OPTIMIZING OPERATING ROOMS UTILIZATION:

SIMULATING AN ETHICAL AND EFFECTIVE CONFIGURATION THROUGH BINARY SEARCH AND MEDICAL STAFFING ANALYSIS

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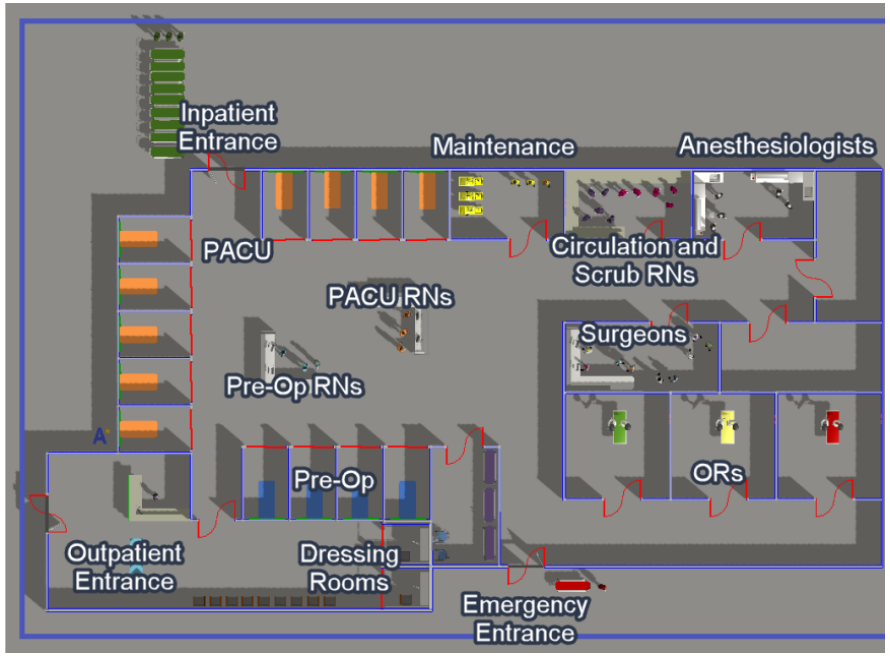
BACKGROUND

Simulation Model Parameters

- 3 operating rooms (ORs), 10 surgeons, and inpatient, outpatient, emergency entrances



- A FlexSim simulation competition has tasked us to complete three main objectives:
  1. Identify the variables your team believes are of the greatest benefit, both to the patients and to the organization that runs the OR.
  2. Test different modeling scenarios to gather data that supports or rejects your assumptions.
  3. Using simulation results, recommend the most effective configuration for the OR.

MOTIVATION

- IE practices and healthcare modeling can offer operation solutions to the medical field
  - Data driven healthcare leadership is crucial to maintain operations.
  - Creative data driven healthcare solutions have mitigated many pandemic-related problems such as protecting staff and patients
- Nurse Burnout
  - Nurse burnout is an emerging issue that has gained significant attention in recent times.
  - Adverse working conditions are pushing nurses to their physical, emotional, and psychological limits, resulting in diminished job satisfaction, increased stress levels, and nurse shortages.

PROJECT OBJECTIVE

- The aim of this project is to determine the optimal operations of a surgical center using a simulation model with **varying levels of buffer.** Specifically, we will configure operation case scheduling and staffing levels to achieve an **ethical and effective** surgical floor.

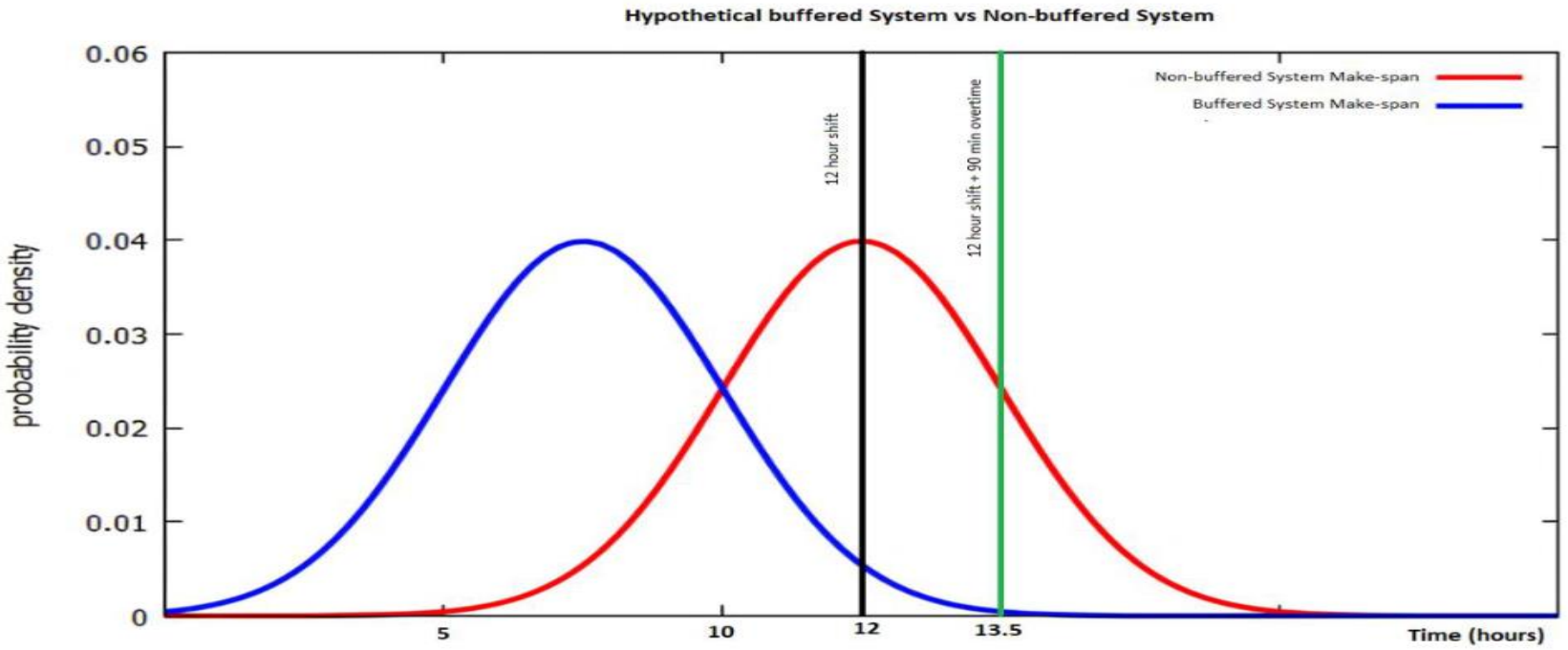


Figure 4. Comparison between a non-buffered system and a buffered system

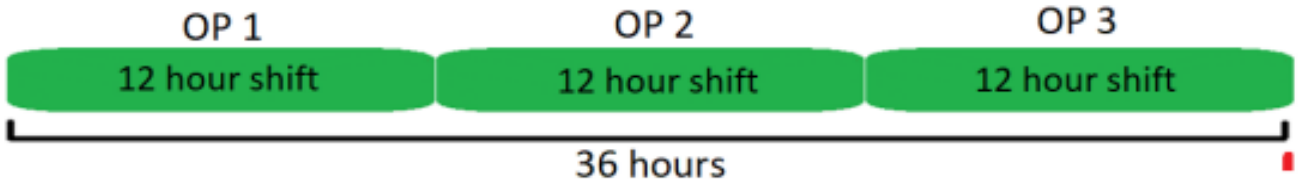
ETHICAL CONSIDERATIONS & ASSUMPTIONS

- Model operation policies are established based on non-profit facilities such as MU hospital
- Feasibility Constraints:
  - Avoid unsafe overtime of > 90 min.
  - Avoid negative profit
- NSPE codes were referenced in determining the most effective OR configuration.
  - #1 - Hold paramount the safety, health, and welfare of the public
  - #6 - Conduct themselves honorably, responsibly, ethically, and lawfully to enhance the honor, reputation, and usefulness of the profession.

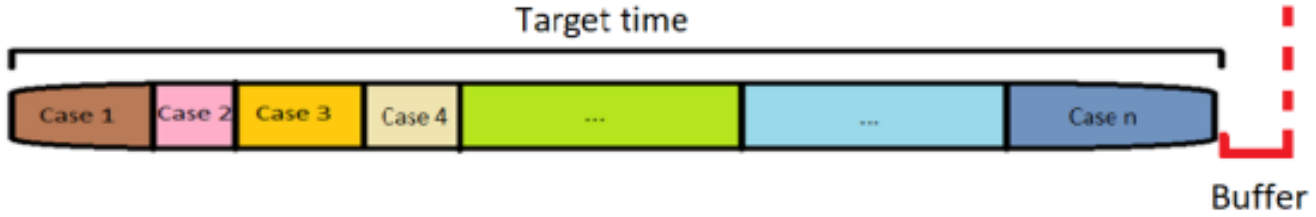
- Perform a General algorithm for each buffer level and compare the results.
  - Experiment with different surgical workloads
  - Compare results and find top performer
- Perform fine tuning on the **most** successful buffer level
  - Experiment with different staffing levels
  - Compare results and find top performer as the final solution

General Algorithm

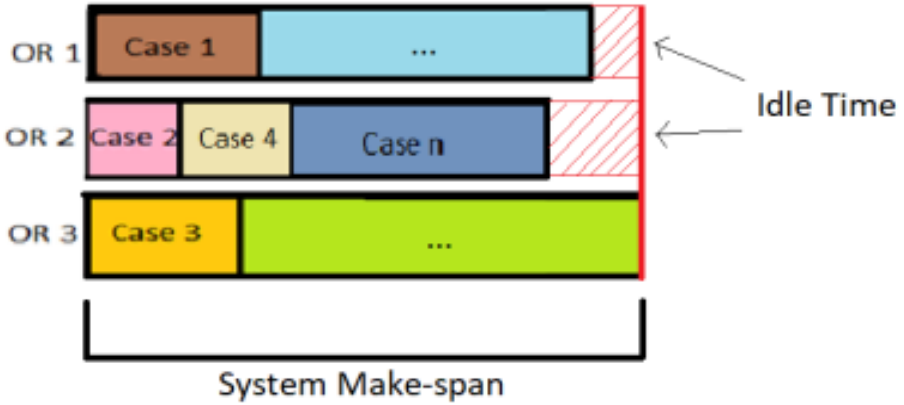
Identify Capacity of System: Step 1:



Select Cases: Step 2:



Split Cases into Rooms: Step 3:



General Algorithm

Figure 9. Gantt chart for OR cases with 50% buffer

BINARY SEARCH

- A binary search method was used through 5 iterations.
  - If a model was infeasible because of the nurse overtime constraint, we chose to increase the buffer.
  - If a model was feasible, we chose decrease the buffer.

Iteration	Theoretical Buffer Percent	Actual Buffer Percent	Case selection and OR assignment	Feasibility
1	0.00%	-0.05%	[[137, 47, 61, 65, 67, 125, 54, 204], [153, 186, 72, 90, 45, 142], [157, 59, 62, 66, 106, 46, 59, 158]]	Not Feasible overtime> 90
2	50.00%	50.00%	[[153, 54, 204], [47, 90, 45, 142], [82, 46, 59, 158]]	Feasible
3	25.00%	24.95%	[[165, 106, 46, 59, 204], [45, 186, 90, 45, 142], [47, 67, 100, 107, 54, 158]]	feasible overtime > 90
4	37.50%	37.45%	[[137, 90, 59, 204], [39, 46, 100, 46, 45, 142], [45, 186, 54, 158]]	Feasible
5	31.25%	31.20%	[[165, 107, 59, 204], [186, 90, 45, 142], [59, 65, 106, 46, 54, 158]]	Feasible

METHODS: FINE TUNING

- Nurse staffing level simulation analysis was conducted only on binary iteration 5.

  (10 replications)

- The max OR utilization was achieved with the following:
  - 3 pre-op nurses, 5 circulation nurses, 2 scrub nurses, 3 PACU nurses & 2 maintenance staff.
- This result shows us that to attain good utilization, it is not necessary to put the staffing level to the maximum.

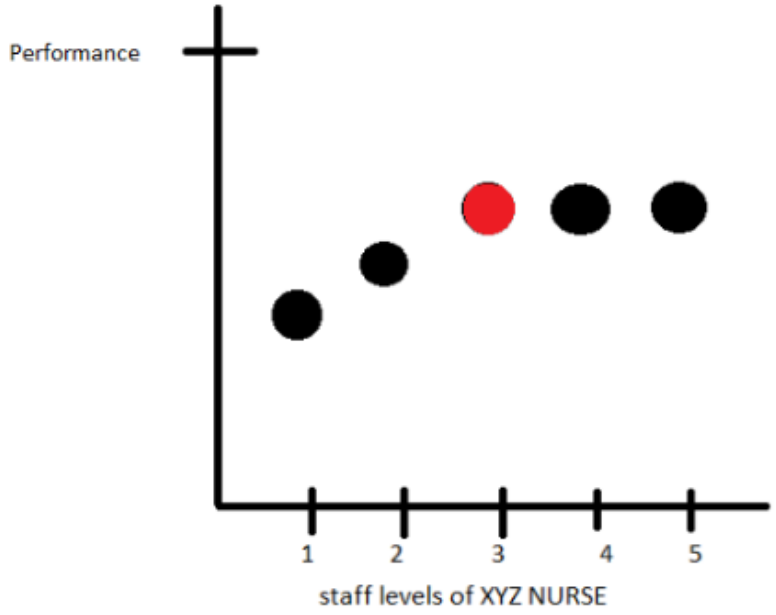


Figure 3. Staffing level selection

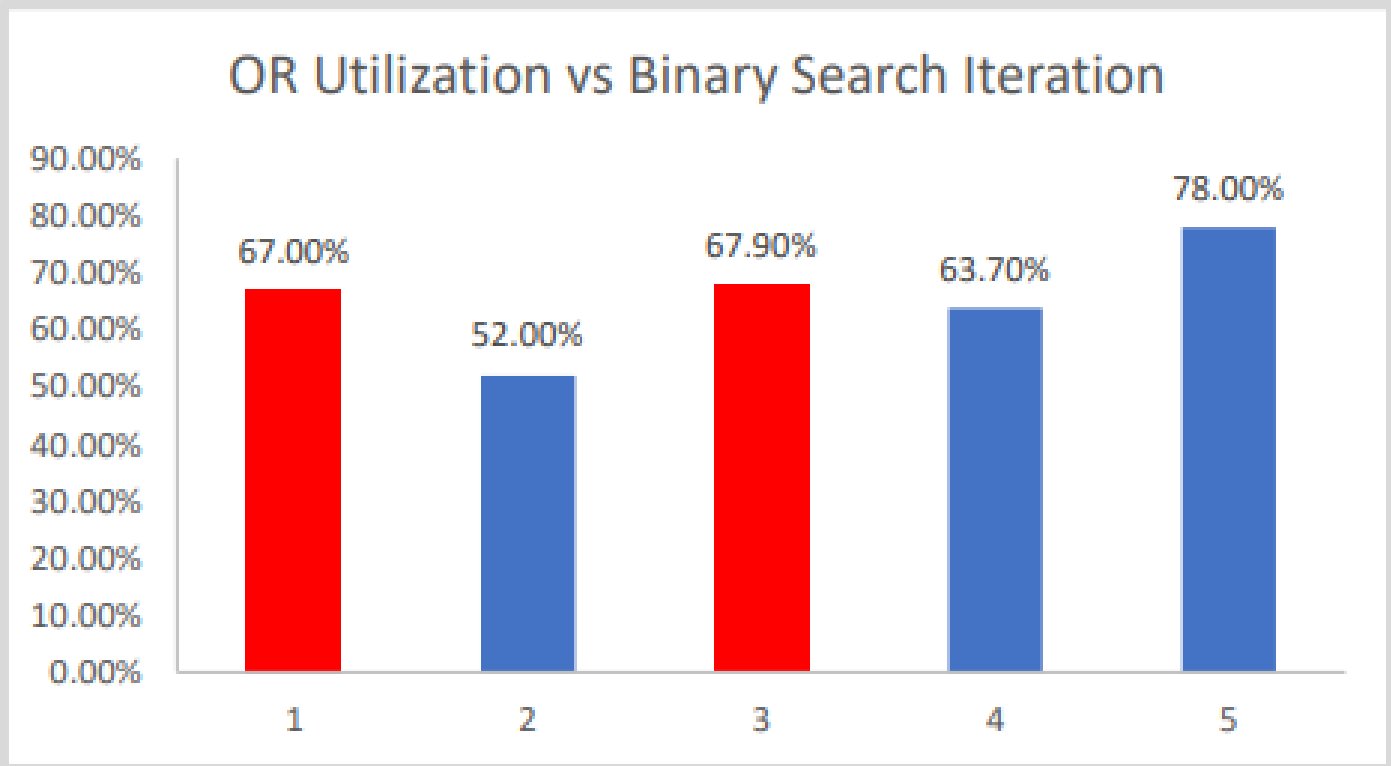
RESULTS

- Optimal buffer size = 31.25%
  - 0 minutes of staff overtime
  - Profit $28,509.00
  - OR utilization 78%
  - Median patient length of stay was 176 minutes

- Binary Search Algorithm pushed the amount of scheduled work to the limit. As seen by oscillating between feasible and infeasible simulations.

Feasibility
Not Feasible overtime> 90
Feasible
feasible overtime > 90
Feasible
Feasible

Iteration	median OR occupied + maintenance	mean OR idle% (95%)	Median staff working overtime (min)	median patient length of stay (min)	median staff utilization	Median profit
1	67.00%	0.2879 ± 0.0722	40	176.4	17.60%	$52,099.00
2	52.00%	0.4486 ± 0.0913	0	174	11.70%	$21,462.00
3	67.90%	0.3784 ± 0.0880	10	189.6	16.00%	$35,094.00
4	63.70%	0.3873 ± 0.0854	0	196.2	14.20%	$29,939.00
5	78.00%	0.3666 ± 0.1101	0	174	17.80%	$28,509.00



CONCLUSIONS

OR utilization increased while maintaining the proposed ethical considerations

NEXT STEPS

Improve General Algorithm

Include Some Allowable Overtime

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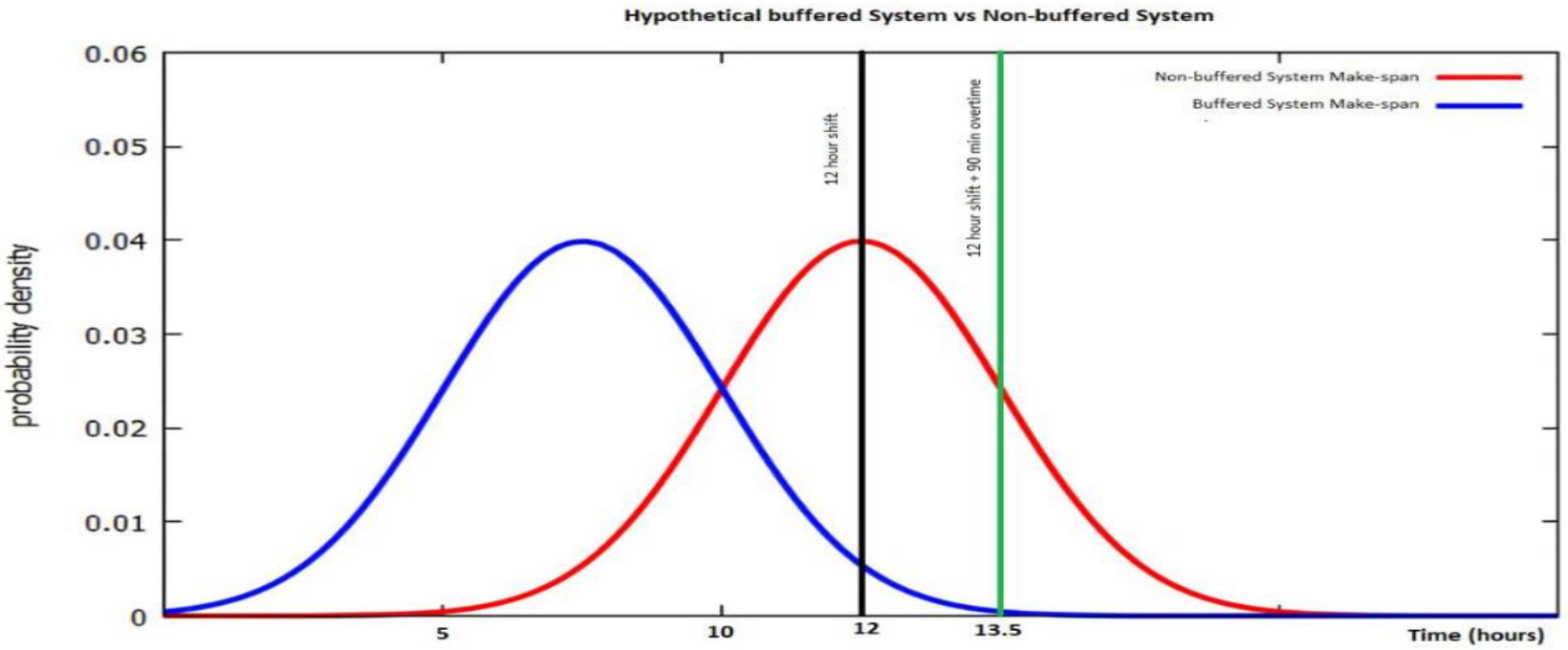

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