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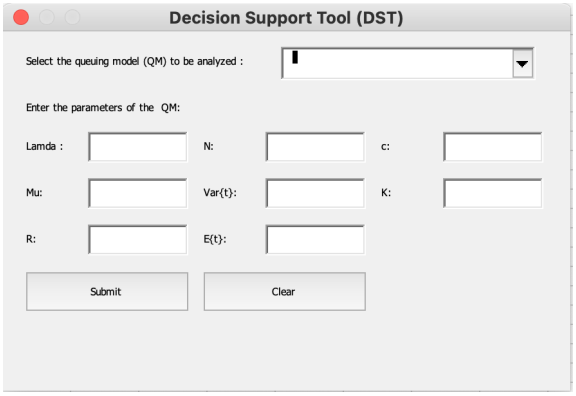
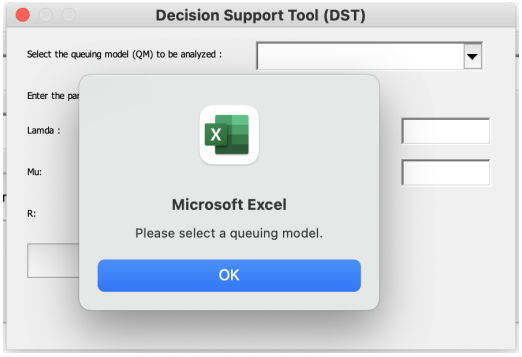
Operation Research Term Project (DST)

This document showcases our operation research term project decision support tool. Our DST tool was developed by using Excel VBA.



Our user interface for decision support tool (DST)

To create this project, we used Excel VBA. Collect user data and make the necessary calculations for the desired queuing model. Our DST adapts for each selected queuing model and takes the necessary parameters from the user. It will alert the user if the user has not entered valid numbers. Our DST has two buttons, one for the submission and another for text box cleaning.



If the user clicks the submit button without entering any queuing model, our DS tool will give this alert: ***"Please select a queuing model."***

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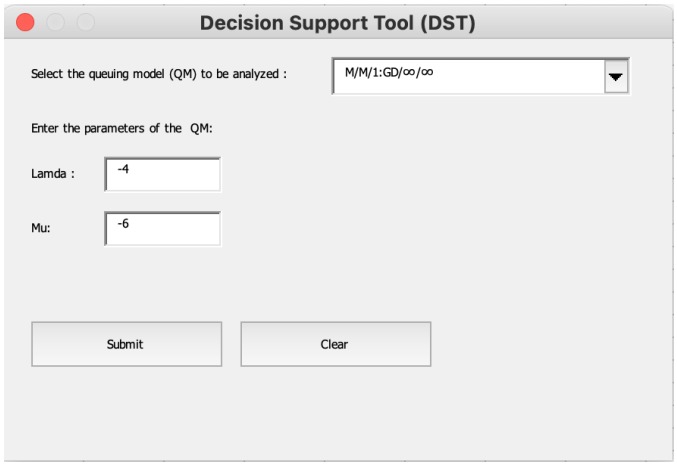
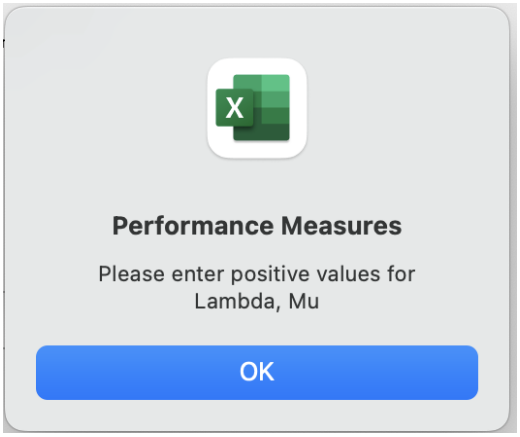
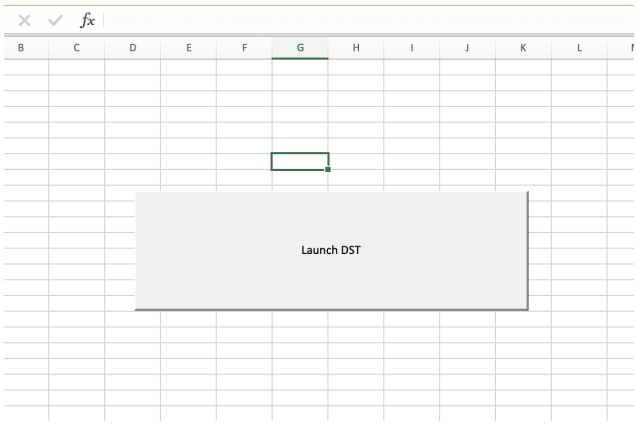




If the user has not entered positive values for the Lambda, it will alert the user with this prompt: ***"Please enter positive values for Lambda, Mu."***



We created a shortcut in our Excel sheet to launch our DS tool.

(M/M/1) Queues– Steady-State Measures of Performance

$\lambda = 4$
$\mu = 6$

$$p_0 = \frac{\mu-\lambda}{\mu} = \frac{6-4}{6} = 1/3$$

$$p_n = \left(\frac{\lambda}{\mu}\right)^n \frac{\mu-\lambda}{\mu} = \left(\frac{2}{3}\right)^n \frac{1}{3}$$

$$L_s = \frac{4}{6-4} = 2$$

$$W_s = \frac{L_s}{\lambda} = \frac{2}{4} = 1/2$$

$$W_q = \frac{\lambda}{\mu(\mu-\lambda)} = \frac{4}{6(6-4)} = 1/3$$

$$L_q = \lambda W_q = 4.(1/3) = 4/3$$

$$\bar{c} = L_s - L_q = \frac{\lambda}{\mu} = 4/6 = 2/3$$

(a) The probability, p_n, of n students in the system. $p_n = \left(\frac{2}{3}\right)^n \frac{1}{3}$
(b) The probability that there is no student visiting the advisor $p_0 = 1/3$
(c) The average number of students waiting to see the advisor $L_q = 4/3$ stu.
(d) The average time a student waits before seeing the advisor. $W_q = 1/3$hr
(e) The average time spent in the campus including queue + visit time $W_s = \frac{1}{2} hr$
(f) The average occupancy of the advisor $\bar{c} = 2/3$

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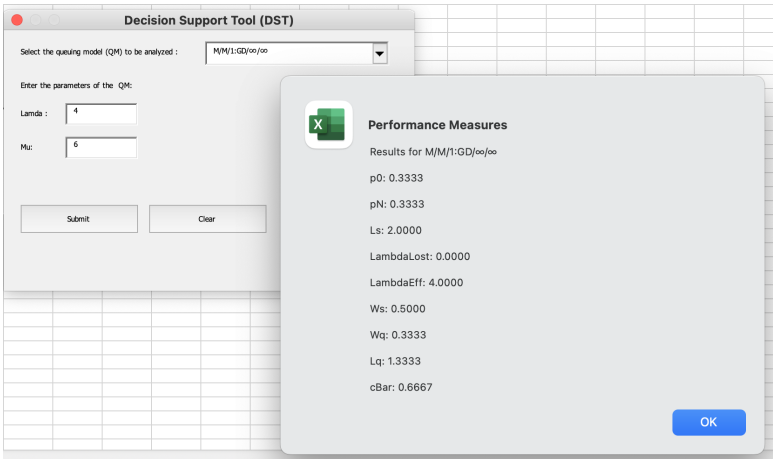

Here are the outputs for the first model (M/M/1:GD/infinity/infinity).

(M/M/1):(GD/***N***/∞) Queues– Example // Comparison with last week

$\lambda = 4$
$\mu = 6$
$N = 5\ or\ \infty$

(M/M/1):(GD/∞/∞)	(M/M/1):(GD/***N***/∞)
$L_s = 2$	$L_s = 1.422$
λ_{lost} = 0 cars/hr	λ_{lost} = 0.1925 cars/hr
$\lambda_{eff} = 4$ cars/hr	λ_{eff} =3.8075 cars/hr
$W_s = 0.5\ hr = 30\ minutes$	$W_s = 0.3736\ hr = 22.4\ mins$
$W_q = 0.3333\ hr = 20\ minutes$	$W_q = 0.2069\ hr$ = 12.4 mins
$L_q = 1.333$ cars/hr	L_q =0.7879 cars/hr
$\bar{c} = 0.666$	$\bar{c} = 0.634$

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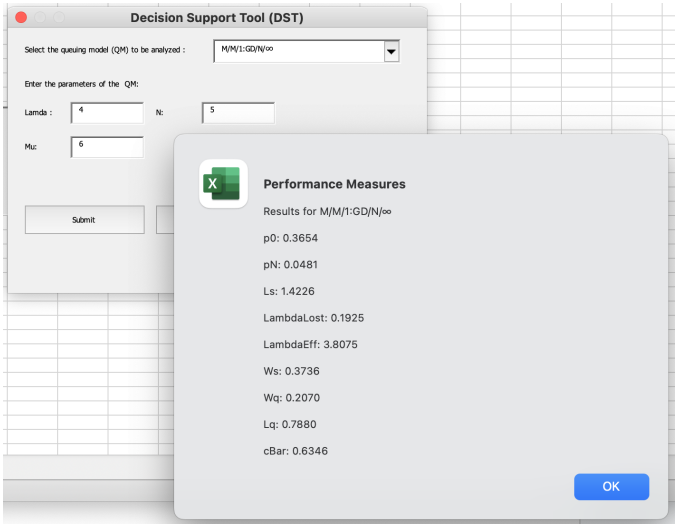
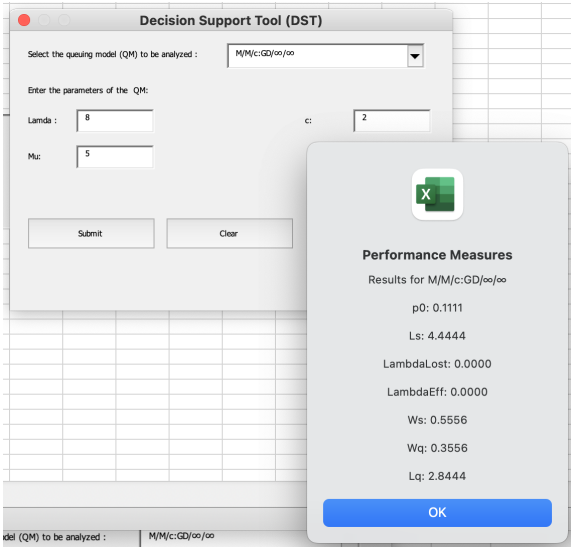


Here are the outputs for the second QM (M/M/1):(GD/N/∞)

c	Lambda	Mu	p0	Ls	Ws	Lq	Wq
2	8.000	5.000	0.110	4.444	0.556	2.844	0.356
4	16.000	5.000	0.027	5.586	0.349	2.386	0.149

Expected answers for the third queuing model (M/M/c):(GD/∞/∞)



Our answers for the (M/M/c):(GD/∞/∞)

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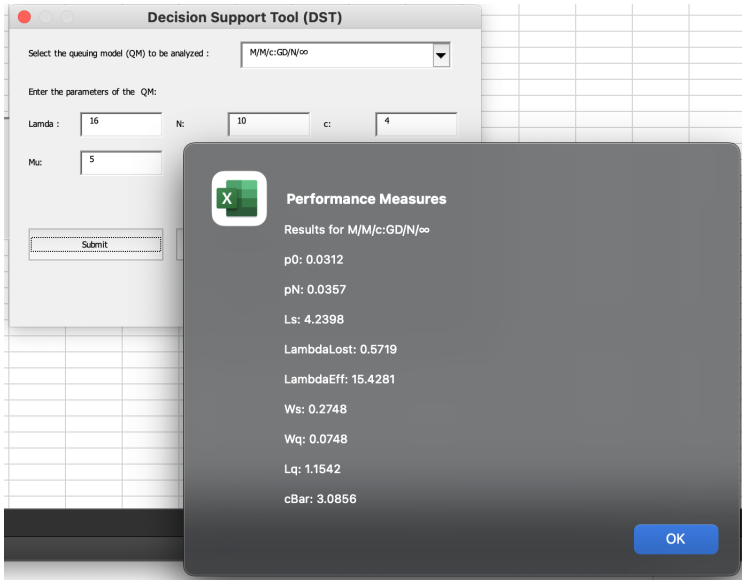
	(M/M/4):(GD/10/∞)	(M/M/4):(GD/∞/∞)
p_0	0.03121	**0.027**
λ_{eff}	15.42815	**16**
λ_{lost}	0.57184	**0**
L_s	4.23984 customers	**5.586 customers**
L_q	**1.15421 customers**	2.386 customers
W_s	**0.27481 hrs**	0.349 hrs
W_q	**0.07481 hrs ~ 5 mins.**	0.149 hrs ~9 mins.
$\bar{c}$	3.17479	**3.2**



Expected Results for(M/M/c):(GD/N/∞)

Answers for the following queuing model (M/M/c):(GD/N/∞)

Example

Consider the car washing facility where customers arrive with exponential interarrival times of 15 minutes and the facility now uses a robot to wash the cars, which takes exactly 10 minutes with no variance.

λ= 4 cars /hr

$E\{t\}$= 1/6 hrs

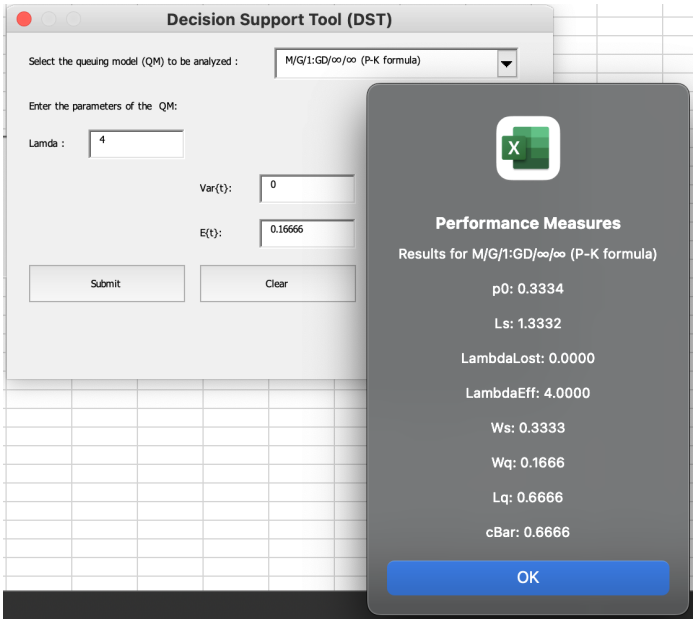
$Var\{t\}$= 0

$$p_0 = 1 - \lambda E\{t\} = 1 - \frac{4}{6} = \frac{1}{3}$$

$$L_s = \lambda E\{t\} + \frac{\lambda^2(E\{t\}^2 + var\{t\})}{2(1 - \lambda E\{t\})} = 1.33\ cars$$

$$W_s = \frac{L_s}{\lambda} = \frac{1.33}{4} = 1/3 \qquad L_q = \lambda W_q = \frac{4.1}{6} = 2/3$$

$$W_q = \frac{1}{3} - \frac{1}{6} = 1/6 \qquad \bar{c} = L_s - L_q = 4/3\text{-}2/3 = 2/3$$



Expected results for (M/G/ 1):(GD/∞/∞)

Outputs that our DST gets (M/G/ 1):(GD/∞/∞)

To conclude, our project has successfully calculated all 7 different queuing models. In addition, with the built-in error check, users cannot enter non-valid inputs.