**ADM3305 – Assignment 2**

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**Due: 2018-10-05**

**Professor: Antoine Sauré**

Question 1

Assume M/M/1 model

\*In this example the units are planes waiting to land at an airport

a)

Therefore the condition is satisfied given a service rate of 20 planes per hour and an arrival rate of 10 planes per hour.

b)

Therefore the condition is not satisfied given a service rate of 20 planes per hour and an arrival rate of 15 planes per hour.

Question 2

In this model, we are simulating the beginning of a day at the box office of a new entertainment company. We want to test the performance of the box office service with the alternatives of one and two clerks acting as servers using a given set of arrival and service times. This will allow management to decide whether to schedule one or two clerks for the box office.

a)

Simulation assuming one server:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Customer # | Arrival Time | State of System | Wait Time | Start Service | End Service | Time in System |
| 1 | 5 | 1\* | 0 | 5 | 13 | 8 |
| 2 | 8 | 1\* 2 | 5 | 13 | 19 | 11 |
| 3 | 17 | 2\* 3 | 2 | 19 | 21 | 4 |
| 4 | 18 | 2\* 3 4 | 3 | 21 | 25 | 7 |
| 5 | 22 | 4\* 5 | 3 | 25 | 32 | 10 |

‘\*’ Indicates customer is being served

The above graph shows the number of customers in the system at any given point in time.

b)

Metrics of single server system:

c)

Simulation assuming two servers:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Customer # | Arrival Time | State of System | Wait Time | Start Service | End Service | Time in System |
| 1 | 5 | 1\* | 0 | 5 | 13 | 8 |
| 2 | 8 | 1\* 2\* | 0 | 8 | 14 | 6 |
| 3 | 17 | 3\* | 0 | 17 | 19 | 2 |
| 4 | 18 | 3\* 4\* | 0 | 18 | 22 | 4 |
| 5 | 22 | 4\* 5\* | 0 | 22 | 29 | 7 |

‘\*’ Indicates customer is being served

The above graph shows the number of customers in the system at any given point in time.

d)

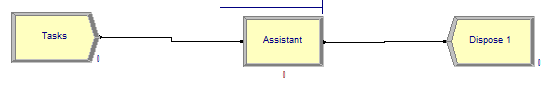
Metrics of dual server system:

Question 3

a)

For this example, two models were built in Arena to simulate the differences in between a M/M/1 system with and a M/M/2 system with . The purpose of this was to determine whether or not two assistant’s (the servers of our model), each working for a respective doctor at an office, resources should be pooled to improve overall efficiency. Both versions of the system were simulated 10 times for 4 hours each. The results of the simulation were summarized in the average time work units (tasks) had to wait in the queue, and the utilization of servers (% of time busy).

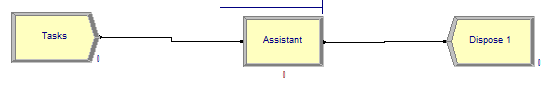
The M/M/1 was built with the following parameters:







The M/M/2 was built with the following parameters:









\*Capacity increased to reflect pooled servers

Arrival interval changed to reflect increased inflow

The results of the simulations were as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Replication** | **Unpooled Wait Time** | **Unpooled Utilization** | **Pooled Wait Time** | **Pooled Utilization** |
| 1 | 2.29 | 0.57 | 2.77 | 0.64 |
| 2 | 10.94 | 0.73 | 13.46 | 0.83 |
| 3 | 15.02 | 0.81 | 3.29 | 0.74 |
| 4 | 18.18 | 0.92 | 11.41 | 0.94 |
| 5 | 1.17 | 0.69 | 5.09 | 0.64 |
| 6 | 11.26 | 0.92 | 2.28 | 0.66 |
| 7 | 66.85 | 1 | 3.16 | 0.61 |
| 8 | 56.44 | 0.93 | 9.8 | 0.93 |
| 9 | 15.11 | 0.78 | 37.31 | 0.96 |
| 10 | 2.39 | 0.55 | 1.43 | 0.48 |
| Total Av. | 19.965 | 0.79 | 9 | 0.743 |

From our results we can see that there tends to be a higher utilization for unpooled assistants, but tasks spend less time in the queue (almost half as long) when the assistants’ resources are pooled. When can see on replication 8 that when utilization is the same, the wait time tasks spend in the queue is much lower.

b)

Overall, there is an inherent trade off most of the time between utilization and service quality (in this case service quality is the time tasks spend in the queue). The disadvantage of pooling resources is a slightly lower utilization rate, but the fact that the service quality almost doubles; tells us that the pooled system is a much better approach to the pre-appointment workflow in the doctor’s office. A qualitative trade-off might be that admin are used to being managed by there respective doctor and now they must take directives from new leadership. None the less, the upside of poling resources is larger than the downside.

**Personal Ethics Statement**

**Individual Assignment:**

By signing this Statement, I am attesting to the fact that I have reviewed the entirety of my attached work and that I have applied all the appropriate rules of quotation and referencing in use at the Telfer School of Management at the University of Ottawa, as well as adhered to the fraud policies outlined in the Academic Regulations in the University’s Undergraduate Studies Calendar. Academic Fraud Webpage

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Signature Date

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Last Name (print), First Name (print) Student Number