	Arrival Distribution	Average Arrival Rate (per hour)	Average Interarrival Time (in minutes)	Std. Dev. Of Interarrival Time (in minutes)	Coef. Of Variation - Arrivals
Receptionist	Neg. Exponential	30	2	2	1
Nurse	Neg. Exponential	20	3	3	1
Physician	Neg. Exponential	13	4.615384615	4.615384615	1

	Service Distribution	Average Service Rate (per hour)	Average Processing Time (in minutes)	Std. Dev. of Processing Time (in minutes)	Coef. Of Variation - Processing
Receptionist	Uniform	40	1.5	0.288675135	0.19245009
Nurse	Normal	30	2	1	0.5
Physician	Normal	15	4	2	0.5

Use Queueing Spreadsheet to plug in lambda, mu, Ca^2, and Cb^2 from the table above.

Receptionist:	lambda	30	
	mu	40	
	Ca^2	1	
	Cb^2	0.037037037	
	s	1	2
	Nq	1.166666667	0.063636364
	Ns	1.916666667	0.813636364
	Wq	0.038888889	0.002121212
	Ws	0.063888889	0.027121212
	P(delay)	0.75	0.204545455
	Utilization	0.75	0.375
Nurse:	lambda	20	
	mu	30	
	Ca^2	1	
	Cb^2	0.25	
	s	1	2
	Nq	0.833333333	0.052083333
	Ns	1.5	0.71875
	Wq	0.041666667	0.002604167
	Ws	0.075	0.0359375
	P(delay)	0.666666667	0.166666667
	Utilization	0.666666667	0.333333333
Physician:	lambda	13	
	mu	15	
	Ca^2	1	
	Cb^2	0.25	
	s	1	2
	Nq	3.520833	0.125228
	Ns	4.387500	0.991895
	Wq	0.270833	0.009633
	Ws	0.337500	0.076300
	P(delay)	0.866667	0.262016
	Utilization	0.866667	0.433333

Question Answer

1 The Service Model software was not employed in this spreadsheet

2 The additional contribution is measured by the change in wait time multiplied by the number of customers who are affected by it.

	Old Operations and Queue time (min)	New Operations and Queue time (min)	Avg. number of customers per hour	Reduced customer-minutes in system per
Receptionist	3.833333333	1.627272727	30	66.18181818
Nurse	4.5	2.15625	20	46.875
Physician	20.25	4.577975376	13	203.7363201

Thus, an additional physician would decrease the total customer wait times by approximately 203.74 minutes every hour.
This translates to approximately (8 (hours/day) * 203.74 (customer-minutes/hour) * 1/60 (customer-hours/customer-minutes)) 27.15 customer-hours saved per day.
Assume the average cost of a customer's time is his/her wage rate, w.
The total savings to customers by an additional physician is 27.15*w per day.
If a physician's wage is less than 27.15*w per day, the company should hire a physician.

3 The numbers above assume a steady state system. In reality, a doctor's office with random arrivals (and a constant average arrival rate) will begin a day without que
These warm-up effects should be considered, because they will decrease the benefits one receives by adding another physician over the course of an average day.
Of course, one may also consider changing arrival rates over the course of a day.

Customers may value time in queue differently from time in operations.
If so, the cost of a customer's time may be higher, as would the savings that another physician would bring.

Also, she may want to realize the benefits in scheduling appointments rather than allow for random arrivals.
Reducing variability in arrivals would decrease the coefficient of variation and consequently, the system time.

If she makes no changes, then she will have to consider the large queues building for the physician.
She should make sure there is sufficient queue capacity, but also take into account the possibility that some customers may exit the service if queue is too long.