STICKLEY ADHESIVES I

1. Calculate the number of workers that would be assigned to each process so that the average capacity of each process (requests per day) is equal to the average demand for the applications service (i.e., 24 requests per day). Note that this analysis will load the service system with a capacity buffer of zero for each process. Show how the calculations were done and the results.

The average capacity per worker is provided in the case. Based on the past scoping requests, about 1 in 8 (12.5%) requests need to be handled by scientists, with the remainder handled by a technician. For the analysis process, half of the requests would need equipment rental, while the other half would not.

If the targeted throughput is 24 requests per day, based on the average capacity per worker, we would need 2 workers for Prioritizing, 1 scientist for Scoping, 3 technicians for Scoping, 4 workers for Experimenting, 2 workers for Analyzing without equipment rental, 6 workers for Analyzing with equipment rental, and 3 workers for reporting. (See the below table for calculations)

Process	Average Capacity per Worker (customers/day)	Targeted Throughput (customers/day)	Required No. Workers
Prioritizing	12	24	2 (24÷12)
Scoping: Scientist	3	3 (0.125×24)	1 (3÷3)
Scoping: Technician	7	21 (0.875×24)	3 (21÷7)
Experimenting	6	24	4 (24÷6)
Analyzing w/o Rental	6	12 (0.5×24)	2 (12÷6)
Analyzing w/Rental	2	12 (0.5×24)	6 (12÷2)
Reporting	8	24	3 (24÷8)

2. Using the number of workers calculated above, run the simulation for forty 30-day periods and summarize these results statistically using two or more numerical summaries and at least one display.

   After running the simulation 40 times using the number of workers calculated in Question 1, we found an average monthly (30 days) throughput of 619.78 with a standard deviation of 23.67 and a mean standard error of 3.74. The table below shows the min-max and quartiles of the samples:

N	Mean	SE Mean = standard error of mean	StDev	Min	Q1	Median	Q3	Max
40	619.78	3.74	23.67	564	607.25	623	635.5	672

N	Monthly Throughput
1	627
2	639
3	634
4	610
5	615
6	570
7	636
8	607
9	621
10	588
11	597
12	624
13	630
14	629
15	637
16	672
17	640
18	622
19	578
20	647
21	662
22	571
23	621
24	645
25	634
26	607
27	612
28	614
29	608
30	564
31	606
32	627
33	631
34	612
35	628
36	612
37	600
38	644
39	631
40	639

3. Analyze the applications service system by running the simulation repeatedly while adjusting the number of workers (i.e., the capacity buffer) to determine how best allocation of workers to each process. Use only whole numbers of servers (1, 2, 3, etc.). Show your key results in tabular form or as a display. Remember that you must run the simulation for multiple iterations so that the effect of random variations does not bias your results. Indicate the number of times you ran the simulation for each analysis.

   We developed 3 scenarios to optimize worker allocation across processes. We ran the simulation **10 times** for each scenario to ensure robust results.

   - Scenario 1: Add 1 worker for only offshore processes, which includes Experimenting and Reporting.
     The additional workers provide 20% buffer capacity for Experimenting and 25% buffer capacity for Reporting. The total additional labor cost would be $125 per day.
     - Result: Average monthly throughput increase to ~637.1 (SD≅20.9), which is 21.2 customers/day.

N	Mean(Avg)	SE Mean	StDev	Min	Q1	Median	Q3	Max
10	637.10	6.60	20.88	613	618.25	635	651.25	674

Process	Average Capacity per Worker (customers/day)	Labor Cost per Worker ($/day)	Required # of workers	# of Assigned Workers	capacity buffer	additional labor cost	
Prioritizing	12	125	2	2	0%	0	
Scoping: Scientist	3	400	1	1	0%	0	
Scoping: Technician	7	250	3	3	0%	0	
Experimenting	6	75	4	5	20%	75	
Analyzing w/o Rental	6	300	2	2	0%	0	
Analyzing w/Rental	2	350	6	6	0%	0	
Reporting	8	50	3	4	25%	50	
					Additional Labor Cost:	125	
					Average Monthly Throughput:	637.1	
						21.24	Customer/Day

   - Scenario 2: Add 1 worker for every process, which will cost $1550 additional for labor
     - Result: Average monthly throughput increases to ~700 (SD≅35.3), which is 23.3 customers/day.

N	Mean(Avg)	SE Mean	StDev	Min	Q1	Median	Q3	Max
10	700.00	11.18	35.34	664	674	686	729.25	763

Process	Average Capacity per Worker (customers/day)	Labor Cost per Worker ($/day)	Required # of workers	# of Assigned Workers	capacity buffer	additional labor cost	
Prioritizing	12	125	2	3	33%	125	
Scoping: Scientist	3	400	1	2	50%	400	
Scoping: Technician	7	250	3	4	25%	250	
Experimenting	6	75	4	5	20%	75	
Analyzing w/o Rental	6	300	2	3	33%	300	
Analyzing w/Rental	2	350	6	7	14%	350	
Reporting	8	50	3	4	25%	50	
					Additional Labor Cost:	1550	
					Average Monthly Throughput:	700	
						23.33	Customer/Day

- <u>Scenario 3:</u> Add 1 worker for every process except for Scoping: Scientist. This is because the labor cost for Scoping with scientist is the highest, and adding a scientist would result in a relatively inefficient 50% capacity buffer. The total additional labor cost would be $1150 per day for Scenario 3.
  - Result: Average monthly throughput increases to ~707.5 (SD≅29.3), which is 23.6 customers/day.

N	Mean(Avg)	SE Mean	StDev	Min	Q1	Median	Q3	Max
10	707.50	9.25	29.25	675	683.5	702.5	719.25	774

Process	Average Capacity per Worker (customers/day)	Labor Cost per Worker ($/day)	Required # of workers	# of Assigned Workers	capacity buffer	additional labor cost	
Prioritizing	12	125	2	3	33%	125	
Scoping: Scientist	3	400	1	1	0%	0	
Scoping: Technician	7	250	3	4	25%	250	
Experimenting	6	75	4	5	20%	75	
Analyzing w/o Rental	6	300	2	3	33%	300	
Analyzing w/Rental	2	350	6	7	14%	350	
Reporting	8	50	3	4	25%	50	
					Additional Labor Cost:	1150	
					Average Monthly Throughput:	707.5	
						23.58	Customer/Day

In summary, Scenario 3 achieves the highest average monthly throughput, indicating that adding one worker to each process except for Scoping with scientist would represent the most effective allocation of resources.

4. Make a final recommendation for the number of workers to assign to each process. Justify your recommendations given the available information using 1-2 paragraphs (about 200 words). Incorporate a table that shows the main options you considered.

After weighing our three scenarios and taking into account the tradeoff between labor cost and average monthly throughput, we propose the final number of workers to be the following:

Process	Number of Workers
Prioritizing	3
Scoping: Scientist	1
Scoping: Technician	4
Experimenting	5
Analyzing w/o Rental	3
Analyzing w/ Rental	7
Reporting	4

We considered the scenarios posed in Question 3. The one that increases average throughput with the lowest total labor costs is adding one worker to all the processes except Scoping: Scientist. To find this, we calculated the ratio of additional labor cost + baseline labor cost per day to average daily throughput. The scenario with the smallest ratio is what would accomplish our goal:

Note: Baseline labor is calculated using the assigned number of workers in Question 1.

Scenario	Baseline Labor Cost	Total Additional Labor Cost per Day	Average Daily Throughput	Daily Total Labor Cost to Average Throughput
Q3 Scenario 1	$4,550	$125	20.66	$226.29
Q3 Scenario 2	$4,550	$1,150	23.33	$244.29
Q3 scenario 3	$4,550	$400	23.58	$209.89

That said, we highlight three potential headwinds with the system the proposed numbers would create:

1. Remote Management Issues: The centralized system requires remote monitoring of operations across multiple locations (e.g., Puerto Rico, Bangladesh, and the Philippines). This can lead to delays in identifying and solving issues (ThinkRemote).
2. Inflexibility in Adapting to Changes: The centralized structure may be less adaptable to regional changes or special requests, as all adjustments must be implemented across multiple locations (MaintenX, 2017).
3. Maintenance Scheduling: Coordinating system maintenance across time zones could be challenging, especially since operations are continuous, and finding downtime in a global operation is difficult (Rounds).

Nevertheless, the final proposed number of workers results in throughput close to the daily target of 24 requests while minimizing excess labor costs.

References

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Rounds, D. X. (n.d.). *The case for centralizing maintenance activities.* FacilitiesNet. Retrieved September 22, 2024, from https://www.facilitiesnet.com/maintenanceoperations/article/The-Case-for-Centralizing-Maintenance-Activities--17495

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