Providing Civilians with Medical Attention

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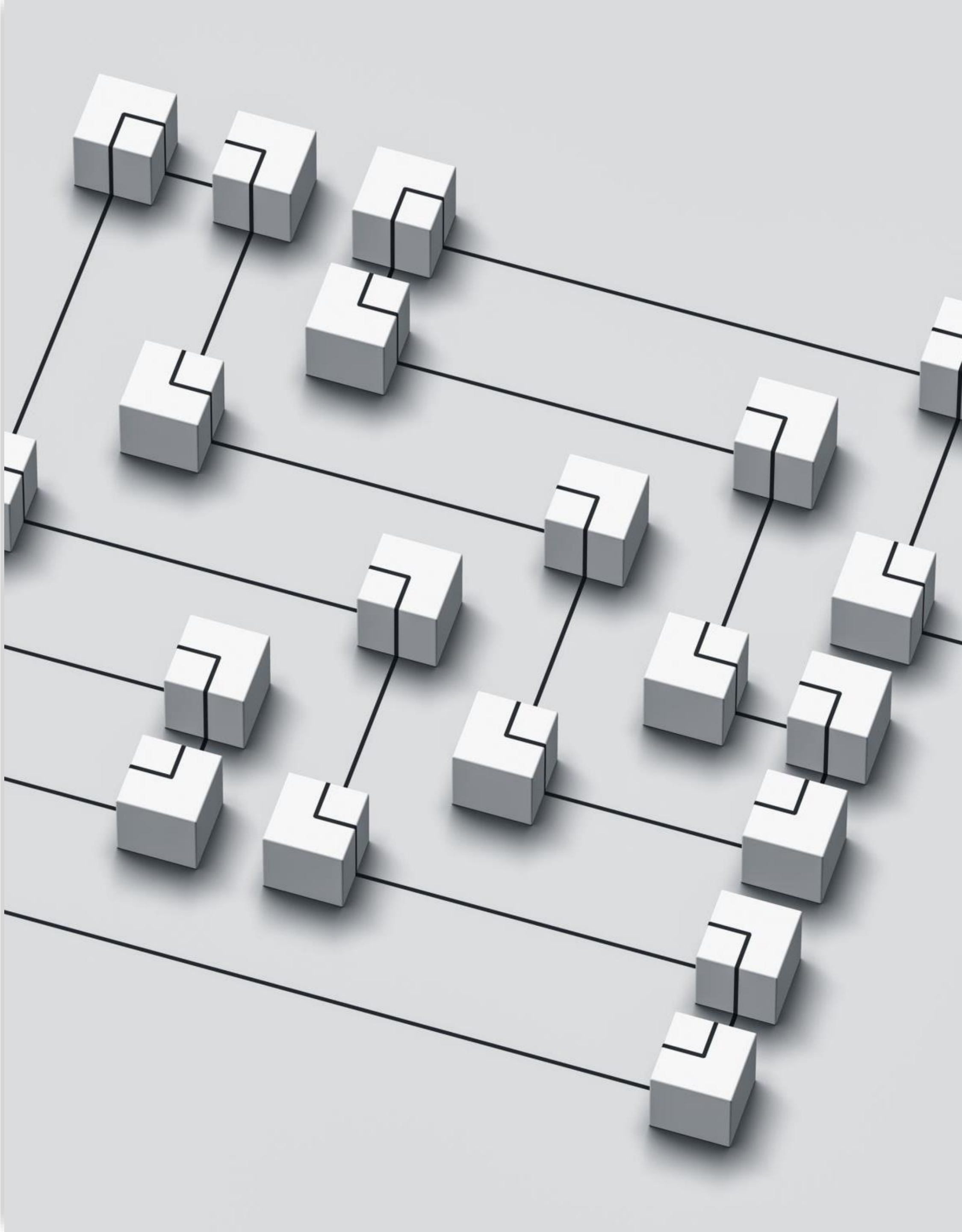
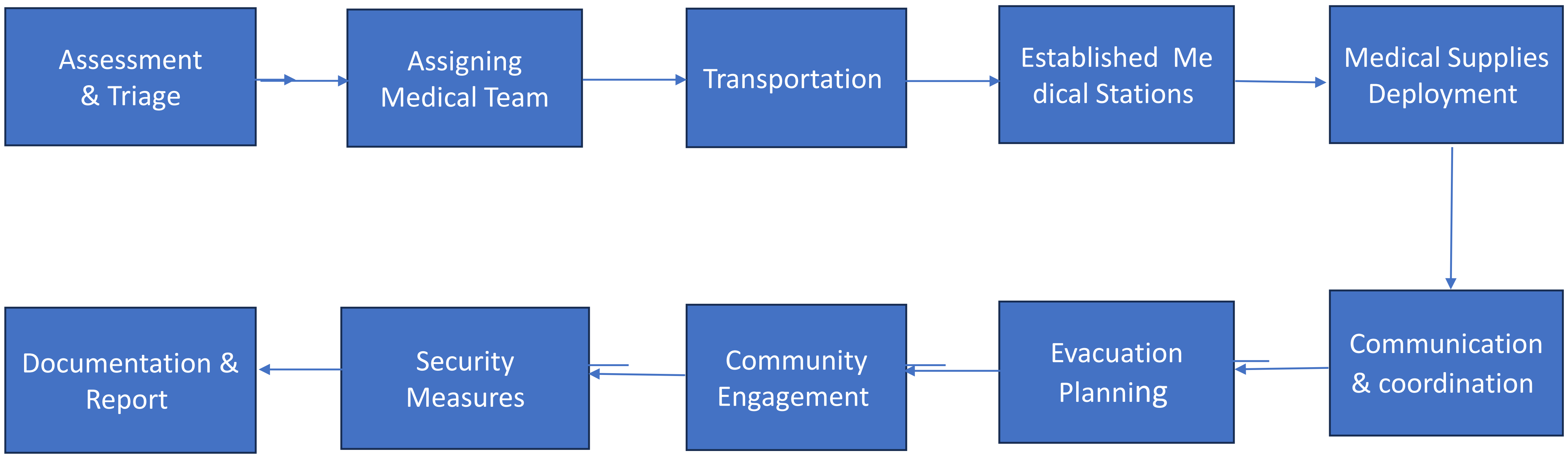


OVERVIEW

Providing civilians with medical attention in a city under siege involves ensuring access to healthcare services and facilities for the general population during emergencies, disasters, and everyday health needs. It encompasses various aspects such as emergency medical response, primary healthcare provision, specialized treatment, and preventive care. Key components include establishing healthcare infrastructure, training medical personnel, developing public health programs, and fostering community engagement to address healthcare disparities and promote overall well-being.

Process Flowchart



BRAINSTORMING

- Develop and deploy mobile medical units that can move to areas in need.
- Establish clear evacuation plans for different scenarios.
- Consider partnerships with transportation companies for emergency services.
- Set up temporary shelters with integrated medical facilities.
- Ensure these centers have sufficient medical supplies and personnel.
- Implement safety protocols for both medical personnel and civilians.
- Collaborate with local communities to identify and train volunteers.
- Provide information and education on safety measures during crises
- Utilize ambulances, helicopters, or other means of transportation for swift medical response.

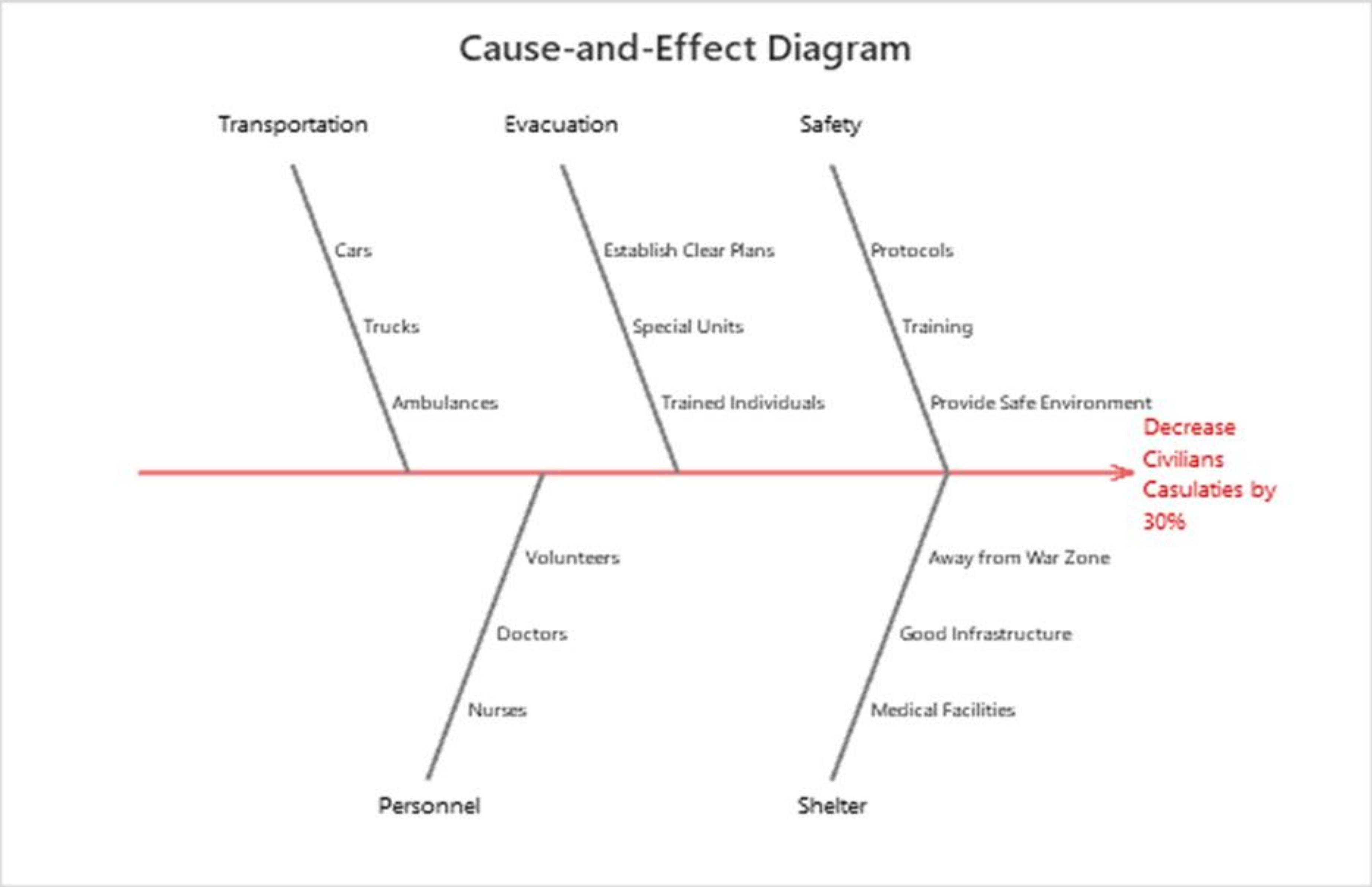
Cost of Poor Quality

COPQ	Internal Failure	External Failure	Appraisal	Prevention
Evacuation	• Roads destroyed • Medical supply issues • Communication errors	• Medical complications • Loss of life • Long term health impacts	• Training and education • Emergency response drills • Pre-Evacuation planning	• Training and education programs • Emergency preparedness planning • Equipment maintenance and upgrades
Transportation	• Equipment malfunctions • Inadequate staff training	• Patient complications • Regulatory fines	• Quality audits and inspections • Training and certification programs	• Risk Management and Assessments • Continuous training
Personnel	• Training and retraining • Corrective action costs • Increased workload on others	• Loss of accreditation • Medical malpractice lawsuits • Reputation damage	• Performance reviews and evaluations • Clinical Competency testing	• Recruitment and selection processes • Certifications and licensing • Ongoing professional development
Shelter	• Inadequate facilities • Equipment's malfunctions • Supply chain failures	• Public health impacts • Inadequate shelter conditions lawsuits	• Facility inspections • Quality audits • Staff training programs • Sanitation and hygiene checks	• Facility design and construction • Infrastructure maintenance • Safety and security measures

Affinity Diagram

Evacuation	Transportation	Shelter	Personnel	Safety
• Establish clear plans for different scenarios. • Develop and deploy units that can move to areas in need	• Consider collaborating with transportation companies for emergency services. • Utilize ambulances, helicopters, or other means of transportation for swift medical response.	• Set up shelters with integrated medical facilities.	• Ensure they are sufficient medical supplies and personnel. • Collaborate with communities to identify and train volunteers.	• Implement safety protocols for both medical personnel and civilians. • Provide information and education on safety measures during crises

Ishikawa Chart



Six Sigma DMAIC

Define

Provide civilians with medical health in a city under siege

⇩

Measure

Once the problem is defined, relevant data is collected to quantify the current state of the process or system.

⇩

Analyze

- In this phase, the collected data is analyzed to identify root causes contributing to the problem or variation in the process.
- Various statistical and analytical tools are used to understand the relationship between inputs and outputs

⇨

Control

- Standardization of Procedure
- Training and Skill Maintenance
- Feedback Loops and Continuous Improvement
- Monitoring and Measurement System

⇧

Improve

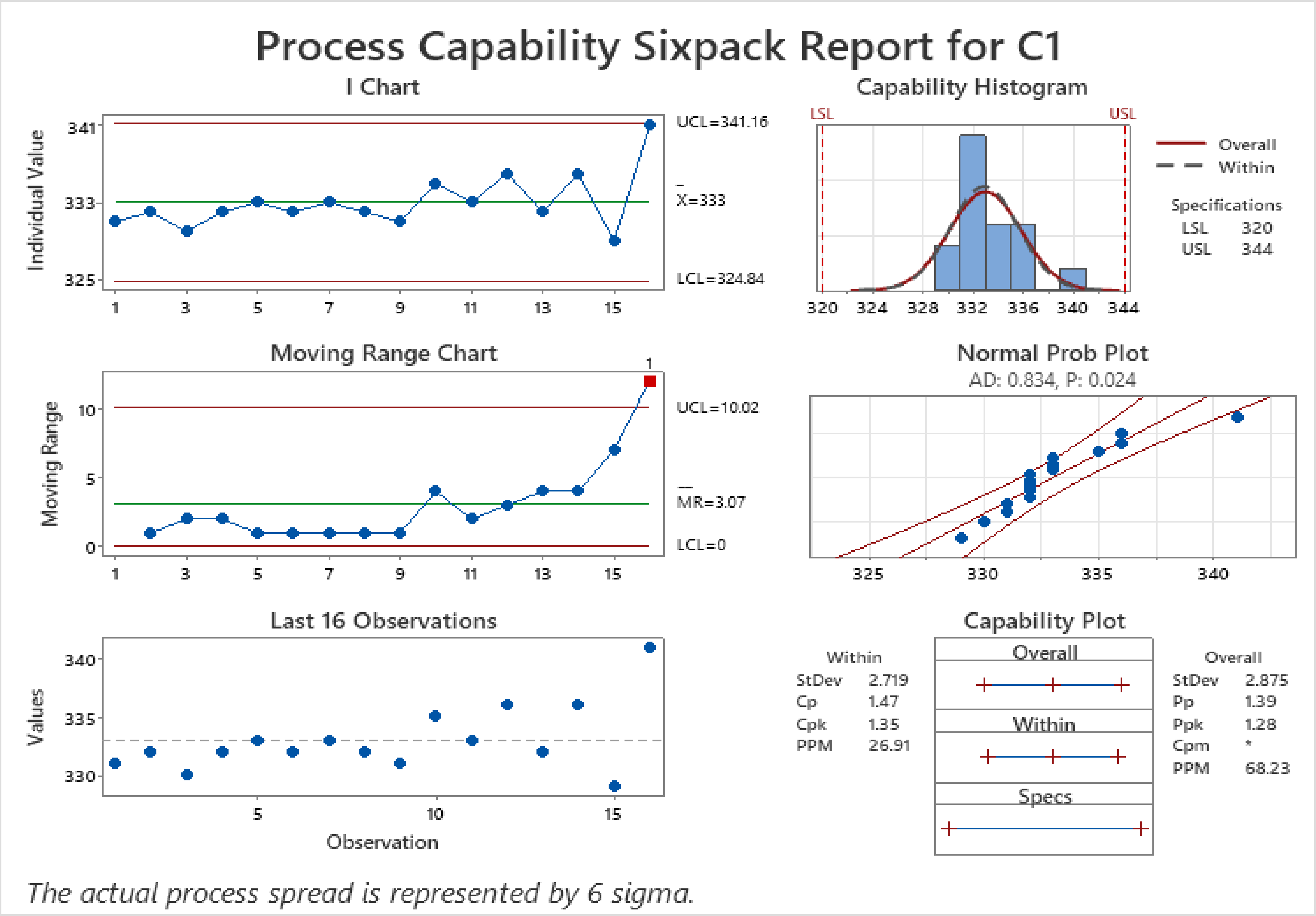
- Strategies for resource allocation
- Emergency response protocols
- Partnerships with external organizations (finding our Champion)
- Develop a plan for implementation and a timeline for completion
- Put improvement initiatives into action
- Adjust strategies as needed to address any unforeseen challenges

Process Capability

- Process Capability is a measure of a process's ability to consistently produce output within specified limits.

- Its primary goal is to assess and ensure that a process can meet customer requirements and expectations reliably.

- The main objective of assessing process capability is to understand the inherent variability of a process and determine if it is capable of producing output that falls within predefined tolerance limits.



Process Capability Sixpack Report for C1
I Chart
Individual Value
UCL=341.16
X=333
LCL=324.84
Capability Histogram
LSL
USL
Overall
Within
Specifications
LSL 320
USL 344
Moving Range Chart
Moving Range
UCL=10.02
MR=3.07
LCL=0
Normal Prob Plot
AD: 0.834, P: 0.024
Last 16 Observations
Values
Observation
Capability Plot
Within
StDev 2.719
Cp 1.47
Cpk 1.35
PPM 26.91
Overall
Within
Specs
Overall
StDev 2.875
Pp 1.39
Ppk 1.28
Cpm *
PPM 68.23
The actual process spread is represented by 6 sigma.

Quality Function Deployment

- QFD involves a structured approach to translating customer requirements (what the customer wants) into specific technical requirements (how those wants can be met). The QFD matrix, also known as the House of Quality, is a central tool in this process.
- The primary goal of the QFD matrix is to ensure that the product or service being developed meets or exceeds customer expectations. It does this by establishing relationships between customer requirements and the technical features or characteristics of the product or service
- The main objectives of the QFD matrix include:

  - Customer Understanding

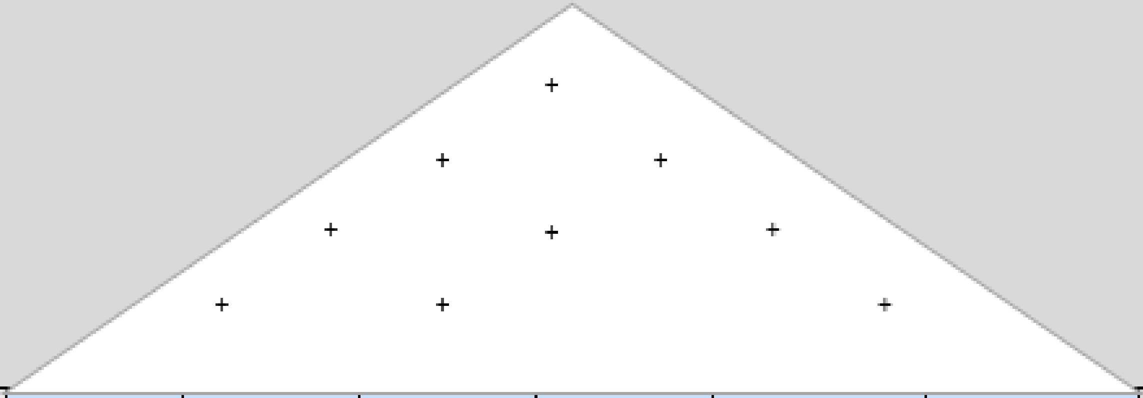
  - Cross-functional Communication

  - Prioritization

  - Design Optimization

Quality Function Development (QFD Matrix)

Quality Function Deployment (House of Quality)



	1: low, 5: high	Functional Requirements (How's) →							
Priorities	Importance rating	Customer Requirements - (What's) ↓	Establishing mobile medical units	Training medical personnel in emergency response	Stockpiling medical supplies and equipment	Creating secure routes for transporting patients	Implementing communication systems for coordination	Setting up counseling services for psychological support	Weighted Score
1	5	Timely medical assistance	5	4	3	5	5	2	110
2	4	Accessible medical facilities	3	3	5	4	3	3	72
3	5	Skilled medical personnel	4	5	3	3	2	3	85
4	4	Adequate medical supplies	4	3	4	2	2	2	60
5	5	Safety and security during treatment	5	5	1	2	4	3	85
6	3	Psychological support for trauma victims	3	1	1	1	2	5	24
		Technical importance score	107	107	107	107	107	107	436
		Importance %	25%	25%	25%	25%	25%	25%	125%
		Benchmark							
		Difficulty	3	3	2	5	4	1	1: very easy, 5: very difficult
		Priority to improve							

Design Of Experiment

- Is a structured method used to systematically vary input factors in a process or system to observe and analyze their effects on the output.
- The primary goal of DOE is to optimize processes, products, or systems by identifying the most influential factors and their optimal settings while minimizing variability and reducing the number of experiments required.
- The main objectives of the Design of Experiments include:

  - Identifying important factors

  - Optimizing process settings

  - Minimizing variability

  - Reducing the number of experiments

Design Of Experiment Analysis

Design of Experiments Analysis — Death Rates

Factorial Experiments 2^3 (Three Replications/Treatment)

Run	A	B	C	AB	AC	BC	ABC	Y1	Y2	Y3	Avg.	Var.
								Run Results				
1	-1	-1	-1	1	1	1	-1	-2.50	-2.42	1.72	-1.066	5.828
2	1	-1	-1	-1	-1	1	1	3.56	0.73	6.87	3.719	9.446
3	-1	1	-1	-1	1	-1	1	-1.71	-0.75	0.72	-0.580	1.499
4	1	1	-1	1	-1	-1	-1	10.98	11.64	13.50	12.037	1.705
5	-1	-1	1	1	-1	-1	1	10.52	4.12	8.61	7.750	10.778
6	1	-1	1	-1	1	-1	-1	14.77	18.00	13.57	15.446	5.237
7	-1	1	1	-1	-1	1	-1	11.19	12.09	10.00	11.093	1.107
8	1	1	1	1	1	1	1	19.71	15.02	20.19	18.310	8.161
TotSum								66.52	58.42	75.18	66.71	43.76
SumY+	49.51	40.86	52.60	37.03	32.11	32.06	29.20					
SumY-	17.20	25.85	14.11	29.68	34.60	34.65	37.51					
AvgY+	12.38	10.21	13.15	9.26	8.03	8.01	7.30					
AvgY-	4.30	6.46	3.53	7.42	8.65	8.66	9.38					
Effect	**8.08**	**3.75**	**9.62**	**1.84**	**-0.62**	**-0.65**	**-2.08**					
Var+	6.137	3.118	6.321	6.618	5.181	6.135	7.471					
Var-	4.803	7.822	4.619	4.322	5.759	4.805	3.469					
F	0.783	2.509	0.731	0.653	1.111	0.783	0.464					

Factors Analyzed

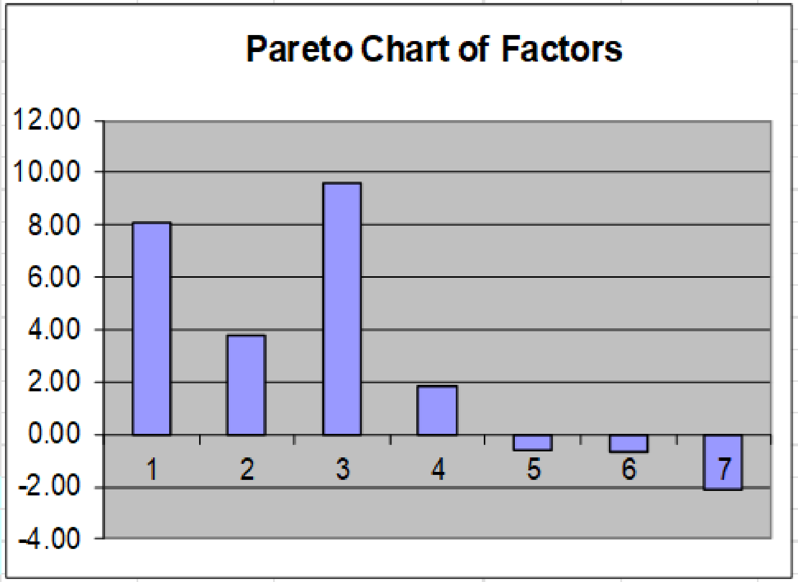
Factor A:	Doctors
Factor B:	Trasnportation
Factor C:	Communication
Response:	Death Rate

Factors	Doctors	Transportation	Communication
Low Level	Implemented	Implemented	Implemented
High Level	None	None	None

Var. of Model	5.47	StdDv	2.34
Var. of Effect	0.91	StdDv	0.95
Student T (0.025;DF) =		2.473	
C.I. Half Width =		**2.361**	

Significant Factors & 95% CI Limits:

Factor	A	B	C	AB	AC	BC	ABC
Signific.	Yes	Yes	Yes	No	No	No	No
LwrLimit	5.72	1.39	7.26	-0.52	-2.98	-3.01	-4.44
UprLimit	10.44	6.11	11.98	4.20	1.74	1.71	0.28



Design Of Experiment Interpretation

All three of the main effects are statistically significant. Effect A, Doctors is statistically significant: its Effect is 8.08; its 95% Confidence Interval is 5.72 to 10.44. Effect B, Transportation is also statistically significant: its Effect is 3.75; its 95% Confidence Interval may allow an increase death rate 1.39 to 6.11 over the desired 15%. Finally Effect C, Communication is also statistically significant. Its 95% CI shows Communication allows an infection rate increase 7.26 to 11.98% over 15% desired. We can see that **Transportation** is the most helpful tool to keep the death rate at a desired 15% level

Supply Chain

- The primary goal of a supply chain is to efficiently and effectively manage the flow of goods, services, information, and finances from the point of origin to the point of consumption, to satisfy customer demands while maximizing profitability.
- The objectives of a supply chain can vary depending on the specific industry, organization, and market dynamics, but they generally include:

  - Customer Satisfaction

  - Cost Efficiency

  - Responsiveness

  - Reliability

Supply Chain

Part#1

Item	No. of Rooms/Beds	No. of Medical Staff	No. of Operations
Production	0 to 12	0 to 13	0 to 11
Inventory Max	9	10	8
Cost of Having a Doctor	2	4	4
Cost of Patient Overflow	6	7	6
Cost of Doctor Shortage	5	7	7
Random/Selection	8*	8*	Distribution J

↑ Avoid any shortages ↑

Distribution J	
Week	Uniform
1	3
2	4
3	2
4	9
5	9
6	7
7	4
8	2
9	3
10	5

Product	Level		1	2	3	4	5	6	7	8	9	10	Total
No. of Operations	0	Demand (J1)	3	4	2	9	9	7	4	2	3	5	48
		Planned Receipt	8	8	8	8	8	8	8	8	8	8	80
		Total Units	16	16	16	13	13	13	15	16	16	16	150
		Having a Doctor	8	8	8	5	5	5	7	8	8	8	70
		Patient Overflow	5	4	6	0	0	1	4	6	5	3	34
		Doctor Shortage	0	0	0	0	0	0	0	0	0	0	0
		Cost of Having a Doctor	32	32	32	20	20	20	28	32	32	32	280
		Cost of Patient Overflow	30	24	36	0	0	6	24	36	30	18	204
		Cost of Doctor Shortage	0	0	0	0	0	0	0	0	0	0	0
No. of Medical Staff	1	Production	8	8	8	8	8	8	8	8	8	8	80
		Planned Receipt	8	8	8	8	8	8	8	8	8	8	80
		Total Units	18	18	18	18	18	18	18	18	18	18	180
		Having a Doctor	10	10	10	10	10	10	10	10	10	10	100
		Patient Overflow	0	0	0	0	0	0	0	0	0	0	0
		Doctor Shortage	0	0	0	0	0	0	0	0	0	0	0
		Cost of Having a Doctor	40	40	40	40	40	40	40	40	40	40	400
		Cost of Patient Overflow	0	0	0	0	0	0	0	0	0	0	0
		Cost of Doctor Shortage	0	0	0	0	0	0	0	0	0	0	0
No. of Rooms/Beds	2	Production	8	8	8	8	8	8	8	8	8	8	80
		Planned Receipt	8	8	8	8	8	8	8	8	8	8	80
		Total Units	17	17	17	17	17	17	17	17	17	17	170
		Having a Doctor	9	9	9	9	9	9	9	9	9	9	90
		Patient Overflow	0	0	0	0	0	0	0	0	0	0	0
		Doctor Shortage	0	0	0	0	0	0	0	0	0	0	0
		Cost of Having a Doctor	18	18	18	18	18	18	18	18	18	18	180
		Cost of Patient Overflow	0	0	0	0	0	0	0	0	0	0	0
		Cost of Doctor Shortage	0	0	0	0	0	0	0	0	0	0	0

Total Cost of Having a Doctor	860
Total Cost of Patient Overflow	204
Total Cost of Doctor Shortage	0

Part#2 (Redesign)

Item	No. of Rooms/Beds	No. of Medical Staff	No. of Operations
Production/Sale	0 to 12	0 to 13	0 to 11
Inventory Max	9	10	8
Cost of Having a Doctor	2	4	4
Cost of Patient Overflow	6	7	6
Cost of Doctor Shortage	5	7	7
Random/Selection	6*	7*	Distribution J

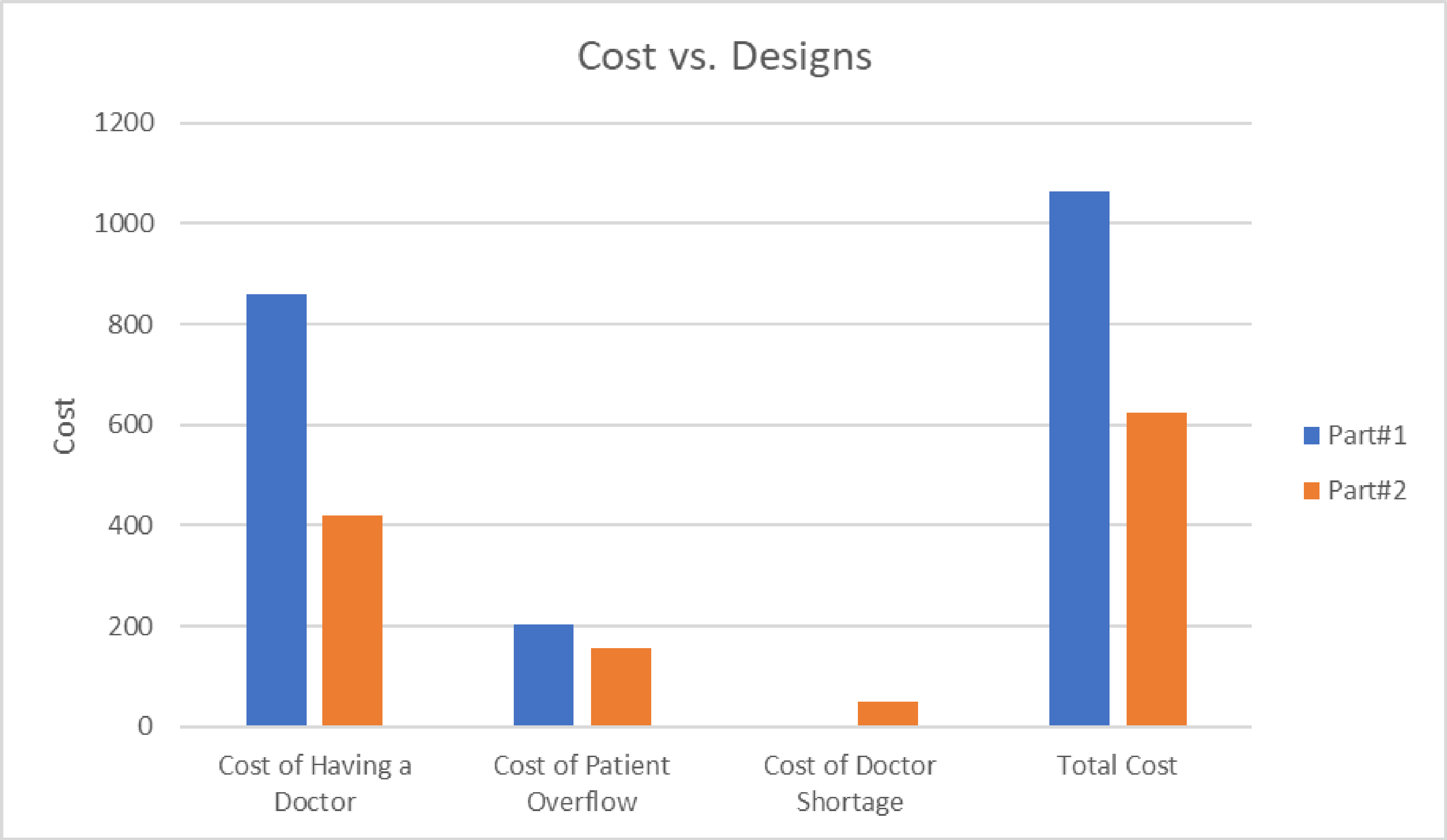
DISTRIBUTION: UNIFORM

Product	Level		1	2	3	4	5	6	7	8	9	10	Total
No. of Operations	0	Demand (J1)	3	4	2	9	9	7	4	2	3	5	48
		Planned Receipt	7	7	7	7	7	7	7	7	7	7	70
		Total Units	10	10	10	11	10	11	9	11	10	8	100
		Having a Doctor	3	3	3	4	3	4	2	4	3	1	30
		Patient Overflow	4	3	5	0	0	0	3	5	4	2	26
		Doctor Shortage	1	0	2	0	0	0	1	1	1	1	7
		Cost of Having a Doctor	20	35	30	20	20	20	30	25	30	20	250
		Cost of Patient Overflow	24	18	30	0	0	0	18	30	24	12	156
		Cost of Doctor Shortage	7	0	14	0	0	0	7	7	7	7	49
No. of Medical Staff	1	Production	0	7	7	7	7	7	7	7	7	7	63
		Planned Receipt	0	6	6	6	6	6	6	6	6	6	54
		Total Units	10	16	15	14	13	12	11	10	9	8	118
		Having a Doctor	10	10	9	8	7	6	5	4	3	2	64
		Patient Overflow	0	0	0	0	0	0	0	0	0	0	0
		Doctor Shortage	0	0	0	0	0	0	0	0	0	0	0
		Cost of Having a Doctor	15	18	16	10	12	10	8	6	4	2	101
		Cost of Patient Overflow	0	0	0	0	0	0	0	0	0	0	0
		Cost of Doctor Shortage	0	0	0	0	0	0	0	0	0	0	0
No. of Rooms/Beds	2	Production	0	6	6	6	6	6	6	6	6	6	54
		Planned Receipt	0	6	6	6	6	6	6	6	6	6	54
		Total Units	9	15	15	15	15	15	15	15	15	15	144
		Having a Doctor	9	9	9	9	9	9	9	9	9	9	90
		Patient Overflow	0	0	0	0	0	0	0	0	0	0	0
		Doctor Shortage	0	0	0	0	0	0	0	0	0	0	0
		Cost of Having a Doctor	7	7	7	7	7	7	7	7	7	7	70
		Cost of Patient Overflow	0	0	0	0	0	0	0	0	0	0	0
		Cost of Doctor Shortage	0	0	0	0	0	0	0	0	0	0	0

Total Cost of Having a Doctor	421
Total Cost of Patient Overflow	156
Total Cost of Doctor Shortage	49

Results and Chart

Results		
	Part#1	**Part#2**
Cost of Having a Doctor	860	421
Cost of Patient Overflow	204	156
Cost of Doctor Shortage	0	49
Total Cost	**1,064**	**626**



Value-Stream Mapping (VSM)

The primary purpose of Value Stream Mapping is to identify and eliminate waste in the process. By visually mapping out the entire value stream

Objective

1. Identifying Waste
2. Improving Efficiency
3. Visualizing Workflow

Implementing Steps in VSM

Identify the Value Stream

- Outline the boundaries of the value stream
- Focus on Patient Needs

Map the Current State

- Emergency Response
- Triage
- Transportation
- Treatment

Identify Waste and Inefficiencies

- Analysis of Current State Map
- Identification of Common Wastes in Healthcare

Implementing Steps in VSM

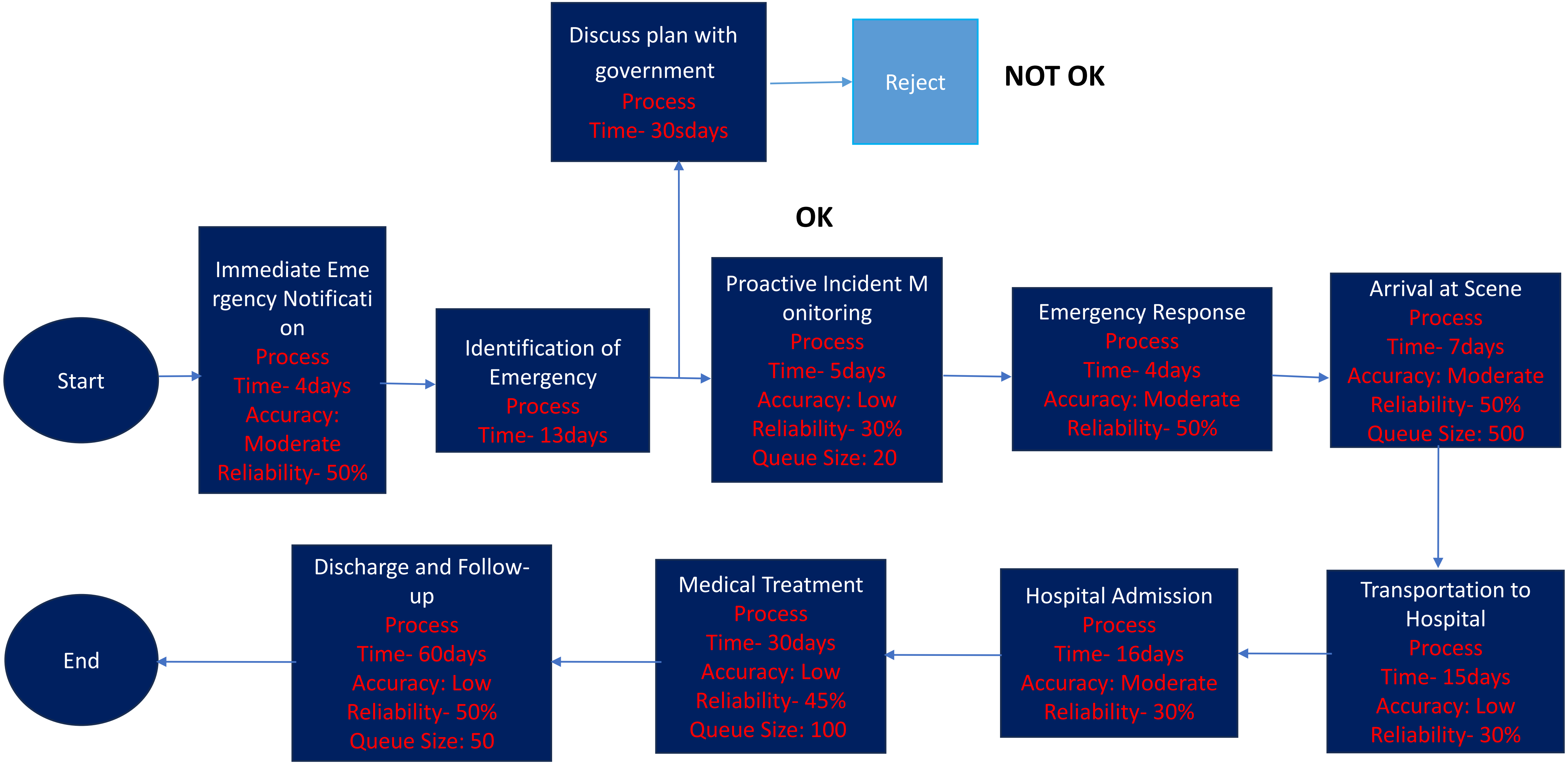
Implement and Monitor Changes

- Key Considerations for Implementing VSM in Healthcare
- Engage Stakeholders
- Prioritize Improvement Opportunities
- Monitor and Adjust Continuously

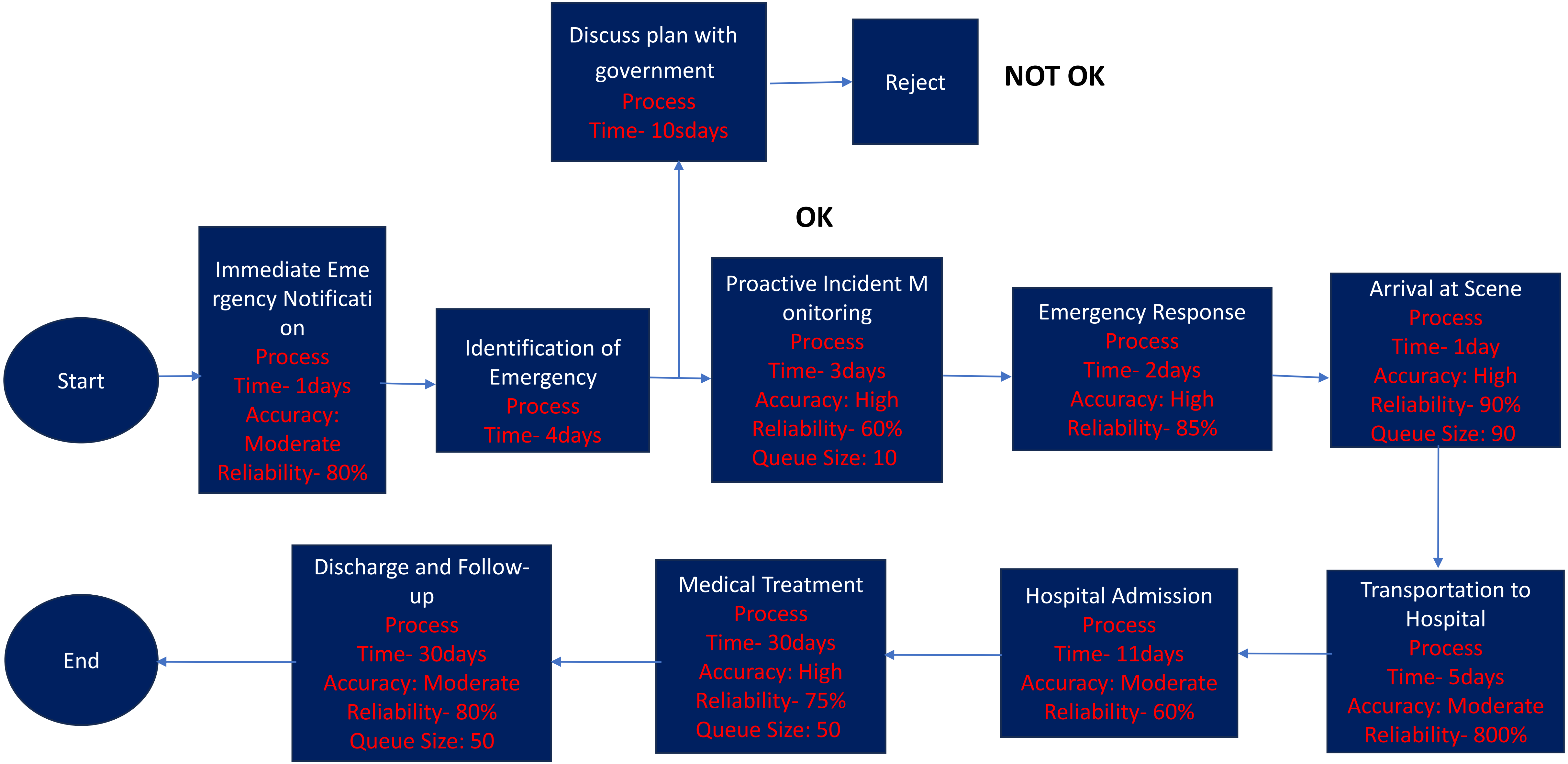
Promote Continuous Improvement

- Proposed Changes and Improvements
- Design of Future State VSM
- Expected Benefits of Future State Map

Current State VSM



Future State VSM



Gage R&R

- The primary goal is to assess the measurement system's capability and reliability.
- The objective is to determine whether the variation observed in the measurements is due to the actual differences in the parts being measured
- Our Gage R&R analysis focused on studying the transportation response time by '3' different ambulance officers.
- The Gage R&R values obtained here can be further improved

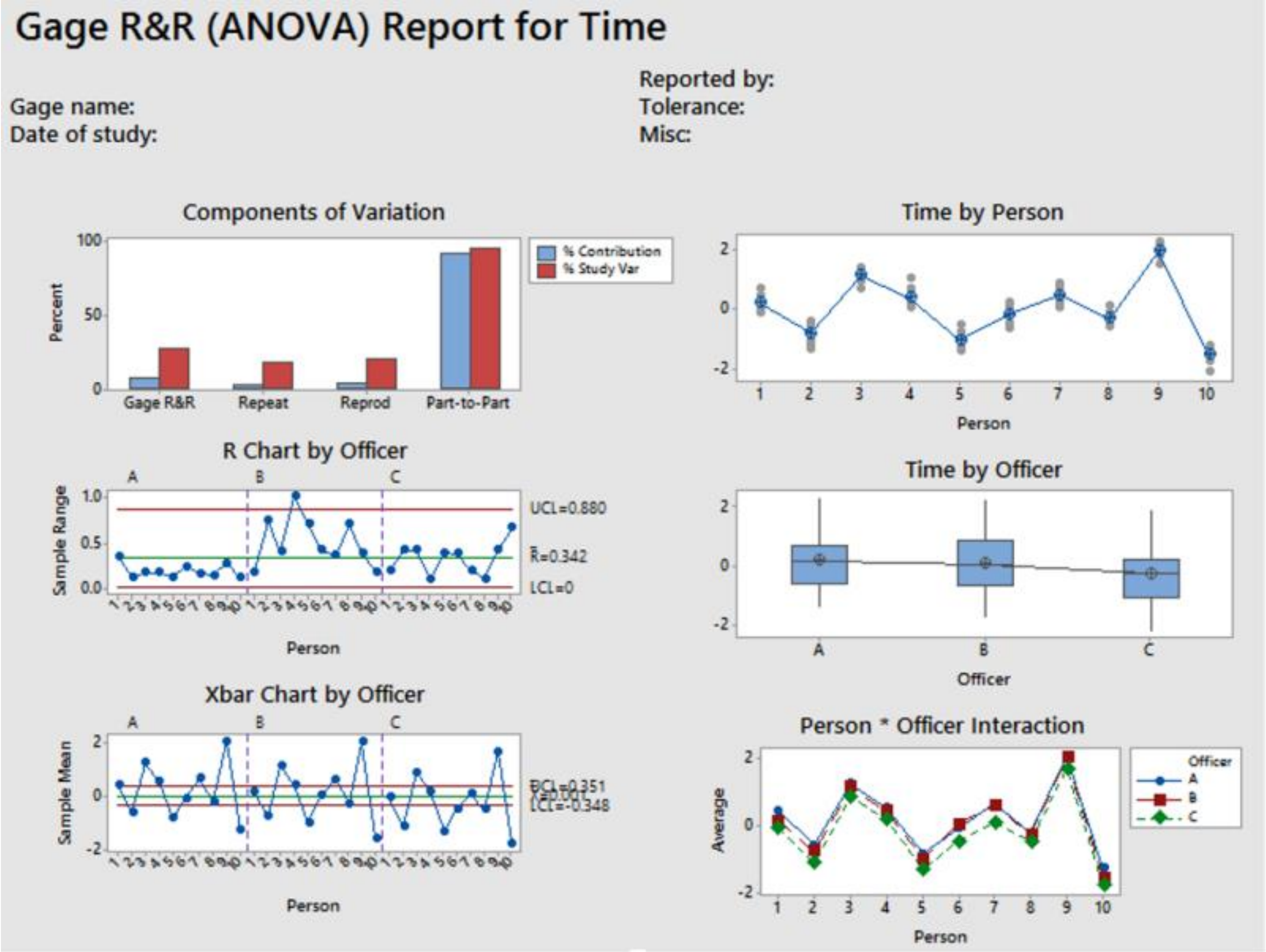
Gage R&R

Source	VarComp	%Contribution (of VarComp)
Total Gage R&R	0.09143	7.76
Repeatability	0.03997	3.39
Reproducibility	0.05146	4.37
Officer	0.05146	4.37
Part-To-Part	1.08645	92.24
Total Variation	1.17788	100.00

Source	StdDev (SD)	Study Var (6 × SD)	%Study Var (%SV)
Total Gage R&R	0.30237	1.81423	27.86
Repeatability	0.19993	1.19960	18.42
Reproducibility	0.22684	1.36103	20.90
Officer	0.22684	1.36103	20.90
Part-To-Part	1.04233	6.25396	96.04
Total Variation	1.08530	6.51180	100.00

Gage R&R Result

- From the gage study we find that the officer 3 has measurements skewed in respect to other inspectors.
- We find that officer 3 has a consistent lower readings in comparison to other two officers.
- We also find that there is a variability between the response time of each officer.



Acceptance Sampling

Acceptance sampling in quality control is a statistical method used to evaluate the quality of a batch or lot of products or materials by inspecting only a sample from the batch rather than examining the entire lot. The purpose is to make decisions about whether to accept or reject the entire batch based on the quality of the sample.

GOAL

Sampling: Randomly selecting a sample from the batch

Inspection: Inspecting the sample for defects

Decision Making: Using statistical methods to analyze the sample data and make a decision

Risk Management: Considering the risks associated with accepting or rejecting a batch

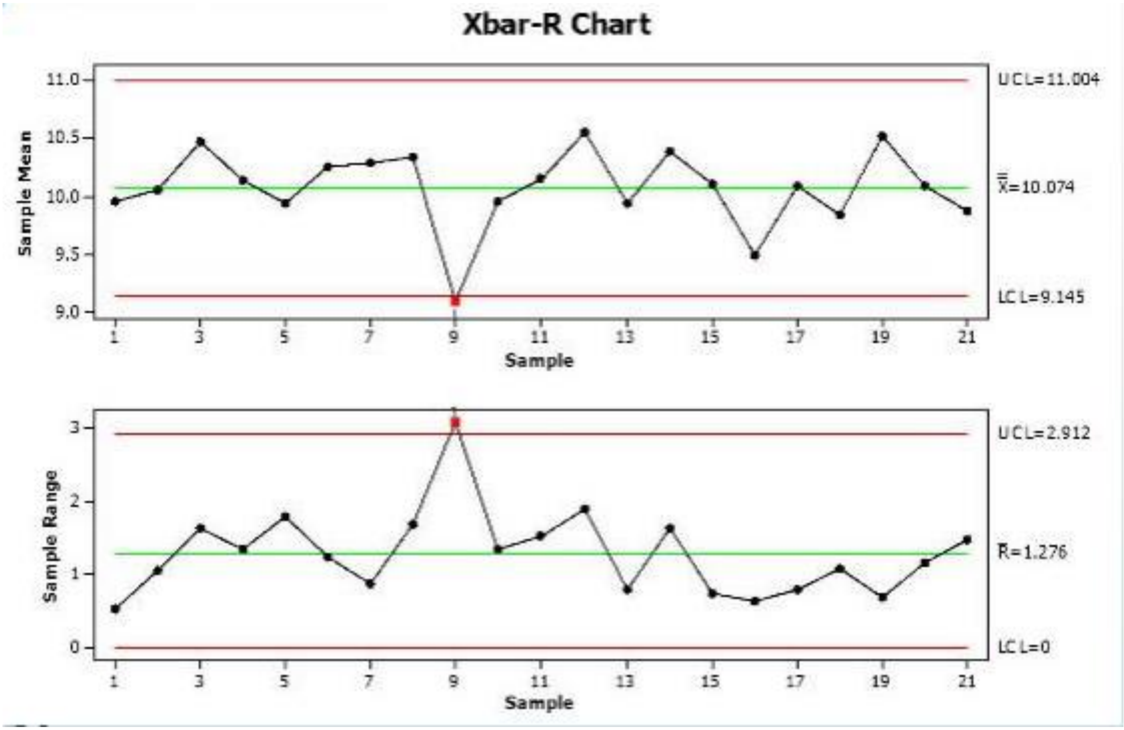
Cost-Effectiveness: Balancing the costs associated with inspection and potential risks of accepting or rejecting a batch

Acceptance Sampling

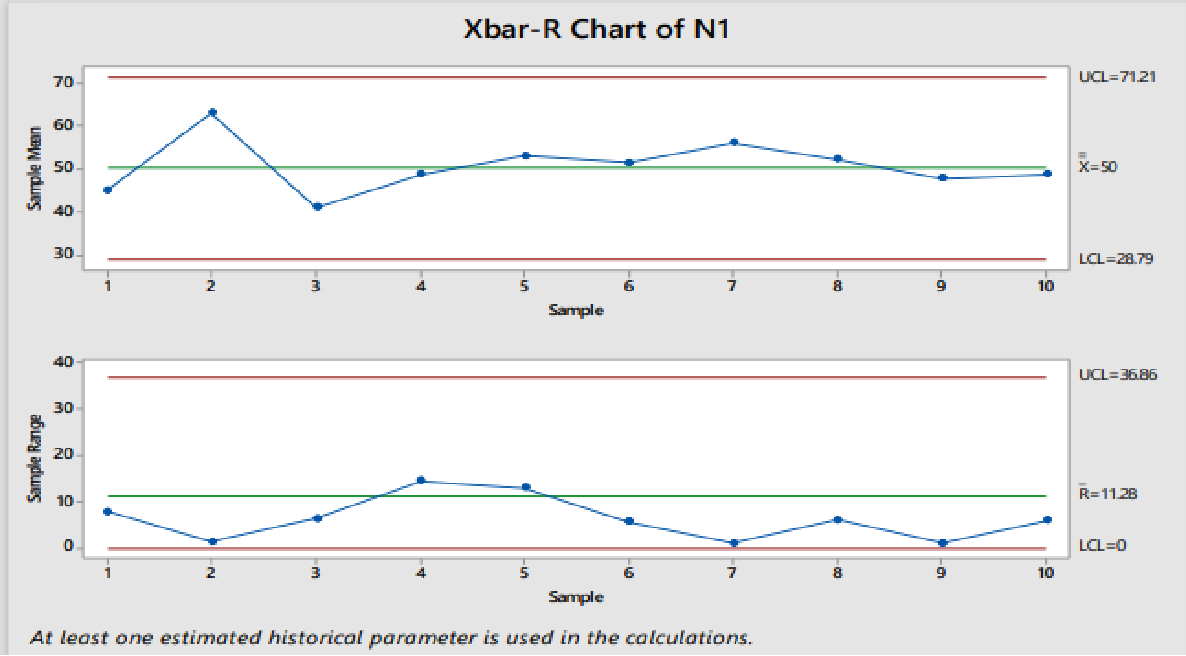
No of items in a lot	N	50,000,000	50,000,000	50,000,000
Sample size	n	10,000	100,000	1,000,000
Prop defective in a lot	p	0.005	0.00025	0.000001
Damage cost	A	1,000	1,000,000	10,000,000,000
Inspection cost	I	10	10	10
Prob that lot will be accepted	Pa	0.95	0.95	0.95
No inspection		250,000,000	12,500,000,000	500,000,000,000
Sampling		262,547,500	11,877,200,000	465,534,500,000
100% Inspection		500,000,000	500,000,000	500,000,000

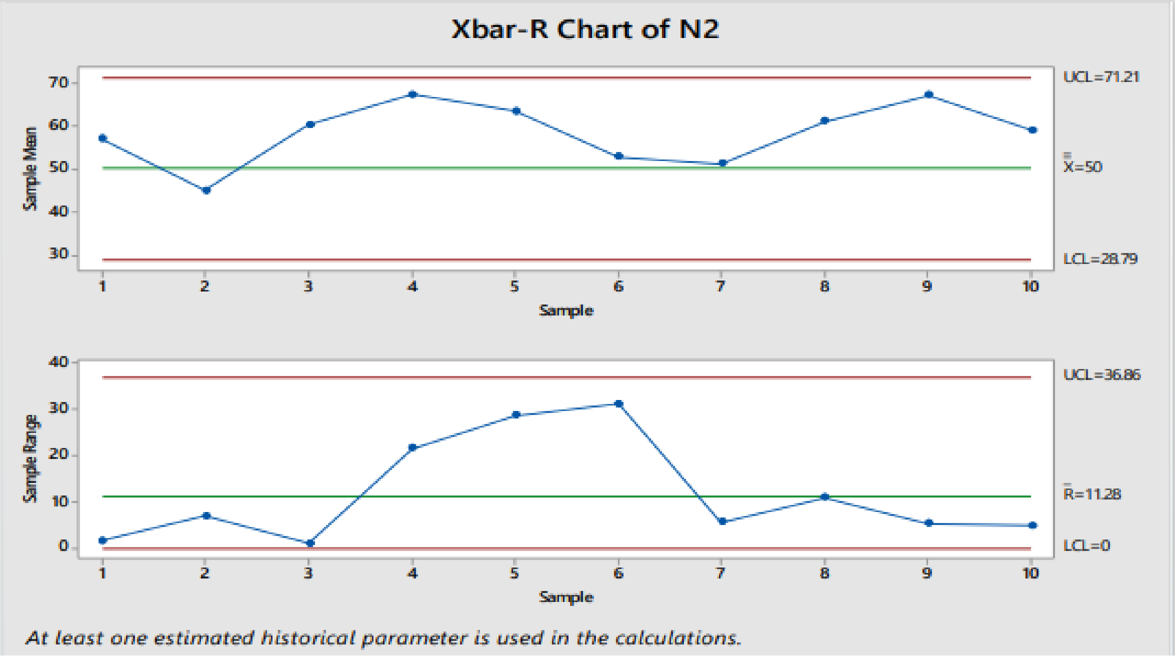
SPC Charts

- A statistical process control chart plots the performance of a process over time and shows the control limits that the results fall within.
- We can then determine if the process is stable and 'in-control' or not.
- For our project we focused on the time it takes to reach an injured civilian
- We studied the time taken by the ambulance to reach the destination and analyzed the control charts developed from the data.

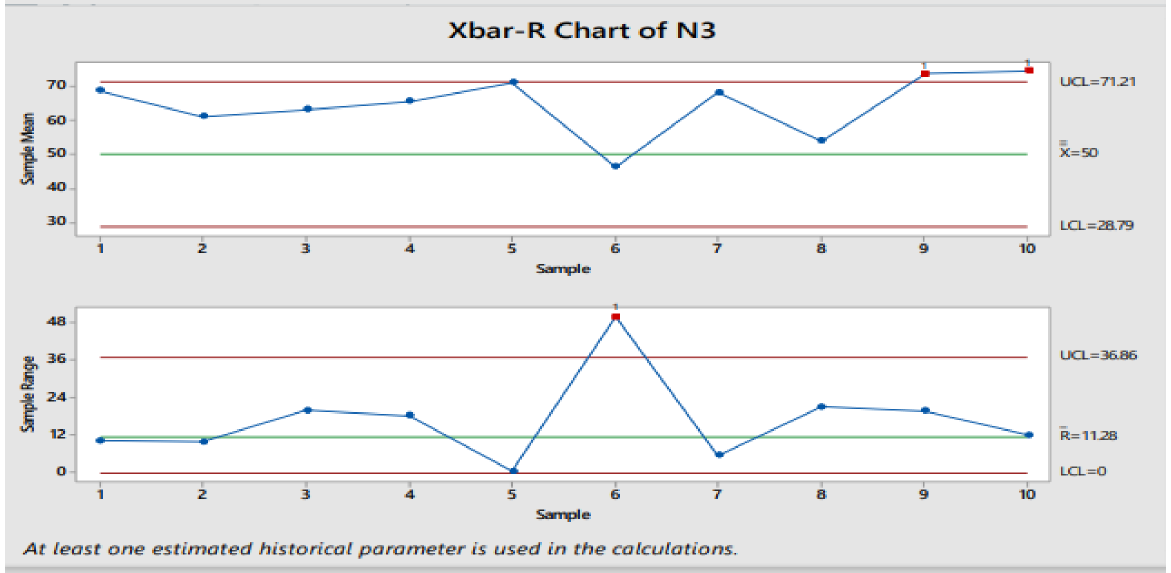


SPC Charts





- These charts represent the time taken from the ambulance hub to the injured civilian's location.
- While the first two tests did not fail, the third test showed both the average and the variation of the process were not stable or in control.
- Further tests seek to analyze the time response of ambulances from 3 different hub locations around the city.



Reliability Analysis (FMEA)

Process Step	Failure Mode	Severity 1-10 10 = most severe	Occurrence 1-10 10 = highest prob of occurrence	RPN	Improvement Action
Assessment and Planning	**Incomplete Information**	7	8	56	**Establishment of Redundant Communication Channels**
Triage and Prioritization	**Lack of Training**	9	6	54	**Standardized Triage Training**
Resource Mobilization	**Shortages of Critical Resources**	10	8	80	**Establishment of Rapid Response Teams**
Communication and Coordination	**Lack of Information Sharing**	8	7	56	**Establishment of unified Command Structure**
Security and Safety	**Inadequate Security Measures**	6	5	35	**Threat Assessments and Risk Mitigation**

CONCLUSION

Providing civilians with adequate medical attention is essential for safeguarding public health and well-being in a city under siege. Timely access to medical care can significantly reduce mortality rates and mitigate the impact of health emergencies. Using the tools provided in the class we were able to take a quality engineering approach to analyze, measure, and improve our methods of providing medical assistance. This helped us reduce the casualty rate in the city under siege.

Thank You!