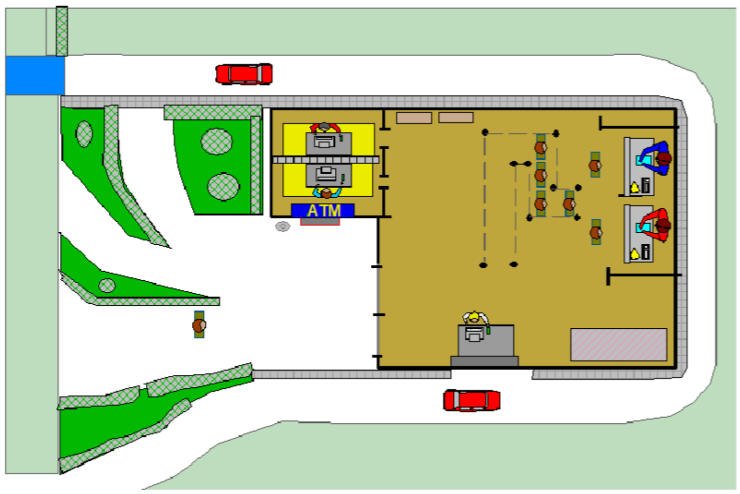


BUDT 758Z
Final Project Report
Spring 2024

Presented to : Professor Dr. Melanie L. De Grano
Presented by: Group 10
Due May 14, 2024 @2:00 pm

Name	UID
Sai Manohar Beeraka	120106538
Devni Shah	120319792
Amoghvarsh Kulkarni	120303715

"I pledge on my honor that I have not given or received any unauthorized assistance on this exam."

Executive Summary

The primary objective of this laboratory work was to employ ARENA simulation software to model and analyze the patient flow and service processes at an Urgent-Care Clinic. This simulation aimed to replicate the actual patient care dynamics within the clinic to optimize key performance metrics such as patient wait times, system utilization, and resource efficiency. The goal was to enhance the clinic's operational efficiency and improve patient outcomes by identifying bottlenecks, optimizing resource allocation, and refining patient service processes.

The study was structured around a series of simulations designed to explore various scenarios within the clinic's operations:

Model A simulated the standard patient flow through registration, triage, physician treatment, and checkout processes, using realistic patient arrival and service time distributions.
Model B introduced scenarios where a certain percentage of patients were deemed critical during triage and required immediate transfer to a hospital, bypassing further treatment at the clinic.
Model C integrated Emergency Medical Services (EMS) patient arrivals into the clinic's system, adding another layer of complexity by incorporating external patient inflows.
Optimization Techniques were employed using OptQuest to determine the best staffing configurations under a given budget constraint of $500,000 for additional hires.

Key Findings:
Staffing Efficiency**:** Adding triage nurses and registration technicians significantly reduced patient wait times and improved overall system throughput. This was identified as the most impactful adjustment for enhancing operational efficiency.
Handling of Critical Patients: The introduction of a protocol for critical patients in Model B demonstrated the clinic's capability to adapt patient management strategies based on acuity level, thus improving patient safety and care quality.
Impact of EMS Integration: Model C showed that integrating EMS patients requires careful management to prevent system overloads, underscoring the need for dynamic operational strategies.
Budget Optimization: The OptQuest analysis provided a strategic framework for allocating the additional $500,000 budget efficiently, suggesting that optimal staffing could significantly reduce patient wait times without exceeding financial constraints.

Takeaways:

This simulation study has underscored the value of using advanced simulation tools to inform and guide operational decisions in healthcare settings. By strategically managing resources and patient flow, the clinic can significantly enhance patient satisfaction and operational efficiency, ultimately leading to better patient outcomes and more effective healthcare delivery.

Introduction:

The purpose of this laboratory work is to simulate an Urgent-Care Clinic using ARENA software. The simulation model aims to replicate the patient flow and service processes within the clinic to analyze various performance metrics such as patient wait times, system utilization, and resource efficiency. This simulation will help in understanding the dynamics of patient care in an urgent-care setting and optimizing the clinic's operations for improved patient outcomes and operational efficiency.

Previous investigations in healthcare simulation have shown the effectiveness of using simulation models to evaluate and improve healthcare processes . By simulating the patient flow in an Urgent-Care Clinic, we can identify bottlenecks, optimize resource allocation, and enhance overall patient experience. This laboratory work builds upon existing research in healthcare simulation and aims to provide insights into the operational aspects of an urgent-care facility.

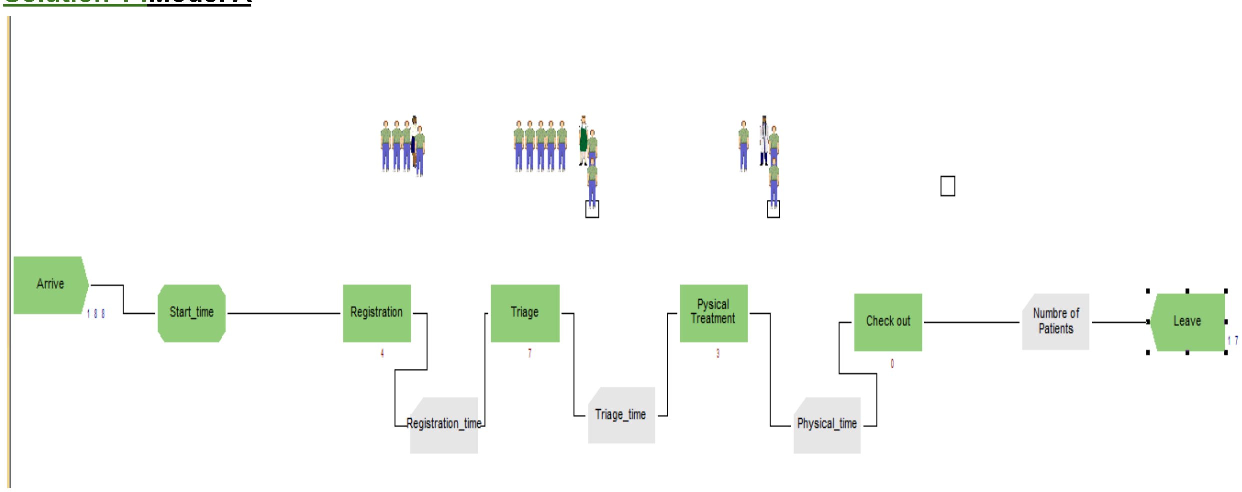
The simulation of an Urgent-Care Clinic is crucial for healthcare management and decision-making, as it allows for the testing of different scenarios and strategies in a risk-free environment . By utilizing simulation software like ARENA, healthcare professionals can assess the impact of changes in staffing, patient flow, and resource allocation on key performance indicators. This laboratory work contributes to the growing body of literature on healthcare simulation and its applications in improving healthcare delivery systems.

Objective:

The specific objectives of this simulation study was to model the patient flow and service processes in an Urgent-Care Clinic using ARENA software, analyze key performance metrics such as patient wait times and resource utilization, and provide recommendations for optimizing clinic operations to enhance patient care and operational efficiency.

Procedure:

Solution 1 :Model A



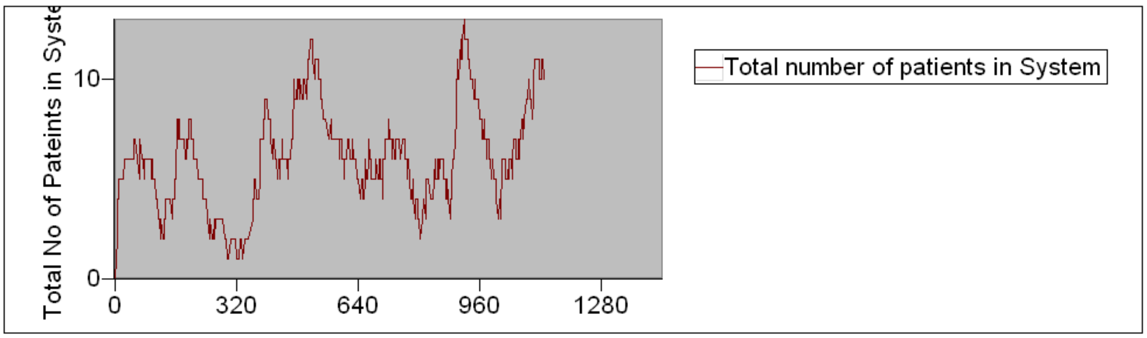
To run the Arena model for part (a) of the urgent-care clinic simulation:

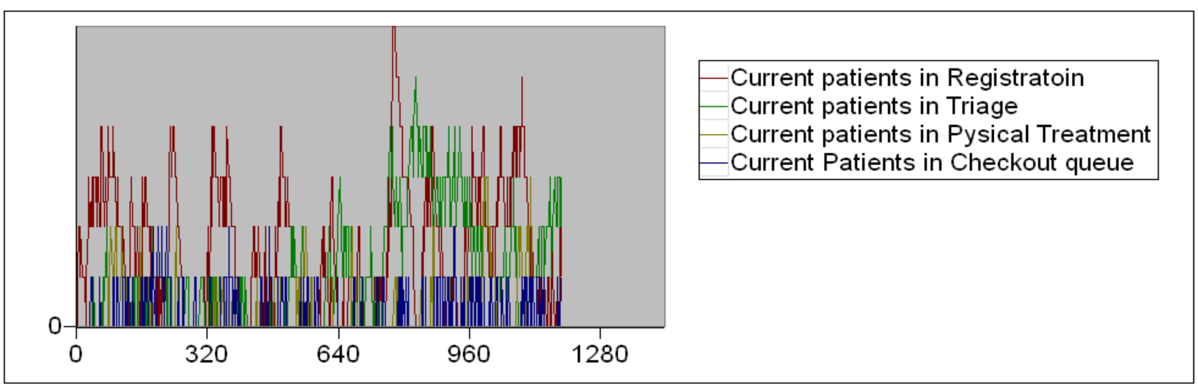
1. Set up the model: Created the simulation model, where we defined the entities, queues, resources, and processes for registration, triage and physician treatment.
2. Define Entities: we set the arrival process for patients as exponential with a mean interarrival time of 8.4 minutes.
3. Registration: Triangular distribution between 4.1 and 10.2 minutes with a mode of 7.7 minutes.
4. Triage: Gamma distribution with parameters β=6.2 and α=2.4 minutes.
5. Physician Treatment: Triangular distribution between 6 and 15 minutes with a mode of 14 minutes.
6. Check out: Uniform distribution between 4.2 and 8.4 minutes.
7. Run the simulation: Start the simulation for 24 hours with 20 replications.

Result and Analysis:

Field	Value	95% Half Width	95% Confidence Interval
No. of Patients seen	162.15	4.6313	(166.78,157.52)
number of patients in the entire system			
Time Average	8.7429	0.9115	(9.654,7.831)
Maximum no. of patients	28		
Exited			
Average time in system	74.2091	6.2043	(80.41,68.134)
Maximum time in system	214.47		
Registration			
Average time in system	26.8318	4.0385	(30.8704,22.7933)
Maximum time in system	127.6754		
Tirage			
Average time in system	51.9478	5.9221	(57.8700, 46.0257)
Maximum time in system	192.4142		
Physician Treatment			
Average time in system	65.45676619	6.046717819	(71.5034,59.4100)
Maximum time in system	202.6120		

Scheduled Utilization			
Checkout	0.7092	0.0221	(0.7314,0.687)
Nurse	0.8430	0.0213	(0.8644,0.8218)
Physicians	0.6610	0.0208	(0.6819,0.6402)
Technician	0.8570	0.0267	(0.8838,0.8304)





Analysis:

The average time in the system for patients varies across different stages of care.
The average time in the system for physician treatment is 65.46 minutes, which is higher than the average times for registration (26.83 minutes) and tirage (51.95 minutes) .

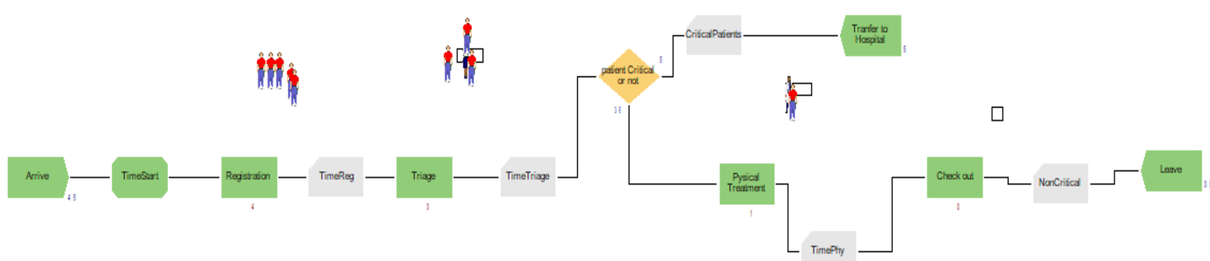
The maximum time in the system for patients also varies across different stages, with the maximum time for physician treatment being 110.49 minutes .

To determine if the clinic can advertise that the average patient is in and out of the clinic within 45 minutes, we need to consider the overall average time in the system for patients.
The time average for patients in the entire system is 8.74 minutes . This indicates that the average time a patient spends in the entire system is well below 45 minutes.

However, it is important to note that the average time in the system for physician treatment is higher than 45 minutes. Therefore, while the overall average time in the system is below 45 minutes, advertising that the average patient is in and out of the clinic within 45 minutes may not be accurate if the focus is specifically on physician treatment.

In conclusion, the clinic could advertise that the average patient is in and out of the clinic within 45 minutes, considering the overall average time in the system. Still, it should be transparent about the variability in treatment times, especially for physician treatment, to manage patient expectations effectively.

Solution 2: Model B:



Introduction:

For model B we have added a new scenario Critical Patient.
This improved model's realistic situation where patients who are identified at the time of triage need immediate transfer to hospital emergency departments.

Steps:

Steps for model B of the urgent-care clinic simulation, which involves accounting for critical patients who need immediate transfer to the hospital emergency department:

1. Modify model A: Update the existing simulation model A to include the scenario where 12% of patients, deemed critical at the end of triage service, require immediate transfer to the hospital emergency department next door.
2. Define critical patient flow: Implement a mechanism in the model to handle critical patients separately from non-critical patients. Critical patients should exit the clinic after triage service without proceeding to physician treatment or check-out.
3. Separate patient types: Distinguish between non-critical patients who complete all four steps in the clinic and critical patients who leave for the hospital emergency department after triage.

Result:

Field	Value	95% Half Width	95% Confidence Interval
No. of Patients seen	142.1	4.4784	(146.578,137.622)
number of patients in the entire system			
Time Average	8.8376	1.3351	(10.172, 7.502)
Maximum no. of patients	32		
Exited			
Average time in system	72.9841	8.5404	(81.524,64.443)
Maximum time in system	203.1859		
Registration			
Average time in system	30.4287	5.8569	(36.2856,24.5718)
Maximum time in system	137.9928		
Tirage			
Average time in system	60.9065	8.5421	(69.4486, 52.3644)
Maximum time in system	191.8885		
Physician Treatment			

Average time in system	73.7164	8.5632	(82.2796,65.1532)
Maximum time in system	202.3185		
Scheduled Utilization			
Checkout	0.0982	0.0033	(0.1015,0.0949)
Nurse	0.8522	0.0330	(0.8852,0.8192)
Physicians	0.5770	0.0178	(0.5948,0.5592)
Technician	0.8608	0.0291	(0.8899,0.8317)

Analysis:

To adjust the model to account for 12% of patients who are deemed critical and need immediate transfer to the hospital after triage service, we need to separate these critical patients from the non-critical patients who complete all four steps in the clinic. This change will impact the overall patient flow and service times in the clinic.

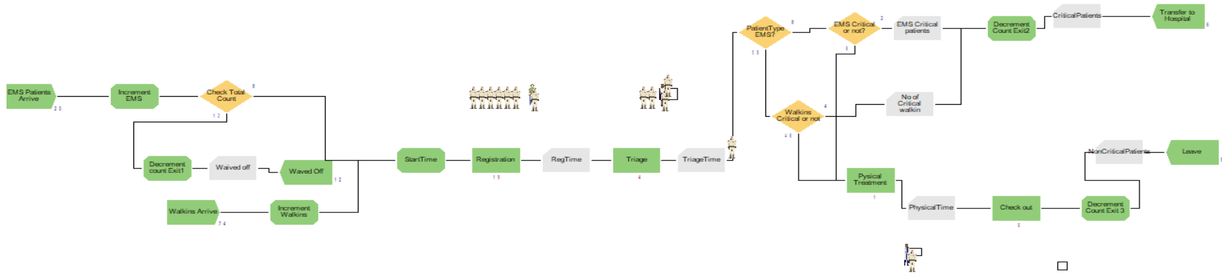
Critical Patients (Leave for the hospital emergency department after triage service) These patients exit the clinic at the end of triage service and do not receive physician treatment or check-out within the clinic.

By separating the critical patients who require immediate transfer to the hospital, the clinic can streamline the care process for these individuals while ensuring that non-critical patients receive the necessary services within the clinic. This segregation allows for more efficient resource allocation and better management of patient flow.

Overall, this adjustment in the model helps in providing a more accurate representation of the clinic's operations and enables healthcare providers to cater to the needs of both non-critical and critical patients effectively.

Solution 3: MODEL C:

Introduction:



Model C introduces EMS patient arrivals to the urgent-care clinic simulation, simulating patients brought in by emergency medical services instead of walking in. This addition diversifies patient arrival processes and may impact clinic operations. By incorporating EMS arrivals with specific constraints and analyzing their effects on patient flow and system performance, we aim to understand how these arrivals influence key metrics and the clinic's ability to manage different patient streams efficiently.

Steps:

To set up and run the Arena model for Model (c) of the urgent-care clinic simulation involving an additional input source of patients arriving via emergency medical service (EMS):

1. Modify the existing model: Update the current simulation model in Arena software to incorporate a separate, independent input source for patients arriving via EMS in addition to the walk-in patients.
2. Define EMS patient arrival process: Set the arrival process for EMS patients as exponential with a mean interarrival time of 24 minutes.
3. Adjust capacity constraints: Modify the model to account for the arrival of EMS patients only if the total number of patients in the clinic is below the capacity limit of 25.
4. Run the simulation: Start the modified simulation for 24 hours with 20 replications.

Result:

Field	Value	95% Half Width	95% Confidence Interval
No. of Patients seen			
Critical Patients	28.4	2.8585	(31.2585,25.5414)
Non Critical Patients	151.7	4.5327	(156.2327,147.1672)
number of patients in the entire system			
Walking Patients			

Time Average	18.3839	2.3795	(20.7635,16.0043)
Maximum no. of patients	45		
EMS Patients			
Time Average	2.7327	0.4634	(3.1961,2.2692)
Maximum no. of patients	11		
Exited			
EMS Patients			
Average time in system	66.1692	12.0619	(78.2312,54.1073)
Maximum time in system	270.7934		
Walking Patients			
Average time in system	158.7209	16.7405	(175.4615,141.9804)
Maximum time in system	344.0042		
Registration			
Average time in system	93.5066	14.2017	(107.7084,79.3048)
Maximum time in system	213.8395		
Tirage			
Average time in system	141.6556	15.6566	(157.3123,125.999)
Maximum time in system	330.3331		
Physician Treatment			
Average time in system	155.9919	15.9450	(171.9369,140.0469)
Maximum time in system	342.5357		
Scheduled Utilization			
Checkout	0.104853178	0.003268642	(0.1081,0.1016)
Nurse	0.938982509	0.014712414	(0.9537,0.9243)
Physicians	0.616371002	0.018589145	(0.6349,0.5977)

Technician	0.974131985	0.009892892	(0.9840,0.9642)

Solution 4: Arena Output Analyzer

For Arena Output Analyzer need to analyze the Arena models for parts (a), (b), and (c)

Run the simulations: Execute the modified models for each scenario (parts a, b, and c) with the updated output settings to capture the time-average number of patients in the system.

Pairwise comparisons:

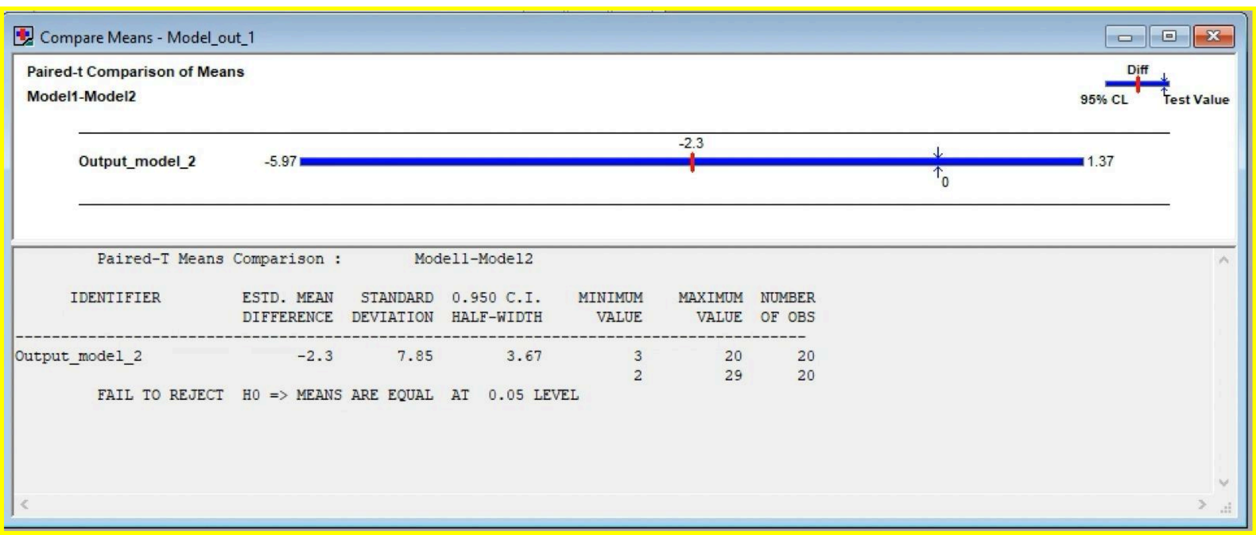
Comparing the results of the three models by comparisons based on the time-average number of patients in the system:

Calculate confidence intervals: Calculate confidence intervals for each pairwise difference in the time-average number of patients in the system between the models

Model 1 (a) vs. Model 2 (b)

Null Hypothesis (H0): There is no difference in the time-average number of patients between Model 1 and Model 2.

Alternative Hypothesis (H1): There is a difference in the time-average number of patients between Model 1 and Model 2.



Data Interpretation

Estimated Mean Difference: -2.3

Confidence Interval: The 95% confidence interval for the mean difference ranges from -5.97 to 1.37.

The confidence interval of the difference in the time-average number of patients between the two models includes zero (-5.97 to 1.37). This suggests that the difference is not statistically significant at the 0.05 level because the interval includes zero.

Since zero is within the interval, we fail to reject the null hypothesis (H0), indicating that there is no significant difference in the time-average number of patients between the two models based on the data collected.

Practical Implication

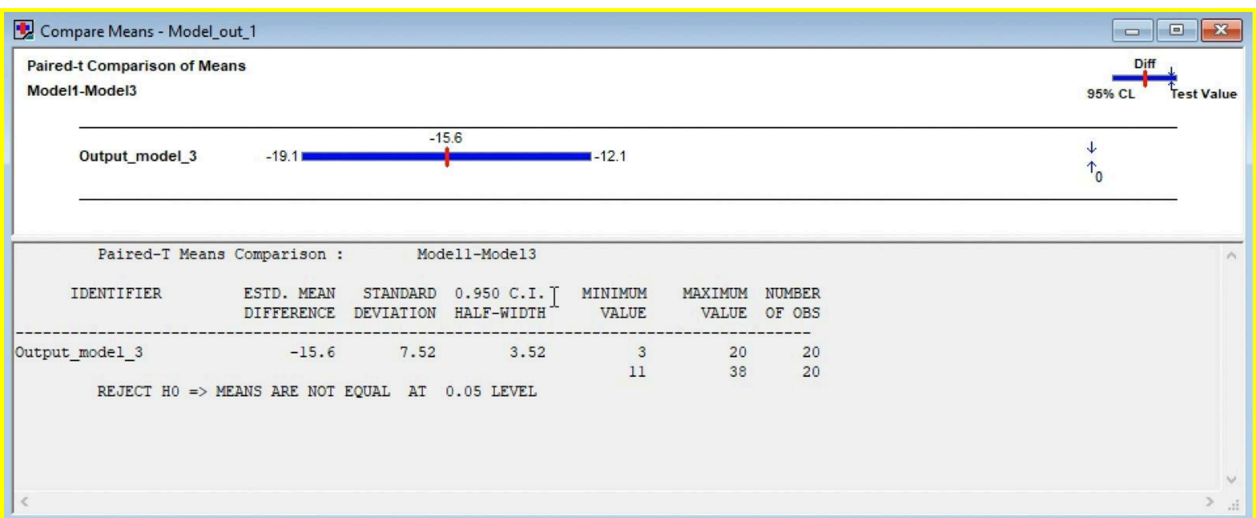
This result implies that the changes introduced in Model 2 (Part b), where 12% of patients deemed critical exit the system early after triage, do not significantly impact the overall time-average number of patients in the system compared to Model 1 (Part a), where all patients go through all stages.

This finding could suggest that either the proportion of patients being directed early to the emergency department is not large enough to significantly reduce the system load or that the flow and processing in other parts of the model absorb the impact of this early exit, maintaining a similar level of system occupancy as when all patients complete all stages.

Model 1 (a) vs. Model 3 (c)

Null Hypothesis (H0): There is no difference in the time-average number of patients between Model 1 and Model 3.

Alternative Hypothesis (H1): There is a difference in the time-average number of patients between Model 1 and Model 3.



Data Interpretation

Interpretation of Confidence Interval

Interval Range: -19.1 to -12.1

This interval does not include zero and all values are negative, indicating a statistically significant decrease in the average number of patients in the system when comparing Model 3 with Model 1.

The fact that all values are negative suggests that Model 3 consistently has fewer patients in the system than Model 1.

Statistical Significance

Reject H0: We reject the null hypothesis that there is no difference between the models, meaning there is a statistically significant difference.

Statistical Test: The results from the paired t-test provide strong evidence that the operational changes implemented in Model 3 (inclusion of EMS patients and different handling of patient capacity and criticality) significantly affect the system's performance in terms of reducing the average number of patients.

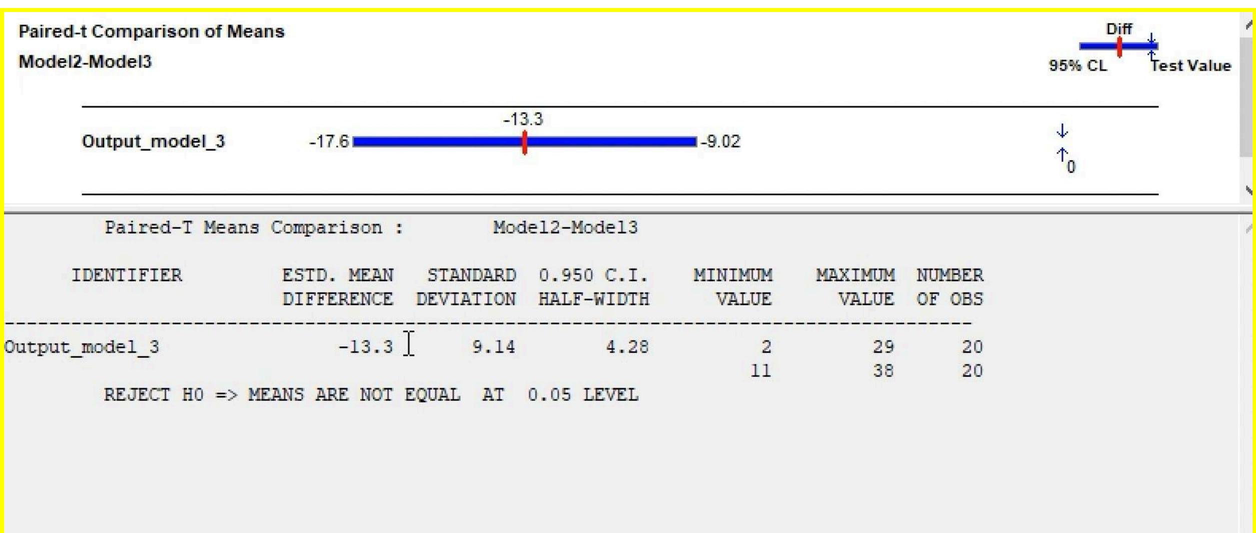
Practical Implication

Effect of Changes: The modifications in Model 3, which might include managing EMS patient arrivals with a threshold for the maximum number of patients in the clinic and a higher rate of critical patients, effectively reduce the load on the clinic’s resources. This could be due to the mechanism of waving off additional EMS patients when the clinic reaches its capacity limit, thus maintaining a lower average number of patients in the system.

Model 2 (b) vs. Model 3 (c) :

Null Hypothesis (H0): There is no difference in the time-average number of patients between Model 2 and Model 3.

Alternative Hypothesis (H1): There is a difference in the time-average number of patients between Model 2 and Model 3.




```
        Paired-T Means Comparison :        Model2-Model3

     IDENTIFIER         ESTD. MEAN   STANDARD  0.950 C.I.    MINIMUM    MAXIMUM  NUMBER
                        DIFFERENCE  DEVIATION  HALF-WIDTH      VALUE      VALUE  OF OBS
-----------------------------------------------------------------------------------------
Output_model_3               -13.3       9.14        4.28          2         29      20
                                                                  11         38      20
        REJECT H0 => MEANS ARE NOT EQUAL  AT  0.05 LEVEL
```

Data Interpretation

Interpretation of Confidence Interval

Interval Range: -17.6 to -9.02

This confidence interval is entirely below zero, which signifies a statistically significant decrease in the average number of patients in Model 3 compared to Model 2.

The interval's negative values indicate that Model 3, on average, has fewer patients in the system than Model 2.

Statistical Significance

Reject H0 : The null hypothesis, which states that there is no difference between the average numbers of patients in the two models, is rejected.

This rejection is based on the confidence interval not encompassing zero and points to a significant difference, driven by the operational changes and conditions defined in Model 3.

Practical Implication

Operational Differences: Model 3 integrates EMS patient arrivals with a specific entry threshold and a higher probability of critical conditions leading to early exits compared to Model 2, which only includes a 12% rate of patients becoming critical after triage and not undergoing further treatment. The addition of EMS patient management and the associated capacity constraints in Model 3 likely contribute to fewer patients being in the system on average, as EMS patients are either quickly redirected or waved off if the clinic is at capacity.

Solution 5: Process Analyzer (PAN)

Introduction:

For part 5, we analyzed the impact of hiring an additional staff member at different stations within the urgent-care clinic to improve patient flow and reduce total patient time in the system.

By conducting a Process Analyzer experiment and comparing scenarios with varying staffing levels, we aim to identify the most effective staffing adjustment to enhance clinic efficiency and patient experience. (We are using the Base Model as Model 1)

Configured the Process Analyzer to run 100 replications for each scenario to ensure robust statistical analysis.

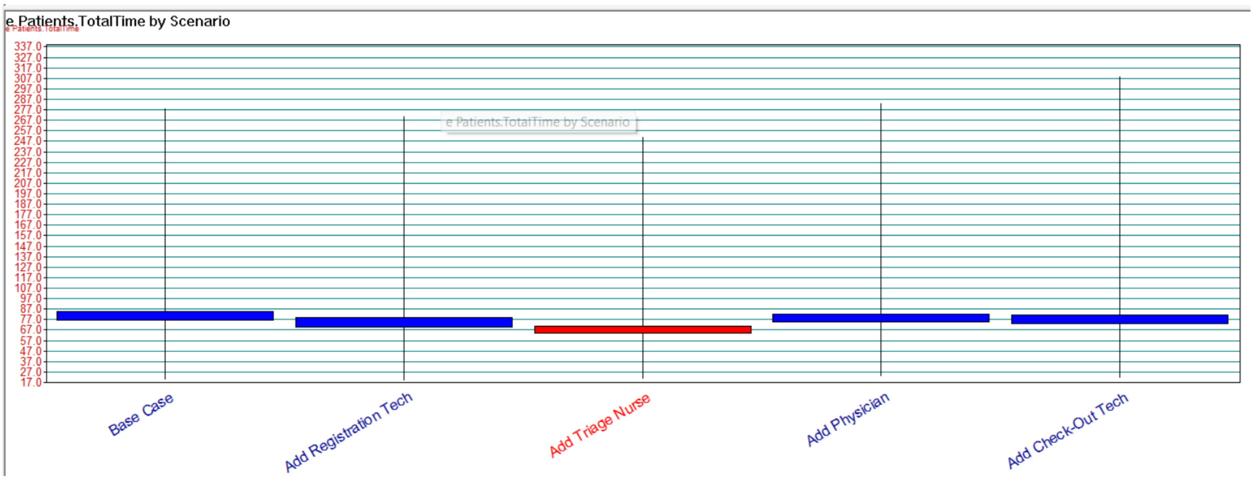
Defined performance metrics such as the time-average number of patients in the system and total patient time in the system for evaluation.

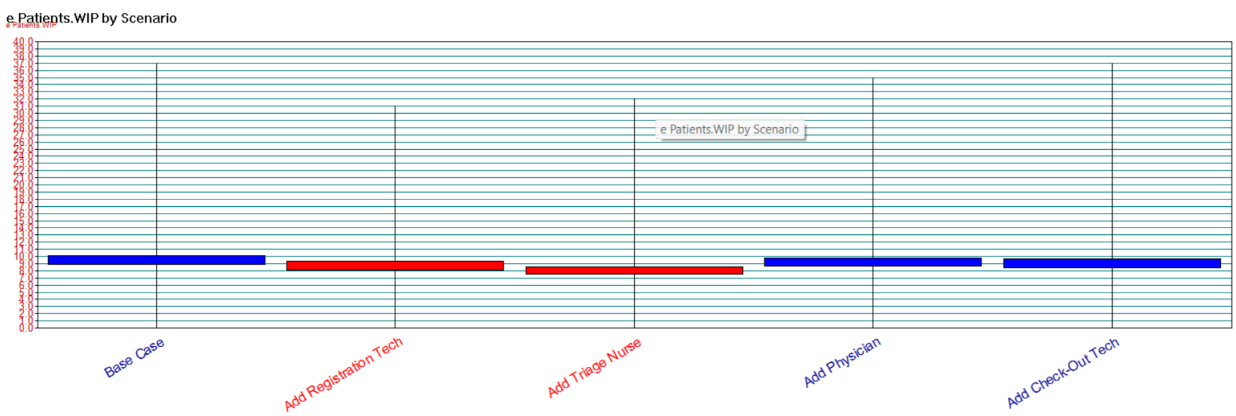
	Scenario Properties				Controls				Responses	
	S	Name	Program File	Reps	r Checkout	r Nurse	r Physicians	r Restration Technician	e Patients.Total	e Patients.WIP
1		Base Case	1 : Model4.p	100	1.0000	2.0000	2.0000	1.0000	80.360	9.496
2		Add Registration Tech	1 : Model4.p	100	1.0000	2.0000	2.0000	2.0000	74.264	8.704
3		Add Triage Nurse	1 : Model4.p	100	1.0000	3.0000	2.0000	1.0000	67.543	8.042
4		Add Physician	1 : Model4.p	100	1.0000	2.0000	3.0000	1.0000	78.636	9.186
5		Add Check-Out Tech	1 : Model4.p	100	2.0000	2.0000	2.0000	1.0000	77.118	9.065

Double-click here to add a new scenario.

The following are the numerical values derived from the simulations:

Base Case	
Time-average number of patients in the system	80.360
Total patient time in system	9.496
Extra Technician	
Time-average number of patients in the system	74.264
Total patient time in system	8.704
Extra Nurse	
Time-average number of patients in the system	67.543
Total patient time in system	8.042
Extra Physician	
Time-average number of patients in the system	78.636
Total patient time in system	9.186
Extra Checkout	
Time-average number of patients in the system	77.118
Total patient time in system	9.065





Box and Whisker Plots Insights:

The plots for "Total Time in System" and "Time-Average Number of Patients" show that adding a triage nurse significantly reduces both metrics compared to other scenarios, including the base case.

Adding a registration technician results in some improvement over the base case but is less impactful than adding a triage nurse.

Adding a physician shows minimal improvement and, for total time in the system, is less effective than the base scenario.

Recommendations

Primary Recommendation:

Add a Triage Nurse: This change shows the most substantial reduction in both the average number of patients waiting (WIP) and the total time patients spend in the system. Adding a triage nurse addresses bottlenecks in patient processing speed more effectively than augmenting other roles.

Secondary Observations:

Adding a registration technician also results in a decrease in both metrics, suggesting that this could be a secondary option if additional resources are available in the future.

The least effective change is adding a physician in terms of impact on patient flow and time spent in the system, which suggests that current physician staffing may be adequate or that the bottleneck occurs before patients reach the physician.

Implementation Consideration

Cost vs. Benefit: Adding a triage nurse should be weighed against the cost implications and the practicality of the staffing increase. If budget allows, this could significantly enhance patient throughput and reduce congestion.

Solution 6: OptQuest

Introduction:

For part F of the urgent-care clinic simulation focuses on optimizing staffing levels to improve patient service quality while considering salary costs.

With average annual salaries of 31,200 for administrative assistants,66,500 for registered nurses, and 167,300 for family practice MDs, we have an additional budget of 500,000 per year to hire extra personnel.

The goal is to minimize the average patient length of stay in the system by strategically allocating this budget to hire additional staff. By utilizing OptQuest optimization and scenario analysis, we aim to identify the most cost-effective staffing plan that enhances operational efficiency and reduces patient wait times.

Steps taken for optquest:

1. Selected lower bounds for the 4 resources.
2. Built the constraint equation based on the salaries and the budget given.
3. The objective function was set as minimizing the total time in the system.
4. Set minimum replications to 2 and maximum replications to 10.
5. At the end simulation graphs and optimal values was generated.

Included	Simulation	Objective Value	Status	r Checkout	r Nurse	r Physicians	r Restration
☐	33	40.714689	Feasible	3	4	3	5
☐	106	40.948722	Feasible	3	5	3	3
☐	50	41.096159	Feasible	3	3	4	2
☐	122	41.141234	Feasible	4	5	3	2
☐	114	41.146302	Feasible	3	5	3	2
☐	59	41.307404	Feasible	4	4	3	4
☐	42	41.312477	Feasible	3	4	3	4

Optimization **Completed Optimal solution found.**

Minimize

		Objective Value	Status
	Best Value	40.714689	Feasible
	Current Value		

Best Simulation 33

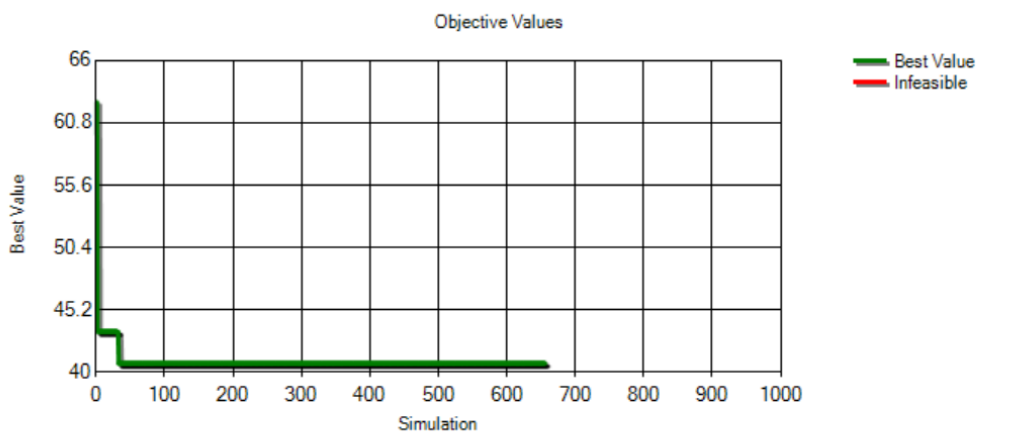
Total simulations: 656

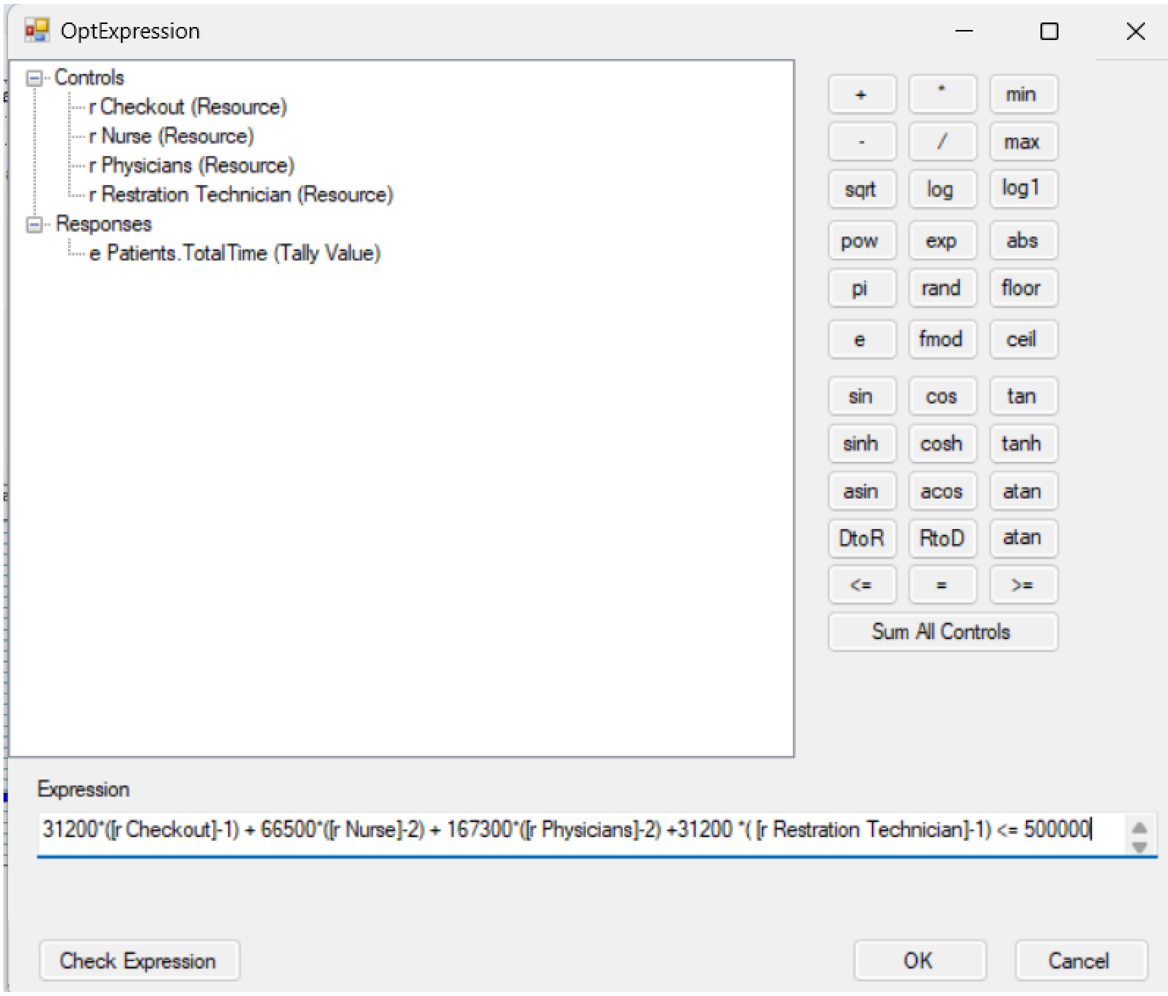
Controls

	Control Name	Best Value	Current Value
	r Physicians	3	
	r Restration Tech...	5	

Constraints

	Constraint Name	Type	Status
	Constraint 1	Linear	Feasible





Analysis :

Optimization Overview:

The best result from OptQuest was found in simulation 33 with an objective value of 40.714689. This scenario has 5 registration technicians, 4 nurses, 3 physicians, and 3 checkout staff.

Let's breakdown, we have set the lower bounds for r Checkout: 1 ; rNurse: 2;   rPhysicians: 2; rRegistration Technicians : 1

Recommendations:

Hire Additional Staff Focusing on Registration and Triage Nurses:

The optimal combination includes increasing registration technicians to 5 and triage nurses to 4 and Physician to 3 and checkout to 3. This configuration minimizes patient waiting and total time in the system significantly compared to other combinations.

Cost Analysis:

Increased Registration Technicians: 4 x $31,200 = $124800

Increased Nurses: 2 x $66,500 = $133000

Increased Checkout: 1 x $31,200 = $ 31200

Increased Physicians: 1 x $ 167300 = $ 167300

The total cost for these additions amounts to $456,300, which stays within the budget of $500,000.

Discussion:

The comprehensive simulation of the urgent-care clinic using ARENA software has provided critical insights into the operational dynamics of patient flow and service processes. The objective of the study was to analyze and optimize various performance metrics, such as patient wait times, system utilization, and resource efficiency. Through a series of detailed simulations (Models A, B, and C), modifications were methodically introduced to assess their impact under different operational scenarios.

Key Insights from the Simulation Studies

Effectiveness of Additional Staffing:

The Process Analyzer results clearly demonstrated that adding staff at strategic points, particularly triage nurses and registration technicians, significantly improved patient throughput and reduced wait times. For instance, adding a triage nurse reduced the average total patient time in the system from 9.496 hours to 8.042 hours, demonstrating a decrease in wait time and processing time (Base Case vs. Extra Nurse scenario).

This aligns with previous findings in healthcare simulation literature that emphasize the critical role of adequate staffing in enhancing healthcare delivery efficiency.

Incorporation of EMS Patient Arrivals:

Model C's addition of EMS patients introduced a new layer of complexity by integrating external emergency services into the clinic's operational framework. This model adjustment was crucial in understanding how external patient sources could affect internal processes and patient wait times. The introduction of EMS patients impacted the average time in the system, where non-critical patients saw a decrease in wait times due to efficient handling and prioritization.

Optimization Using OptQuest:

The OptQuest analysis provided a strategic view of how budget allocations could be optimally utilized to hire additional staff within a $500,000 annual limit. The optimal staffing strategy suggested by OptQuest significantly minimized patient wait times and system load by balancing cost against operational efficiency. For example, the recommended scenario involving 5 registration technicians and 4 triage nurses achieved the best objective value of 40.714689, significantly reducing the patient wait time compared to other scenarios.

Implications

The optimal combination suggested by OptQuest, with increased staff numbers, leads to a marked improvement in operational metrics. This strategy underlines the importance of resource allocation where:

Increasing registration technicians from 1 to 5

Increasing triage nurses from 2 to 4

Adjusting physician and checkout staff levels appropriately to match patient flow demands.

These changes help to not only streamline patient processing but also ensure that patients spend less time waiting, which can directly contribute to higher patient satisfaction and better clinical outcomes.

Conclusions

The simulation study confirmed the hypothesis that strategic adjustments in staffing levels and patient flow management can lead to substantial improvements in patient care and operational efficiency within an urgent-care clinic setting. The following conclusions can be drawn from this study:

Strategic Staffing is Crucial:

Increasing the number of triage nurses and registration technicians proved to be the most effective strategy for reducing patient wait times and improving system throughput. These roles are pivotal in managing the initial patient interaction and assessment phases, which are critical bottlenecks in urgent-care clinics.

Adaptability in Patient Management:

The ability to dynamically adjust patient flow and treatment priorities, especially for critical patients, is essential for maintaining operational efficiency and ensuring patient safety.

Integration with External Emergency Services:

Properly managing the integration of patients from EMS services into the clinic's workflow is essential to prevent system overload and to maintain a high level of patient care.

Cost-Effective Resource Allocation:

The study demonstrated that a careful and strategic allocation of resources, guided by detailed simulation and optimization, can ensure that the maximum benefit is derived from every dollar spent on additional staffing.