***“Simulation Modeling and Analysis of Software Made Personal”***

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Finish Service, If queue is non- empty, pull waiting customer and Schedule Service~ Erlang(2), else free agent

**Current Process Overview and Simulation Architecture:**

Financial Tracking

Agent 1

Seize 1 agent, Schedule Service~ Erlang(2)

Agent 2

Agent 3

Agent 4

Yes

Arrival (Only between 8 AM and 4PM)

U1 < 0.59

U2 >= 0.06

Fin FIFO Queue

No

Finish Service, If queue is non- empty, pull waiting customer and Schedule Service~ Erlang(3), else free agent

Customer leaves without service Service

Any Agent Available?

Draw U2~ Uniform (0,1)

U2 < 0.06

U1 >= 0.59

Contact Management

Any Agent Available?

Draw U2~ Uniform (0,1)

Agent 3

Agent 2

Agent 1

Seize 1 agent, Schedule Service~ Erlang(3)

No

Yes

Draw U1~ Uniform (0,1)

Schedule next Arrival ~ Exponential (1 minute)

Leave without Service

Con FIFO Queue

U2 < 0.06

U2 >= 0.06

**Results:**

Number of Replications Needed= **520** (Minimum required for relative error < 5%)

|  |  |  |
| --- | --- | --- |
|  | Mean | 95% CI of Mean |
| Average daily number in Fin Hold Queue | 0.77 | [0.73,0.80] |
| Average wait time in Fin Hold Queue | 1.34 minutes | [1.28,1.40] |
| Average daily number in Con Hold Queue | 0.52 | [0.50,0.55] |
| Average wait time in Con Hold Queue | 1.31 minutes | [1.25,1.37] |
| Total number of callers lost per day | 12.53 | [12.18,12.87] |

**\*After 4 PM, no arrivals are entertained but the Scheduled Services are finished at their respective times**

**Cross Trained Process Overview and Simulation Architecture**

Finish Service, If queue is non- empty, pull waiting customer. If customer type = ”Fin”, Schedule Service~ Erlang(2), else Schedule Service~ Erlang(3). Increase service time by 10% i.e. 1.1\*sampled value

1. Seize 1 agent
2. If customer type = ”Fin”, Schedule Service~ Erlang(2), else Schedule Service~ Erlang(3). Increase service time by 10% i.e. 1.1\*sampled value

Arrival (Only between 8 AM and 4PM)

Agent-2

Agent-1

|

Yes

Agent-K

FIFO Hold Queue

U2 >= 0.06

No

1. Draw U1~ Uniform (0,1)
2. If U1<0.59, Customer Type = “Fin”, Else Customer Type= “Con”
3. Schedule next Arrival ~ Exponential (1 minute)

Any Agent Available?

U2 < 0.06

Draw U2~ Uniform (0,1)

Customer leaves without service Service

**Results:**

Number of Cross Trained Servers = **7**

Number of Replications Needed= **410** (Minimum required for relative error < 5%)

|  |  |  |
| --- | --- | --- |
|  | Mean | 95% CI of Mean |
| Average daily number in Hold Queue | 0.85 | [0.80,0.89] |
| Average wait time in Hold Queue | 0.87 minutes | [0.82,0.91] |
| Average wait time in Hold Queue for Fin Customers | 0.87 minutes | [0.83,0.91] |
| Average wait time in Hold Queue for Con Customers | 0.87 minutes | [0.82,0.91] |
| Total number of callers lost per day | 11.78 | [11.36,12.21] |

**\*After 4 PM, no arrivals are entertained but the Scheduled Services are finished at their respective times**

Number of Cross Trained Servers = **6**

Number of Replications Needed= **734** (Minimum required for relative error < 5%)

|  |  |  |
| --- | --- | --- |
|  | Mean | 95% CI of Mean |
| Average daily number in Hold Queue | 2.83 | [2.68,2.97] |
| Average wait time in Hold Queue | 2.98 minutes | [2.83,3.12] |
| Average wait time in Hold Queue for Fin Customers | 2.97 minutes | [2.82,3.12] |
| Average wait time in Hold Queue for Con Customers | 2.99 minutes | [2.84,3.14] |
| Total number of callers lost per day | 18.67 | [18.29,19.04] |

**\*After 4 PM, no arrivals are entertained but the Scheduled Services are finished at their respective times**

Number of Cross Trained Servers = **6 (Without 10% increase in Service Time)**

Number of Replications Needed= **471** (Minimum required for relative error < 5%)

|  |  |  |
| --- | --- | --- |
|  | Mean | 95% CI of Mean |
| Average daily number in Hold Queue | 1.30 | [1.23,1.36] |
| Average wait time in Hold Queue | 1.35 minutes | [1.28,1.41] |
| Average wait time in Hold Queue for Fin Customers | 1.35 minutes | [1.28,1.41] |
| Average wait time in Hold Queue for Con Customers | 1.35 minutes | [1.28,1.42] |
| Total number of callers lost per day | 16.01 | [15.22,16.80] |

**\*After 4 PM, no arrivals are entertained but the Scheduled Services are finished at their respective times**

**Summary and Conclusion:**

Numerically we observe that the distribution of the waiting times under both the systems (Two Separate Queues vs Cross Trained Servers) are identical for both kinds of customers- Financial Tracking and Contact Management i.e. there is no service Differentiation. Having 7 Cross trained servers decreases the expected time in system for both kinds of customers from about 1.3 [1.25,1.37] minutes to 0.87 [0.82,0.91] minutes (p value<0.05), and also reduces lost calls from 12.53 [12.18,12.87] to 11.78[11.36,12.21]( p value <0.05). Having 6 Cross Trained Servers increases the average wait time to 2.98[2.83,3.12] minutes (p-value < 0.05) as well as number of lost calls to 18.67[18.29,19.04]**. However, if the servers are cross trained properly such that there is no increase in service time (as opposed to 10%), then then 6 servers can provide the same level of service in terms of wait times 1.35[1.28,1.41] minutes, albeit increasing the customers lost per day.**