**Model 3-7 Hand analysis**

Q: Do a paper-and-pencil, that is, no-simulation, analysis of what’s happening in the long run, that is, infinite run-length, at both the inspection center and the washing center; figure out the “effective” arrival rates to both of those places, and compare with their service rates—are your simulation results consistent with this? Maybe extend your simulation run as far past the 480 minutes as you can.

**Analysis:**

We will depend on the average for arrival and service time

1. We will calculate the arrival rates for washing and inspection center
2. Then will compare them to the service rates for both places.

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* **λ**: mean rate of arrival = 1/E[Inter-arrival-Time], where E[.] denotes the expectation operator.
* **µ**: mean service rate = 1/E[Service-Time]

Let’s start from beginning:

* The inter-arrival time is exponentially distributed with a mean of 5 minutes

While the service time also exponentially distributed with a mean of 3 minutes in drilling center this means:

* E(service) < E(interarrival)
* So there is no queue in drilling
* machine is idle for Steady-state (long-run, forever)
* waiting time in queue (0)
* Before the re-washed parts go back to washing center

The inter-arrival time mean to washing center is 3 minutes (processing time in drilling)

While the service time in washing center is 3 minutes

this means:

* E(service) = E(interarrival)
* So there is no queue in washing now
* machine is idle for Steady-state (long-run, forever)
* waiting time in queue (0)

**Inspection center:**

The inter-arrival time mean to inspection center is 3 minutes (processing time in washing)

While the service time in inspection center is 4.5 minutes

λ I  = mean arrival rate to Inspection center

µ I = mean service rate of Inspection center

λ I  = 1 / 3 , µ I = 1 / 4.5

λ I  > µ I

arrival rate **>** service rate

this means:

* a queue will form
* machine is not idle for Steady-state (long-run, forever)
* means that the queue would explode

**Washing center:**

AS the inspection fail parts go back to washing center to be re-washed,

We can assume that the mean inter-arrival time of the failed inspection parts to the washing center is 4.5 minutes (processing time in inspection center)

**Then**:

Arrival rate for ( washing center) will be as follows:

Every 3 minutes a part come from drilling and every 4.5 minutes a part come from inspection

λ w = mean arrival rate to washing center

λ 1 =mean arrival rate from drilling center or (production rate from drilling)

λ 2 = mean arrival rate from inspection center or (production rate of filed parts from drilling)

λ w = λ 1 + λ 2

= 1/3 + 1/ 4.5

= 7.5 / 13.5

**= 0.555 part/minute** Arrival rate to washing center

Service rate of washing center is 1/3 = 0.333 part/minute

arrival rate to washing > service rate of washing

this means:

* a queue will form
* machine is not idle for Steady-state (long-run, forever)
* means that the queue would explode

**When we extend the simulation time far for 4025 minutes as we can**

**The results from the simulation are slightly different as we depend on average arrival and processing times, but the model taking into account the changes of arriving and processing times between unit to another,**

**In terms of the increases of number of parts in queues by the time, after 4025 minutes the inspection queue starts to be much longer than the beginning after 4025 minutes, the queue exploded and the system stop with errors.**

**So we can say that the analysis is consistent with the simulation results.**