



SAFHE 2026

SOUTHERN AFRICAN
HEALTHCARE CONFERENCE

SYNERGY
IN ACTION:

SHAPING THE FUTURE OF
HEALTHCARE TOGETHER



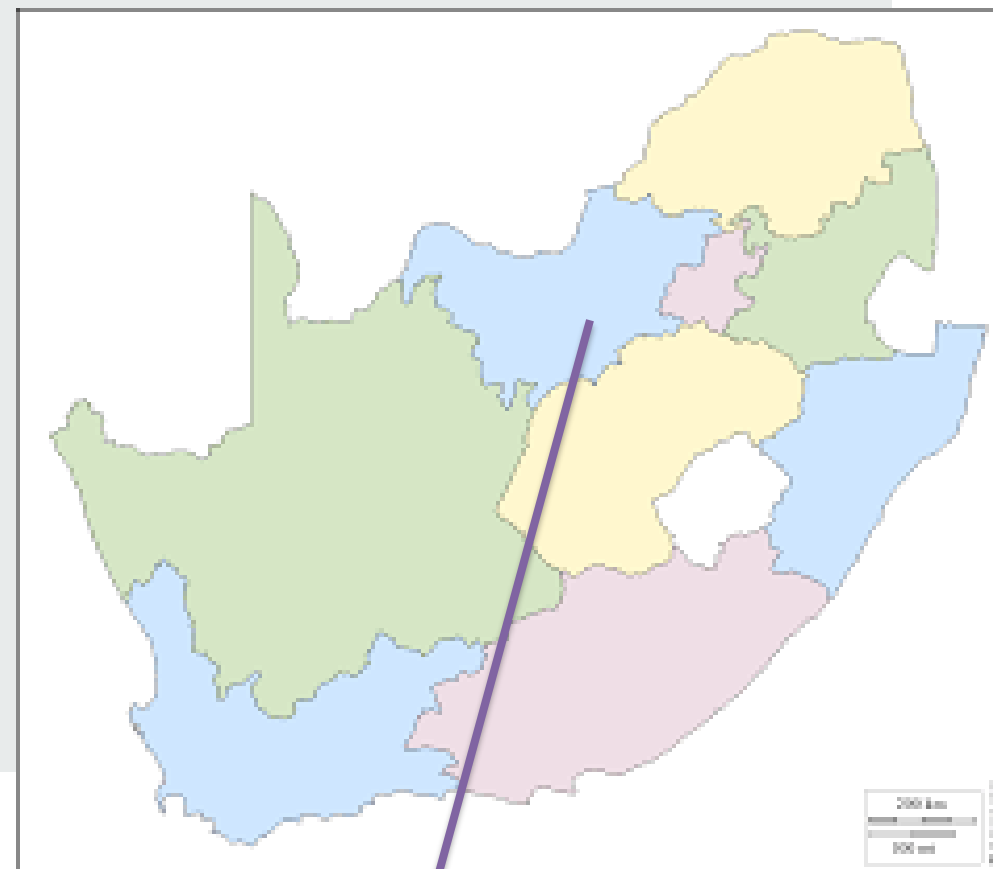
9 – 10 JUNE 2026



CTICC 2 CAPE TOWN

Efficiencies in Healthcare from a Systems Engineering Perspective

Dr. Maria van Zyl



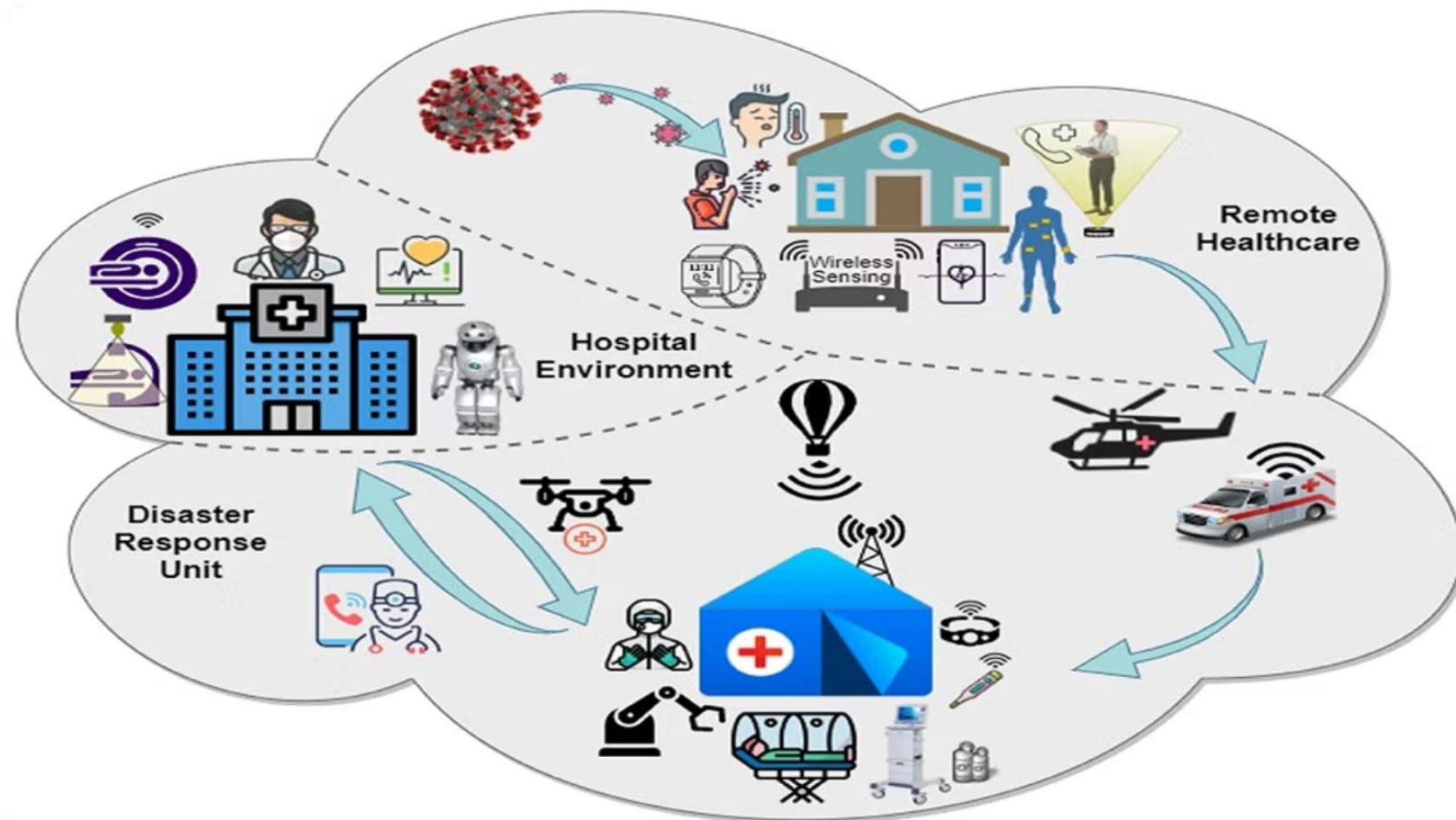
Dr. Maria van Zyl

Senior Lecturer

NWU School of Industrial Engineering

Head: Healthcare Systems Engineering Impact Initiative

Industrial Engineering Definition



"The engineering discipline that designs and improves systems to make organizations operate more effectively and efficiently."

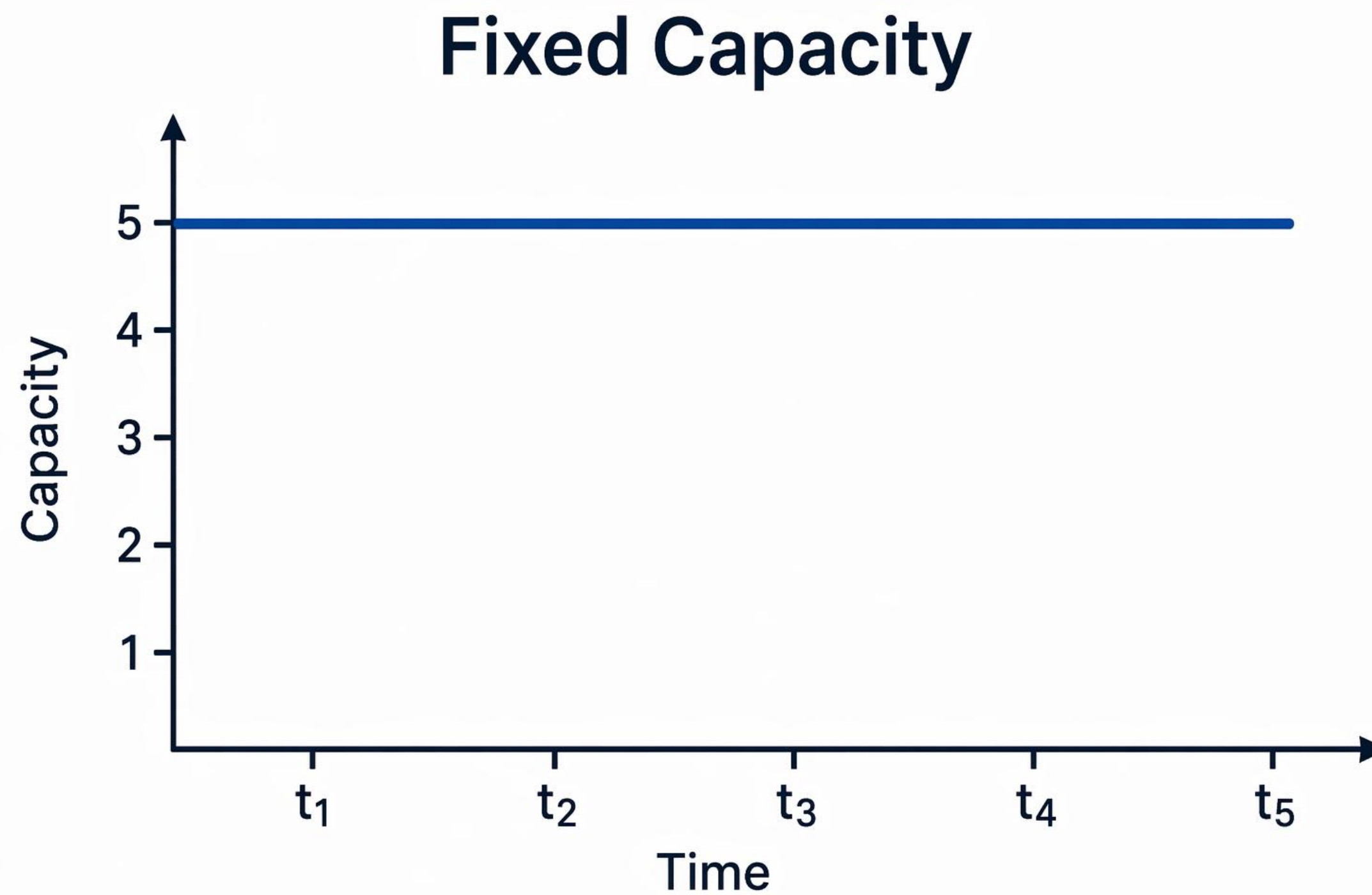
THE HOSPITAL DESIGN PROCESS



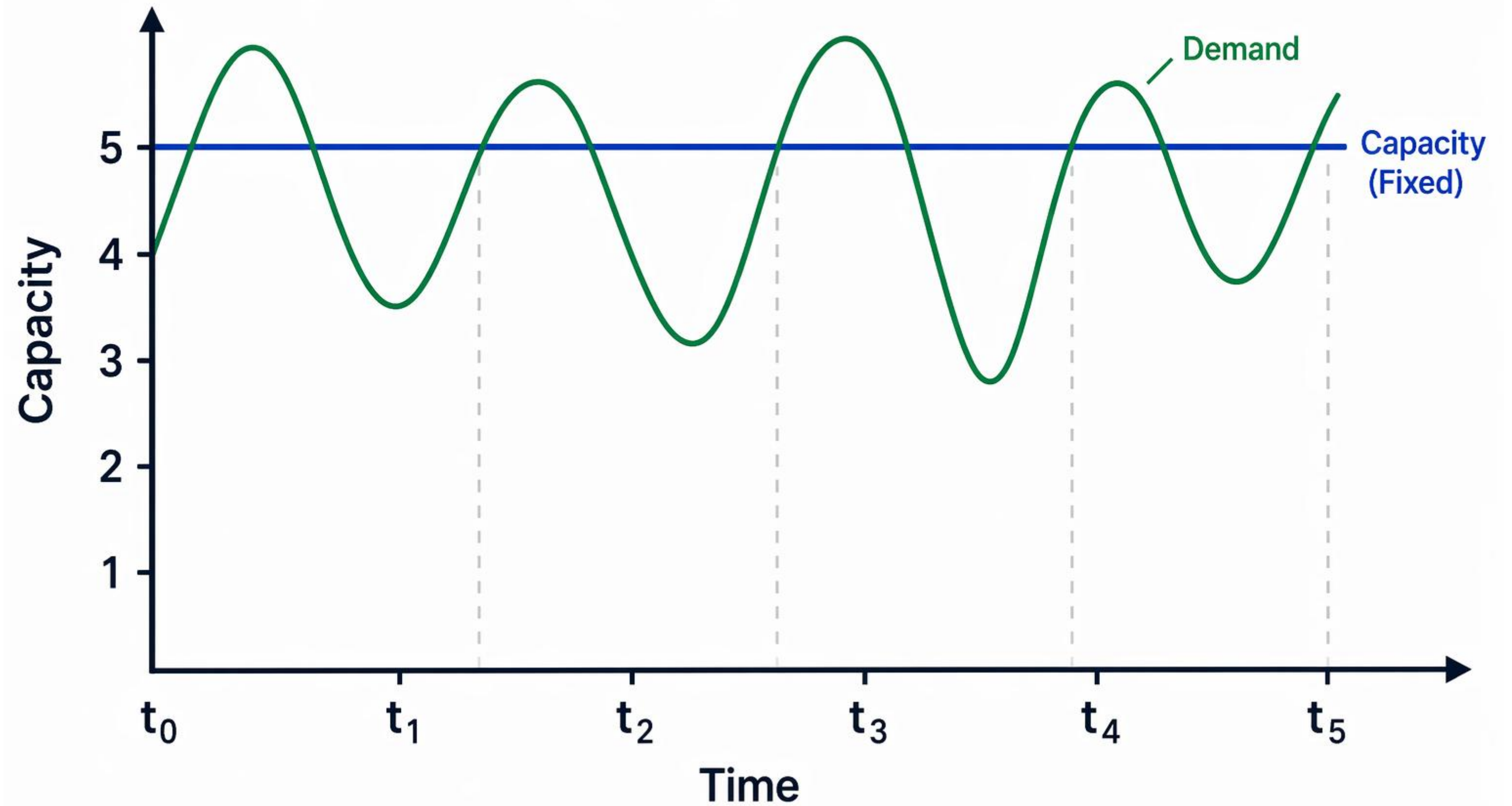
DECISIONS

- Goals & Values
- Capacity Needs
- Layout Design
- Patient Flow
- Clinical Spaces
- Tech Selection
- Balanced Decisions

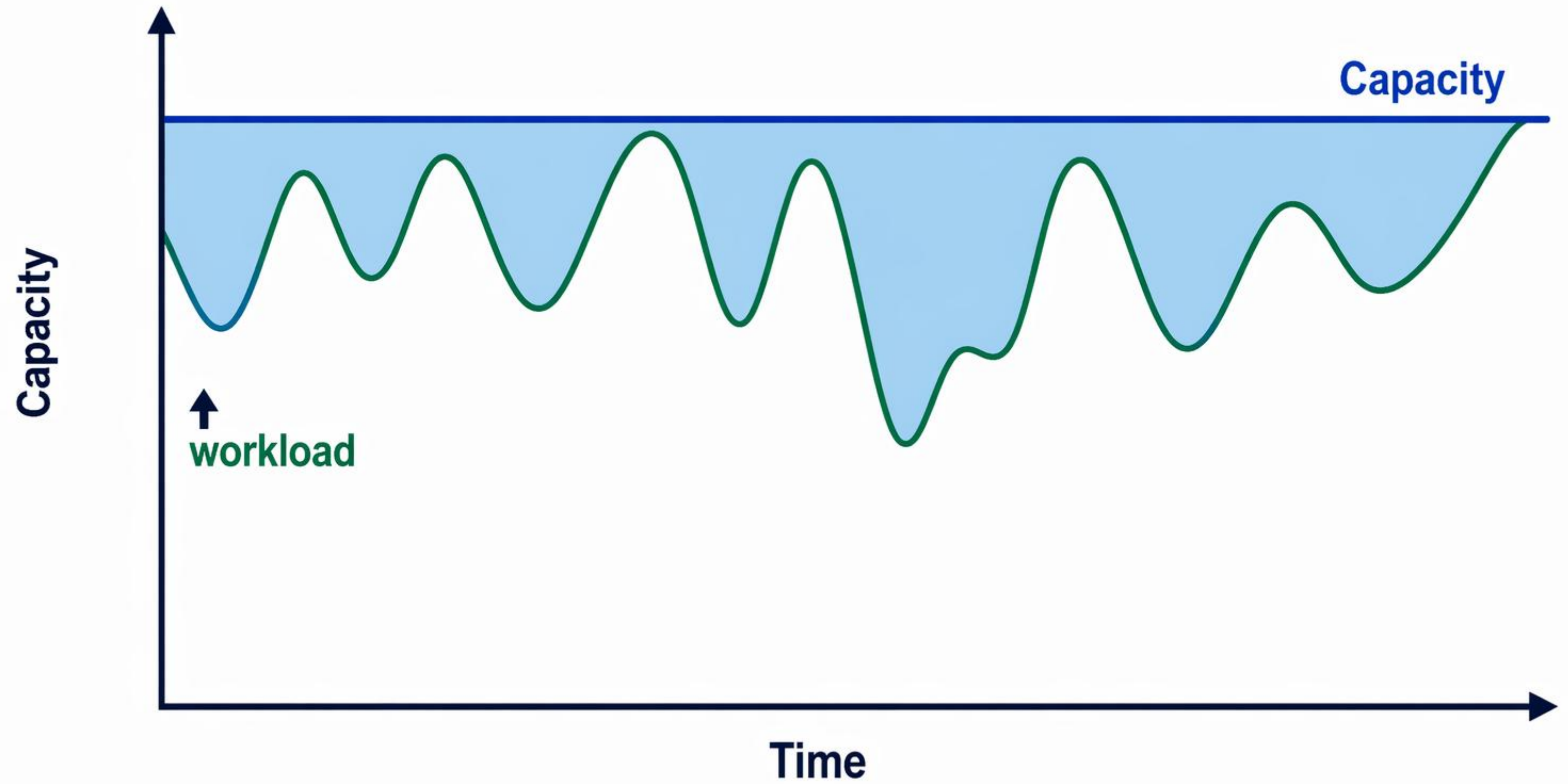
DESIGNING FOR CAPACITY



Fixed Capacity



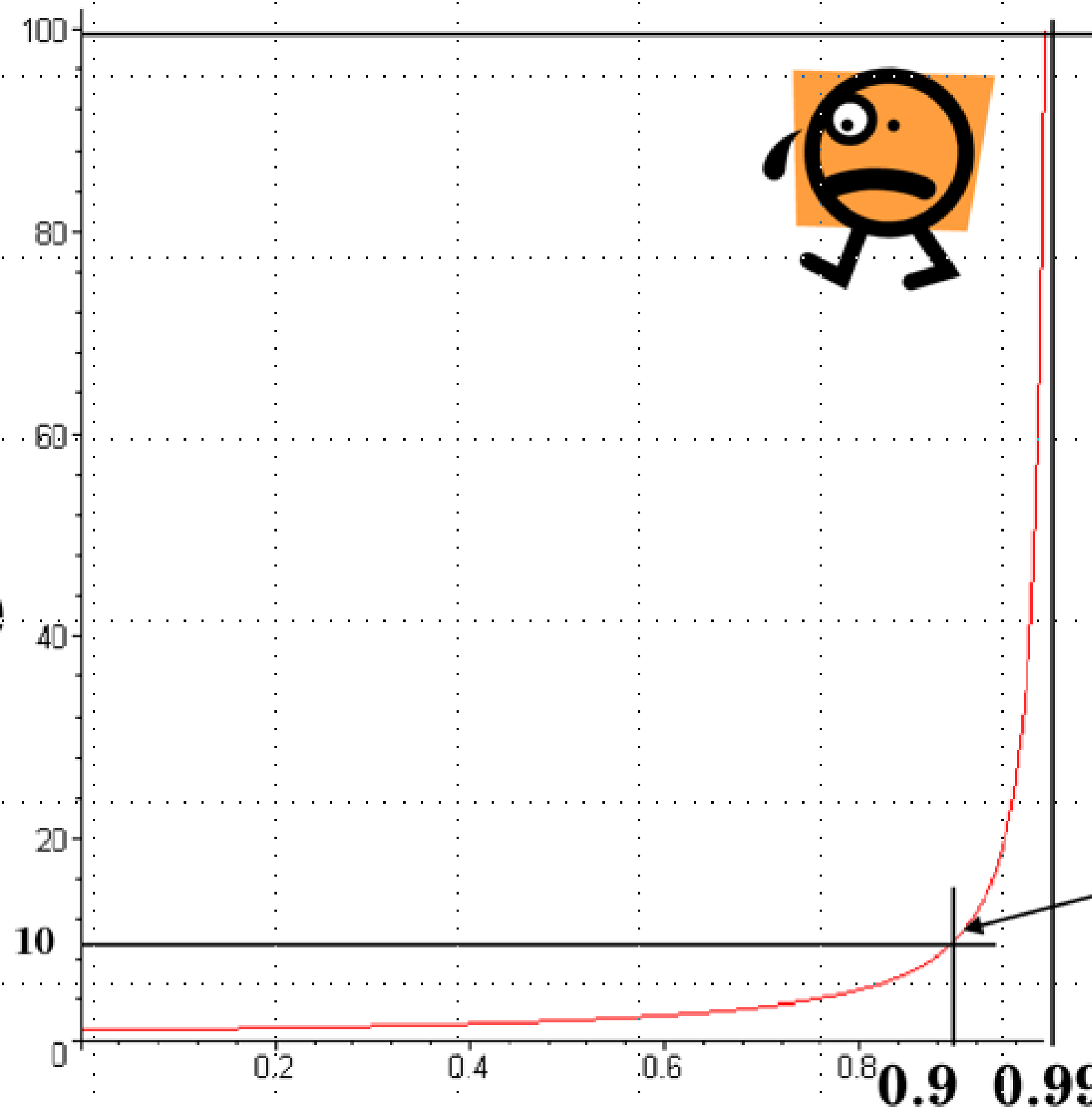
Management dogma: maximize utilization



DESIGNING FOR CAPACITY

Effect of variability in queues

↑
Waiting time



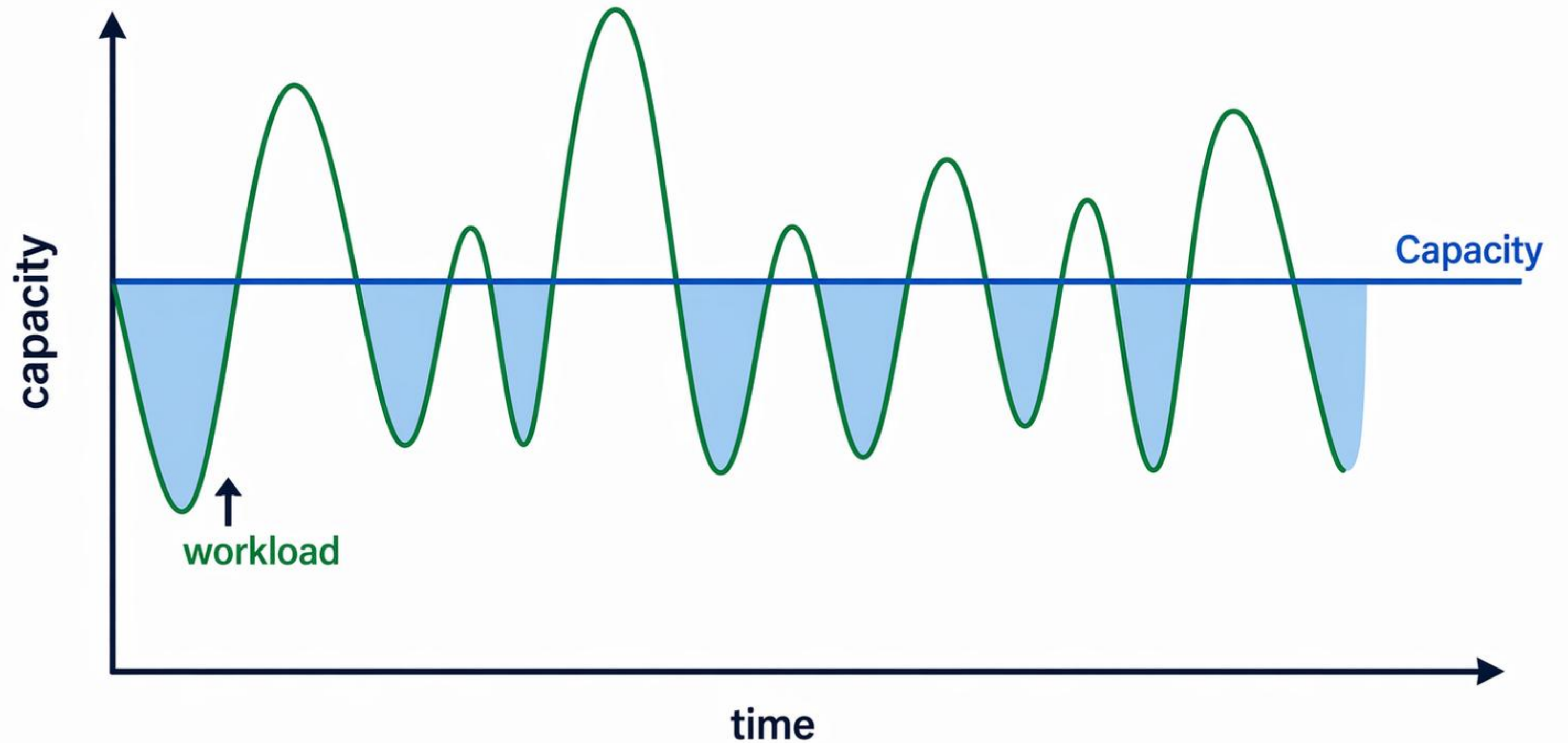
**Pollaczek-Khinchine
formula**

$$W = \frac{\rho + \lambda \mu \text{Var}(S)}{2(\mu - \lambda)} + \mu^{-1}$$

$$L = \rho + \frac{\rho^2 + \lambda^2 \text{Var}(S)}{2(1 - \rho)}$$

**Waiting time =
10 x service time**

Maximizing utilization leads to even more patient waiting & overtime



NETT EFFECT

NO SYSTEMS VIEW MEANS REQUIREMENTS ARE LOST IN TRANSLATION....

Designers

Design for demand requirements



Management

Maximize utilization



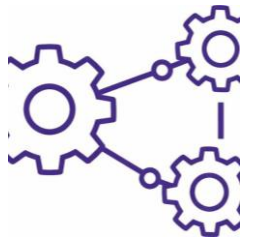
Patients

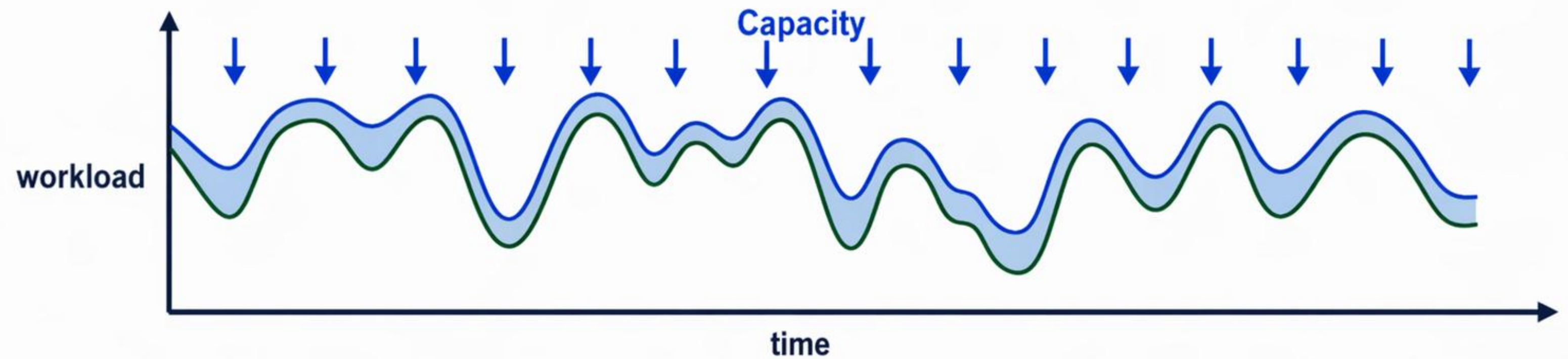
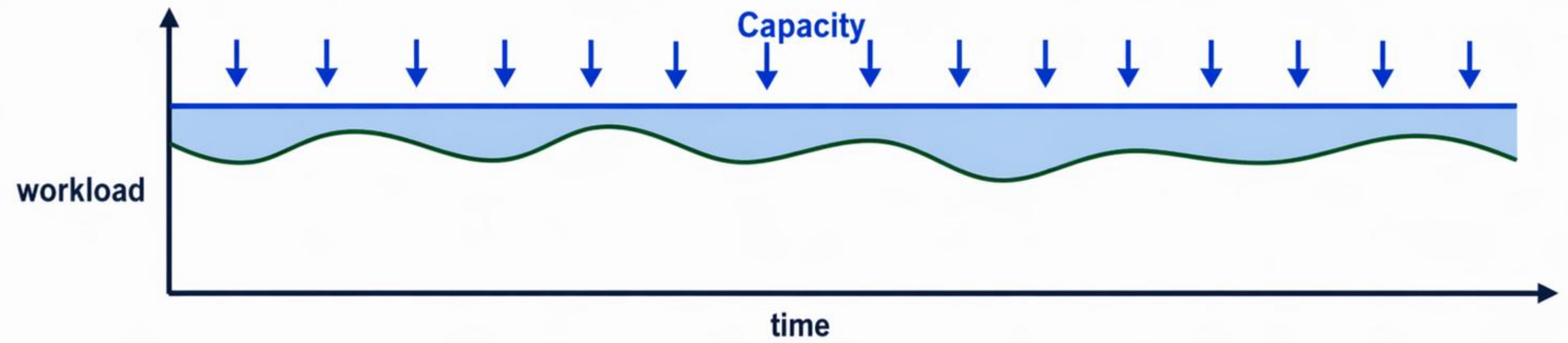
Don't want to wait



The System

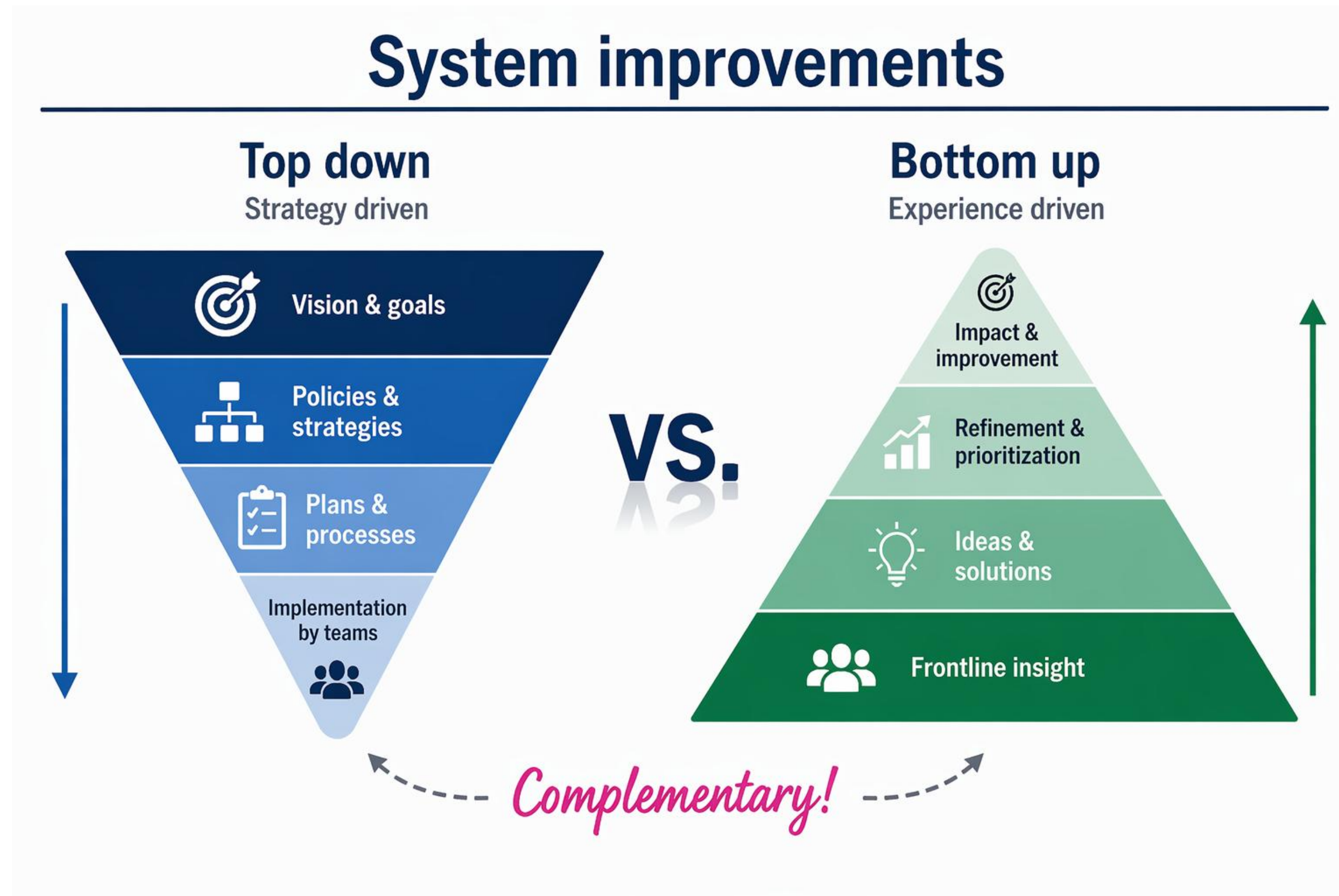
Reacts different than anticipated





- ✓ Higher utilization with less capacity
- ✓ *and* reduced overtime!
- ✓ More flow, so *also* reduced waiting!

HOW DO WE DO THIS?



Planning is variability management - THE SECRET IS IN THE SYSTEM
Create and cleverly use flexibility to deal with variability and variations

WHICH SYMPTOMS OF VARIABILITY IS MOST PROMINENT IN YOUR WORK ENVIRONMENT ?

Mentimeter

Which of the following symptoms of variability is most prominent in your work environment?

Not sure for which capacity to design for



Variability places strain on our technical capabilities



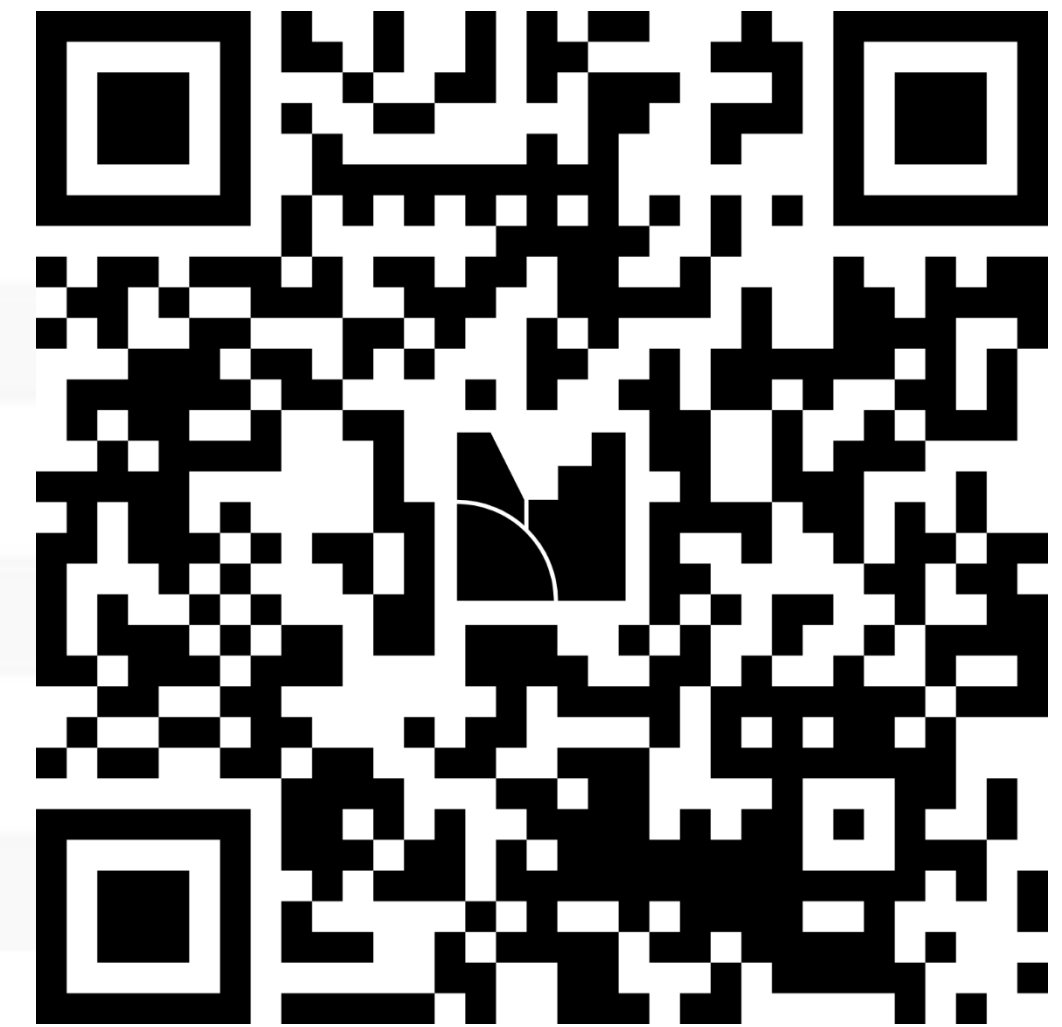
Higher utilization rates cause failure of hospital systems



Variability drives costs up since we can't plan

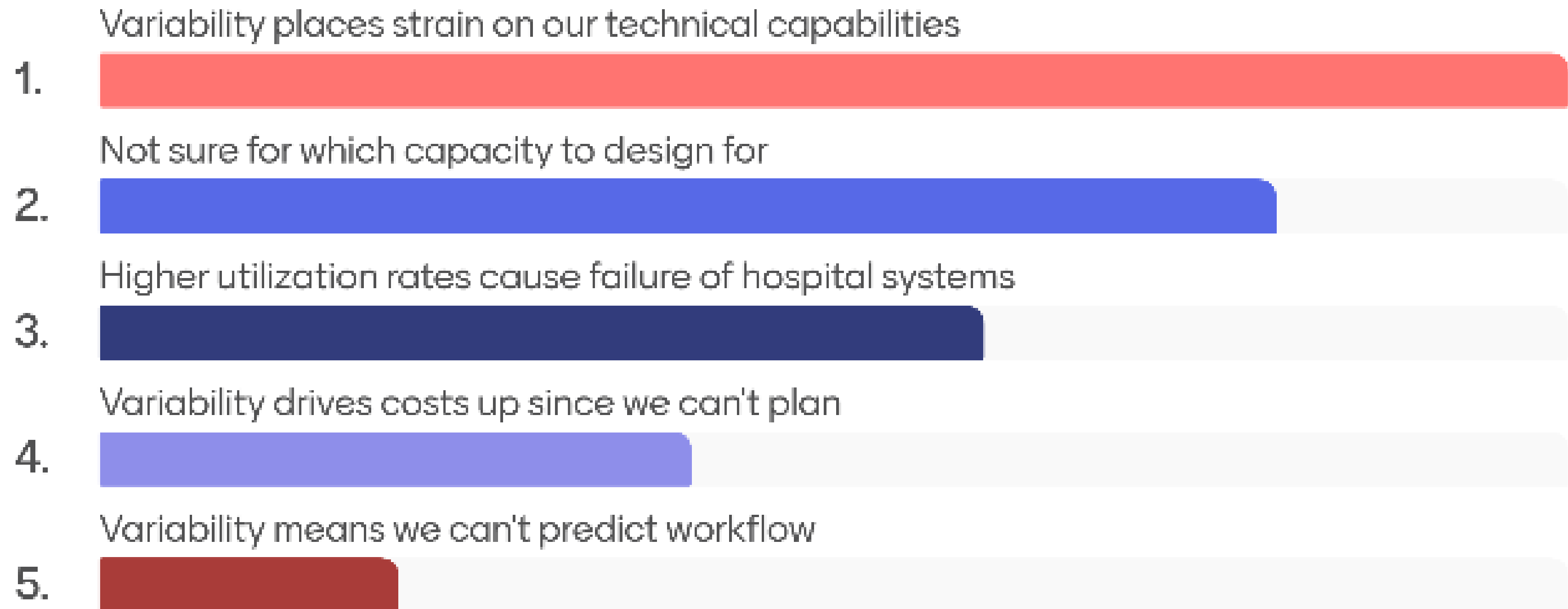


Variability means we can't predict workflow



WHICH SYMPTOMS OF VARIABILITY IS MOST PROMINENT IN YOUR WORK ENVIRONMENT ?

Which of the following symptoms of variability is most prominent in your work environment?



Case 1: Technical Work-Order System



South African Hospital

Flagship Facility
Historical Building

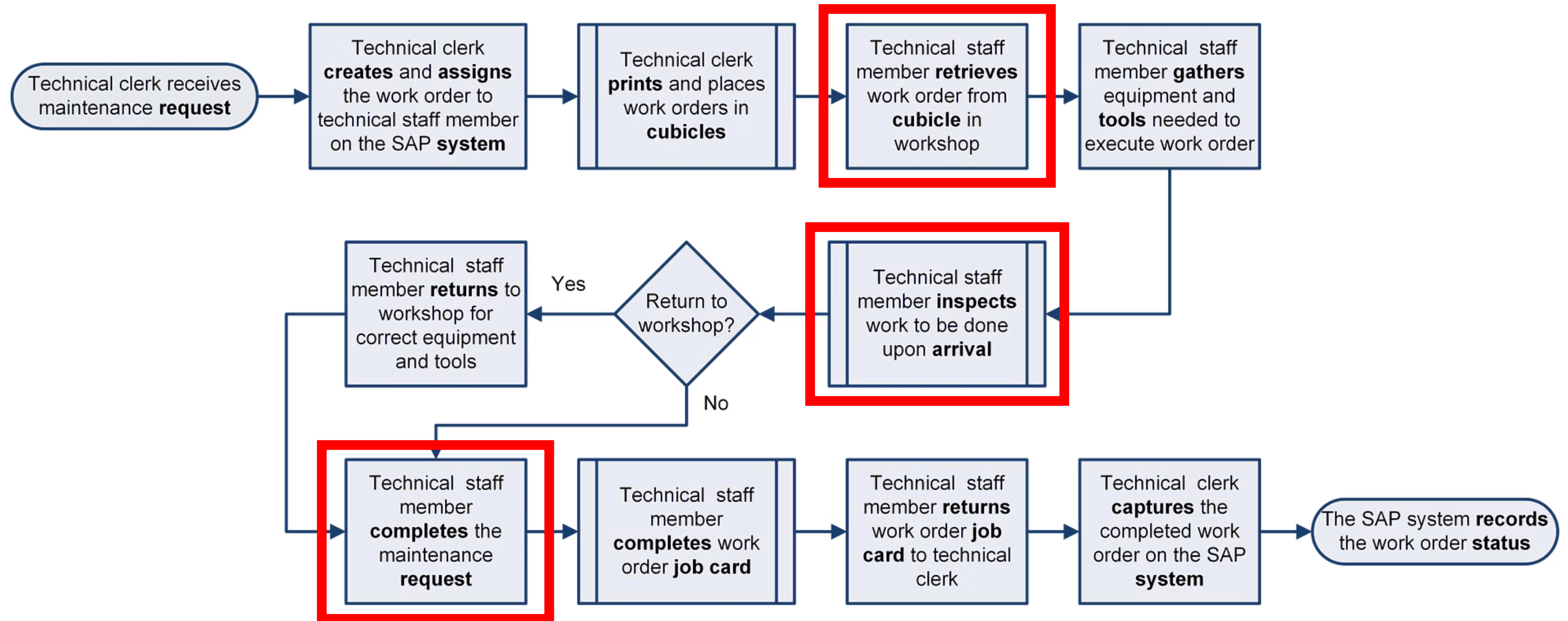
469 Beds

16 Operating Theatres

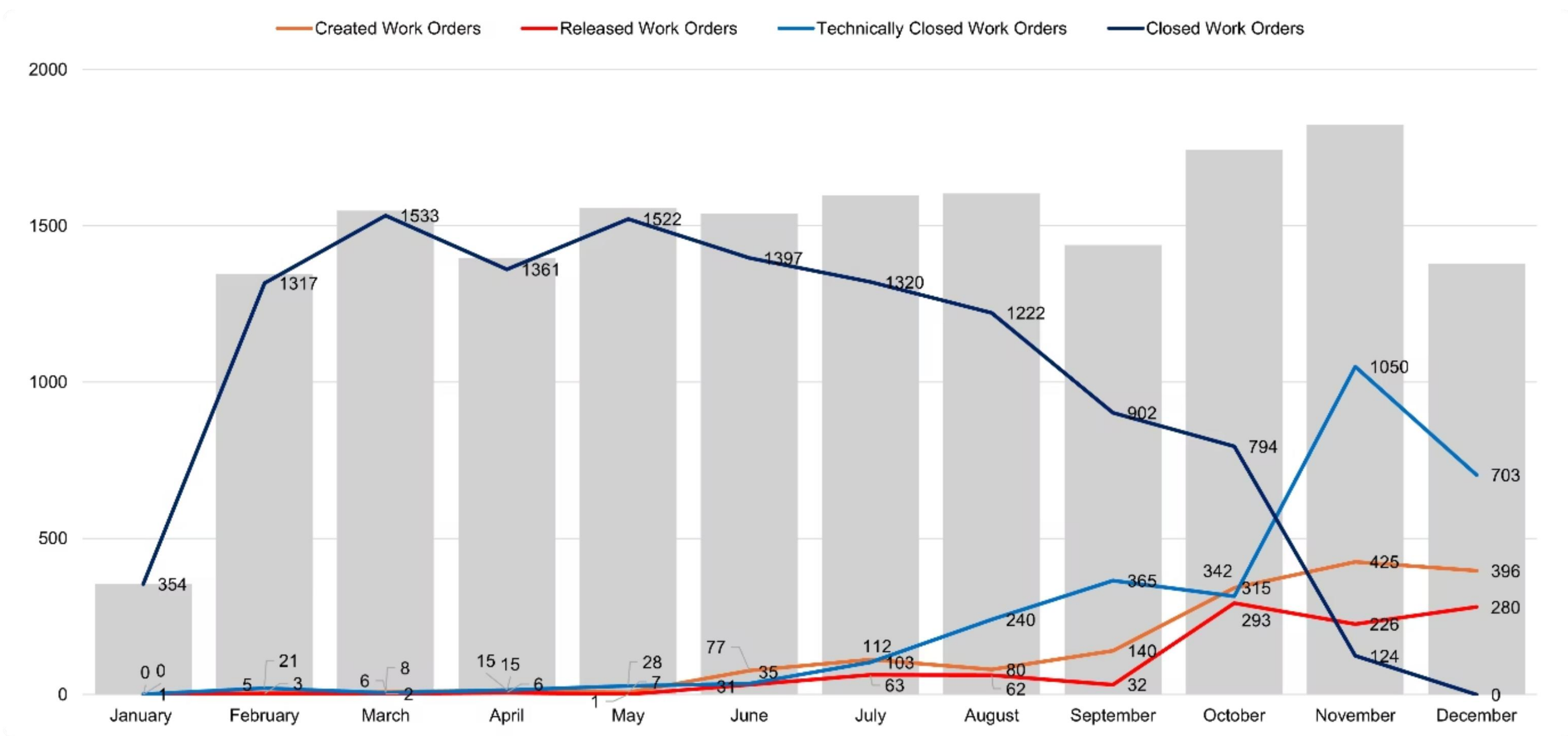
140 Practitioners

2 Cardiac Catheterisation Laboratories

Problem Background

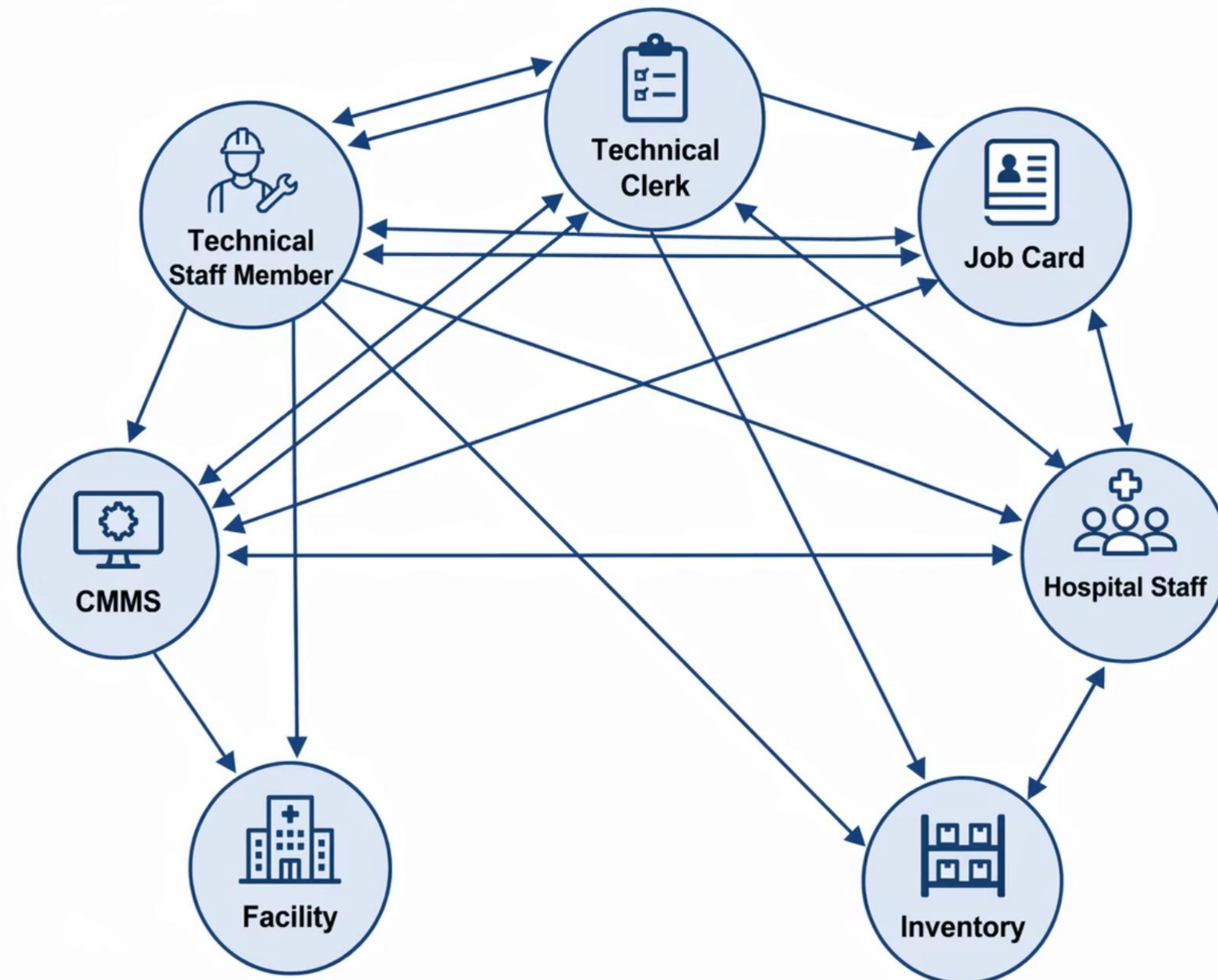


Work Order Process Compliance for 2023



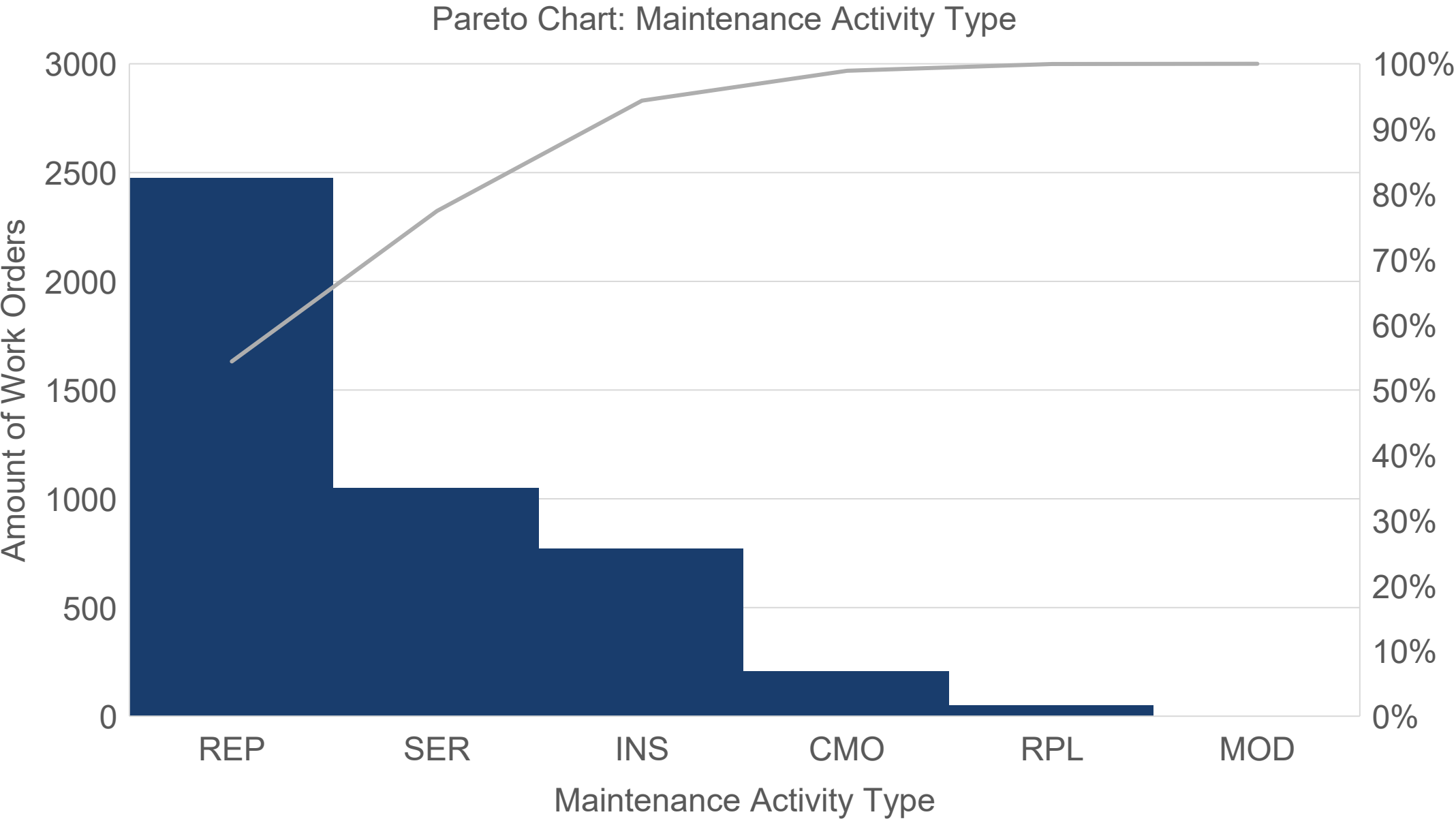
SYSTEMS VIEW

Understanding the hospital as an interconnected system of flows, resources, and processes



ROOT CAUSE ANALYSIS

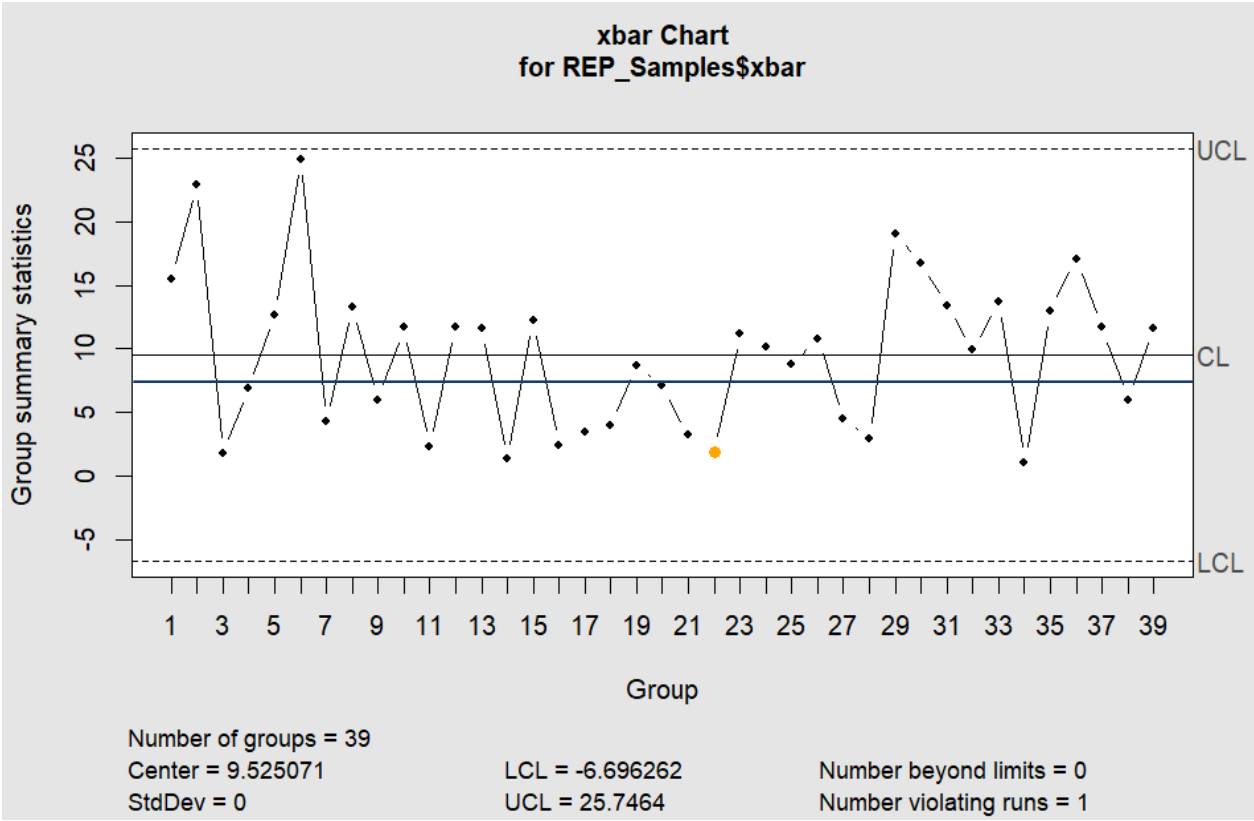
Pareto Chart



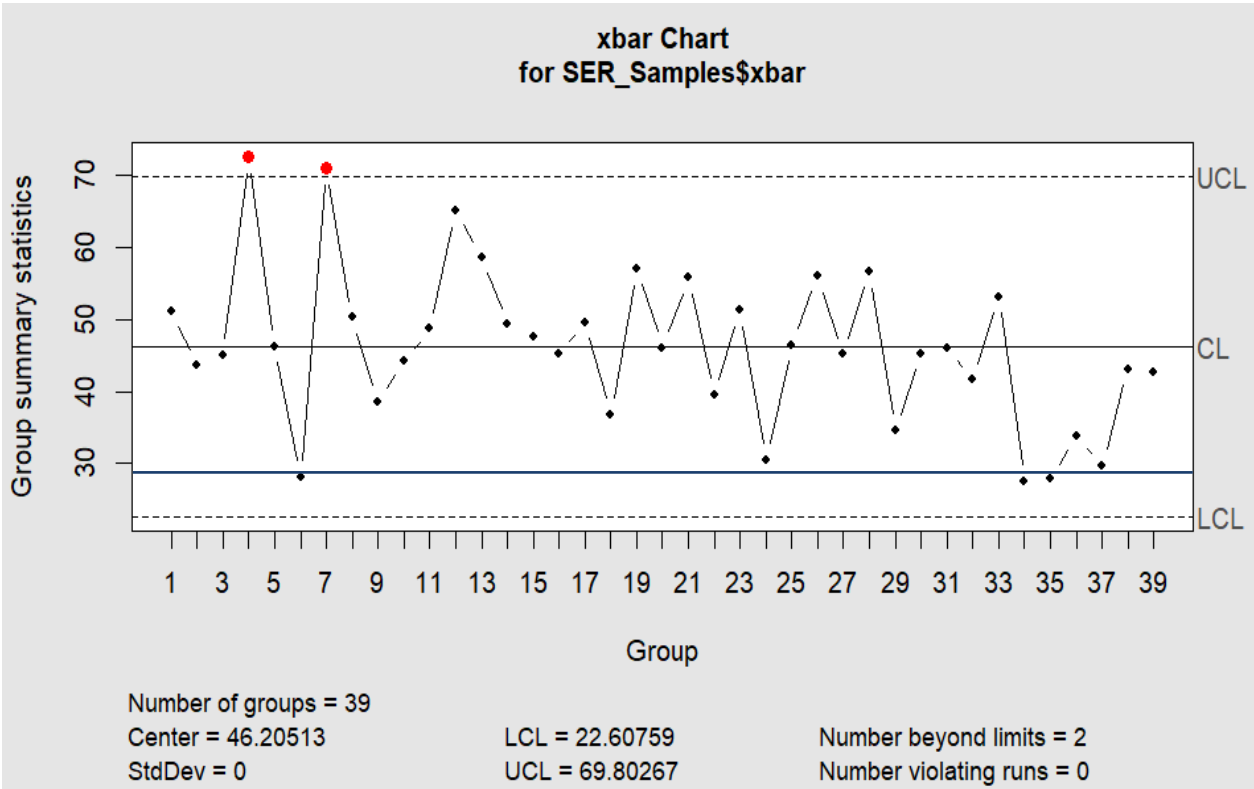
Repair

Service

Statistical Process Control



Control Limit:
7 days



Control Limit:
28 days

FINAL DESIGN

Flagging Mechanism

Repair

0 – 5

5 – 7

7+



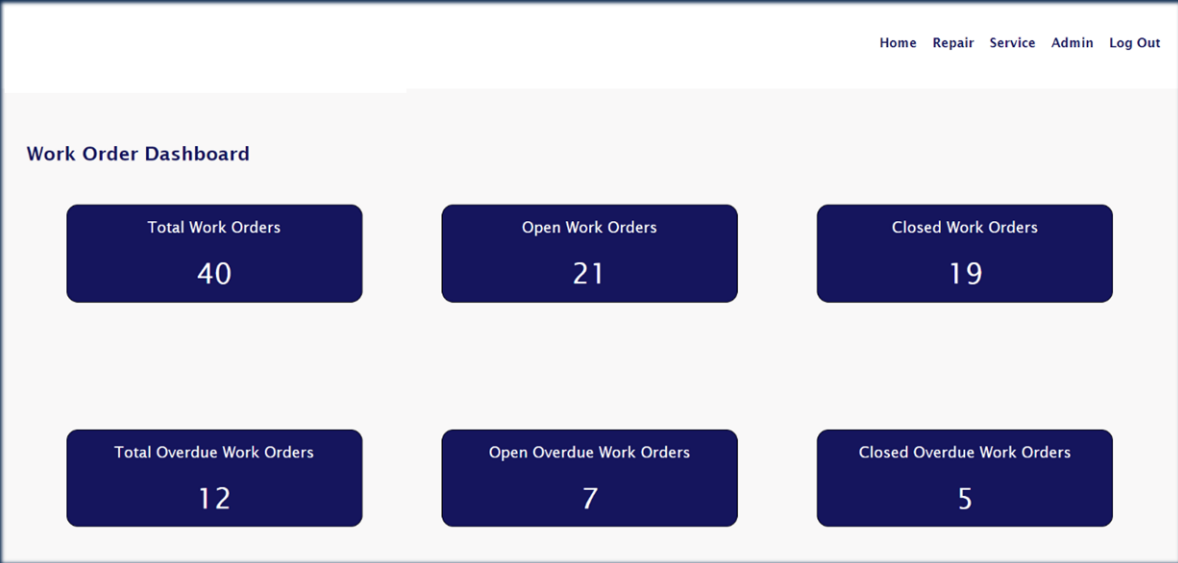
Service

0 – 26

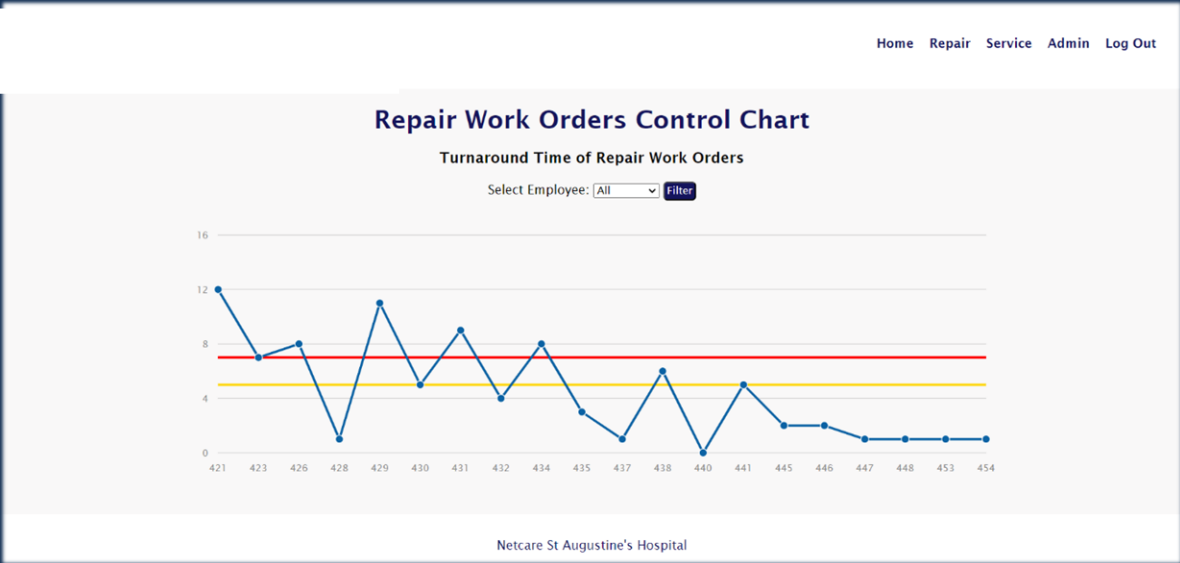
26 – 28

28+

Dashboard



Control Charts



Case 2: Lean Management



Duke Health – 4 hospitals and medical schools

Duke Regional Hospital, Durham, North Carolina, USA

Team members

2,776

Lab tests/year

1.3 million

Surgeries/year

25,529

ED visits/year

59,330

ED visits/day (avg)

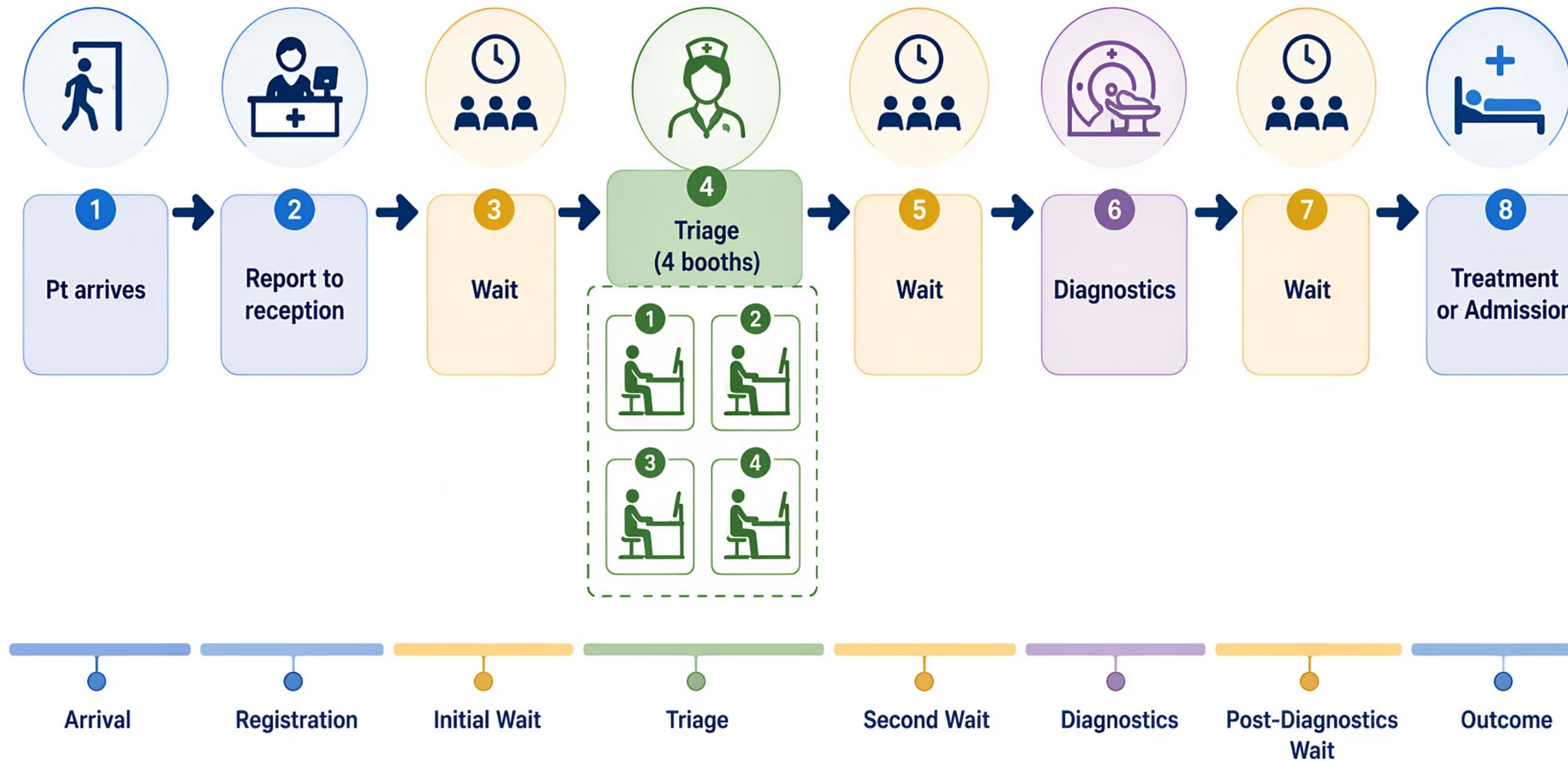
162

Challenges in the ED: High volume, long waiting times, nurse shortages, aggravated patients (workforce safety)
Left without being seen rate = >20%

DUKE REGIONAL HOSPITAL – ED LAYOUT



Patient Journey – Emergency Department



Initial Process

DUKE REGIONAL HOSPITAL – HOW TO IMPROVE?

Lean Implementation

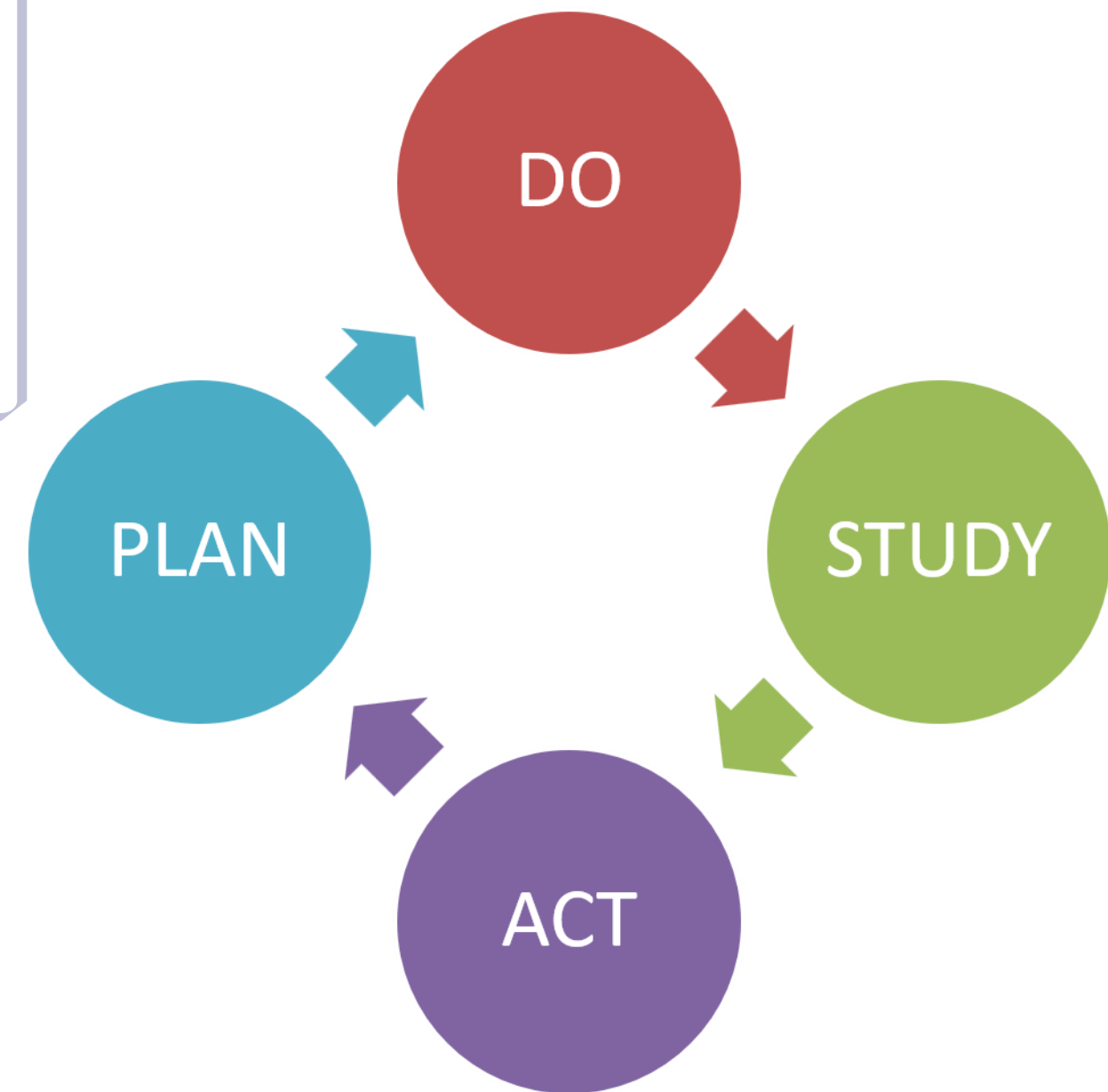
"What activities create value for the customer (or patient), and how can we eliminate everything that does not?"

Initial Process

Pt arrives → Report to reception → Wait → Triage (4 booths) →
Wait → Diagnostics → Treatment or Admission

What if the process could change?

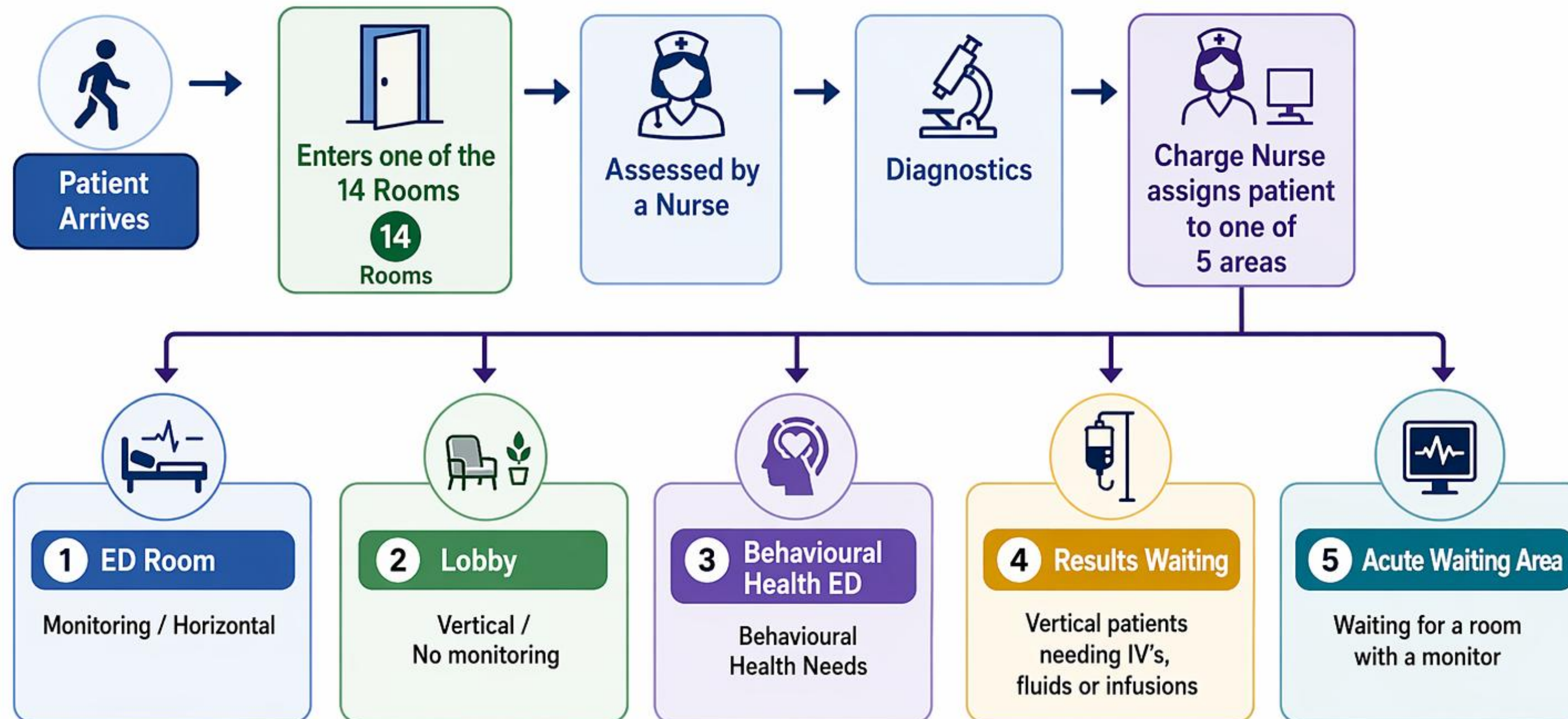
Lean Training — Simulated Game



DUKE REGIONAL HOSPITAL – ED LAYOUT

Redesigned Patient Flow

No waiting in reception

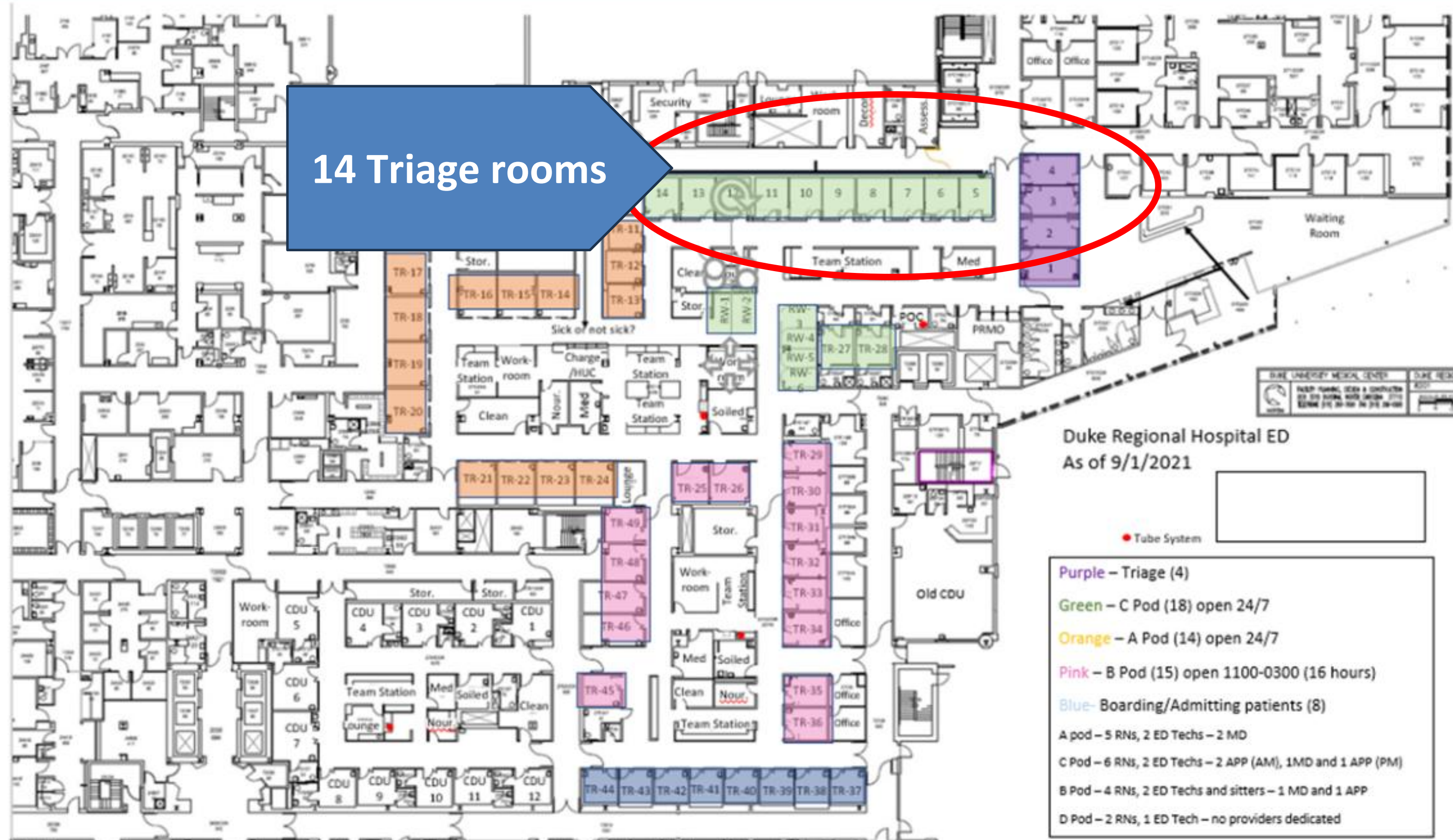


GOAL: Time spent in rooms
< 25 minutes

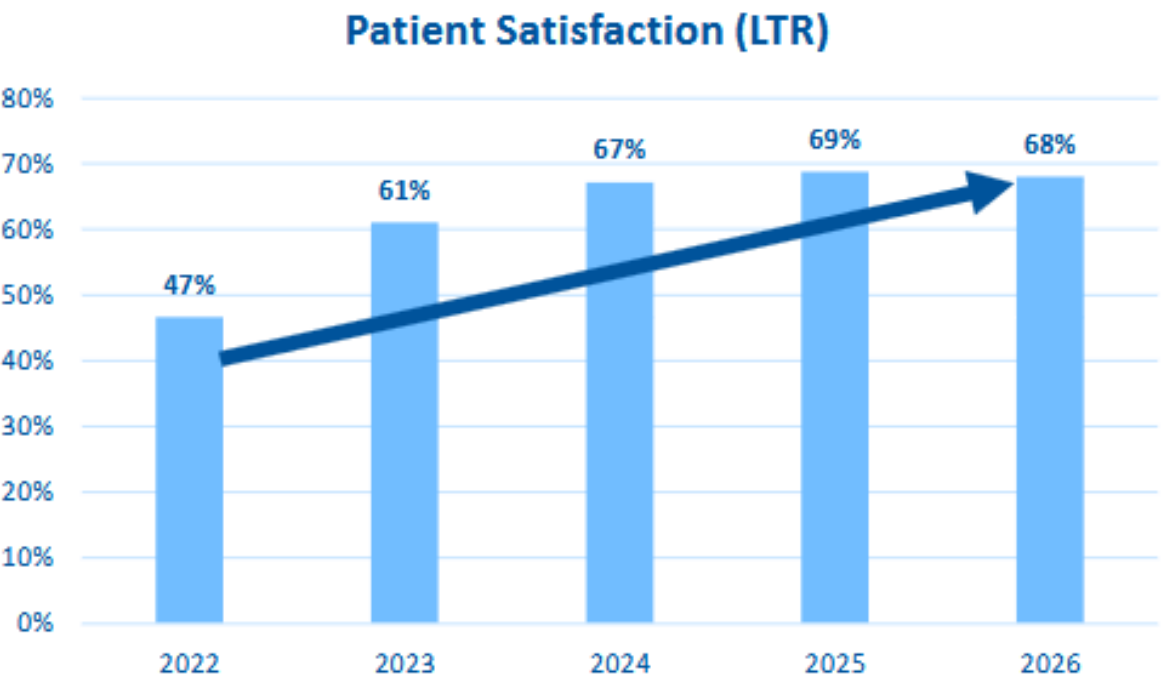
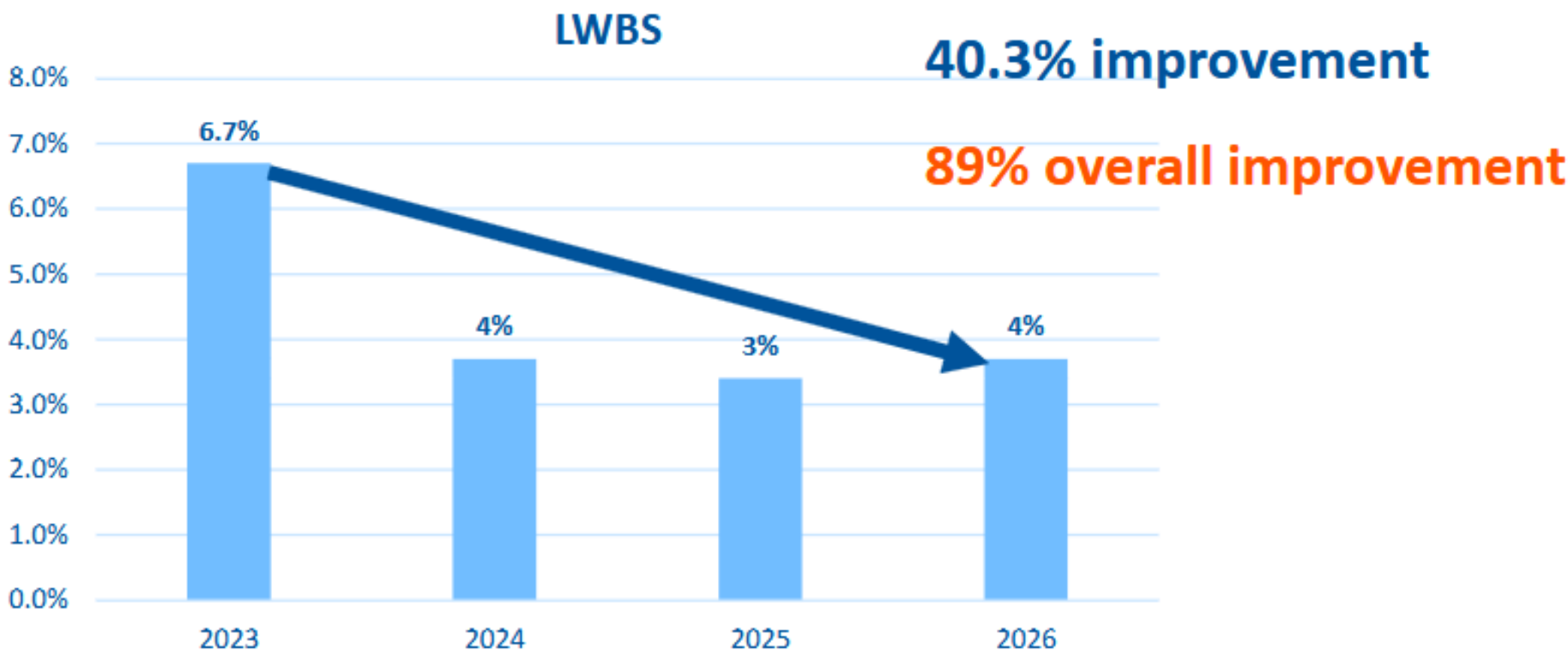
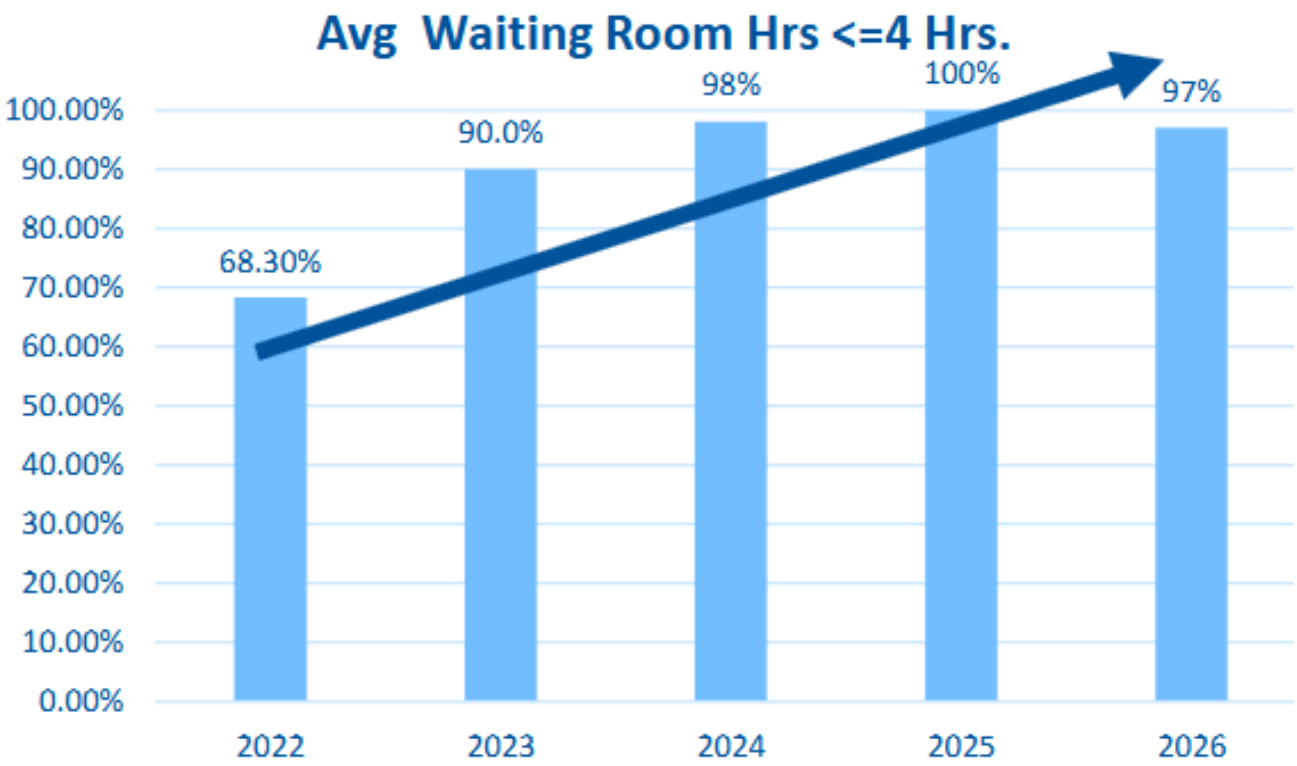


Patients pulled from the 5 areas first by
ESI level (2, 3, 4, 5) then by waiting time

DUKE REGIONAL HOSPITAL – ED LAYOUT



DUKE REGIONAL HOSPITAL RESULTS





ARE WE DESIGNING HEALTHCARE FACILITIES FOR THIS FLEXIBILITY? THE SECRET IS THE SYSTEM

Case 3 – Systems Engineering: Johns Hopkins Hospital



Location

Baltimore, USA



Size

~1,100 beds



Staff

10,000+



Type

Teaching hospital



Status

Global leader



Hospital Flow Problem

Patient Flow Bottlenecks

Patient flow bottlenecks delay care

ED & OR Delays

ED boarding and OR delays common — impacts safety, outcomes, and satisfaction

Insufficient Methods

Traditional improvement methods insufficient

Systems Engineering Approach



Inspired by Command Centres

Inspired by command centres in other industries to proactively manage flow across hospital



Focus Areas

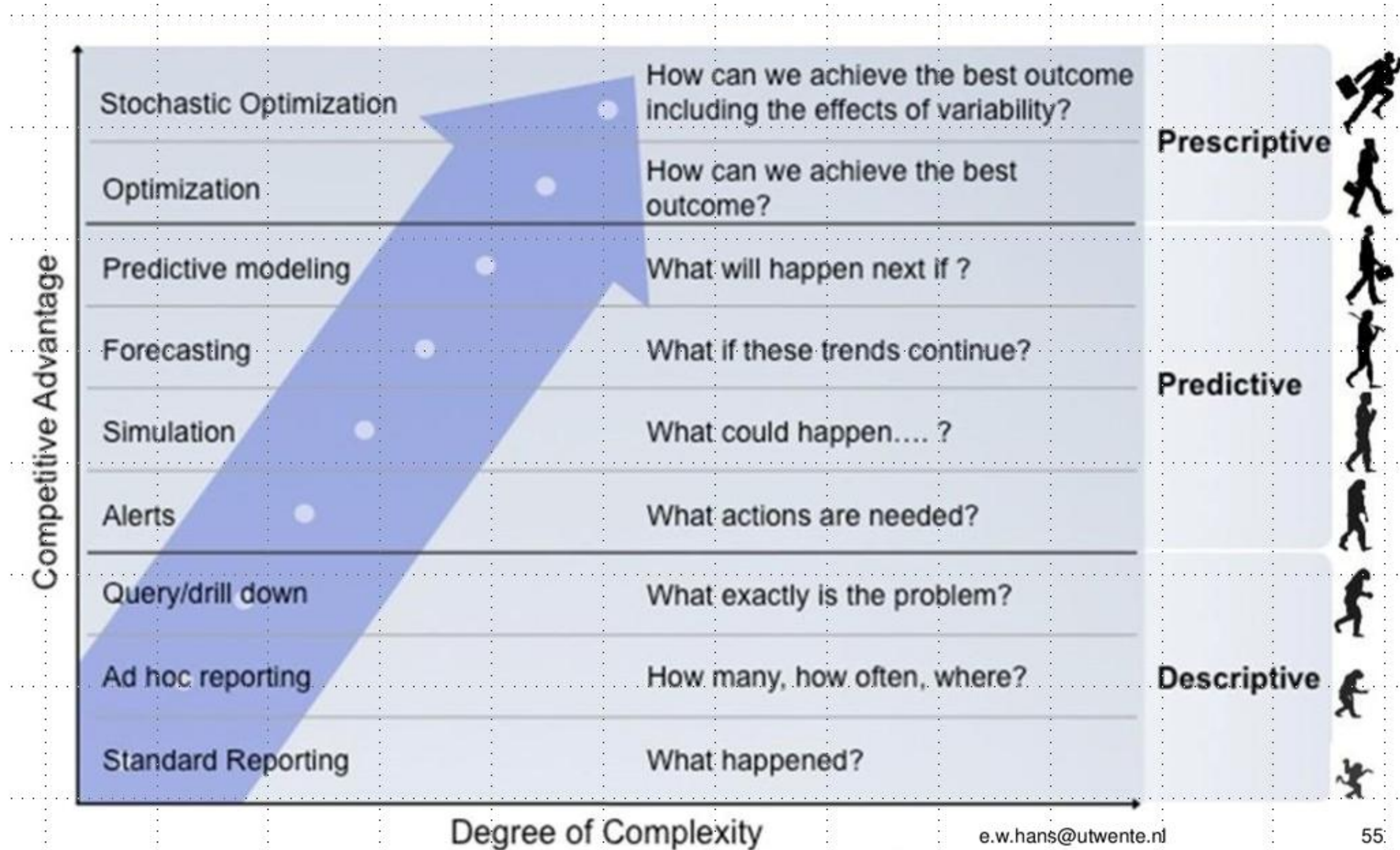
Focus on ED, OR, and transfers — shift from reactive to proactive management

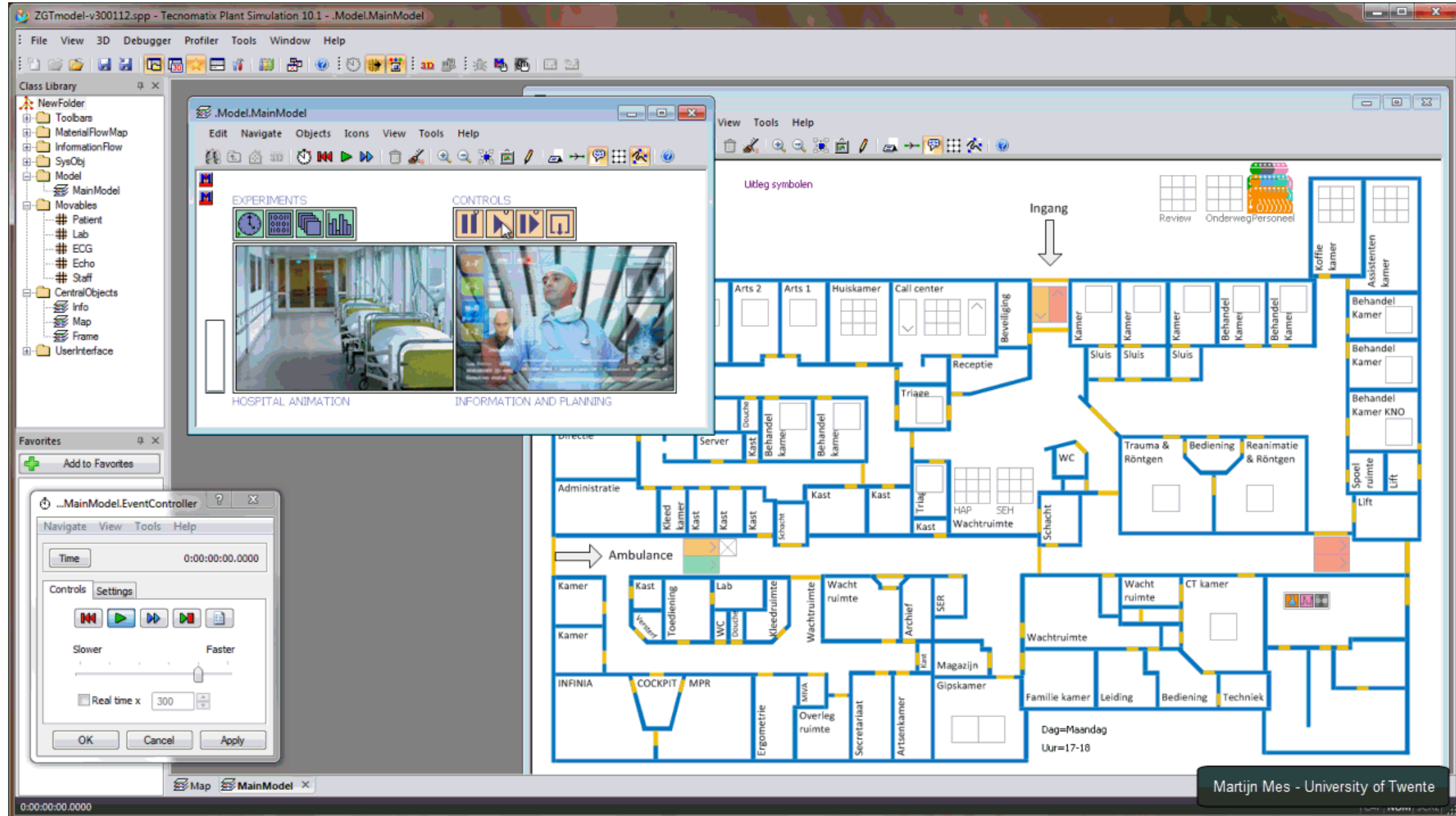


Tools: Data Analytics

Managing the system through data analytics

THE EVOLUTION OF ANALYTICS





How It Works



Co-located Teams

Co-located teams improve coordination

Real-Time Dashboards

Real-time data dashboards for visibility

Predictive Analytics

Predictive analytics anticipate demand

Standard Rules

Standard rules guide decisions and actions

How It Works — Detail

Co-located Teams

Co-located teams improve coordination

Real-Time Dashboards

Real-time data dashboards for visibility

Predictive Analytics

Predictive analytics anticipate demand. In brainstorming potential solutions to our capacity challenges, teams considered a wide variety of options (fully staffed ICUs, additional monitored beds, timely hospital discharge, implementation of an extended stay unit, the creation of a pediatric observation unit, decreasing PACU length of stay, and many others). **Simulation modeling was used to predict the impact of each.**

Standard Rules and SOPs

Standard rules guide decisions and actions. For example: SOPs that govern perioperative flow describe actions when a patient in the PACU is not cleared within 90 minutes — a red triangle that appears on the procedural tile triggers the PACU charge nurse to conference with the bedside nurse and contact the anesthesiologist, who clears the patient if appropriate. **Target time frames are included in the SOP.**

ANALYTICS

Bed Summary												
Functional Unit	Census	Occ	Unoccupied				Unassign Reqs	Transfer/Discharge			Blocked	
			Clean	+ Dirty	- Pre/Assign	= Avail		Pend	Potl	▲ ⓘ		
Med	240	93%	13	6	4	15	55	18	15	-7	5	>
Surg	185	80%	41	5	10	36	17	7	22	+48	20	>
Neuro	62	72%	22	2	3	21	7	8	6	+28	2	>
Onc	72	87%	11	0	5	6	0	2	3	+11	0	>
Gyn/OB	6	50%	6	0	0	6	3	0	0	+3	0	>
Peds	157	79%	38	3	7	34	1	8	8	+49	7	>
Psych	68	89%	8	0	0	8	4	2	0	+6	12	>
Rehab	16	89%	2	0	0	2	1	0	0	+1	0	>

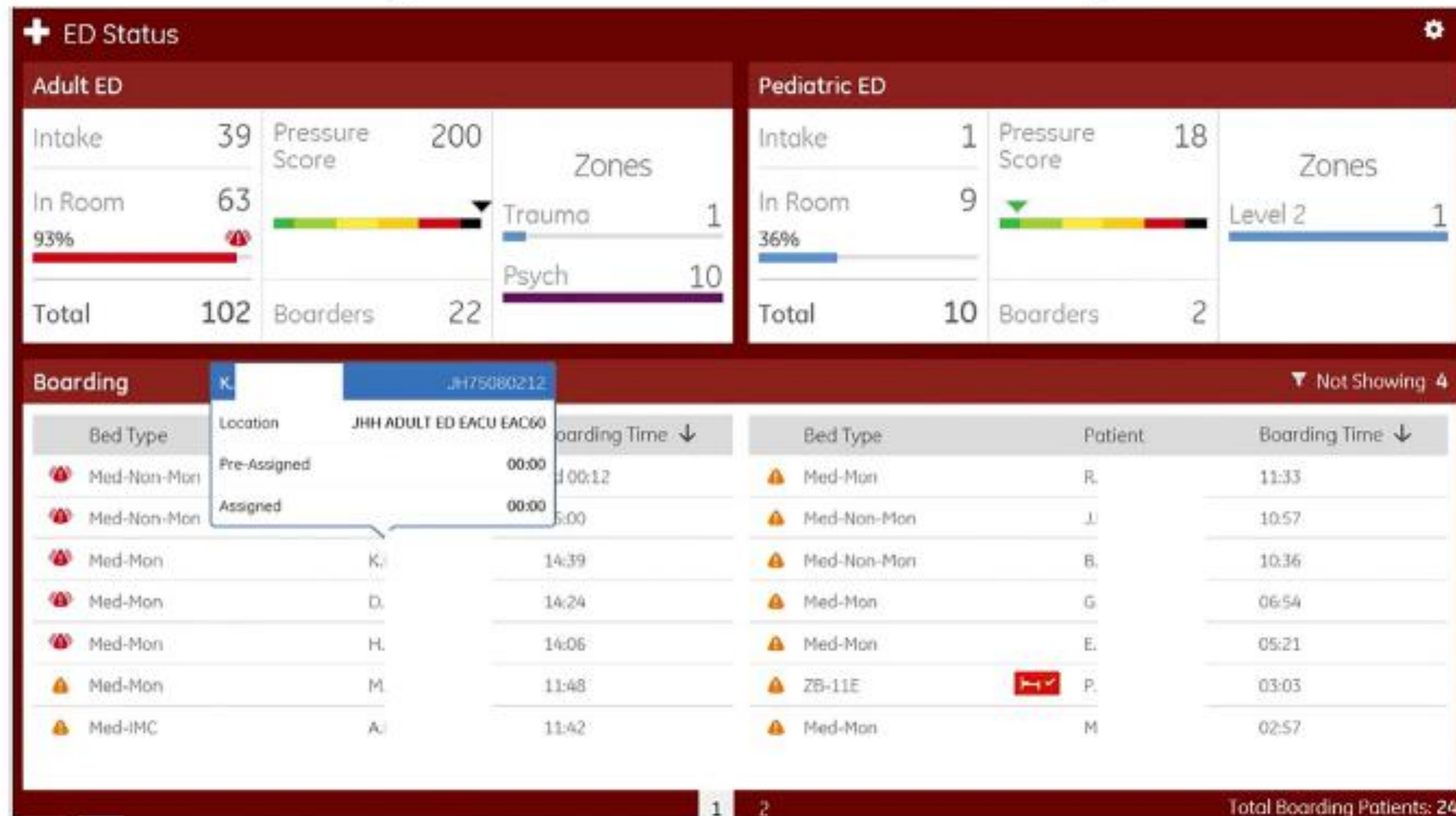
Bed status per day

Forecast - Occupancy		24 HRS 48 HRS		Last Forecast: Jul 10 2018 16:00 Simulated at: 15:58											
	Occ	Capacity	Tue 10 17:00	Tue 10 20:00	Tue 10 23:00	Wed 11 02:00	Wed 11 05:00	Wed 11 08:00	Wed 11 11:00	Wed 11 14:00					
Med	93%	256	92%	88%	89%	91%	93%	94%	95%	94%					
Surg	80%	242	79%	80%	81%	82%	82%	82%	82%	82%					
Neuro	72%	85	74%	76%	76%	78%	79%	80%	81%	80%					
Onc	87%	83	84%	84%	84%	87%	88%	88%	88%	87%					
Gyn/OB	50%	12	67%	75%	92%	100%	100%	100%	100%	92%					
Peds	79%	201	78%	79%	79%	80%	82%	82%	82%	79%					
Psych	89%	78	88%	88%	88%	88%	88%	88%	88%	88%					
Rehab	89%	18	89%	94%	94%	94%	94%	94%	94%	94%					

Bed status per hour

WALL OF ANALYTICS

Sample Tiles on the Wall of Analytics



RESULTS



13–15

Equivalent Additional Beds

Capacity optimization efforts added the equivalent capacity of 13 to 15 additional beds

92%

Occupancy Rate

Flagship hospital increased from 85% to 92% occupancy while decreasing patient delays

6.3h

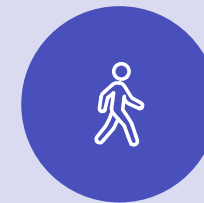
ED Boarding Time

ED boarding at 92% occupancy reduced from 9.7 hours to 6.3 hours

CONCLUSION



Collaboration leads to impact



Walk the process together



Empower through knowledge

Lean training, consulting, publishing



The secret is in the system



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Thank you Q&A

Please connect!



Maria Van Zyl

Industrial Engineer | Healthcare Systems
Engineering Researcher | Healthcare S...

