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SIMULATION-BASED OPTIMIZATION OF RESIDENT-DRIVEN HEALTHCARE CLINIC OPERATIONS AT EMORY HEALTHCARE

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ABSTRACT

This case study examines the application of discrete-event simulation to optimize operations at Emory Healthcare's Dunwoody Family Medicine clinic, a resident-driven healthcare facility. The clinic faced challenges with patient wait times and complex resident-preceptor interactions that impacted patient flow. Using Simio simulation software, researchers developed a digital twin model of clinic operations, incorporating data from electronic health records and time studies. The validated model identified key bottlenecks and tested multiple improvement scenarios. Results showed that implementing a first-come-first-served preceptor queue system could reduce preceptor waiting time by 31%, while strategic resident pod assignments could decrease travel time by 60%. This project demonstrates how simulation modeling can provide healthcare facilities with data-driven insights to improve operational efficiency while maintaining educational quality in teaching environments.

1 INTRODUCTION

Emory Healthcare, headquartered in Atlanta, Georgia, is the only academic medical center in the state with ten hospitals, over 580 locations, and 230 primary care facilities. The Dunwoody Family Medicine clinic, the focus of this study, is a comprehensive facility with primary care, family medicine, orthopedics, spine, cardiology, imaging, laboratory services, and physical therapy. The 60,000 ft² facility contains 86 clinical rooms with capacity to serve over 350,000 patients annually.

What makes this clinic unique is its educational mission—71% of providers are medical residents completing their training. This resident-driven model creates distinctive operational challenges as residents must consult with preceptors (supervising physicians) at various points during patient visits, with consultation requirements varying based on resident experience level. First-year residents must consult preceptors mid-appointment for every patient, while more experienced residents can "stack" multiple patients before consulting.

This complex environment, with its interacting variables and educational requirements, presented an ideal opportunity for simulation-based analysis to identify operational improvements while maintaining educational quality.

2 METHODOLOGY

Simulation Approach

The project team, comprising Emory Healthcare staff and Georgia Tech Industrial and Systems Engineering students, developed a discrete-event simulation model using Simio software. The model created a digital twin of the Dunwoody clinic, replicating physical layout, patient flow, resource constraints, and the unique resident-preceptor interaction patterns.

Data Collection and Analysis

The team utilized two primary data sources:

- Electronic Health Records (EHR): Provided patient-facing data including check-in times, rooming times, provider service times, and visit end times from October 2024 to January 2025.
- Time Studies: Conducted on-site to collect non-patient-facing data, particularly preceptor interaction times and queuing patterns not captured in EHR systems.

Statistical analysis identified key factors influencing process times at each stage of patient flow. To reduce model complexity while maintaining accuracy, the team performed correlation analysis to cluster similar attributes.

Model Development and Validation

The simulation model incorporated:

- Physical clinic layout with four distinct pods
- Patient flow processes from arrival through discharge
- Resource constraints (nurses, providers, preceptors, rooms)
- Experience-based resident-preceptor interaction rules
- Appointment type-specific service time distributions
- Time-of-day arrival patterns

The team validated the model through:

- **Face validity:** Ensuring logical operations matched real-world processes
- **Input model validation:** Comparing simulated service times with observed data
- **System performance validation:** Testing the model against March 2025 data (not used in model development)

3 DISCUSSION AND CONCLUSIONS

This project demonstrates the value of simulation modeling in healthcare environments with complex operational constraints and educational requirements. The digital twin approach provided Emory Healthcare with:

- **Data-driven insights:** The simulation identified non-intuitive improvement opportunities that weren't apparent to staff immersed in daily operations.
- **Risk-free testing:** The model allowed testing of operational changes without disrupting patient care or educational experiences.
- **Quantifiable benefits:** Clear metrics showed potential improvements in wait times, resource utilization, and overall efficiency.
- **Scalable methodology:** The approach established a framework that can be applied to other Emory Healthcare facilities.

The clinic leadership has begun implementing recommendations, starting with the pod reassignment strategy. Future work will focus on optimizing resident scheduling to ensure all required procedures are completed within residency timeframes while maintaining operational efficiency.

This case study highlights how academic-industry partnerships can leverage simulation technology to improve healthcare operations while balancing educational needs with patient experience. The methodology demonstrates that even in complex healthcare environments with competing priorities, simulation modeling can identify practical improvements that benefit all stakeholders.