Gies Business

BADM 567: Process Management

Module 6: Process Improvement Projects in Continuous Improvement Programs

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Today's Session

- Six Sigma
  - Understand the metric – Why "6", why "Sigma"?
    - Defects Per Million Opportunities (DPMO) calculation
    - Process capability analysis (Cp and Cpk)
      - Underlying idea and implications
  - Discuss the Academic Medical Hospital case
    - Analyze the organizational initiative
    - Evaluate the project execution framework

Poll #1– Choose One Option

Which company introduced “Six Sigma”?

- Toyota
- GE
- Motorola
- Ford

Poll #2– Choose One Option

What does the Greek symbol σ mean in statistics?

- Summation
- Variance
- Standard Deviation
- Correlation

Poll #3 – Choose One Option

If the data follows a Normal distribution, there is approximately ___ chance that a value will be within three standard deviations of the mean.

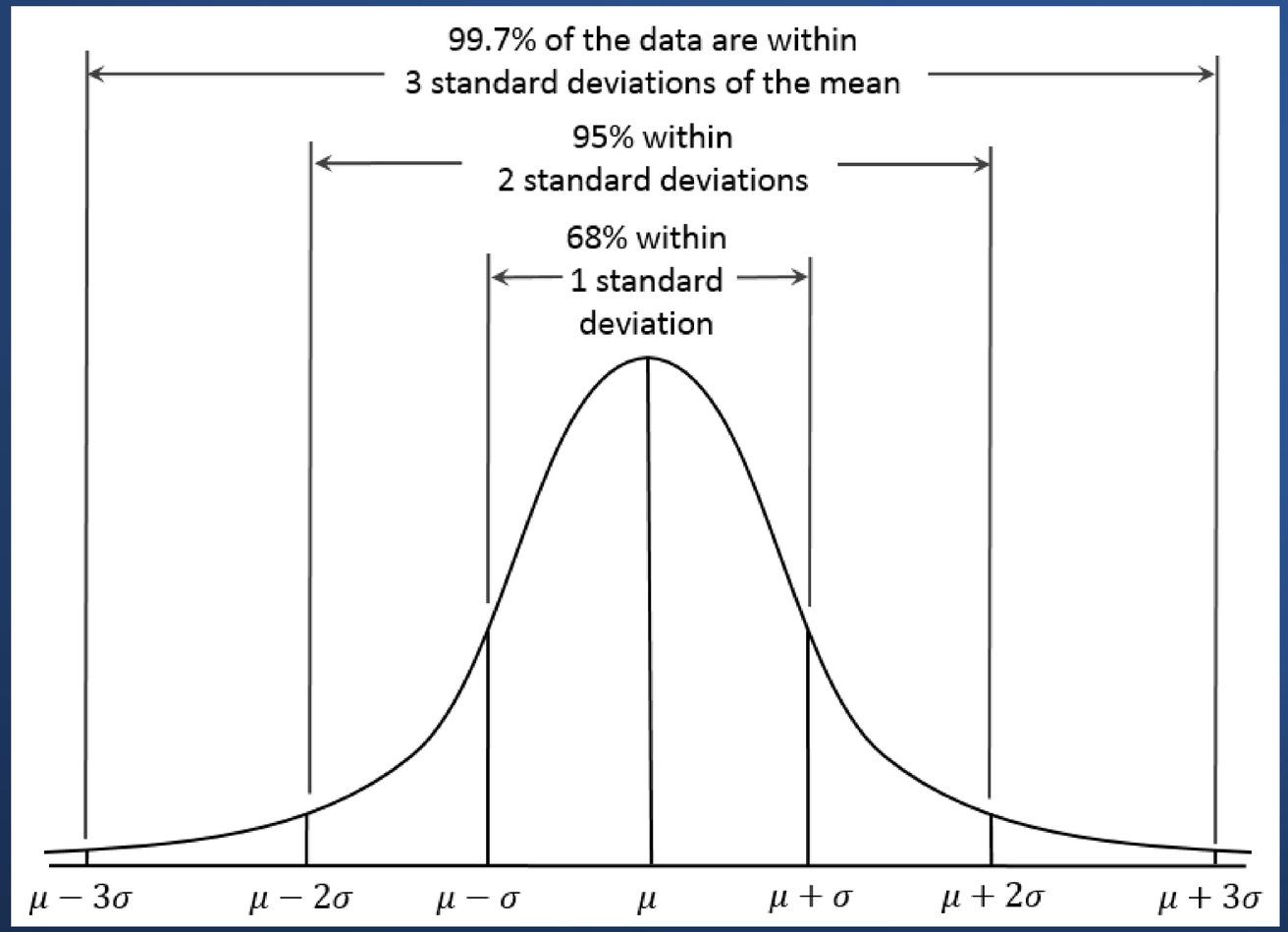
50%

68%

95%

99.7%

Underlying Basis: Normal Distribution



(Kernler, 2014)

μ = Population Mean **σ = Standard Deviation**

Six Sigma Performance

Commonly referred to as 3.4 defects per million opportunities (DPMO)

Same as 0.0000034 proportion defects

or 0.00034%

From the opposite “accuracy” perspective…

(1 – 0.0000034) = 0.999996 proportion non-defects

or 99.9996% of all relevant features expected to be defect-free

Diabetes Infusion Sets Recalled

Michelle Cortez, Washington Post, September 11, 2017

1 in 2 million sets susceptible to excess insulin delivery

“The risk of an excessive insulin dose is greatest right after the patient changes the infusion set, which is done every three days”.

https://www.bloomberg.com/news/articles/2017-09-11/medtronic-recalls-diabetes-infusion-sets-for-overdose-risk

https://www.drugdangers.com/medtronic-insulin-pump/lawsuit/

Home-Use Respiratory Devices

Nick Paul Taylor, Health Care Dive, January 19, 2023

“Philips’ recall of 5.5 million continuous positive airway pressure devices and other respiratory machines in 2021 represented a large undertaking.”

https://www.healthcaredive.com/news/health-tech-hazards-philips-PHG-recall/640775/

Widely Used Terminology

Defect (nonconformance)

Any mistake or error that is passed on to a customer

Defects per opportunity (DPO)

Number of defects discovered ÷ number of opportunities for error

Defects per million opportunities (DPMO)

(Number of defects discovered ÷ opportunities for error) × 1,000,000

Notion of Opportunities

Aspects of the products – goods, services, transactions – that the customer cares about.

Examples:

- 4 opportunities for errors in an electric toothbrush
- 6 opportunities for errors in a visit to the doctor
- 3 opportunities for errors in an online payment

Opportunities: Example for Analysis

An online application for car insurance has 16 fields.

> An error is any incorrect or missing information in any of the fields.

An inspection of 100 applications revealed a total of 144 errors.

Analysis

Opportunities for error

= 100 applications inspected * 16 fields

= 1,600

Defects per million opportunities

= (144 errors ÷ 1,600 opportunities) *1,000,000

= 0.09 * 1,000,000

= 90,000

Generally, Calculating DPMO

DPMO =

$$\frac{Number\ of\ Defects\ * 1{,}000{,}000}{Number\ of\ defect\ opportunities\ per\ unit\ * Number\ of\ Units}$$

Sigma Level (With Motorola Adjustment of +1.5 sigma)

= NORM.S.INV(1 - 0.09) + 1.5

= 1.34 + 1.5

= 2.84 sigma

Excel Formulae for Sigma Level (with 1.5 Shift)

=NORM.S.INV(1 – dpmo/1000000) + 1.5

OR =NORM.S.INV(1 – proportion defective) + 1.5

Or use one of the freely available online calculators

DPMO Values for Sigma Levels With and Without “Motorola” Shift

Shift	Sigma Levels						
	3	3.5	4	4.5	5	5.5	6
0	1,350	233	32	3.40	0.29	0.02	0.001
1.5	66,807	22,750	6,210	1,350	233	32	3.40

Another Perspective – For Measurement Data

Voice of Customer (VoC)

- Customer expectation of a product or process feature such as time waiting in line, weight of a burger patty etc.
- Usually, a range with upper and lower specification limits (USL and LSL), with an ideal expectation (nominal value)

Voice of Process (VoP)

- Established performance in the product or process feature
- Could be an average and a standard deviation

“Six” Standard Deviations

Let’s say VoC for temperature of soda is 34 to 42 degrees Fahrenheit

LSL = 34, USL = 42, Calculated the center as 38

Let’s say that the average temperature (VoP) for a beverage dispenser

is 38 degrees Fahrenheit (which happens to be the center of VoC)

If you want this to be at least a Six Sigma level of soda temperature delivery, what is the maximum standard deviation that can be tolerated?

$38 + 6 * s = 42$ OR $38 - 6 * s = 34$ $s = 0.67$

Process Capability Analysis

Ability of the process to meet (and exceed) the customer specifications for a service or product

Comparing VoC and VoP

Standard metric based on this concept

Process Capability Ratio (Cp)

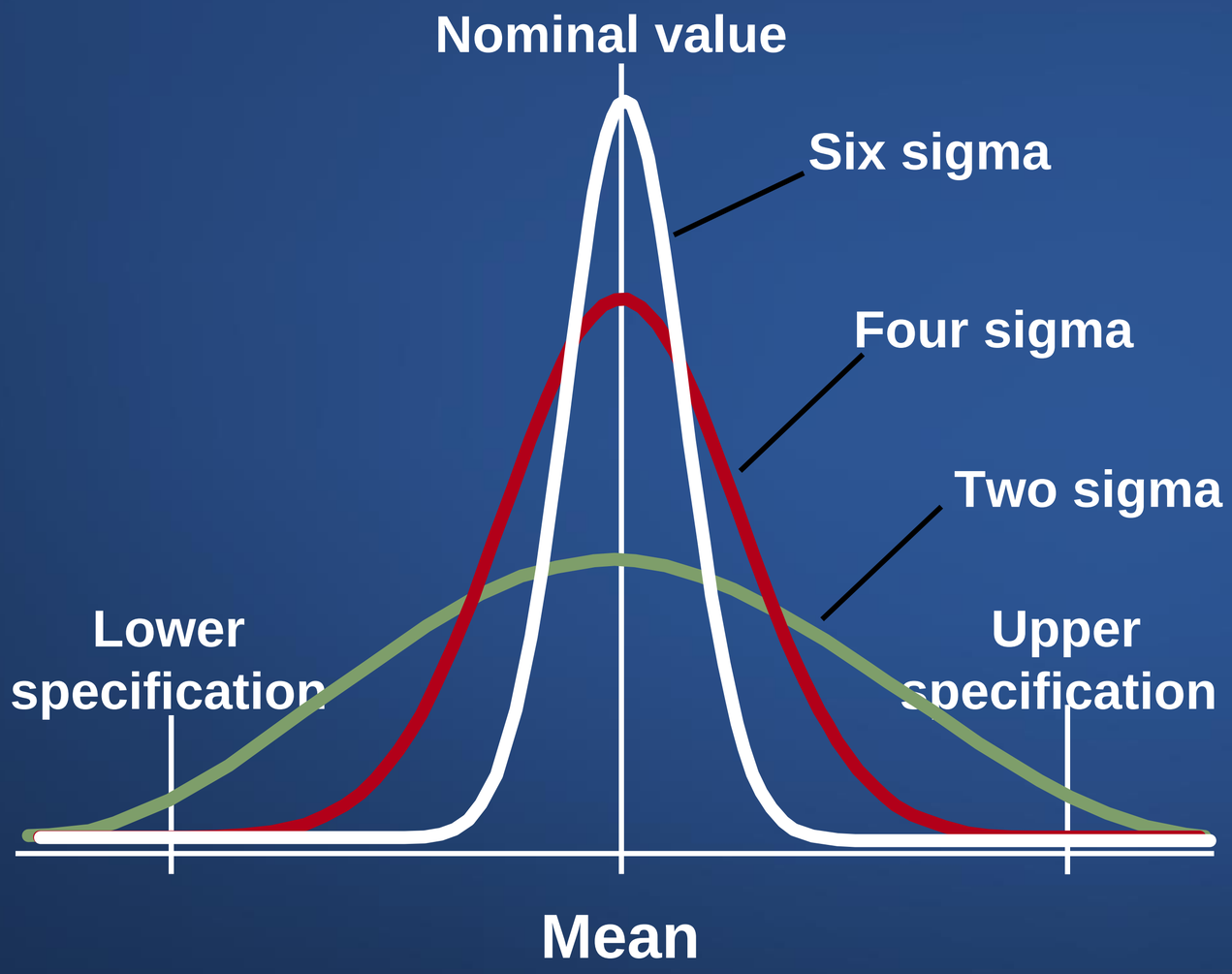
Process Capability Index (Cpk)

(to be used in combination as a pair)

Matching Cp and Cpk Values from Process Capability Analysis with Sigma Levels

Sigma Level	Minimum C_p and C_{pk} Value
3-Sigma	1
4-Sigma	1.33
5-Sigma	1.67
6-Sigma	2

Sigma Levels

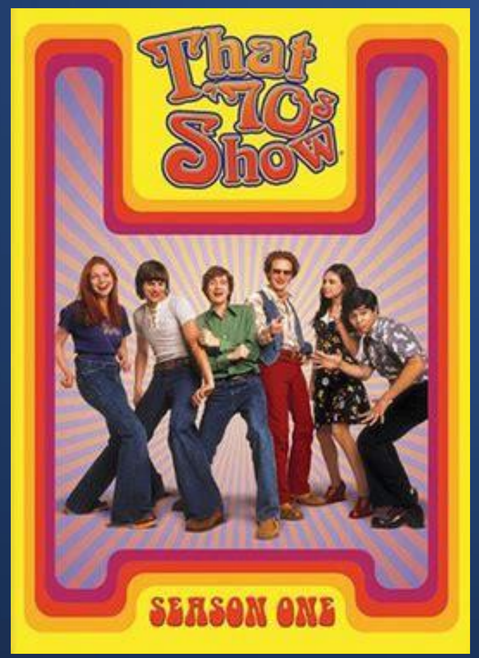


Effects of Reducing Variability

Just for Fun

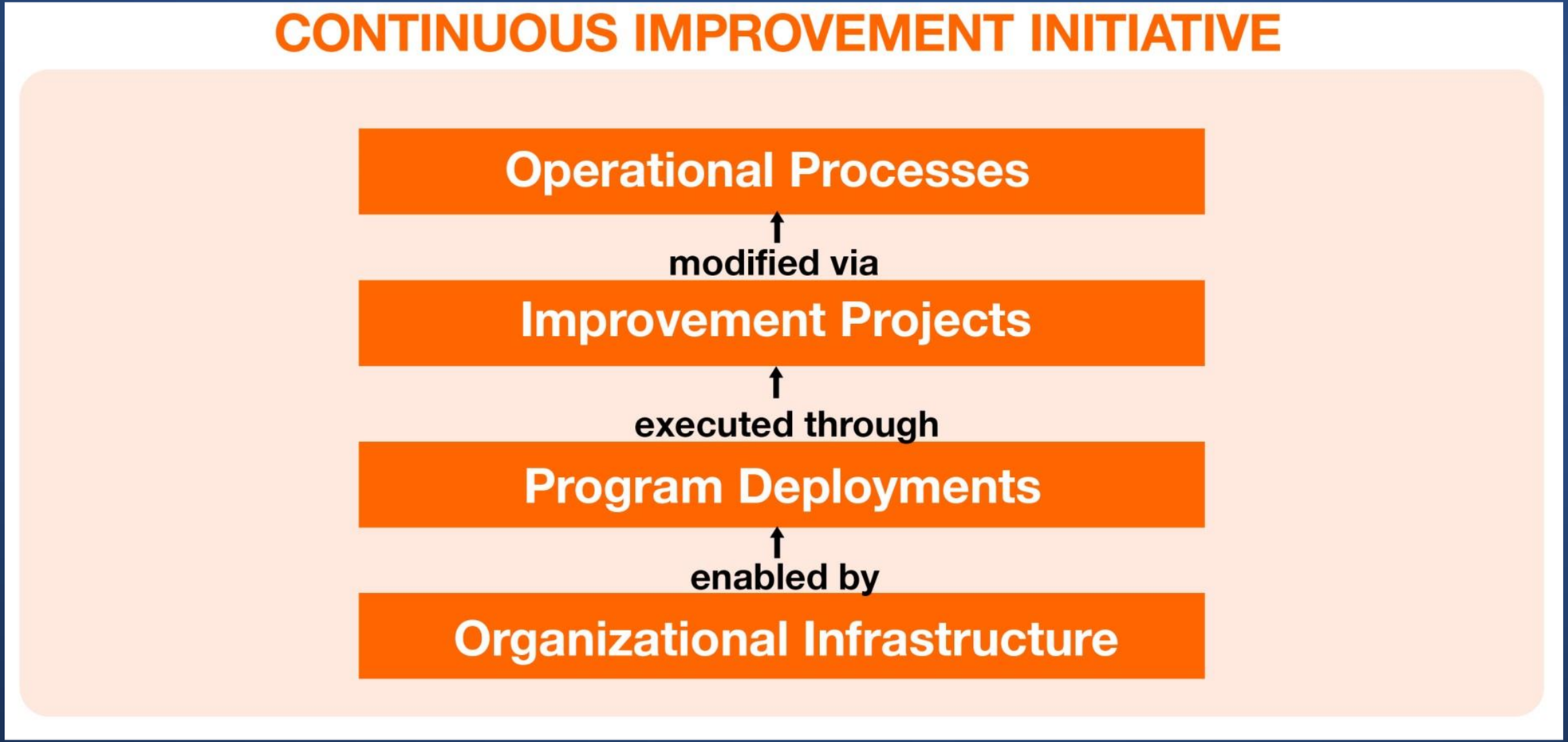
Somewhat related TV show clip

https://www.youtube.com/watch?v=H4vZN-cMJyY



Six Sigma at Academic Medical Hospital

Programs and Projects



Anand, G., Ward, P. T., Tatikonda, M. V., & Schilling, D. A. (2009). Dynamic capabilities through continuous improvement infrastructure. Journal of operations management, 27(6), 444-461.

Questions for Academic Medical Hospital (AMH)

What are the issues with the deployment of the Six Sigma process improvement program?

How are the issues being addressed? How should they be addressed?

What would you say are the pros and cons of Six Sigma as a process improvement program?

Poll #4 – True/False

At the start of the emergency department (ED) wait time project, all the ED physicians were enthusiastic about working on a Six Sigma initiative.

Why was this the case?

Poll #5 – True/False

Six Sigma was the first program that AMH implemented for managing quality.

Why did they adopt it?
Is the reaction different in other organizations?

Common Challenges of Deployment for any Improvement Initiative

Push-back for “black belts”

Lack of champions for projects

Skepticism of employees

Resources from upper management

Support from middle management

- Desire for and acceptance of change

Fatigue from previous initiatives

Basis for Selecting Projects

Performance Metrics

- Hard benefits
  - Balance Sheet or Income Statement
  - One-time or recurring
- Soft benefits
- Project leadership training
- Tie with strategy
- Standardized by cost and time

Weighted Criteria Project Prioritization (Academic Medical Hospital)

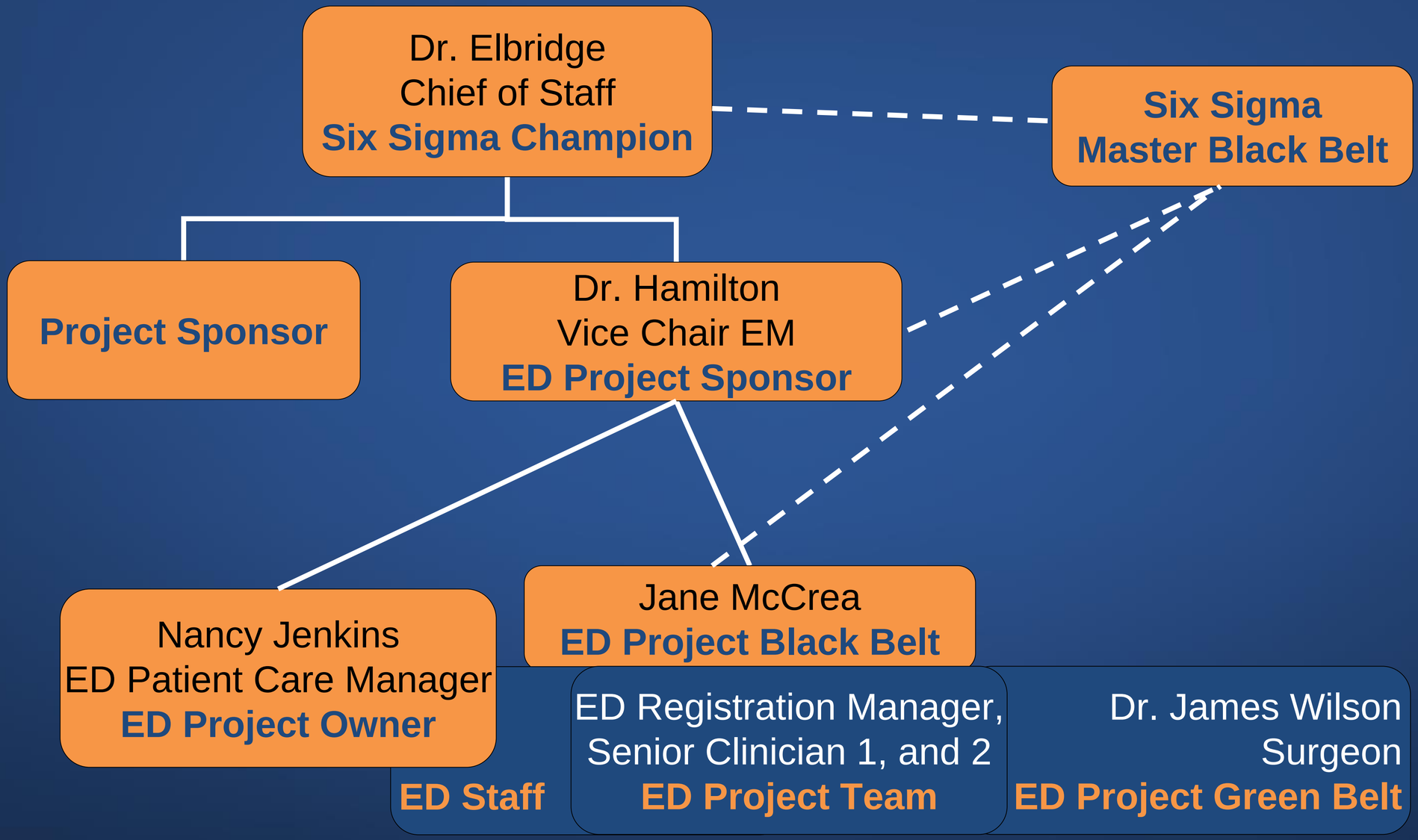
Strategic Objectives			Potential (Competing) Projects Relationship Strength: 0 = none, 1 = little, 3 = moderate, 9 = Extremely high			
			Emergency Department Wait Time Project	Payment Cycle Time Project	Employee Morale Project	Inventory Management Project
Safer Environment for patients and staff	WEIGHTS	.35	3	0	9	3
Best place to care for health care professionals		.35	1	1	9	3
Become preferred choice for care (Increase mkt. share)		.15	1	3	9	3
Reduce variability and waste in processes		.15	9	3	1	9
Weighted Average Scores for Projects			=.35x3 + .35x1 + .15x1 + .15x9 = 2.9	1.25	7.8	3.9

Poll #6 – True/False

The Project Owner for the ED Project was a local operations leader who was accountable for sustaining long-term gains of process changes.

Why the assigned roles? Useful?

Structure


Dr. Elbridge
Chief of Staff
Six Sigma Champion
Six Sigma
Master Black Belt
Project Sponsor
Dr. Hamilton
Vice Chair EM
ED Project Sponsor
Nancy Jenkins
ED Patient Care Manager
ED Project Owner
Jane McCrea
ED Project Black Belt
ED Staff
ED Registration Manager,
Senior Clinician 1, and 2
ED Project Team
Dr. James Wilson
Surgeon
ED Project Green Belt

Poll #7 – True/False

In the analyze phase of the Six Sigma project, Y referred to a process output, excessive wait times, and Xs referred to causal factors that were thought to be the causal factors impacting that Y.

What is the structure for a project? Useful?

The Emergency Department Project

Define

Determined the Y
Identified expected benefits of ED wait time project
Signed off on Project Charter

Measure

Constructed process flow diagram
Determined baseline measures and target performance of the ED process:
Upper Specification Limit (USL), wait time in steps of process
Validated measurement systems

Analyze

Identified key Critical to Quality (CTQ) drivers (X's)
Conducted data analysis

Improve

Determined optimal settings of Xs for desirable values of Y:
- Patient flow changes based on priority levels
- Modification of assignments, New communication boards
- Streamlined order entry and results retrieval

Control

Setting guidelines, assigning responsibilities
Conducting reviews
Reporting of progress, Recognition of progress

E = Q * A, and Change Acceleration Process (CAP)

To Summarize

- Metric
  - 3.4 defects per million opportunities or DPMO
- Methodology
  - Policy deployment – Relating organizational objectives to project goals
  - Belt system of experts
  - DMAIC framework
- Philosophy
  - Projects by cross-functional teams
  - Lead by methodology experts (Black Belts)
  - Clearly stated project goals

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Thank you!

Next:

Statistical Process Control

Lean Principles and Practices

Toyota Motor Manufacturing