out (Inventory). We use Little's Law ($I = R \times T$).

- Throughput Rate R = 15 DVDs/day.
- Average Flow Time T = $(0.2 \times 2) + (0.3 \times 3) + (0.4 \times 4) + (0.1 \times 5) = 3.4$ days.
- Inventory I = $15 \times 3.4 = 51$ DVDs.

SSV should carry 51 copies.

b. Average daily revenue from a Star Wars DVD

First find the average revenue per rental, then the total daily revenue, and finally the revenue per copy.

- Avg. revenue per rental = $(0.2 \times \$4) + (0.3 \times \$7) + (0.4 \times \$10) + (0.1 \times \$13) = \$8.20$.
- Total daily revenue = 15 rentals/day × \$8.20/rental = \$123.00/day.
- Avg. daily revenue per copy = \$123.00/51 copies = \$2.41.

4.

a. Process diagram

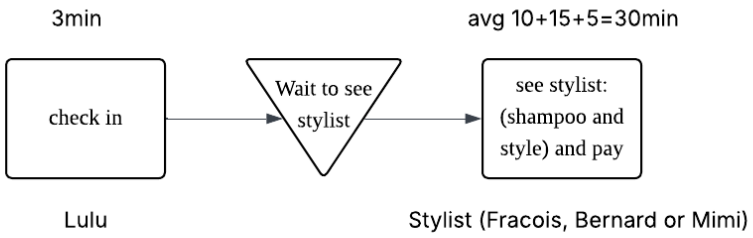

Figure 3: Stylist process

b. Customers serviced per hour

System capacity is determined by the bottleneck (the slowest resource).

- Capacity of Lulu = (60 min/hr)/(3 min/cust) = 20 customers/hr.
- Capacity of Stylist Pool = $3 \times$ (60 min/hr)/(30 min/cust) = 6 customers/hr.
- System Capacity = $\min(20, 6) = 6$ customers/hr.

c. Impact of transferring billing

Recalculate capacities with the new process times.

- New Lulu time = $3 + 5 = 8$ min. New Capacity = $60/8 = 7.5$ customers/hr.
- New Stylist time = $10 + 15 = 25$ min. New Capacity = $3 \times (60/25) = 7.2$ customers/hr.
- New System Capacity = $\min(7.5, 7.2) = 7.2$ customers/hr.

The capacity increases from 6.0 to 7.2 customers/hr, a 20% increase.

5.

a. Capacity of KWF

System capacity is determined by the bottleneck resource. First, find the total work for each resource per panini.

- Kerry's work $= 2 + 2 + 1 = 5$ min. Capacity $= 60/5 = 12$ paninis/hr.
- Sarah's work $= 1 + 1 + 1 = 3$ min. Capacity $= 60/3 = 20$ paninis/hr.
- Grills' work $= 5$ min per grill. Capacity $= 2 \times (60/5) = 24$ paninis/hr.
- System Capacity $= \min(12, 20, 24) = 12$ paninis/hr.

b. Hourly profit at capacity

Multiply the system capacity by the profit margin per panini.

- Hourly Profit $= 12$ paninis/hr $\times$ \$4/panini $=$ \$48 per hour.