

UTILIZATION & CAPACITY SIMULATION FOR MRI EFFICIENCY

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Systems & Procedures

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BACKGROUND/INTRODUCTION



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- At Vidant Medical Center (VMC), the current operations with Magnetic Resonance Imaging (MRI) services have seen a steady increase in usage from the inpatient, outpatient and Emergency Department population. With increased demand on MRI services, operational details like staff and patient scheduling, service turn-around-times, and throughput have become more challenging.
- VMC leadership looked to capitalize the use of Simulation Modeling to help provide necessary information that would allow them to make appropriate decisions on improving MRI operations.

COLLABORATIVE TEAM MEMBERS



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- Michael Zimmer – Project Manager & Simulation Designer
- Sandra Sackrison – Service Line Administrator & Subject Matter Expert
- Charlotte Wallace – Radiology Division Manager & Clinical Stakeholder
- Chasity Stubbings – MRI Supervisor & Clinical Stakeholder
- VMC Performance Analytics Team – Support & Data Analytics

AIM STATEMENT



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- Validate MRI utilization and performance to devise future state improvements to maximize MRI capabilities with current resources within 90 days.
- Simulation modeling will be used to replicate MRI operations to test new scheduling options and configurations to develop improvement recommendations.
- The results and analytics produced will allow VMC leaders to make informed decisions to address MRI backlog, prepare for the growing need of MRI services, ensure MRI availability for all inpatient, outpatient, and emergency department patient population.



- **SIX SIGMA**
 - DMAIC Methodology
 - **Define:** Project purpose
 - **Measure:** Investigation and data collection
 - **Analyze:** Analytics and Simulation Model construction (**Validation and Verification**)
 - **Improve:** Scenario testing and optimization work
 - **Control:** Decision and strategic planning based on project outcomes
 - Simulation Modeling enables the ability to see impacts of proposed changes before they are implemented in a risk-free environment. Other capabilities include:
 - Provide optimal solution to the system being modeled
 - Identify bottlenecks and points for improvement
 - Model the dynamics of an operation
 - Manage critical constraints by incorporating delays, interactions, and complex logic
 - Manage variations
 - Apply competing risks to make assessments
 - Identify rate of breakdowns relative to the system capacity
 - Assess utilization and capacity of the system

DATA & ANALYSIS SUMMARY

Patient Volumes 10/2015 – 9/2016

- Inpatient: 4895
- Outpatient: 2922
- Obs. Patient: 724
- Canceled: 807
- Daily Backlog: 4.44 inpts. (1600/yr)

Observed Service Times

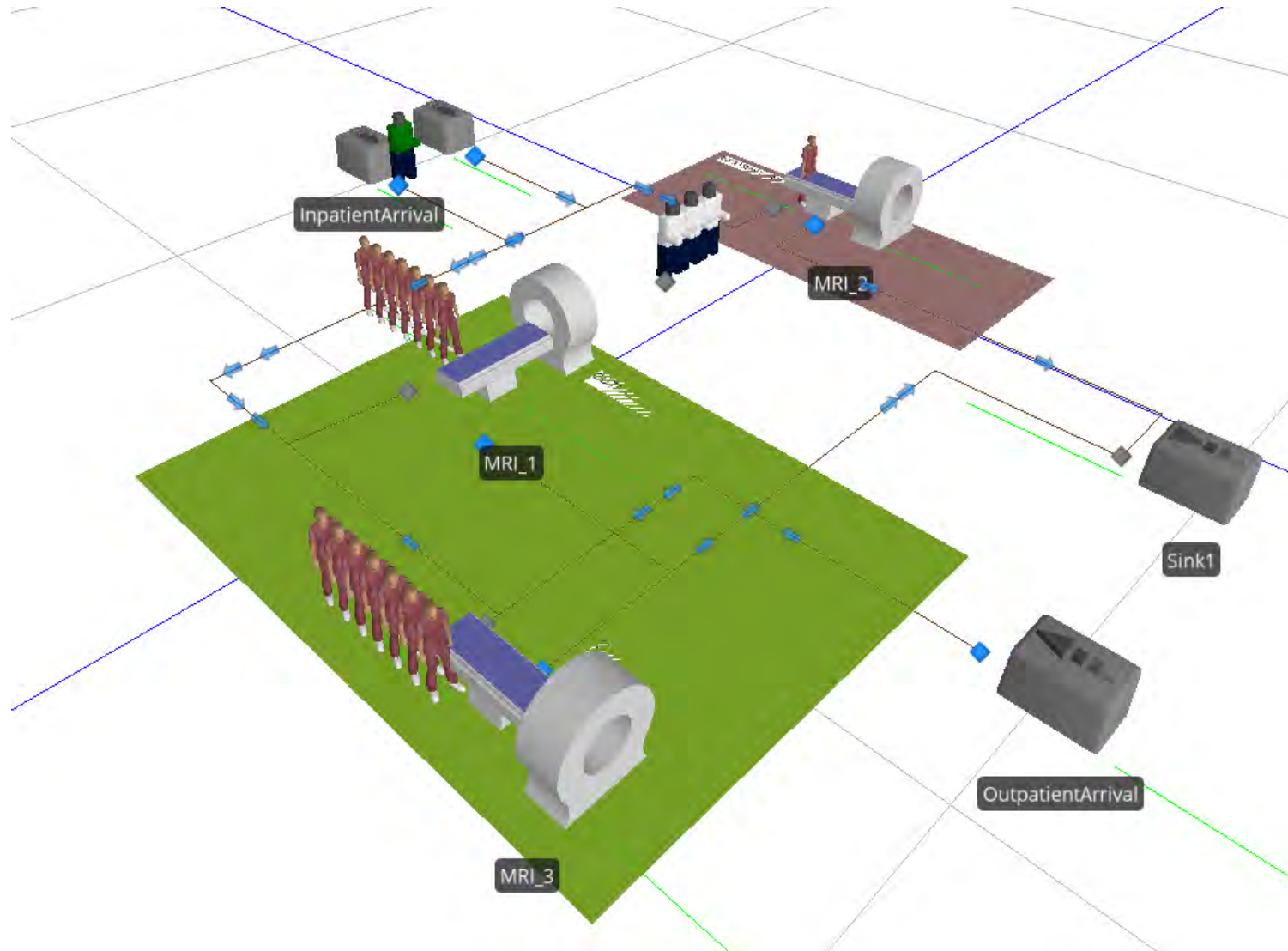
- Range: 24 minutes to 160 minutes
- Average: 58 minutes
- Standard Deviation: 11.72

- Radiology supports 3 MRIs: MRI 1, MRI 2, MRI3
 - MRI 1 & 3 is designated for Outpatients in the Brody School of Medicine
 - MRI 2 is designated for Inpatients located within VMC
- Conditions:
 - Obs-patients may use any of the 3 MRIs when available
 - Inpatients may use MRI 1 & 3 when available
 - Under special conditions, outpatients may be required to use MRI 2
- Considerations accounted for in the model
 - Staffing schedules
 - Operating hours
 - MRI staffing requirements
 - Delays: Transportation, Sedations, Ventilator pts., Late patient arrivals, Equipment setup

SIMULATION DESIGN



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SCENARIO 1: CURRENT STATE

DESIGN MRI 2 (Radiology Inpatient) operating 24 hours per day, 7 days a week
MRI 1 & 3 (Brody Outpatient) operating from 6AM to 11PM, Monday through Friday

ASSUMPTION VMC operation with expected delays

RESULTS

INPATIENT VOLUME			OUTPATIENT VOLUME			OBS-PATIENT VOLUME			UTILIZATION (%)		
AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	MRI 1	MRI 2	MRI 3
5,387	5,380	5,394	3,267	3,113	3,386	729	684	786	73.88	70.22	78.49

- NOTES**
- The volume total of all patients is within reason of the actual data.
 - The utilization percentages (70% range) indicate the MRI's usage at current state is operating effectively but to its optimal efficiency.
 - The 2017 North Carolina State Medical Facilities Plan indicates for 3 fixed MRIs should be at 65% utilization to meet planning threshold.

SCENARIO 2: CURRENT STATE MAX



DESIGN MRI 2 (Radiology Inpatient) operating 24 hours per day, 7 days a week
MRI 1 & 3 (Brody Outpatient) operating from 6AM to 11PM, Monday through Friday

ASSUMPTION VMC has optimal performance with no delays and setbacks. Inpatient are ready to move in and out of the MRI suite much like an assembly line.

RESULTS

INPATIENT VOLUME			OUTPATIENT VOLUME			OBS-PATIENT VOLUME			UTILIZATION (%)		
AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	MRI 1	MRI 2	MRI 3
7,950	7,866	8,044	3,279	3,143	3,440	705	645	753	83.27	99.99	87.65

NOTES

- This model was created based upon the current state to test the absolute max capacity of inpatient captures in the most ideal environment.
- This helps form the expectation of the upper limit of VMC's capabilities. To perform MRIs for another 1600 patients is achievable.
- However, to have a utilization of nearly 100% is unrealistic.
- Other scenario testing would need to be appropriately designed to have realistic outcomes.

SCENARIO 3: 2 MRIs 24 HOURS – 7 DAYS A WEEK



DESIGN MRI 2 (Radiology Inpatient) operating from 6AM to 11PM, Monday through Friday
MRI 1 & 3 (Brody Outpatient) operating 24 hours per day, 7 days a week

ASSUMPTION VMC operation with expected delays

RESULTS

INPATIENT VOLUME			OUTPATIENT VOLUME			OBS-PATIENT VOLUME			UTILIZATION (%)		
AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	MRI 1	MRI 2	MRI 3
7,007	6,989	7,029	3,279	3,168	3,393	722	671	793	31.40	90.54	34.05

NOTES

- The setup to have MRI 1 and 3, in the Brody Outpatient setting, to run 24 hours, 7 days week was determined based on best staffing configuration
- The increase in inpatient volume from the Current State model is 1,619.47, which equates to 4 -5 patients a day to **resolve the daily backlog**
- This design does show a major shift in the MRI’s utilization values
 - MRI 2 operating 17 hours a day, has a utilization of 90.54% - reduced hours concentrates utilization value
 - The expanded hours for MRI 1 and 3, the utilization reduces to 31.40% and 34.05% respectively
 - Reduced utilization indicates not enough inpatient volume
 - The extra hours create increased idle time for MRI 1 and 3

SCENARIO 4: ADJUSTED SCENARIO 3



DESIGN MRI 2 (Radiology Inpatient) operating 6AM - 11PM Monday to Friday & 24 hours on Saturday and Sunday
 MRI 1 & 3 (Brody Outpatient) operating 24 hours per day, Monday through Friday

ASSUMPTION VMC operation with expected delays

RESULTS

INPATIENT VOLUME			OUTPATIENT VOLUME			OBS-PATIENT VOLUME			UTILIZATION (%)		
AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	MRI 1	MRI 2	MRI 3
6,989	6,968	7,008	3,269	3,175	3,935	731	686	813	85.66	51.56	88.83

- NOTES**
- The inpatient volume increase is nearly the same as Scenario 3, **resolving daily backlog**
 - The utilization values for MRI 1 and 3 achieve top performing state of around 85%
 - MRI 2’s utilization makes adjustments to 51.56%. This could indicate the ability to do “just in time” MRI.

BEST DESIGN FOR MRI PERFORMANCE AND CAPACITY WITH EXISTING RESOURCES. ALLOWS MORE FLEXIBILITY FOR FUTURE DESIGN TO EXPAND OPERATIONS IN MRI SERVICES.

CHALLENGES IN QI PROCESS

Challenges:

- Data acquisition
- Data verification and validation

Solutions:

- Detailed process mapping of the operation to accurately correlate “verified” data points and using onsite observations for missing data
- Onsite observations – 24 hours a day for a month
- Cross referencing from multiple records to validate



- From the Project Team:
 - Translating “BIG DATA”, analytics, and modeling into information for clinical relevance
 - Communicating the information appropriately for all participants to understand and come together to drive change
- From the Stakeholders:
 - Ability for participants to use data to make informed decisions on clinical processes & in practical equipment and staffing needs
 - Determining real value-add to avoid high-cost situations



- VMC Leaders proposing plans on MRI operations
- Using modeling in other clinical areas
 - Imaging Modalities (VIR, CT, VS)
 - Clinical Operations
 - Nursing Units
- Sustainment efforts underway to develop scorecards and dashboards to track performance and key operational processes
 - Used to review status and progress
 - Help make plans for continuous improvement
 - Isolate root causes to address in a timely manner

QUESTIONS?

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