MFE-634
SUPPLY OF FOOD,WATER & SHELTER TO CIVILIANS IN A CLOSED WAR ZONE

GROUP-4

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Problem Statement

In a closed war zone, ensuring the daily supply of enough amount of food and water to civilians faces a critical challenge. The dire circumstances of war exacerbate the logistical difficulties inherent in delivering essential resources to populations facing displacement, violence, and scarcity. Moreover, the dynamic nature of conflict zones, characterized by unpredicted shifts in population size and accessibility, further complicates the provision of sustenance.

Objectives

Develop a comprehensive strategy for efficiently supplying food and water to civilians trapped within inaccessible and volatile war zone. The key challenges:

- **Limited Access**: no in, no out
- **Viable Population**: not fixed number of populations due to immigrant, displacement, etc.
- **Resource Scarcity**: scarce resources lead to conflict
- **Security risks**: NGO workers might be exposed to attacks, ambushes
- **Infrastructure Damage**: destructed roads, bridges inhibit delivery of food

<u>Need a multidisciplinary approach to reach the objective</u>

Overview

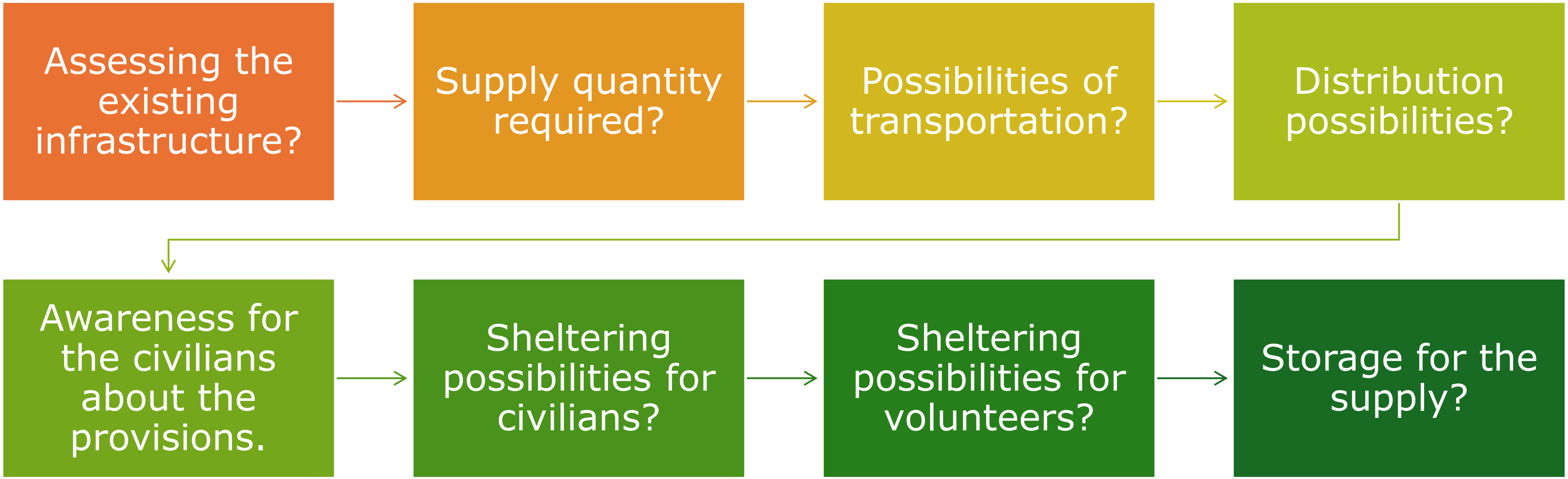
Objective: Applied advanced quality engineering methodologies to tackle the critical issue of providing essential resources (food, water, shelter) in closed warzones.

Methodologies Used:

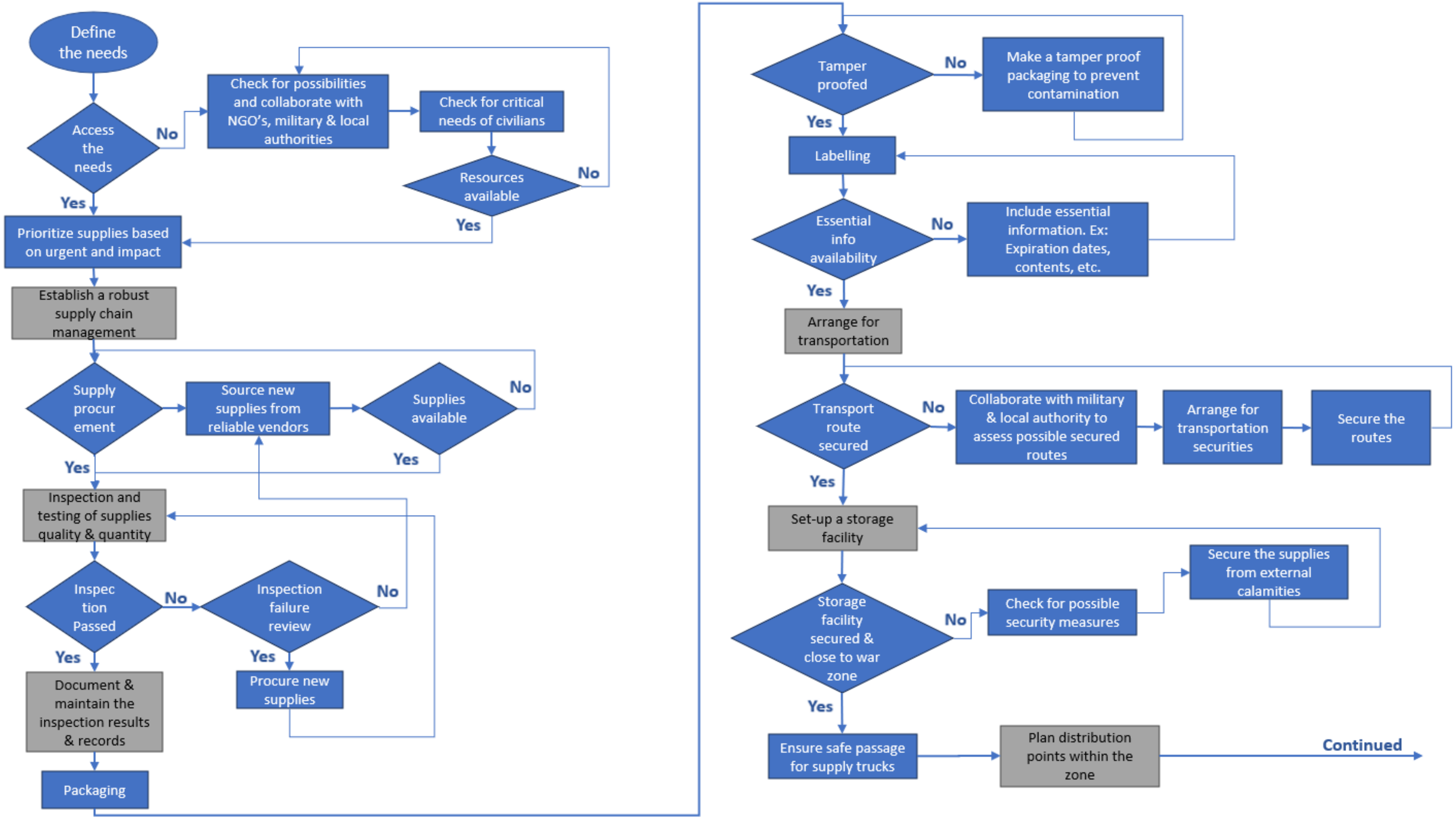
- Six Sigma (DMAIC), Process Capability, DFSS: Optimized supply chain processes to enhance the quality and reliability of delivered resources.
- Matrix Tools, QFD, FMEA: Identified and mitigated risks in resource procurement, transportation, and distribution.
- Lean Manufacturing (VSM, 5Ss): Streamlined operations and eliminated waste for efficient resource utilization.
- Inspections, Testing, Metrology (MSA, Gage R&R, COPQ): Maintained high quality standards and minimized defects.
- Acceptance Sampling, DOE (Fractional Factorial): Optimized processes for consistent quality outcomes.
- SPC, Reliability Models (FMEA, Fault Trees): Monitored and improved process reliability and product quality.
- Data Analysis Tools: Derived actionable insights to enhance operational reliability and effectiveness.

Impact: Demonstrated proficiency in a wide range of quality engineering tools to improve essential resource delivery in crisis situations.

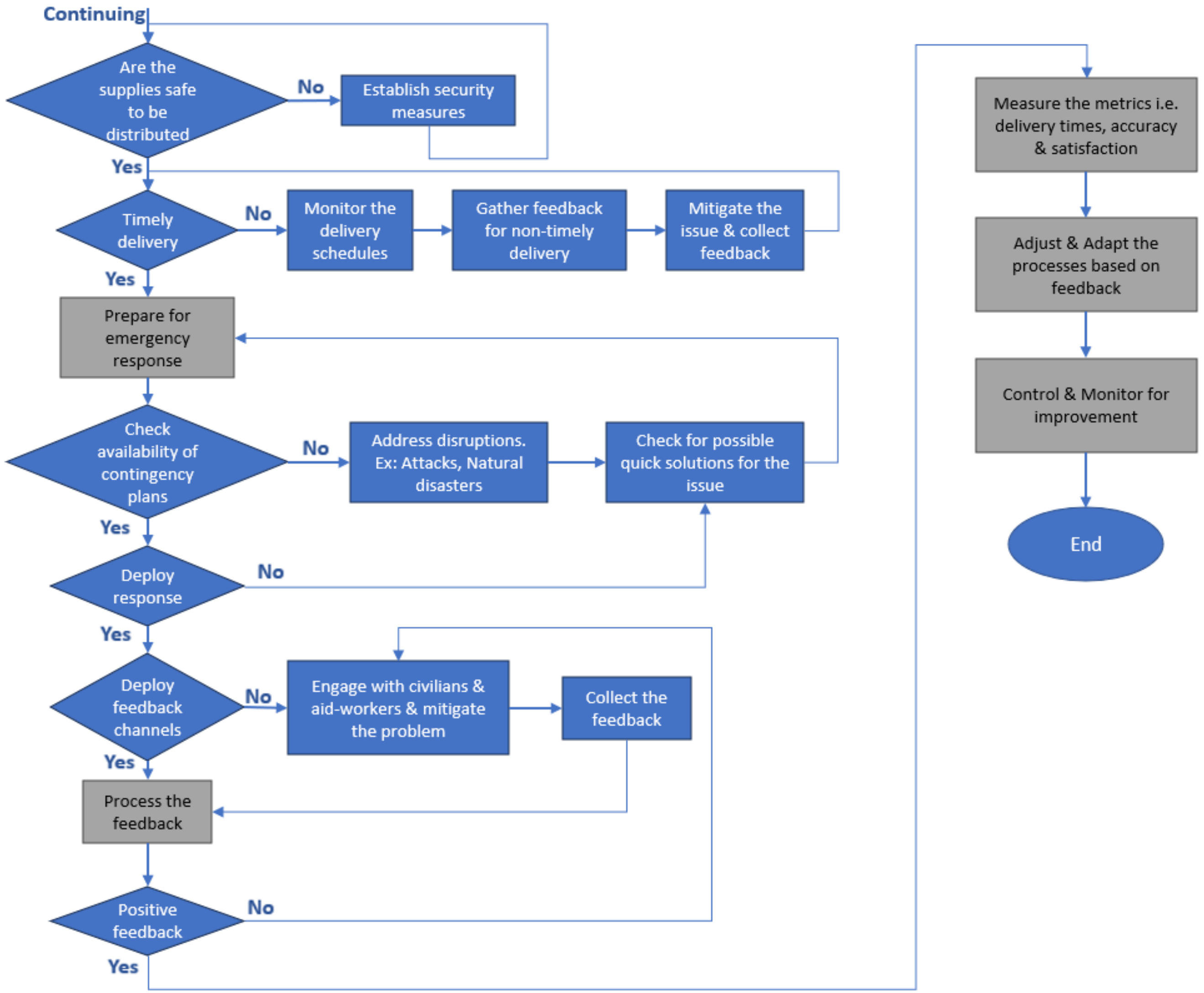
Brainstorming Ideas



Process Flowchart



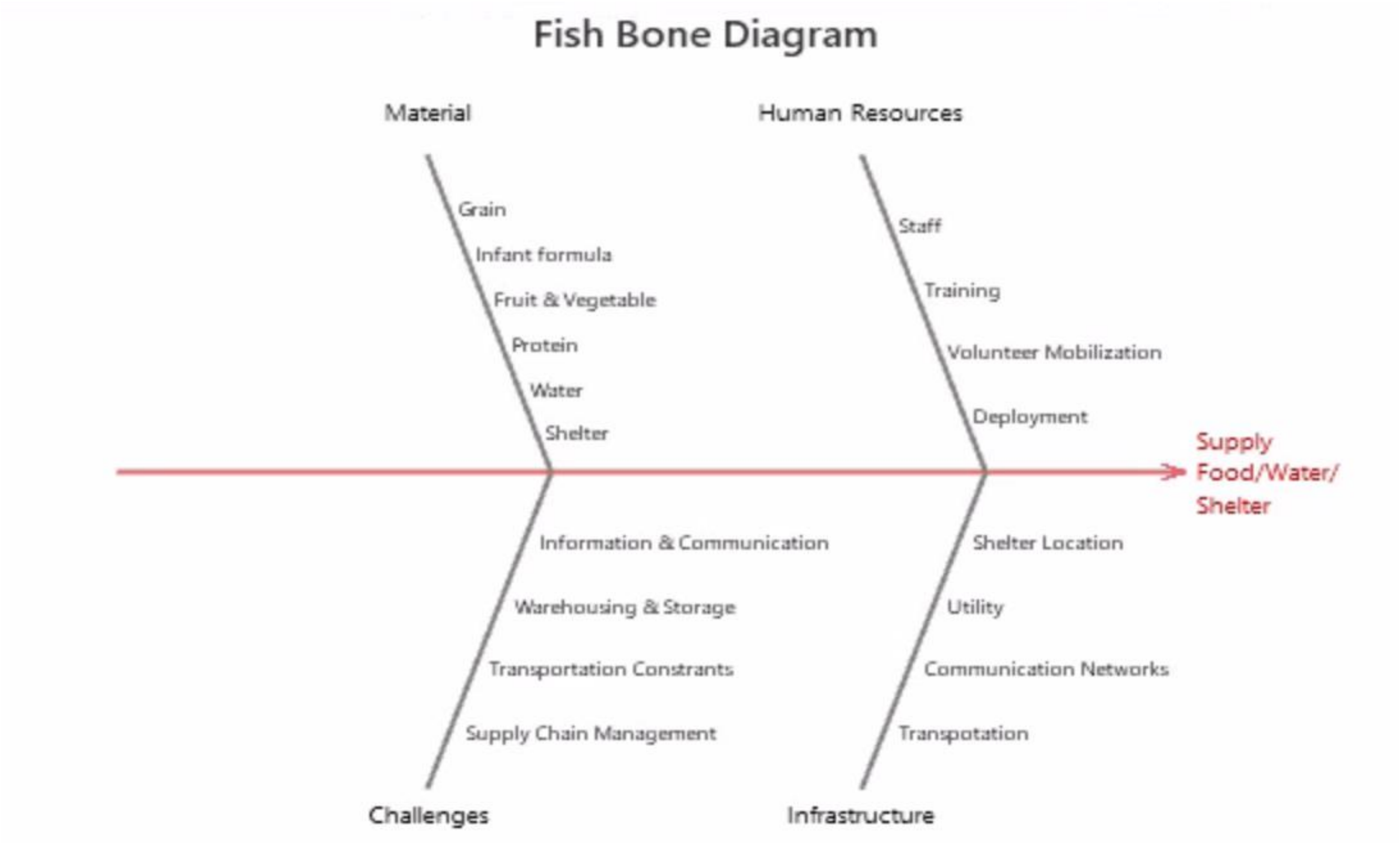
Process Flowchart



Cost of Poor Quality-COPQ

Process	Internal Failure Cost	External Failure Cost	Appraisal Cost	Prevention Cost
Order Management	• Inaccurate Forecasting • Miscommunication • Inventory Management	• Incorrect Orders • Delay Deliveries • Customer Complaints	• Quality Assurance • Order Tracking System • Customer Feedback	• Demand Forecasting • Continuous Improvement
Supplier	• Quality Control Issues • Delivery Delays • Reliability Concerns	• Product Recalls • Legal Liabilities • Loss of Customers	• Supplier Audits • Supplier Training • Quality Assurance Agreement	• Relationship w/ Supplier • Diversification of Suppliers • Early Warning Systems
Packing Distribution	• Improper Handling • Inadequate Packaging • Suboptimal Routing	• Spoilage & Contamination • Product Returns • Brand Damage	• Quality Inspections • Employee Training • Technology Investments	• Packaging Technology • Supply Chain • Training Programs

Ishikawa Diagram



Voice of Customer

- **Safety and Security**: not create more risks or insecurity
- **Reliability and Consistency**: consistent access to food and water
- **Accessibility**: ensure no individual or community is left behind
- **Adaptability**: flexible supply system due to population change
- **Quality and Nutritional Value**: meet basic health standards
- **Simplicity and Easy of Use**: uncomplicated processes

Design Requirements

Dependable modes of transportation: robust trucks and trains with a 98% efficiency rate.

Adequate storage infrastructure: spacious silos and food in dry environments.

Effective equipment handling and loading mechanisms: employment of cranes, trolleys, and dry storage containers.

Reliable communication tools and software: utilization of tracking software and phones.

Advanced tracking and tracing systems: integration of GPS technology.

Strong quality control and assurance procedures: implementation of well-structured quality inspection processes.

Quality Control

EXAMINATION AND TESTING OF FOOD/WATER OR SHELTER TO ASSESS QUALITY AND QUANTITY

SUPERVISION AND REGULATION OF STORAGE CONDITIONS

SCRUTINY AND UPKEEP OF TRANSPORTATION METHODS AND EQUIPMENT

EXAMINATION AND DOCUMENTATION OF QUALITY DATA

ONGOING ENHANCEMENT OF QUALITY CONTROL PROCEDURE

DMAIC-phase

PROVISION OF FOOD,WATER AND SHELTER IN A CLOSED WARZONE
(Phase 2-Measure)

Activities:

- Collect data on the number and locations of people in need.
- Assess available resources and potential risks.
- Define key performance indicators (KPIs) related to the efficiency and effectiveness of providing food, water, and shelter.

PROVISION OF FOOD,WATER AND SHELTER IN A CLOSED WARZONE
(Phase 1-Define)

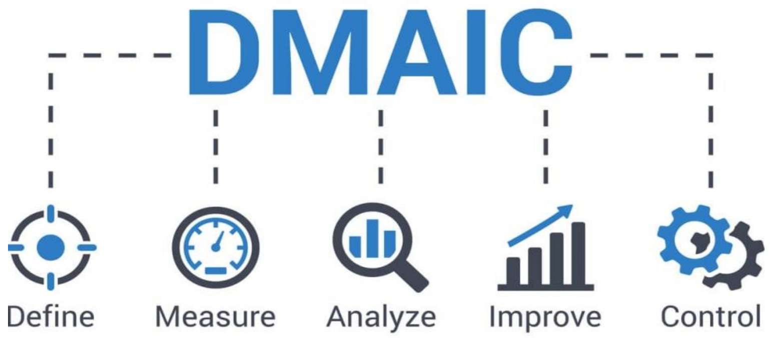
Activities:

- Clearly define the objectives of your humanitarian mission, such as the number of people to be served.
- The types of assistance needed (food, water, shelter).
- The specific challenges and risks associated with operating in a warzone.
- Establish a team with diverse skills, including logistics, medical expertise, security, and communication.

PROVISION OF FOOD,WATER AND SHELTER IN A CLOSED WARZONE
(Phase 3-Analyze)

Activities:

- Analyze the data to identify bottlenecks, inefficiencies.
- Analyze potential risks in the current humanitarian efforts.
- Conduct a risk assessment to understand and mitigate potential dangers associated with operating in a warzone.



QFD Matrix

Quality Function Deployment

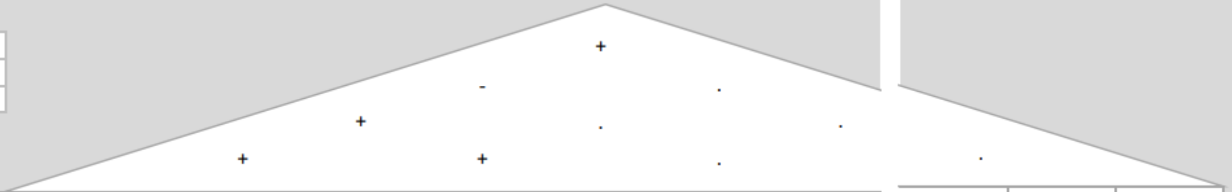
Project title: Providing food, water and shelter to civilians in a closed warzone
Project leader: AMEYA N SHENOY
Date: 4/22/2024

Correlation:

+	.	-
Positive	No correlation	Negative

Relationships:

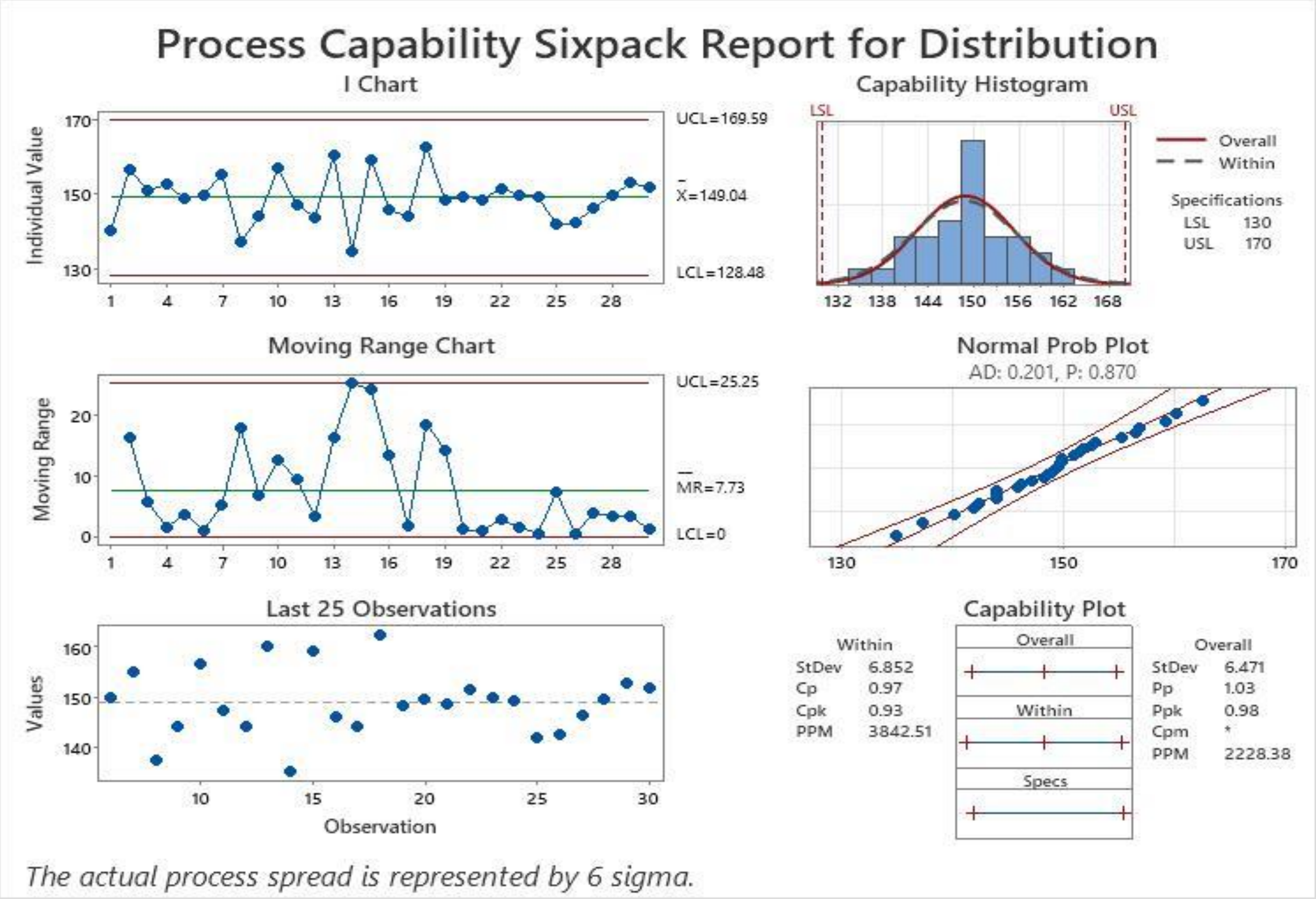
9	7	1	
Strong	Moderate	Weak	None



Competitive evaluation (1: low, 5: high)

	Customer importance rating (1: low, 5: high)	Customer Requirements - (What's) ↓ / Functional Requirements (How's) →	Availability	Accessibility	Reports/Data	Purification efficiency	Safety	Sustainability	Affordability	Emergency packaging	Durability	Environmental impact	Cost effectiveness	Weighted Score	Satisfaction rating	Competitor rating 1	Competitor rating 2	Competitor rating 3
		Desired direction of improvement (↑,0,↓)	↑	↑	↓	↑	↑	↑	↑	↓	↑	↓	↑					
1	5	Food	9	9	7	9	9	9	7	9	7	7	3	38.64				
2	5	Water	9	9	7	9	9	9	7	9	8	7	7	40.91				
3	5	Shelter	9	9	7	9	9	9	7	9	9	7	7	41.36				
4	3	Sanitary supplies	7	7	7	8	7	8	3	8	7	7	7	20.73				
5	3	Border Patrol	3	3	3	3	9	7	3	1	3	3	3	11.18				
6	5	Volunteers	7	7	7	3	9	8	3	3	7	3	3	27.27				
7	4	Administrators	7	7	7	3	9	8	7	3	7	3	3	23.27				
8	1	Quarantine rooms	3	7	8	7	7	8	7	1	7	3	3	5.55				
9	4	Equipments	7	8	8	7	7	8	8	1	8	7	3	26.18				
10	4	Facilities	7	8	8	7	8	7	7	1	8	7	7	27.27				
11	2	Procedures	7	7	7	1	7	7	3	1	7	3	7	10.36				
12	3	Transportation capacity	7	9	1	1	3	1	7	1	7	7	7	13.91				
		Technical importance score	82	90	77	67	93	89	69	47	85	64	60	286.64				
		Importance %	29%	31%	27%	23%	32%	31%	24%	16%	30%	22%	21%	26%				
		Priorities rank	**5**	**2**	**6**	**5**	**1**	**2**	**3**	**7**	**8**	**9**	**10**					
		Current performance																
		Target																
		Benchmark																
		Difficulty												1: very easy, 5: very difficult				
		Cost and time												1: low, 5: high				
		Priority to improve																

Process Capability



- To define the capability of process
- Xbar chart shows data in control
- Range chart shows the range is in USL and LSL but there are too many times closed to UCL
- The data spreads all over place
- Cp is 0.97 which is less than 1.33.
- Process is not capable, need to move data closer to mean value
- Enhance the supply chain management to have enough food supply
- Try to avoid waste from tossing out the spoiled food, leading to not enough supply

Supply Chain-Distribution

Product	Level		1	2	3	4	5	6	7	8	9	10	Total
No. of Dislodged Families	0	Demand (J1)	6	2	9	9	9	4	6	8	4	10	67
		Planned Receipt	8	8	7	6	4	5	7	6	5	5	61
		Total Units	16	16	15	12	7	5	8	8	5	6	98
		Inventory	8	8	6	3	-2	1	2	0	1	-4	23
		Overflow	2	6	0	0	0	0	0	0	0	0	8
		Shortage	0	0	0	0	2	0	0	0	0	4	6
		Cost of Inventory($70 ea)	$560	$560	$420	$210	$0	$70	$140	$0	$70	$0	$2,030
		Cost of Overflow ($100 ea)	$200	$600	$0	$0	$0	$0	$0	$0	$0	$0	$800
		Cost of Shortage ($50 ea)	$0	$0	$0	$0	$100	$0	$0	$0	$0	$200	$300
Number of Tents/Shelters	1	Production	8	8	7	6	4	5	7	6	5	5	61
		Planned Receipt	8	8	7	6	4	5	7	6	5	5	61
		Total Units	18	18	17	16	14	15	17	16	15	15	161
		Inventory	10	10	10	10	10	10	10	10	10	10	100
		Overflow	0	0	0	0	0	0	0	0	0	0	0
		Shortage	0	0	0	0	0	0	0	0	0	0	0
		Cost of Inventory ($10 ea)	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$1,000
		Cost of Overflow ($10 ea)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Cost of Shortage ($30 ea)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
No. of Construction Workers	2	Production	8	8	7	6	4	5	7	6	5	5	61
		Planned Receipt	8	8	7	6	5	5	4	6	5	5	59
		Total Units	17	17	16	15	14	14	13	15	14	14	149
		Inventory	9	9	9	9	9	9	9	9	9	9	90
		Overflow	0	0	0	0	0	0	0	0	0	0	0
		Shortage	0	0	0	0	0	0	0	0	0	0	0
		Cost of Inventory ($20 ea)	$180	$180	$180	$180	$180	$180	$180	$180	$180	$180	$1,800
		Cost of Overflow ($20 ea)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Cost of Shortage ($40 ea)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

Supply Chain Management

- Too much cost of inventory which is about $2000 for no. of dislodged families, $1000 for no. of tents/shelters, and $1800 for no. of construction workers
- Some extra costs for overflow and shortage at no. of dislodged families ($800 and $300 respectively)
- Quantity in inventory is full at all time in no. of construction workers and no. of tents/shelters -> leading to waste of money and waste of space
- Use Excel Solver to optimize the supply chain, hence reduce the total cost. The inventory amount has to be used to reduce cost of inventory in all 3 phases.
- Using Excel Solver to find optimized solution to minimize the total cost while still providing enough supply
- By changing the number of distribution J for each week (no. of construction workers), changing the inventory quantity of 2 phases: no. of construction workers & no. of tent/shelters
- The constrains is number of distribution and inventory quantity has to be in integer, inventory level max of no. of construction workers is 9, and of no. of tents/shelters is 10.

Supply Chain Management-Result

Product	Level		1	2	3	4	5	6	7	8	9	10	Total
No. of Dislodged Families	0	Demand (J1)	6	2	9	9	9	4	6	8	4	10	67
		Planned Receipt	2	0	3	9	4	4	7	7	4	10	50
		Total Units	10	4	5	9	4	4	7	8	4	10	65
		Inventory	4	2	-4	0	-5	0	1	0	0	0	-2
		Overflow	0	0	0	0	0	0	0	0	0	0	0
		Shortage	0	0	4	0	5	0	0	0	0	0	9
		Cost of Inventory($70 ea)	$280	$140	$0	$0	$0	$0	$70	$0	$0	$0	$490
		Cost of Overflow ($100 ea)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Cost of Shortage ($50 ea)	$0	$0	$200	$0	$250	$0	$0	$0	$0	$0	$450
Number of Tents/Shelters	1	Production	2	0	3	9	4	4	7	7	4	10	50
		Planned Receipt	2	0	3	9	4	4	7	7	4	10	50
		Total Units	12	10	13	19	14	14	17	17	14	20	150
		Inventory	10	10	10	10	10	10	10	10	10	10	100
		Overflow	0	0	0	0	0	0	0	0	0	0	0
		Shortage	0	0	0	0	0	0	0	0	0	0	0
		Cost of Inventory ($10 ea)	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$1,000
		Cost of Overflow ($10 ea)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Cost of Shortage ($30 ea)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
No. of Construction Workers	2	Production	2	0	3	9	4	4	7	7	4	10	50
		Planned Receipt	2	0	3	9	5	4	4	7	4	10	48
		Total Units	11	0	3	9	5	4	4	7	4	10	57
		Inventory	9	0	0	0	0	0	0	0	0	0	9
		Overflow	0	0	0	0	0	0	0	0	0	0	0
		Shortage	0	0	0	0	0	0	0	0	0	0	0
		Cost of Inventory ($20 ea)	$180	$0	$0	$0	$0	$0	$0	$0	$0	$0	$180
		Cost of Overflow ($20 ea)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
		Cost of Shortage ($40 ea)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

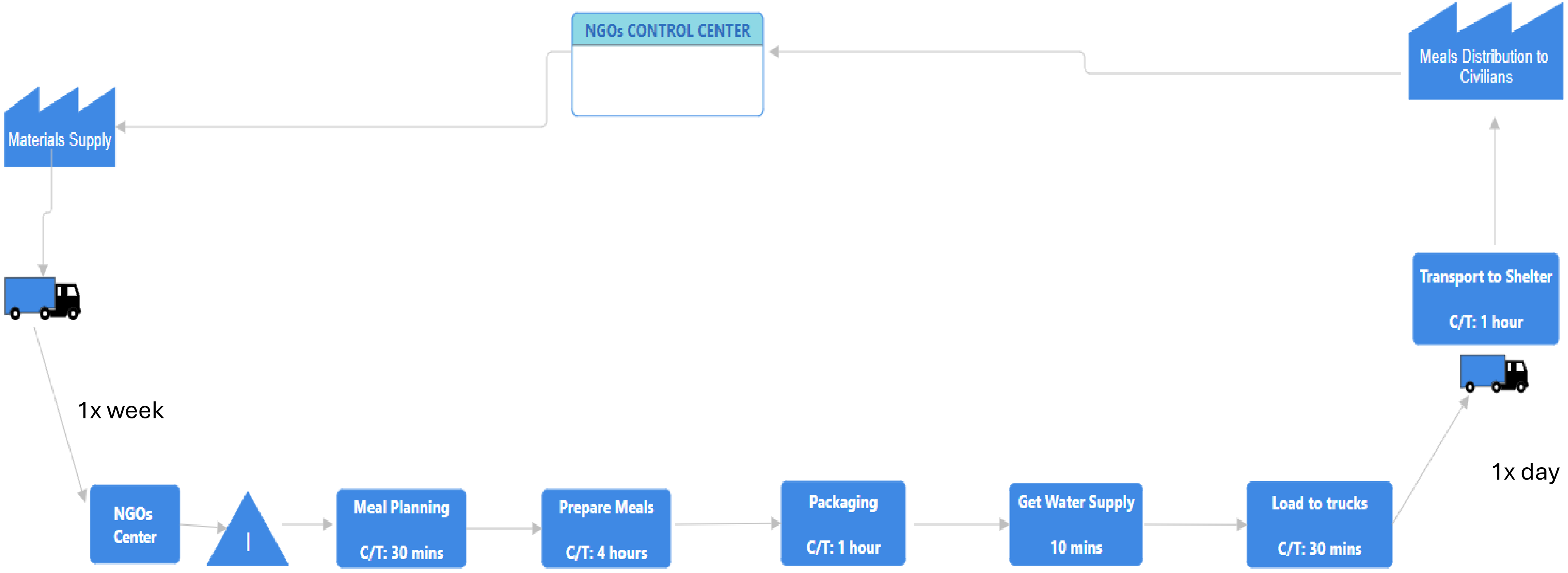
	Level 0	Level 1	Level 2
Cost of Inventory	$2,030	$1,000	$1,800
Cost of Overflow	$800	$0	$0
Cost of Shortage	$300	$0	$0
Cost/Level	$3,130	$1,000	$1,800
Total Cost	$5,930		

Supply chain with optimization

	Level 0	Level 1	Level 2
Cost of Inventory	$490	$1,000	$180
Cost of Overflow	$0	$0	$0
Cost of Shortage	$450	$0	$0
Cost/Level	$940	$1,000	$180
Total Cost	$2,120		

Supply chain with optimization

Value Stream Map



7 DAYS 30 MINS

5 HOURS 10 MINS

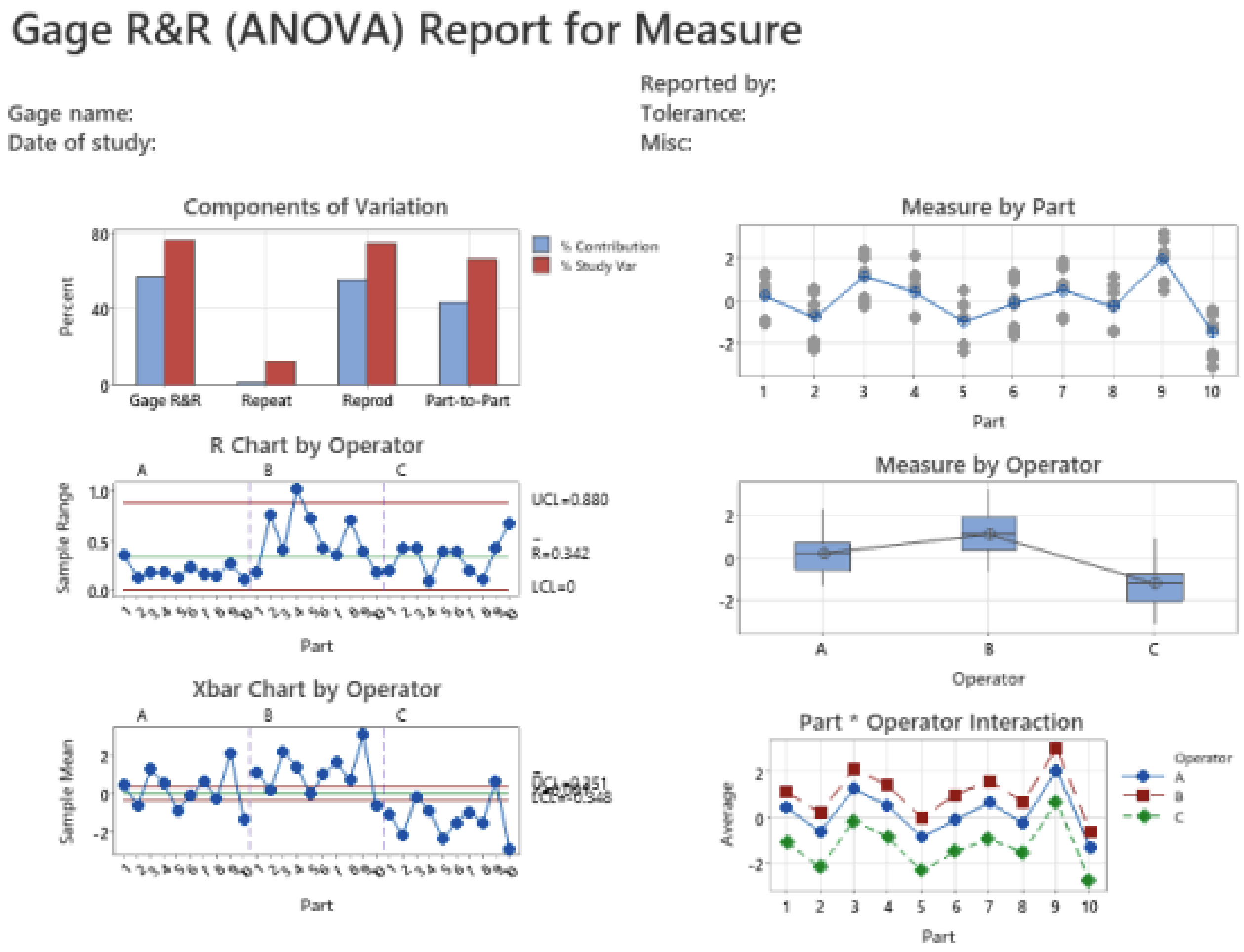
1 HOUR 30 MINS

Total Lead Time: 175 hours 10 minutes
Waiting Time: 170 hours

Lean Process Improvement

- From the VSM, the waiting time (waiting to transport) is too much, takes up to 97% of total lead time.
- Need to apply lean process to reduce it
- Can reduce to time to transport the raw material to NGOs center by delivery 2x a week

Gage R&R Study



- Randomly pick 3 food inspectors
- Randomly pick 10 different meals
- A gauge measurement to test for food quality.

➢ Goal: to see if the measurement system work correctly or not

Two-Way ANOVA Table With Interaction

Source	DF	SS	MS	F	P
Part	9	88.362	9.8180	492.29	0.000
Operator	2	82.527	41.2636	2069.03	0.000
Part * Operator	18	0.359	0.0199	0.43	0.974
Repeatability	60	2.759	0.0460		
Total	89	174.007			

α to remove interaction term = 0.05

Two-Way ANOVA Table Without Interaction

Source	DF	SS	MS	F	P
Part	9	88.362	9.8180	245.61	0.000
Operator	2	82.527	41.2636	1032.28	0.000
Repeatability	78	3.118	0.0400		
Total	89	174.007			

Gage R&R Result

Variance Components

Source	VarComp	%Contribution (of VarComp)
Total Gage R&R	1.41410	56.55
Repeatability	0.03997	1.60
Reproducibility	1.37412	54.95
Operator	1.37412	54.95
Part-To-Part	1.08645	43.45
Total Variation	2.50054	100.00

Gage Evaluation

Source	StdDev (SD)	Study Var (6 × SD)	%Study Var (%SV)
Total Gage R&R	1.18916	7.13494	75.20
Repeatability	0.19993	1.19960	12.64
Reproducibility	1.17223	7.03338	74.13
Operator	1.17223	7.03338	74.13
Part-To-Part	1.04233	6.25396	65.92
Total Variation	1.58131	9.48786	100.00

Number of Distinct Categories = 1

Keys:

% Contribution:

- <1% = Acceptable
- 1–9% = acceptable, dependent upon method of measurement, application, etc.
- >9% = Unacceptable and requires improvement

% Study Variance:

- < 10% = Acceptable
- 10-30% = acceptable, dependent upon method of measurement, application, etc.
- 30% = Unacceptable and requires improvement

Recommendation

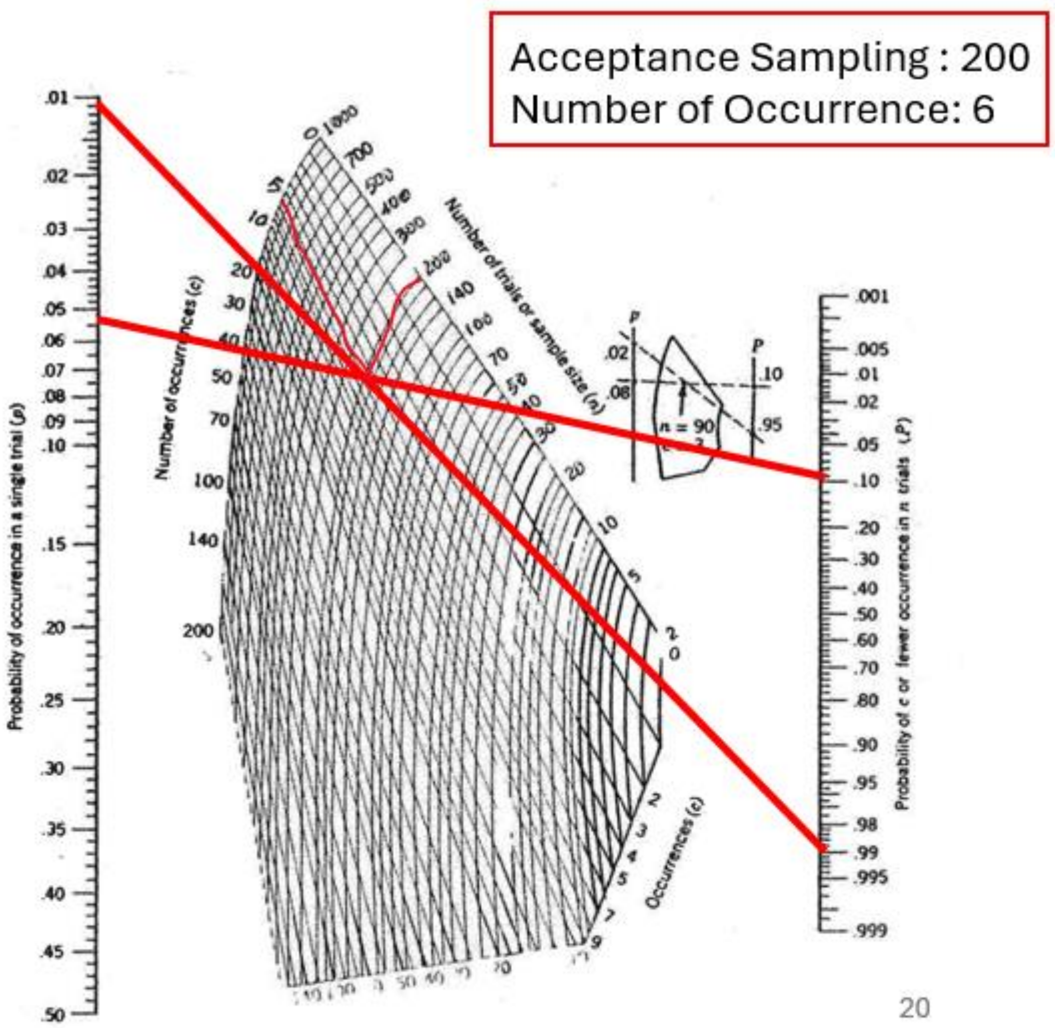
- The % reproducibility is too high, 54.95% in % contribution and 74.13% variance.
- Need to train the inspectors in how to measure for quality of food
- Every needs to inspect in the same way and follow standard process

Acceptance Sampling

- Acceptable Quality Level (AQL) is the percent of defectives that the plan will accept 99% of the time
- Lot Tolerance Percent Defective (LTPD) is the percent defective that the plan will reject 95% of the time

Goal:

- AQL of 99% confidence = 0.01
- LTPD of 95% confidence = 0.05
- Producer Risk (alpha) = 0.99
- Customer Risk (beta) = 0.1

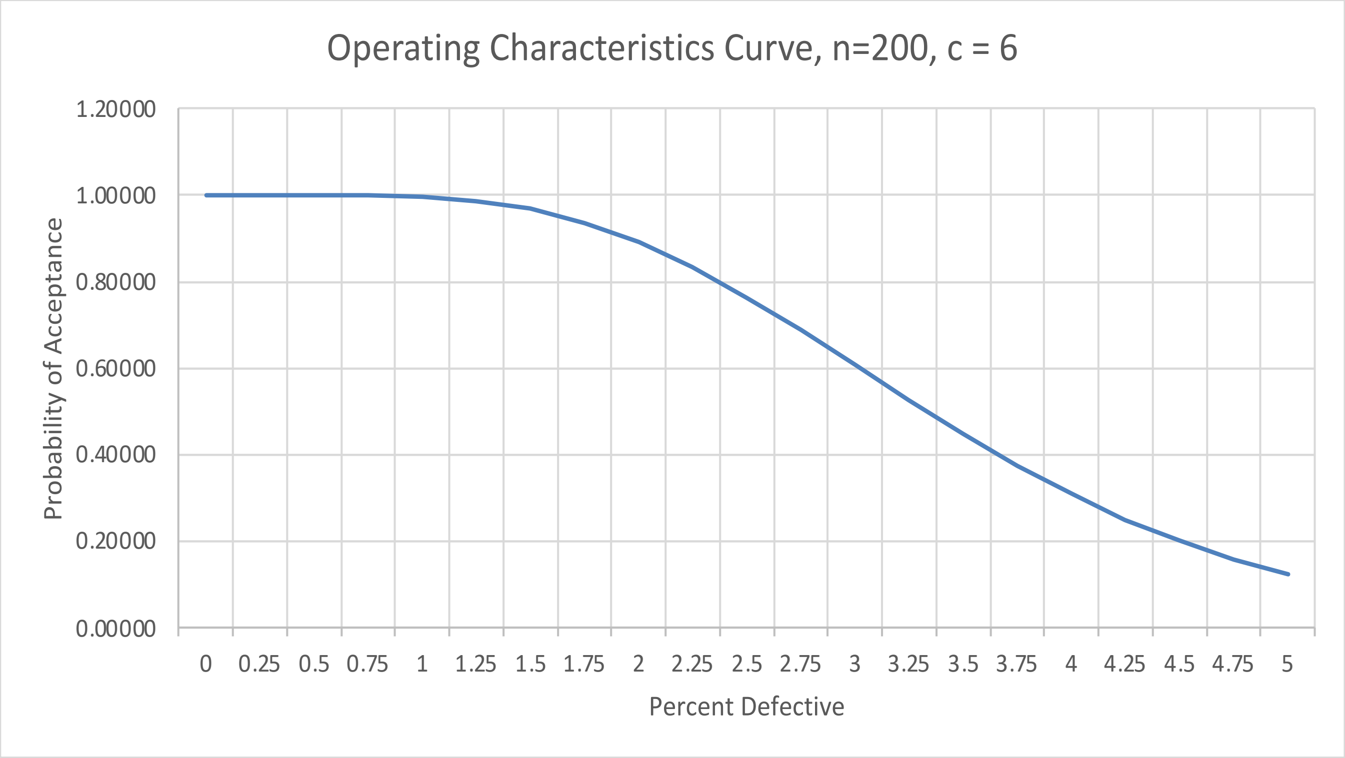


Steps in Acceptance Sampling

Acceptance sampling is a method used to determine if a batch of material meets specified quality standards. Here's a brief outline of the steps involved:

- Define Objectives: Set the purpose and quality standards for sampling.
- Determine the Sampling Plan: Choose the type of sampling plan and establish acceptance criteria.
- Select the Sample: Randomly draw a sample from the batch.
- Inspect the Sample: Test or inspect the sample based on set criteria.
- Make a Decision: Accept or reject the batch based on the inspection results.
- Take Action: Use, return, or dispose of the batch accordingly.
- Record Results: Document the inspection outcome and relevant details.
- Review and Adjust: Periodically reassess and adjust the sampling plan as needed.

Acceptance Sampling



- Probability of Acceptance decreases as percent defective increases
- Probability of acceptance is 99% at 1% defective
- To increase the probability of acceptance, keep the percent defective at minimal

DOE-Design of Experiment

- Design of Experiments (DOE) serves as a potent statistical technique frequently applied in Quality Engineering.
- It scrutinizes multiple input factors concurrently to detect their interactions that impact product or process quality.
- By managing these factors identified through DOE, it facilitates the enhancement of product or process quality.
- 3 main factors to be concerned are: population density, supply chain management, and community engagement. All three factors have both high level (+) and low level (-)

Design of Experiment

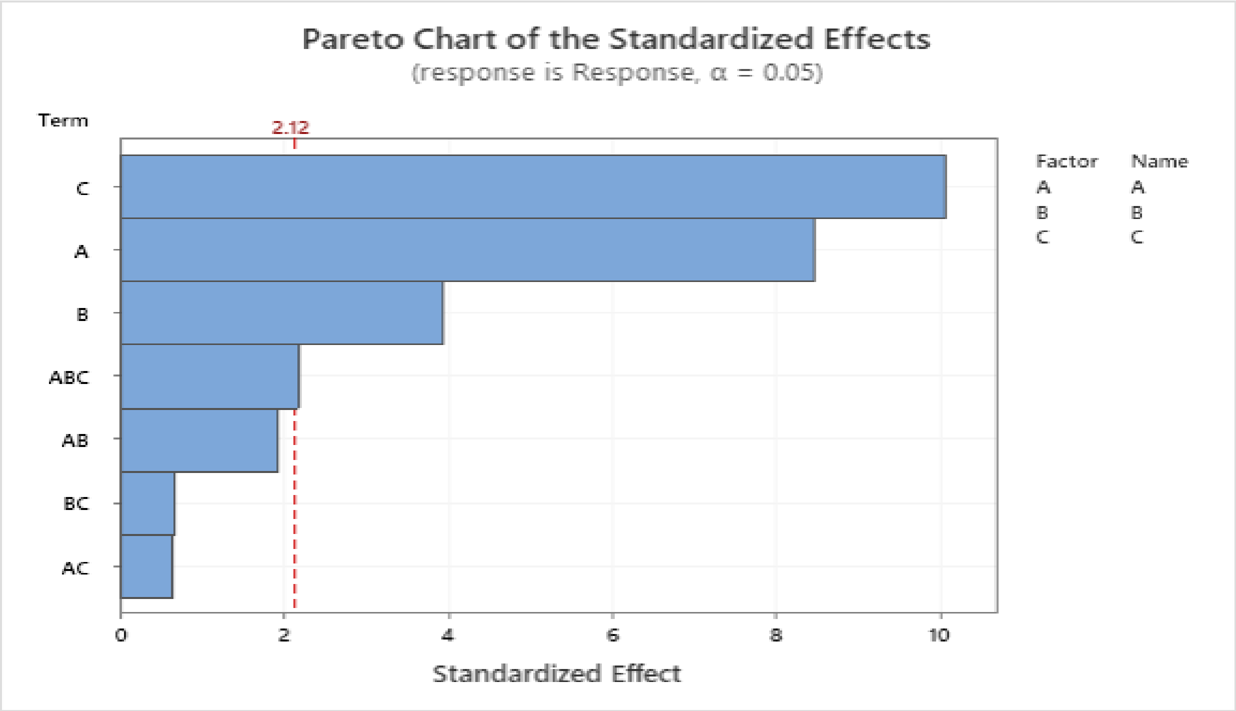
				Factorial Experiments 2^3 (Three Replications/Treatment)					Run Results			
Run		A	B	C	AB	AC	BC	ABC	Y1	Y2	Y3	Avg.	Var.
	1	-1	-1	-1	1	1	1	-1	-2.50	-2.42	1.72	-1.066	5.828
	2	1	-1	-1	-1	-1	1	1	3.56	0.73	6.87	3.719	9.446
	3	-1	1	-1	-1	1	-1	1	-1.71	-0.75	0.72	-0.580	1.499
	4	1	1	-1	1	-1	-1	-1	10.98	11.64	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					

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-Result



- The 3 factor A-population density, B-supply chain management, and C-community engagement are all significant.
- Community engagement is the most effective to the strategic. Hence, focus more on this by some more collaboration and transparency in community.
- Also, the population density is a very important element that need to be aware
- Supply chain management is not important as other but still an important factor.

Coded Coefficients

Term	Effect	Coef	SE Coef	T-Value	P-Value	VIF
Constant		8.339	0.477	17.47	0.000	
A	8.079	4.039	0.477	8.46	0.000	1.00
B	3.753	1.876	0.477	3.93	0.001	1.00
C	9.622	4.811	0.477	10.08	0.000	1.00
A*B	1.838	0.919	0.477	1.93	0.072	1.00
A*C	-0.623	-0.311	0.477	-0.65	0.524	1.00
B*C	-0.649	-0.325	0.477	-0.68	0.506	1.00
A*B*C	-2.078	-1.039	0.477	-2.18	0.045	1.00

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
2.33883	92.52%	89.25%	83.17%

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	7	1082.60	154.657	28.27	0.000
Linear	3	1031.56	343.854	62.86	0.000
A	1	391.58	391.578	71.59	0.000
B	1	84.49	84.491	15.45	0.001
C	1	555.49	555.494	101.55	0.000
2-Way Interactions	3	25.13	8.378	1.53	0.245
A*B	1	20.28	20.279	3.71	0.072
A*C	1	2.33	2.325	0.43	0.524
B*C	1	2.53	2.528	0.46	0.506
3-Way Interactions	1	25.91	25.907	4.74	0.045
A*B*C	1	25.91	25.907	4.74	0.045
Error	16	87.52	5.470		
Total	23	1170.12			

Regression Equation in Uncoded Units

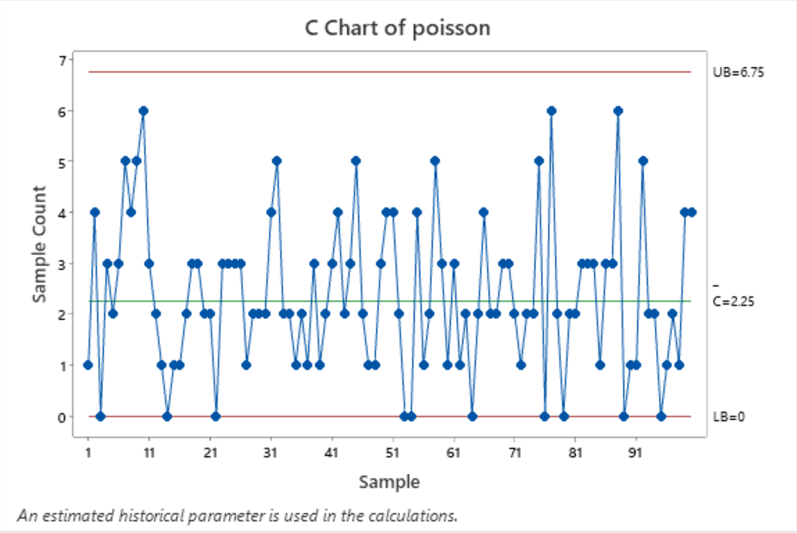
Response = 8.339 + 4.039 A + 1.876 B + 4.811 C + 0.919 A*B - 0.311 A*C - 0.325 B*C - 1.039 A*B*C

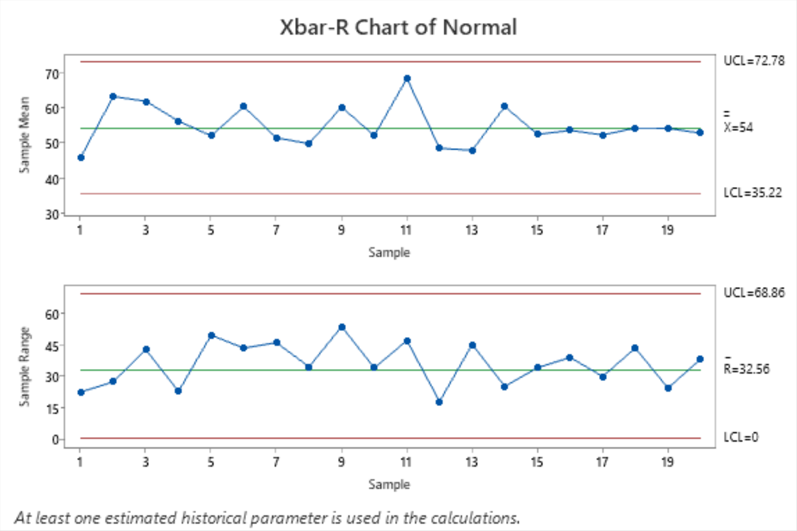
Statistical Process Control

X-bar R charts and C charts are used in statistical process control to monitor manufacturing and business processes:

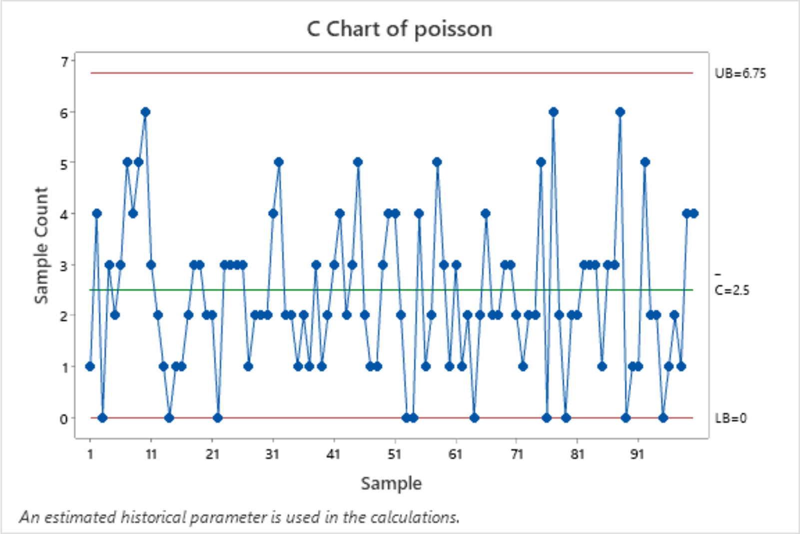
X-bar R Chart: Monitors the average and range of subgroup samples to detect shifts in process means and variability, ensuring process stability and consistency.

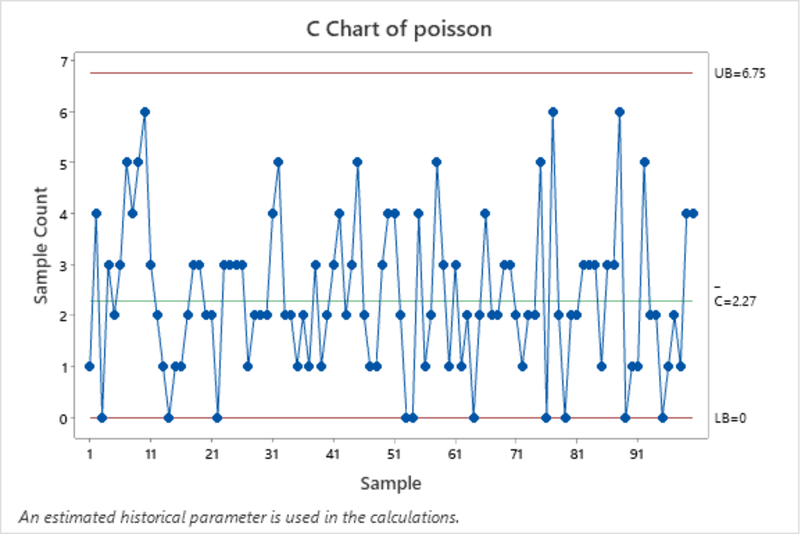
C Chart: Tracks the number of defects per unit to identify changes in defect rates, helping maintain quality and reduce defects in constant-opportunity processes.

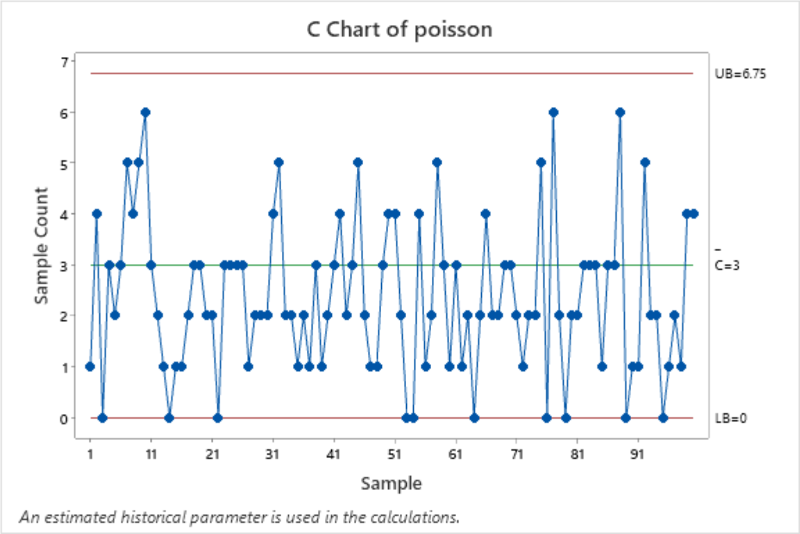


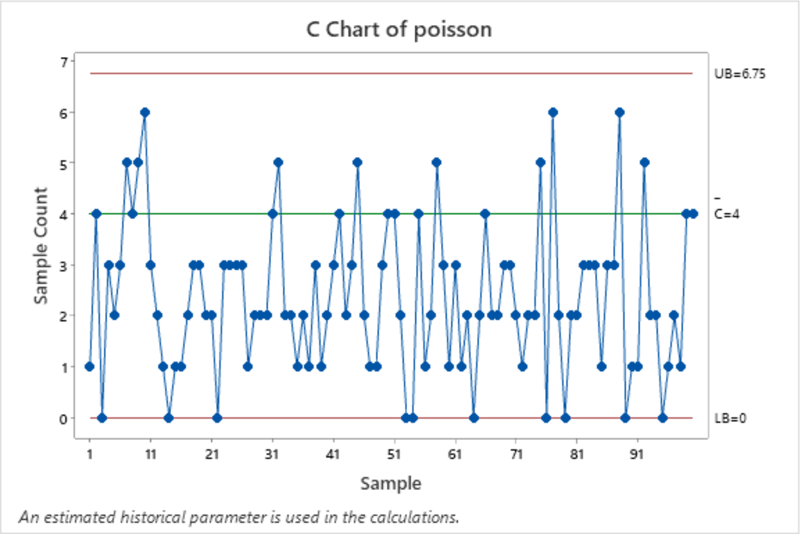


Statistical Process Control-C Chart

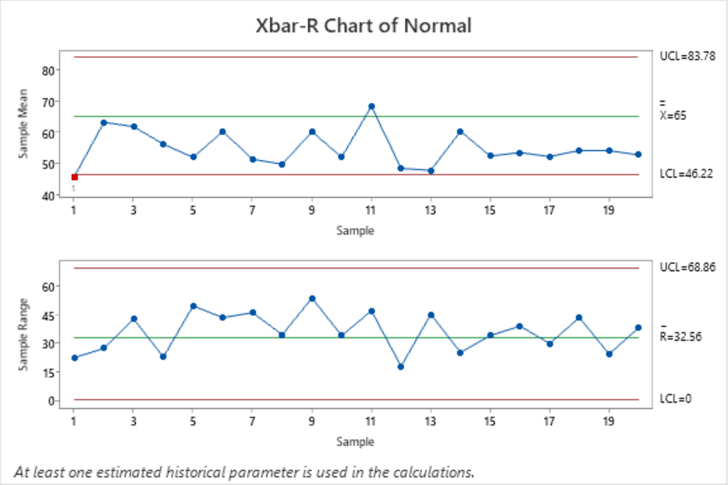


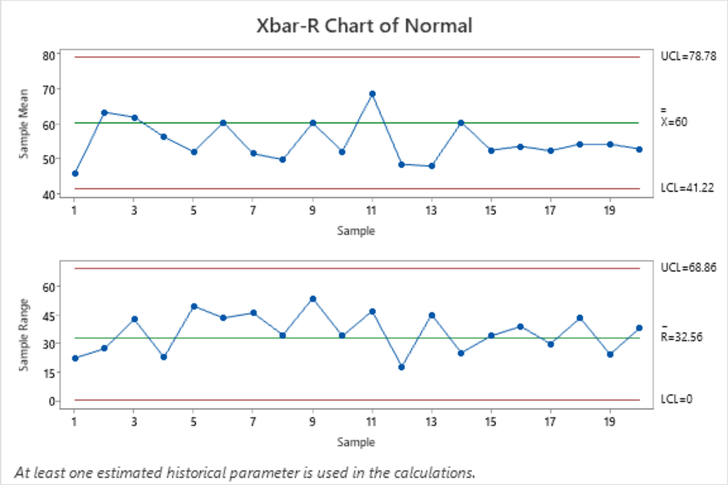


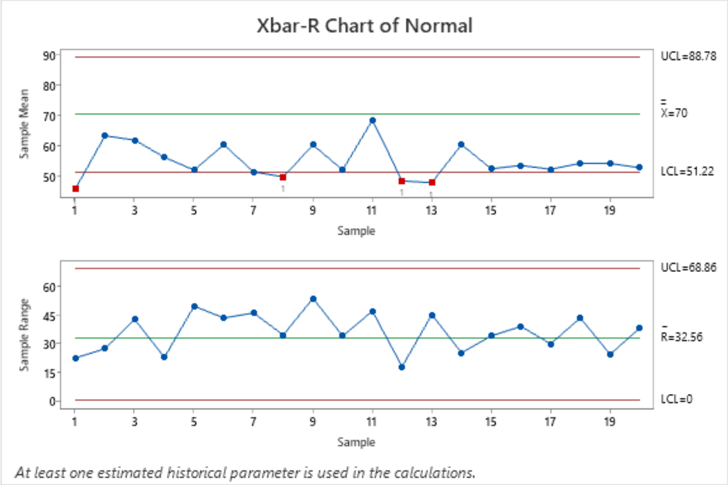


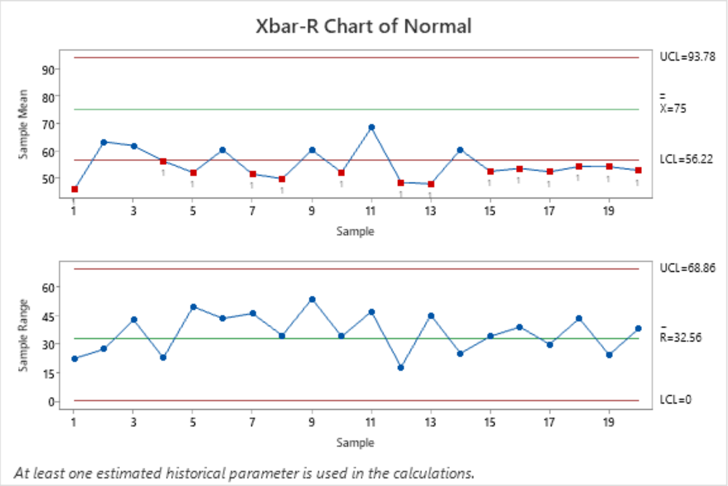


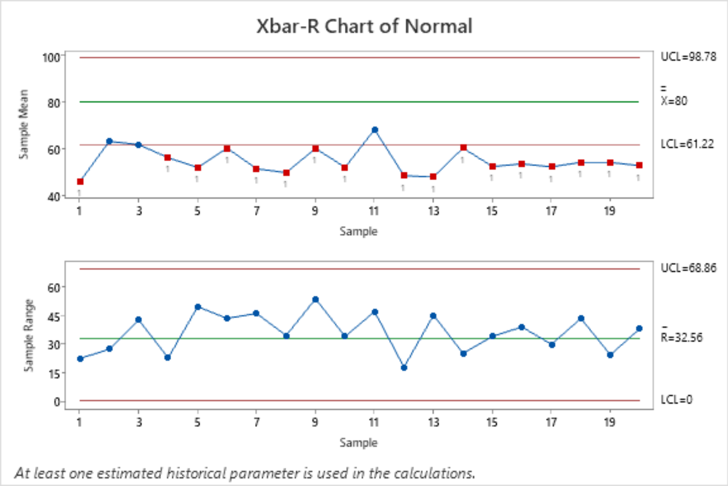
Statistical Process Control Xbar-R Chart

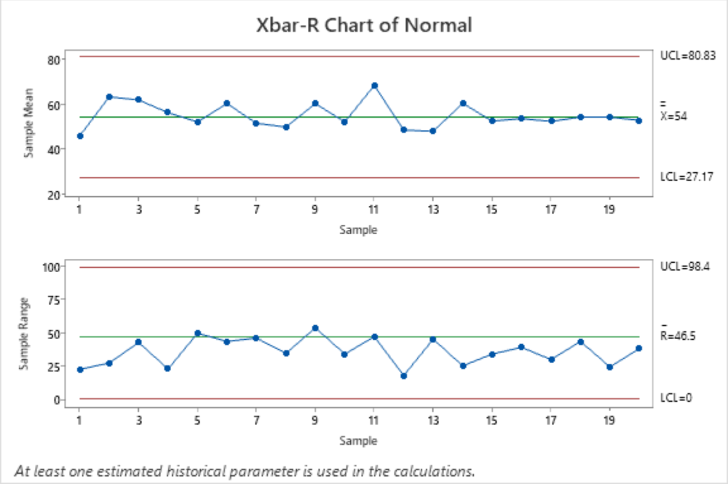




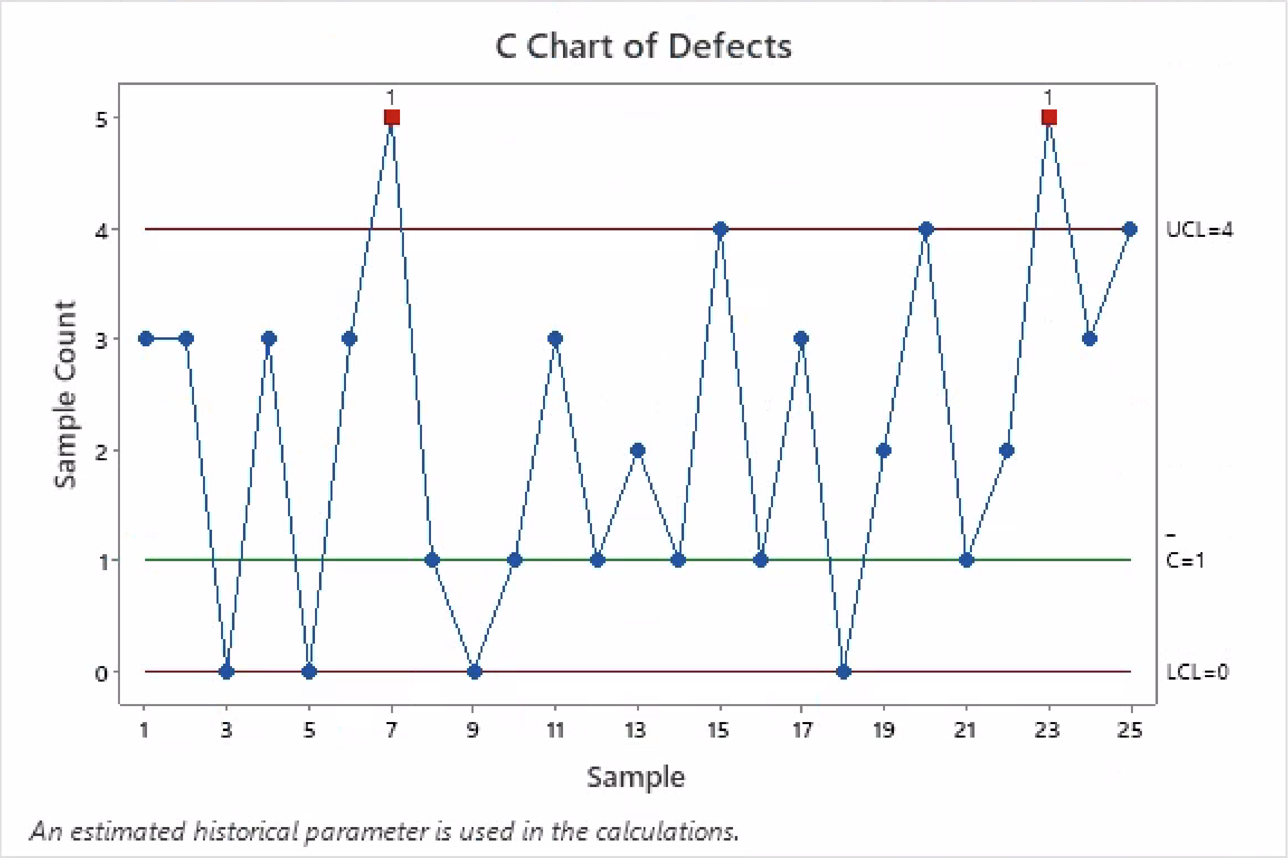






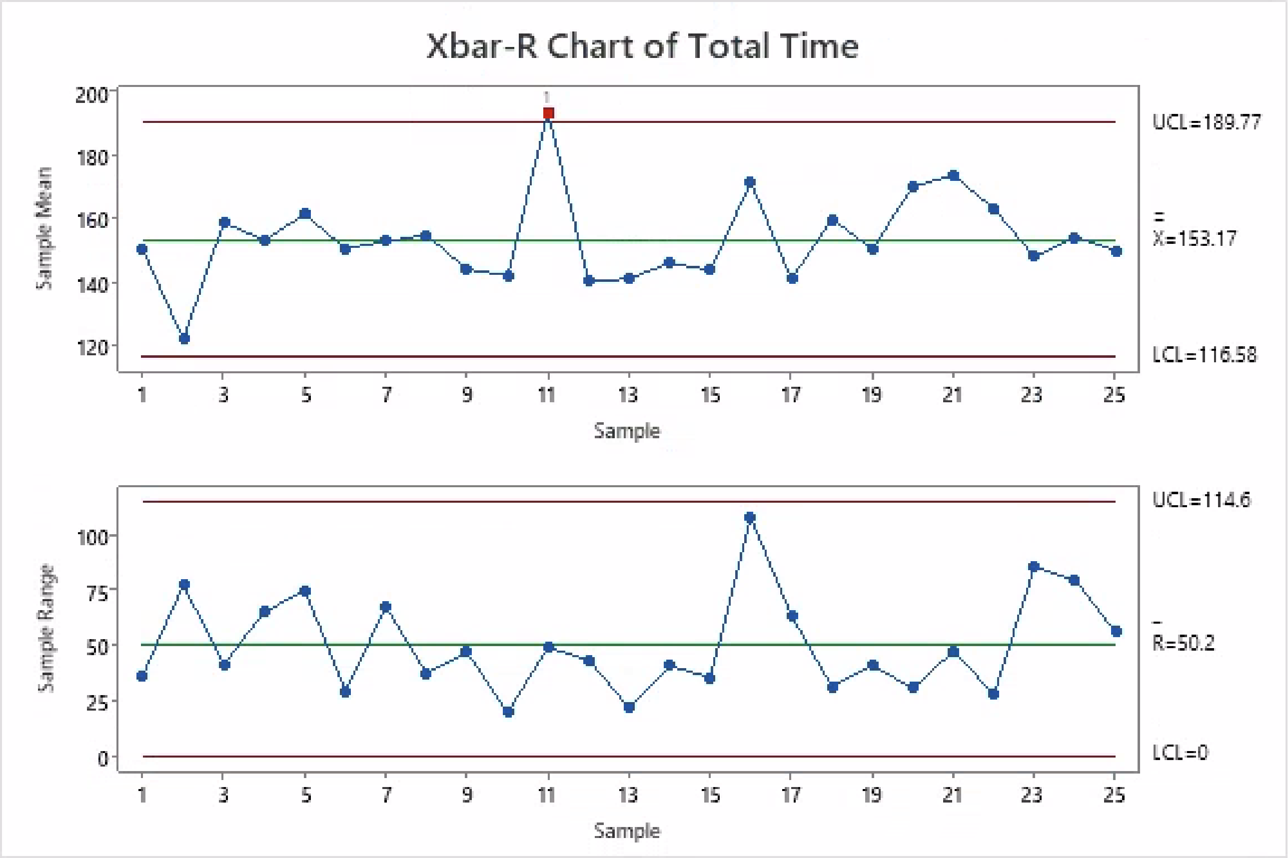


Statistical Process Control



- The maximum acceptable number of defects is 5 to satisfy the 95% of acceptance sampling
- Out of 25-time testing, there are 2 times that the number of defects reach maximum and out of control limit.
- Need to put more effort in supply chain of storing the materials for food, like first in first out to reduce waste from spoiled food

Statistical Process Control



- To monitor the process (supplying food) behavior
- Address any issues and find solutions
- Sample size of 10 over times
- The Xbar-R chart shows the mean of 153, once the mean is out of CL.
- The range shows in CL but there is once it’s closed to out of the CL range
- Need to address the issues and prevent it from non-conforming.

Reliability Analysis

Reliability analysis involves assessing the likelihood that a product or system will function without failure in a specified environment. This involves:

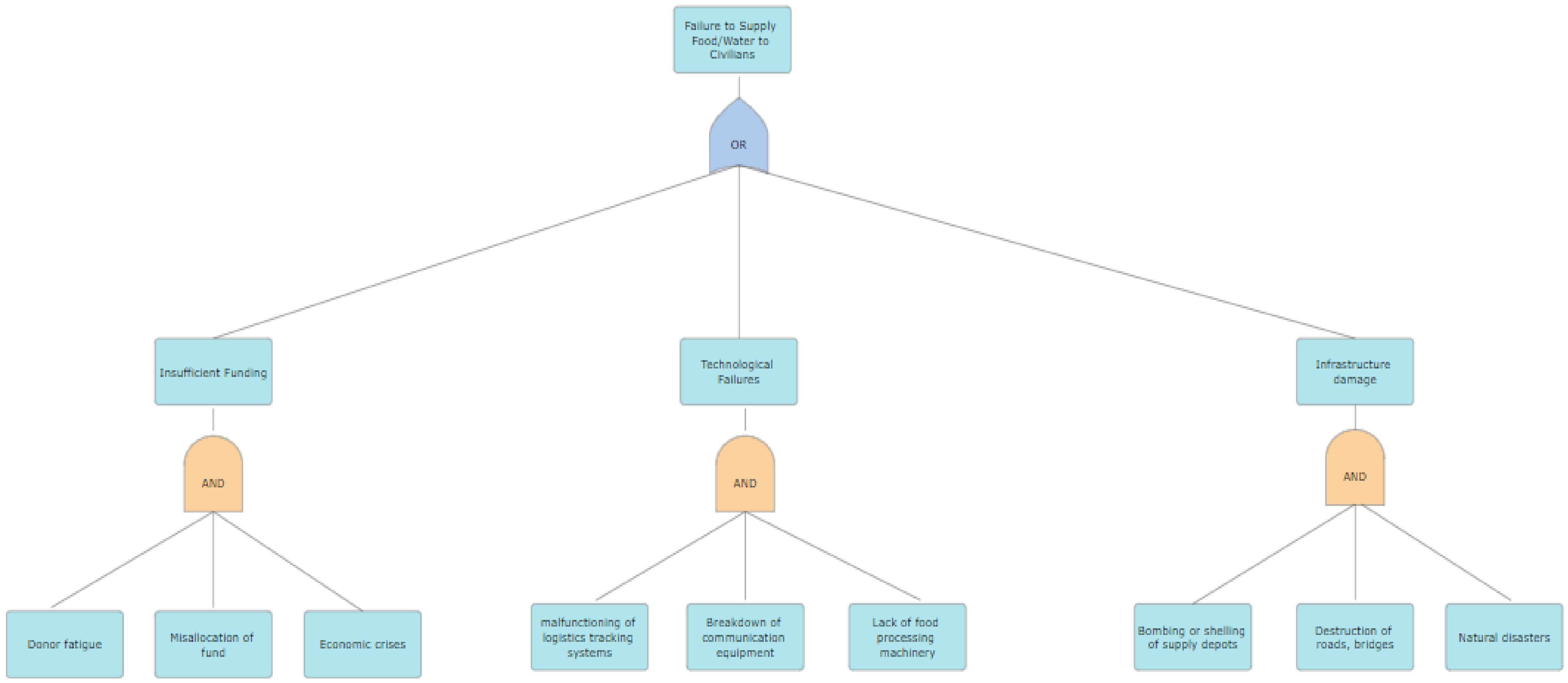
- Defining reliability as the probability of successful operation.
- Outlining what constitutes successful performance and the operational environment.
- Specifying the required duration of operation between failures.
- Using tools like Failure Mode Effects Analysis (FMEA), which identifies and addresses potential failure risks for improvement, and Fault Tree Analysis (FTA), a visual method to trace system failures back to component-level issues.

FMEA-Failure Mode & Effect Analysis

Function	Failure Mode	Effects	Severity (10-Most)	Cause	Occurrences (10-Most)	Detection Action	Ease of Detection (10-Lowest)	Risk Priority Number	Recommended Action
Supply Chain Management	Delayed Procurement of Supplies	Delayed delivery of essential supplies	8	Insufficient forecasting of demand	9	Regular forecasting updates and monitoring	7	504	Strengthen demand forecasting processes, establish contingency plans for supply shortages.
Supply Chain Management	Supply Chain Interruption	Suspension of aid operations	10	Conflict-related security incidents	8	Continuous monitoring of security situation, contingency planning	6	480	Establish alternate supply routes, improve security measures along transportation routes.
Distribution Operations	Inadequate Distribution Network	Uneven distribution of aid supplies	7	Lack of access to remote areas	9	Conducting site assessments, exploring alternative delivery methods	8	504	Improve access to remote areas, establish partnerships with local NGOs.
Distribution Operations	Incorrect Distribution of Supplies	Misallocation of resources	9	Inaccurate beneficiary data	7	Implementing beneficiary registration and verification processes	7	441	Enhance data collection and validation processes, improve communication with beneficiaries.
Quality Assurance and Monitoring	Contamination of Water Supplies	Spread of waterborne diseases	10	Inadequate water purification	8	Regular water quality testing and monitoring	8	640	Enhance water purification processes, increase community awareness of water hygiene practices.
Quality Assurance and Monitoring	Spoilage of Food Supplies	Food waste and loss	8	Inadequate storage facilities	7	Implementing proper storage practices, conducting regular inspections	7	392	Upgrade storage facilities, implement pest control measures.
Community Engagement and Feedback	Lack of Community Participation	Mistrust and resistance from communities	9	Cultural barriers, language barriers	6	Conducting community outreach and engagement activities	6	324	Enhance cultural sensitivity training, utilize local interpreters and mediators.

- The highest RPN is the contamination of water supplies (640)
- Next, at RPN of 504 are delayed procurement of supplies and inadequate distribution network
- To reduce the risk of failure, these modes above needed to address and put in action immediately.
- Next, the actions need to be done with lower RPN in descending order

Reliability – Fault Tree Analysis



Conclusion

- The project armed to address the critical challenge of supplying essential aid to civilians in a war zone, where access to food, water, shelter is compromised by conflict and instability
- Using tool such as MSA, Supply Chain Management, FMEA, FTA, etc. key risk factors and potential failure modes were identified, allowing for development
- Key recommendation:
  - Strengthen supply chain resilience by improving forecasting, contingency planning, and diversification of supply routes
  - Enhancing coordination and collaboration among humanitarian agencies, local authorities to optimize resource allocation
  - Investing in technology and innovation to eliminate technological failures, improve communication
  - Prioritizing mental health and psychosocial support to employees, volunteers to address any psychological impact of conflict and trauma
  - Investing in training employees and volunteers to have better skill
- By implementing the recommendations outlined, the capacity to meet the urgent needs of vulnerable populations and contribute to build resilience and stability in war-affected communities.

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Thankyou!