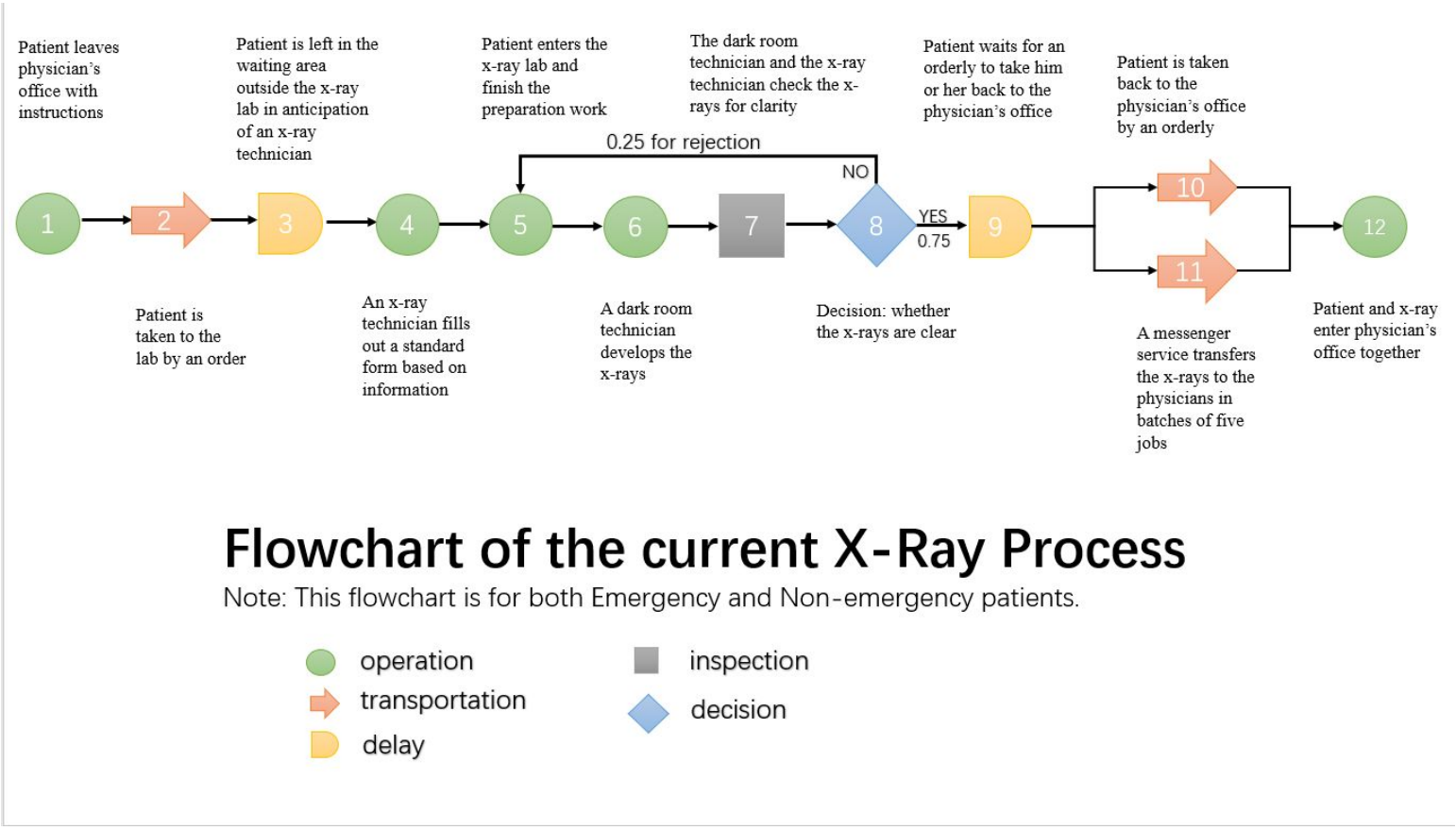
DNSC 6225 Business Process Simulation - Project 1

Team PZQZ

Question 1 - Flowchart



Question 2 - Model

Assumptions:

- Emergency patients would be served as priority throughout the whole process.
- When both X-ray labs are open, patients would always enter lab 1.
- All technicians would be released to work on other activities after finish one, since they're not required to work on sequential activities.

Question 3 - Report

From the whole process, we can get the average cycle time with running a 1-day simulation with random seed set at 100 is 111.17 minutes (around 1.85 hours) and the throughput rate is 7.64% which means 7.64% of the total operation will complete in one minute. Either emergency or non emergency patients need to wait for a long time to take x-ray in this hospital. To be specific, the average cycle time of non-emergency patients is 112.82 minutes (around 1.88 hours) and for emergency patients is 82.67 minutes (around 1.38 hours). Although emergency patients have priority in the process, they also spent long time on x-rays which might causes missing the optimal treatment timing. Considering the reason why this process cost much time, we collected the statistical data from different types of blocks to find problems in this process.

Block	Ave Wait	Max Wait	Queue Length	Arrival	Departures	Reneges	Utilization	Time (min)
Wait at office	60.893	136.03	30	127	97	0	0.84404	720
Priority Q	34.446	78.24	14	107	93	0	0.82857	720
Orderlie Q	1.7806	5	0	95	60	35	0.2819	720
Patients at off	10.407	94.74	3	59	56	0	0.47972	720
X-ray at office	1.7195	18.305	0	55	55	0	0.074337	720
Collect 5 X-ray								720
Wait at lab	2.2622	21.514	0	59	59	0	0.10347	720

Table 3.1 Queue block statistical data

Obtaining the statistical data (table 3.1) from queues in this process, there are several queues keeping long average waiting time, especially the queue which patient need to wait for orderlies to take them to the labs. The average waiting time of this queue is approximately 60.89 mins (around 1 hours). In this way, if a patient wants to go to x-ray lab, they need to wait for orderlies to guide them in a long time. According to rules about orderlies, they need to take one patient back from the x-ray lab when they have dropped one off. After they arrive at labs, if there are no patients who want to go back to doctors' offices, they need to wait for 5 minutes which is a large time and human resource waste. Moreover, the utilization of orderlies is 84.4% which shows the orderlies resources were not used fully efficiently and there is some time wasting in this process. Also, this utilization shows a lack of orderlies' resource in the hospital.

Based on the data and description of the rules about orderlies, we can see the orderlies is a big deal: the efficiency of orderlies is much lower than other parts and the rules for orderlies restricted them to increase their efficiency, for example, one guider only can take one patient at one time, and they need to serve patients who definitely can walk to labs, also they need to wait extra unnecessary five minutes. In this way, how to arrange orderlies' resource is a big problem in queue block part.

Block	Arrivals	Departures	Utilization	Wait	Ave Wait	Max Wait	Busy	Time (min)
X-ray Lab 1	59	58	0.81392	9.6069	10.084	17.243	0.81392	720
X-ray Lab 2	34	33	0.44744	7.0617	9.6398	26.315	0.44744	720
Transport to la	96	95	0.37173	5.08	8.3789	11.85	0.37173	720
Transport to of	59	59	0.22566	7.6523	8.2616	11.793	0.22566	720
Sending X-ray	11	11	0.06897	4.4536	4.5144	6.3019	0.06897	720

Orderlie 5-min	35	34	0.24087	5	5	5	0.24087	720

Table 3.2 Activities block statistical data

Comparing different activities' data, we found that there is a big difference between the utilizations of lab 1 and lab 2. Based on our assumption: when these two labs are empty, patients priority to go to the first lab.

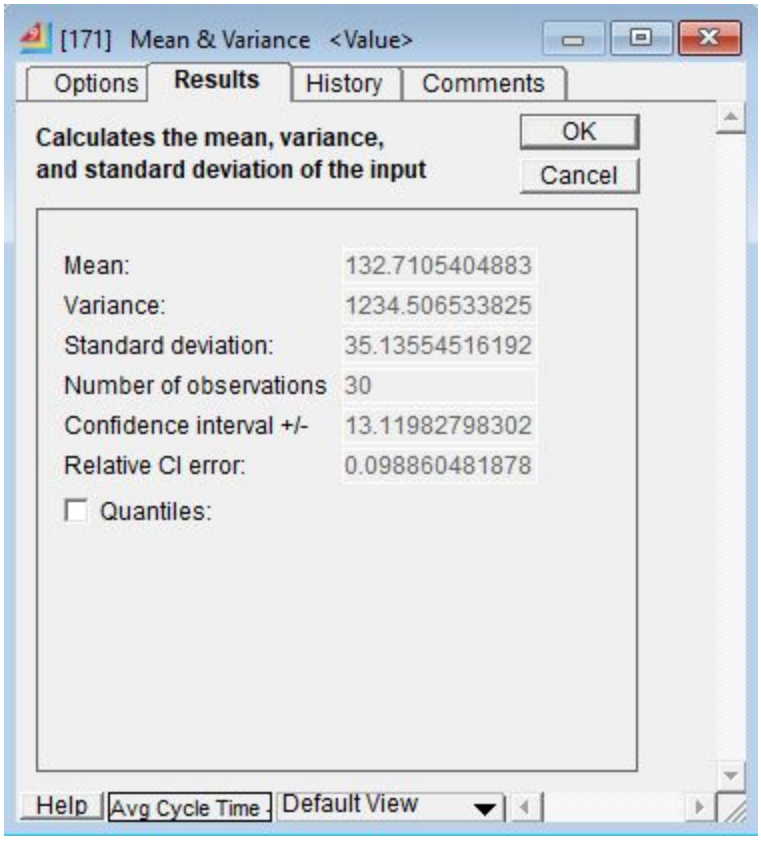
Block	Resource Pool	Utilization	Available	In Use	Items waiting	Ave items waiti	Ave wait time	Time (min)
4	X-ray Technician	0.96675	0	3	33	16.283	30.502	720
5	Dark Room Technician	0.51879	1	1	11	5.8939	23.688	720

Table 3.3 Resource pool block statistical data

As for data from resource pool blocks (Table 3.3), the average wait time for x-ray technicians is 30.502 minutes and the utilization is 96.68%. The long wait time and much higher utilization means there is a lack of x-ray technicians' resource.

Question 2 - Report

Same as 1-day simulation, we also have a block to record the data after we simulate 30 days of operation. Based on our record, the average cycle time is 132.71, the standard deviation of cycle time is 35.14, the 95% confidence interval for the cycle time mean is 97.57 167.84. You also can check the result in Appendix I for the number with more digits after the decimal place. Compare with the cycle time in (3), the cycle time for one day (111.17) is 21.54 less than the average cycle time based on 30 days, but the result is in our 95% confidence interval. For the non-emergency patient's cycle time, the average is 125.57, the standard deviation is 45.30, the 95% confidence interval for the cycle time mean is 116.39 134.75. By comparison, the cycle time in (3) for non-emergency is 112.82 which also less than our average. Overall, the performance of cycle time in (3) is better than the average.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Results
History
Comments
Calculates the mean, variance, and standard deviation of the input
OK
Cancel
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Variance: 1234.506533825
Standard deviation: 35.13554516192
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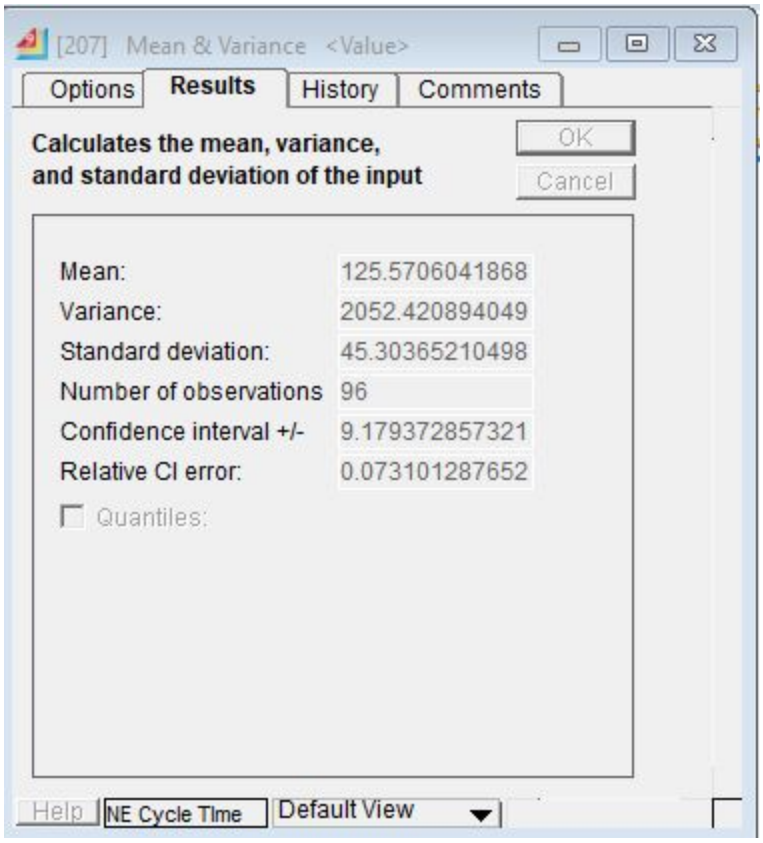
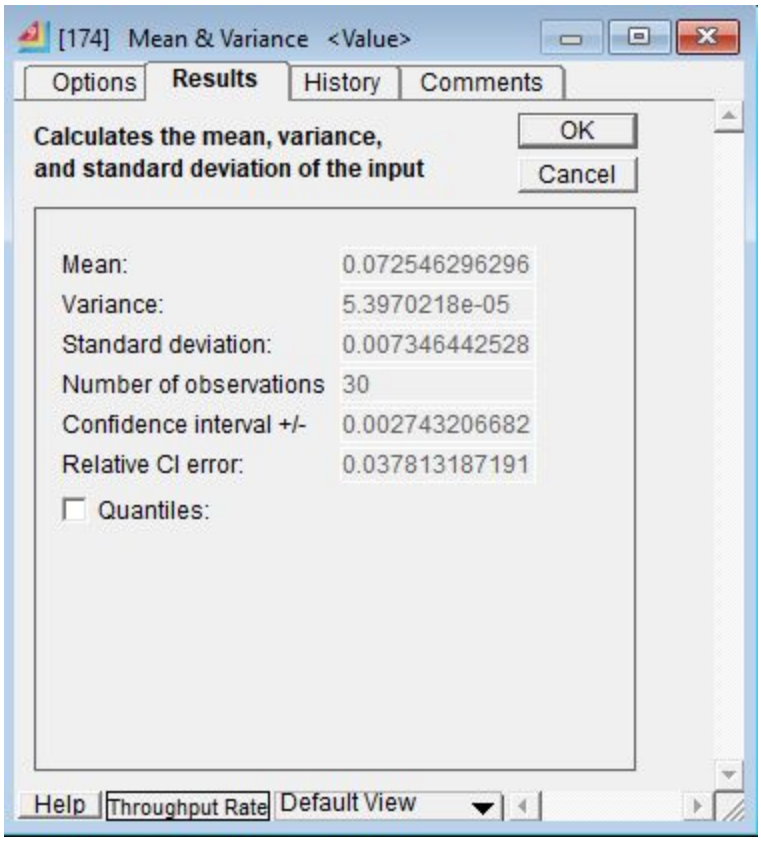


We also used another block to record 30-days daily throughput rate. Based on our record, the average throughput rate is 7.25%, the standard deviation of daily throughput is 0.0073, the 95% confidence interval for the throughput rate is 0.0652 0.0799. You also can see Appendix II to check for the number with more digits after the decimal place. Compare with the throughput rate in (3), the throughput rate for one day (7.64%) is greater than the average 30-days throughput rate. From the difference, we serve more

patient in (3) than the average 30-days, this results also shows the performance in (3) outweighs the average.



The following result for the 30days simulation is under 95% confidence:

For the Check Clarity Workstation, Develop X-ray Workstation and Filling Forms Workstation, the average wait is 19.21±1.567, 38.47±5.006 and 35.25±2.160. The utilization of these three workstations is the length of queue in the workstation is 0.2054±0.006764, 0.8239±0.02671 and 0.5638±0.01071. To contrast with 1-day, the average waiting time from 30-days Develop X-ray Workstation is 9.89 minutes longer than the 1-day. The result surprised us because in (3), the result is 28.58, it even lower than our lower 95% confidence level. That is one reason of (3) have a better performance than the average.

		Average Wait	Max Wait	Arrivals	Departure	Number in Service	Utilization
Check Clarity	Workstation	19.21±1.567	64.97±4.865	78.43±2.174	73.83±2.444	0.2333±0.1606	0.2054±0.006764
Develop X-ra	Workstation	38.47±5.006	97.63±11.28	87.43±1.410	78.43±2.174	0.8667±0.1291	0.8239±0.02671
Filling Forms	Workstation	35.25±2.160	90.73±5.488	92.50±1.172	80.67±1.381	0.500±0.1899	0.5638±0.01071

For the Orderlie Queue, Patients at off Queue, Priority Queue, Wait at lab Queue, Wait at office Queue and X-ray at office Queue. The average wait is 1.905±0.09806, 10.97±1.089, 33.57±2.217, 2.581±0.6009, 82.71±12.66 and 1.517±0.4191 separately. The utilization for these queues is 0.2885±0.01099, 0.4564±0.03107, 0.844±0.01832, 0.1021±0.01565, 0.916±0.03035 and 0.06176±0.01187 separately. By comparison, one thing catches our eyes is the queue named "Wait at office". From the result (3), the waiting time is 60.89 which is way less than the average from 30-days. The 21.82 minutes less in this queue would influence the cycle time and throughput rate.

		Average Wait	Max Wait	Arrivals	Departures	Utilization
Collect 5 X-ray	Queue Matchi	±	±	±	±	±
Orderlie Q	Queue	1.905±0.0980	5.000±0.000	92.50±1.172	54.87±2.077	0.2885±0.01099
Patients at off	Queue	10.97±1.089	79.51±10.21	53.63±2.067	52.83±2.007	0.4564±0.03107
Priority Q	Queue	33.57±2.217	89.83±5.086	99.53±1.660	88.83±1.345	0.844±0.01832
Wait at lab	Queue	2.581±0.6009	21.48±3.731	54.97±2.086	54.53±2.084	0.1021±0.01565
Wait at office	Queue	82.71±12.66	182.6±21.52	121.9±3.424	94.63±1.265	0.916±0.03035
X-ray at office	Queue	1.517±0.4191	18.40±3.841	52.67±1.945	52.47±1.948	0.06176±0.01187

For the Orderlie 5-min Activity, Sending X-ray Activity, Transport to lab Activity, Transport to office Activity, X-ray Lab 1 Activity, and X-ray Lab 2 Activity, the average wait is 5.000±0.000, 4.657±0.4047, 8.595±0.742, 8.611±0.930, 11.97±2.002 and 10.05±1.447. The utilization/busy for these 0.2577±0.01076, 0.07118±0.003623, 0.3653±0.004548, 0.2113±0.008308, 0.804±0.01292 and 0.5208±0.01726. After checking the result in (3), we find that the average waiting time in all the activity from 30-days are larger than in 1-day. In 1-day simulation, the utilization for Sending X-ray activity is 0.06897, which is lower than the utilization in 30-days. Although in 1-day simulation it does not as efficient as 30-days, it can reflect that the overall performance in 1-day simulation.

For the X-ray Technical Resource Pool and Dark Room Technical Resource Pool, the average items waiting is 16.38±0.8168 and 6.928±0.6039. The average wait time is 32.19±1.722 and 29.64±2.866, the utilization for this resource pool is 0.9727±0.003717 and 0.5147±0.01207. The results mean we have around 16 and 7 patients in average to wait for X-ray and Dark Room technician. In 1-day simulation, the

average number of patients waiting for technician are similar, but the average wait time is 2 mins and 6 mins less. This result also can support the overall 1-day performance is better.

For the Orderlie Pool Resource item, the utilization for this resource item is 0.9969±0.002933. This result is almost the same as in (3), all of 3 orderlies are in-use almost every time.