A Systems Approach To Nitrogen Delivery

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Disclaimer

Introduction / Problem Statement

- Multiple Uses
- Delivered at Various Times Through the Week
- Supplemental Use or Direct Use

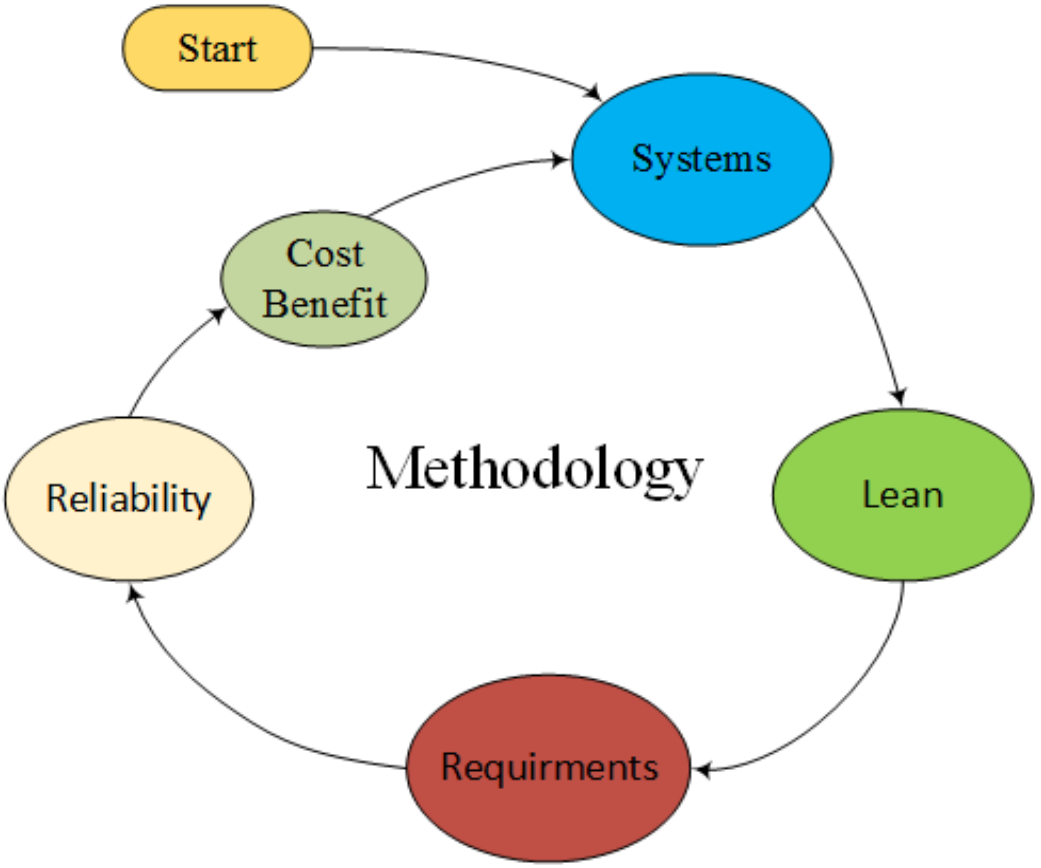
- Demurrage Charges
- Declining Workforce Population

Literature Review

Title	Type	Author(s)
Improving road transport operations through lean thinking: a case study	Journal Article	Villarreal, Garza-Reyes, Kumar, Lim
Reduction of cycle time & Defects of Bogie Frames in Rail Coach Using Lean	Journal Article	Sathishwaran, Jose, Hithyanandam
Lean Supply Chain and Logistics Management	Book	Myerson
Identifying root causes of inefficiences in road haulage: case studies from Sweden, Switzerland and Germany	Journal Article	Sternber, Harispuru
End-To-End Lean Management: A Guide to Complete Supply Chain Improvement	Book	Trent
A modified FMEA approach to enhance reliability of lean systems	Journal Article	Sawhney, Subburaman, Sonntag, Rao, Rao, Capizzi
Lean road transportation-a systematic method ofr the improvement of road tranport operations	Journal Article	Villarreal, Garza-Reyes, Kumar
Lean Logistics	Journal Article	Jones, Hines, Rich

General Approach

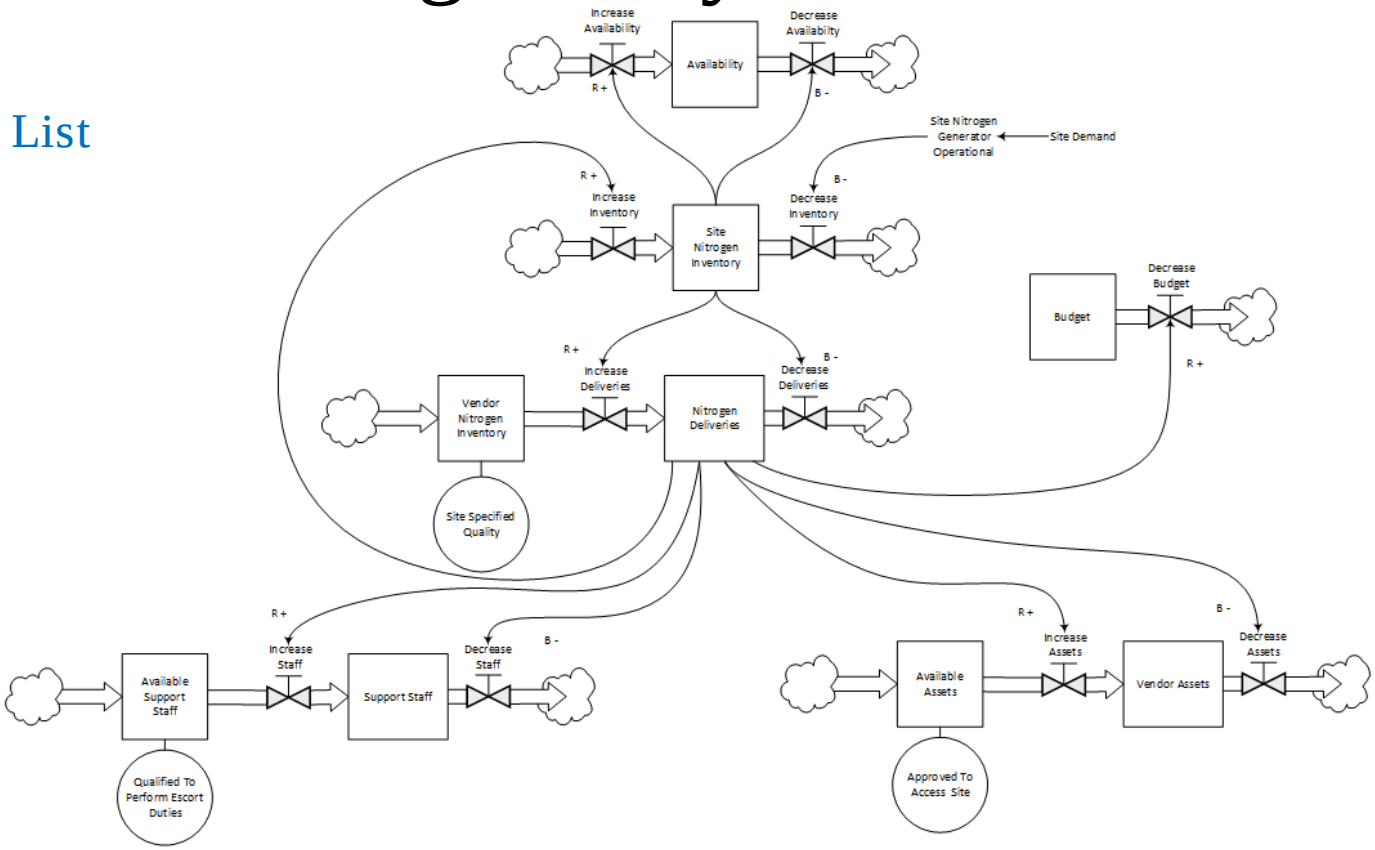
- Other resources as needed
- Iterative



Phase 1-Understanding the System

Aggregated Variable List

Vendor Assets
Support Staff
Nitrogen
Inventory
Quality
Schedule
Budget
Availability



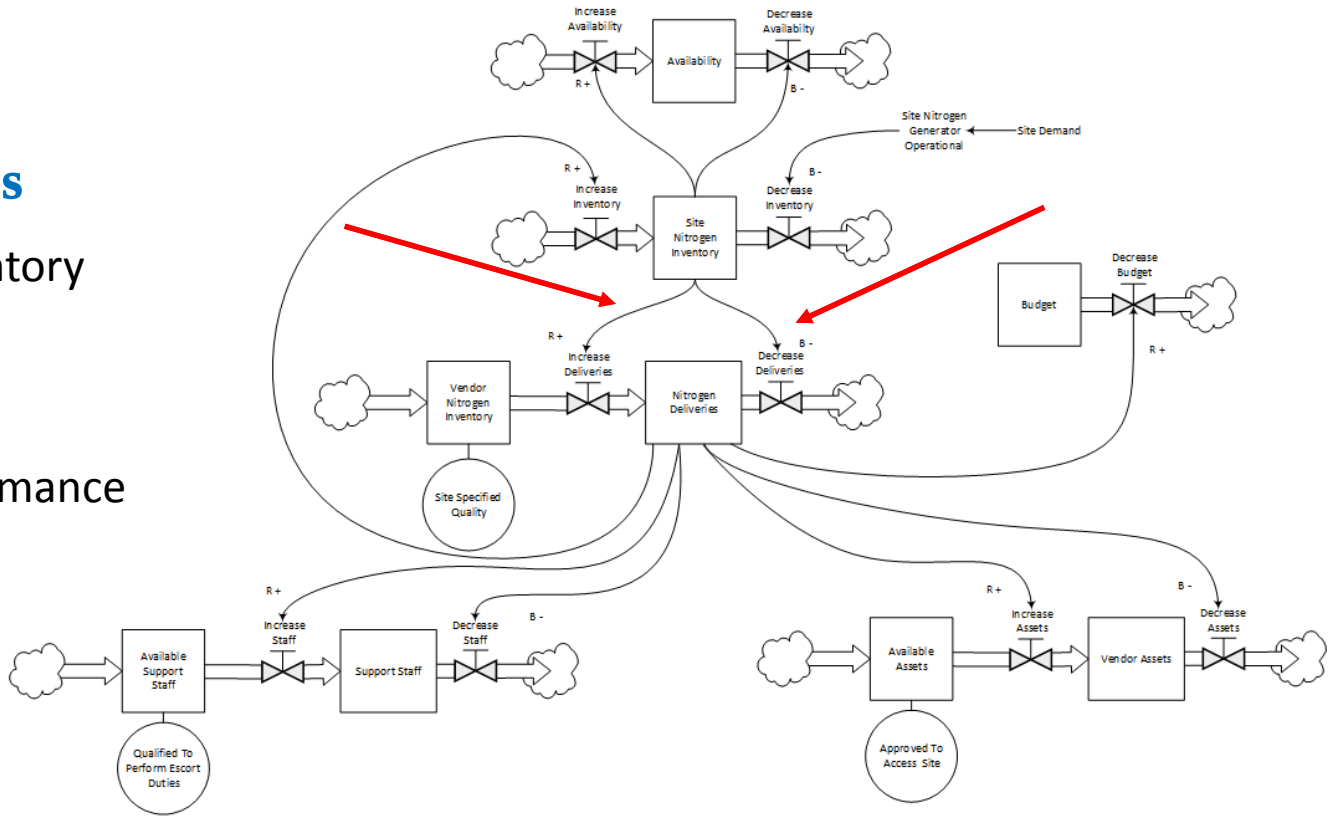
Phase 1-Understanding the System

Dominate Loops

- Site Nitrogen Inventory

Archetypes

- Drift to Low Performance



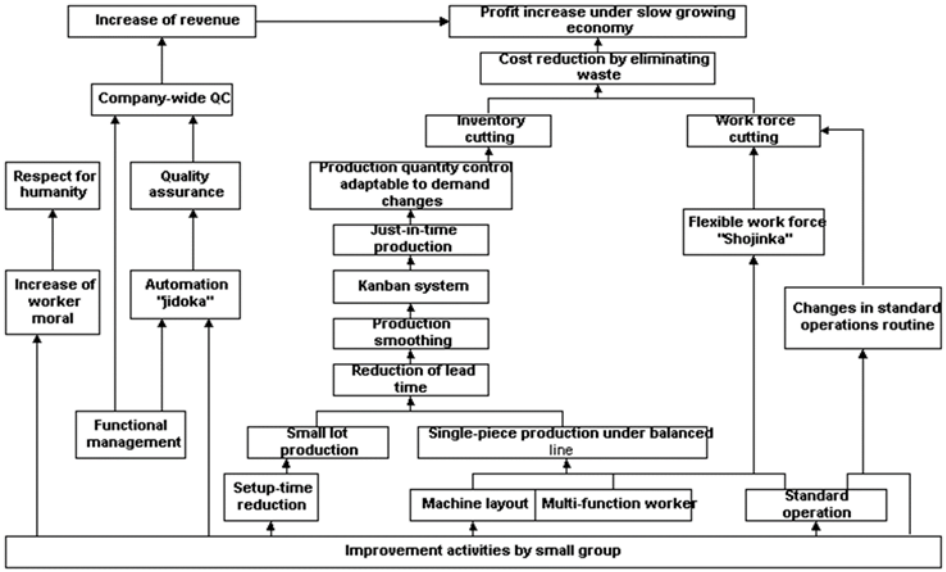
Phase 2-Lean

Principles Of Lean

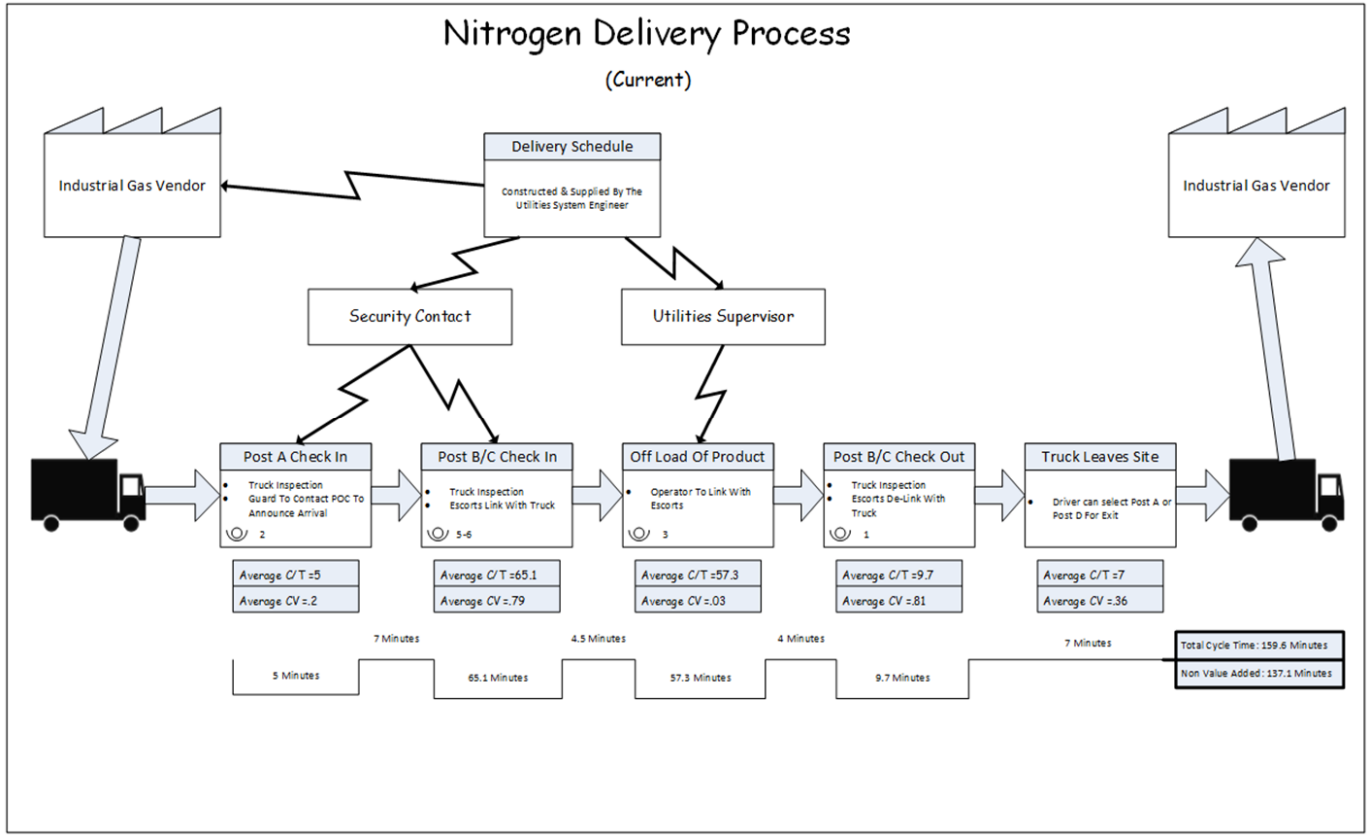
Reduce Lead Time

Reduce Variation

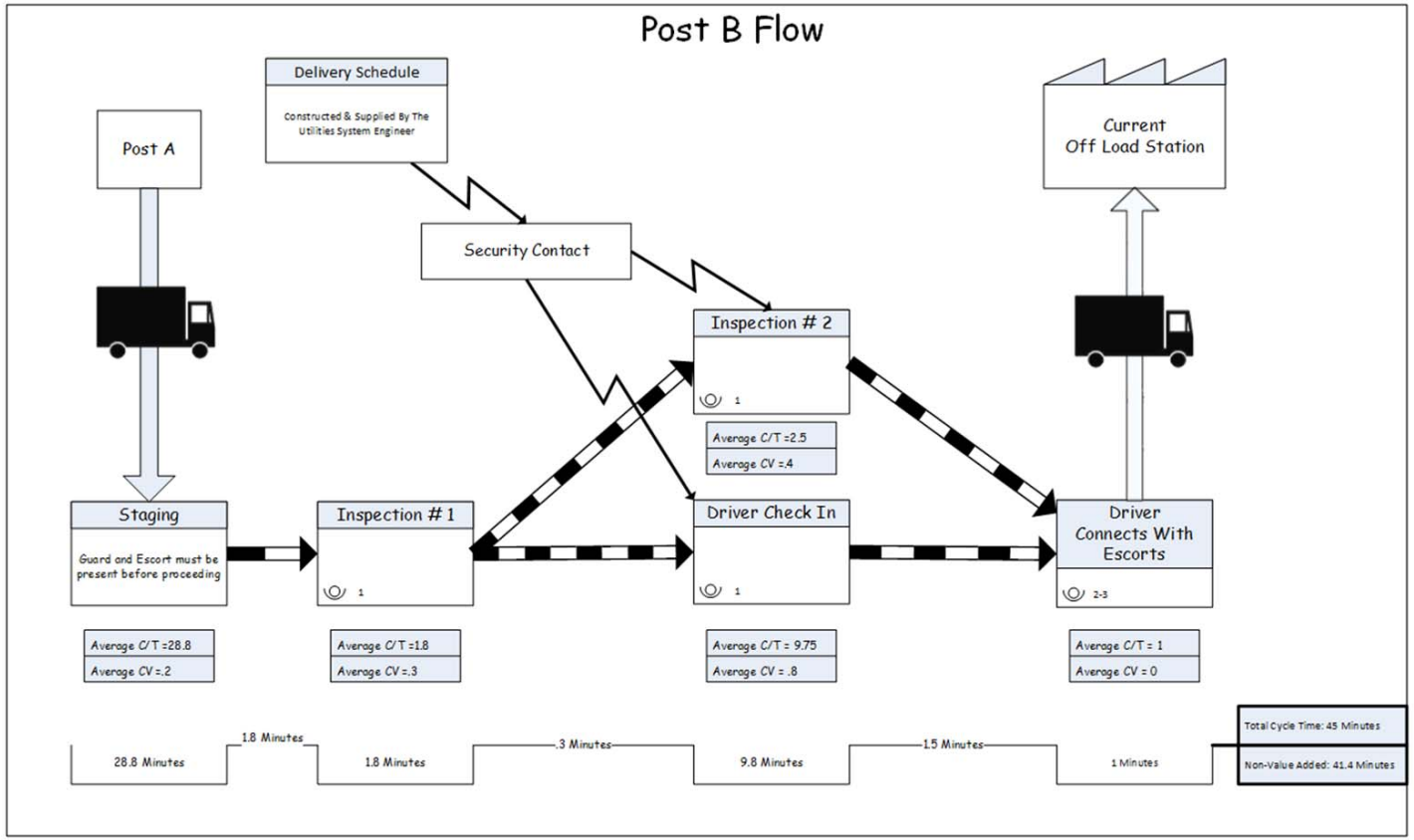
Improve the Quality of Human Life



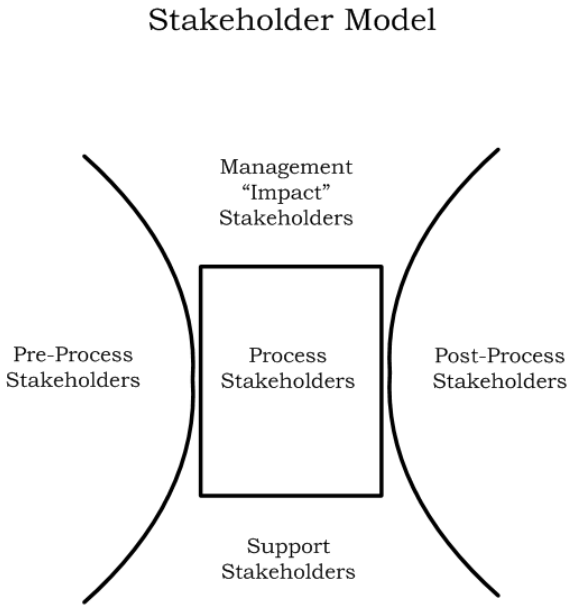
Phase 2-Lean

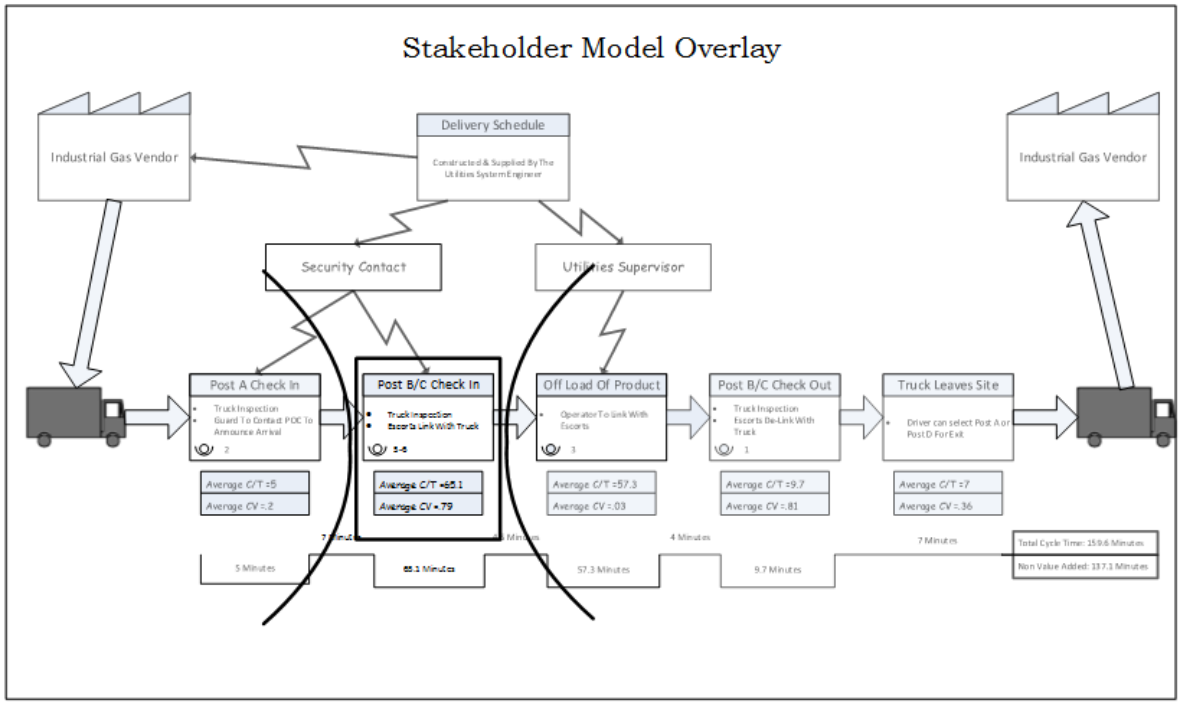

Nitrogen Delivery Process
(Current)
Industrial Gas Vendor
Delivery Schedule
Constructed & Supplied By The Utilities System Engineer
Industrial Gas Vendor
Security Contact
Utilities Supervisor
Post A Check In
Truck Inspection
Guard To Contact POC To Announce Arrival
2
Post B/C Check In
Truck Inspection
Escorts Link With Truck
5-6
Off Load Of Product
Operator To Link With Escorts
3
Post B/C Check Out
Truck Inspection
Escorts De-Link With Truck
1
Truck Leaves Site
Driver can select Post A or Post D For Exit
Average C/T =5
Average CV =.2
Average C/T =65.1
Average CV =.79
Average C/T =57.3
Average CV =.03
Average C/T =9.7
Average CV =.81
Average C/T =7
Average CV =.36
7 Minutes
4.5 Minutes
4 Minutes
7 Minutes
5 Minutes
65.1 Minutes
57.3 Minutes
9.7 Minutes
Total Cycle Time: 159.6 Minutes
Non Value Added: 137.1 Minutes

Phase 2-Lean


Post B Flow
Delivery Schedule
Constructed & Supplied By The Utilities System Engineer
Post A
Security Contact
Current Off Load Station
Inspection # 2
1
Average C/T =2.5
Average CV =.4
Staging
Guard and Escort must be present before proceeding
Average C/T =28.8
Average CV =.2
Inspection # 1
1
Average C/T =1.8
Average CV =.3
Driver Check In
1
Average C/T = 9.75
Average CV = .8
Driver Connects With Escorts
2-3
Average C/T = 1
Average CV = 0
28.8 Minutes
1.8 Minutes
1.8 Minutes
.3 Minutes
9.8 Minutes
1.5 Minutes
1 Minutes
Total Cycle Time: 45 Minutes
Non-Value Added: 41.4 Minutes

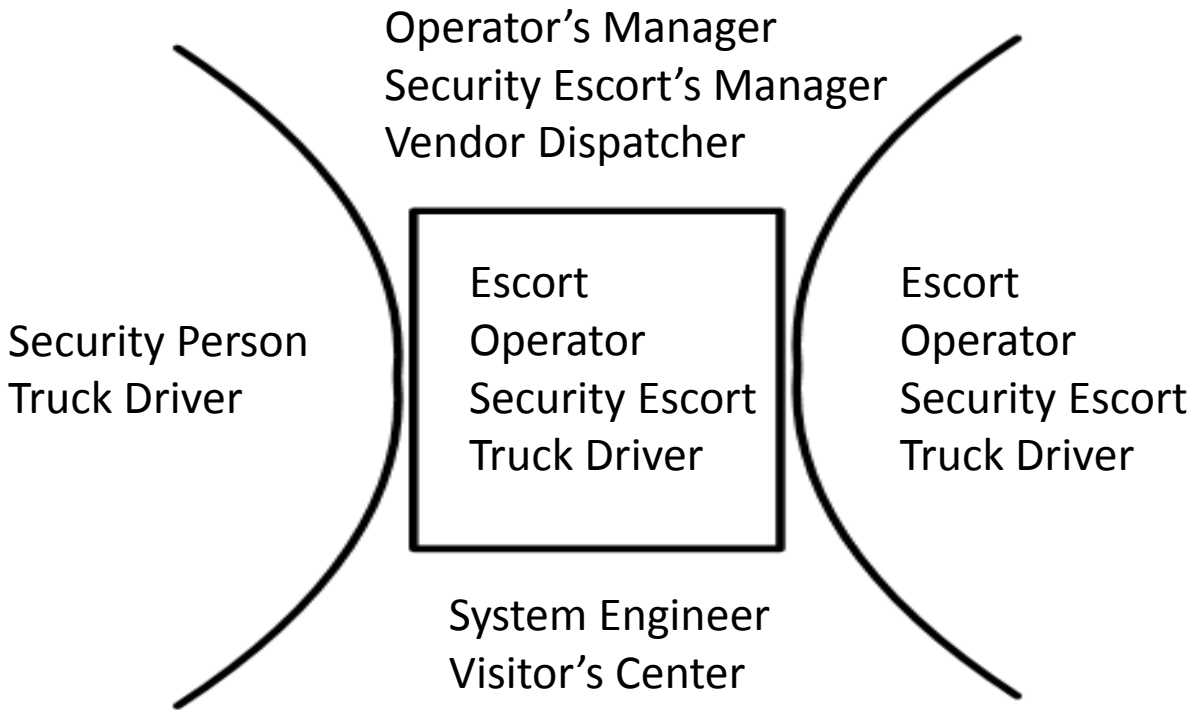
Phase 3-Understanding Requirements





Phase 3-Understanding Requirements

Stakeholders



Phase 3-Understanding Requirements

Risk Priority Number

- Likelihood of Occurrence of Failure
- Severity of Failure Effects

$$RPN = Severity \times Occurence \times Detection$$

Risk Assessment Value

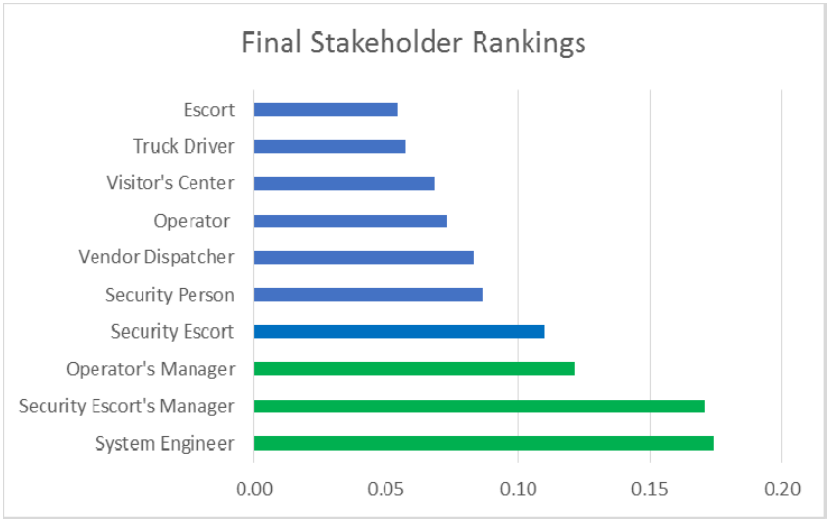
- Detectability

$$RAV = \frac{Severity \times Occurence}{Detection}$$

FMEA

PKF-PROCESS	Category	Failure Type	Potential Impact	Severity	Potential Causes	Occurance	Detection Mode	Detection	Risk Priority Number (RPN)	Risk Assessment Value (RAV)
	Human	Driver Has To Leave Prematurely	Delays in the operation and securing/linking up with the driver at the post	7	Unexpected sickness/Family Emergency	8	Driver to notify the vendor when a family emergency occurs so the vendor can assign a replacement driver.	2	112	28
		Driver Does Not Have Access	Delays in the operation and securing/linking up with the driver at the post	7	Driver not on approved list. Driver fails to pick up badge	5	System Engineer to verify driver with vendor. Give instruction as needed to ensure driver is approved and badged.	2	70	18
		Security Person Has To Leave/Check Point Prematurely	Delays in the operation and securing/linking up with the driver at the post	7	Unexpected sickness/Family Emergency	4	Security person to notify their supervisor when a family emergency occurs so management can assign a replacement.	4	112	7
	Equipment	Truck Breaks Down	Product Delivery is Delayed	8	Numerous (Flat Tire, Air Leak, Engine Problem, Etc.)	4	Vendor to ensure all preventative maintenance is performed on time and that all equipment is in good working order.	2	64	16
		Check Point Access Equipment is Not Functioning	Delays in truck leaving the	5	Improper Preventative Maintenance	2	System Engineer should be informed by the Security Escort Supervisor if any issues so that delays can be expected.	4	40	3
	Schedule	Product Not Delivered On Scheduled Day	Insufficient product to serve nitrogen generator and backup system	6	Not enough drivers to make scheduled deliveries. Not enough product to fill the demand.	5	System Engineer to verify with vendor 24 hours prior to delivery to ensure scheduled delivery will be made.	2	60	15

Phase 3-Understanding Requirements



Organizational

- System Engineer to provide schedule to vendor, security, and operations.
- Driver must have permission to access site.
- Delivery should be made no later than 11:00, Monday through Thursday unless special permission is granted.
- Driver shall issue operator a shipping ticket detailing the quantity of the offload and the time they were on campus.

Technical

- Driver must obey all traffic laws while onsite.
- Driver must stop at each checkpoint.
- Driver must be escorted by security escort and operator escort from the time he/she clears checkpoint B until he/she passes back through checkpoint B.

Political

- Driver must operate equipment associated with truck.
- Operator must operate equipment not associated with the truck.

Phase 4-Reliability

Theoretical System Capacity

$$Throughput = \frac{WIP}{Cycle\ Time} = \frac{1\ Truck}{120\ Minutes} = .0083\ \frac{Trucks}{min}$$

$$or$$

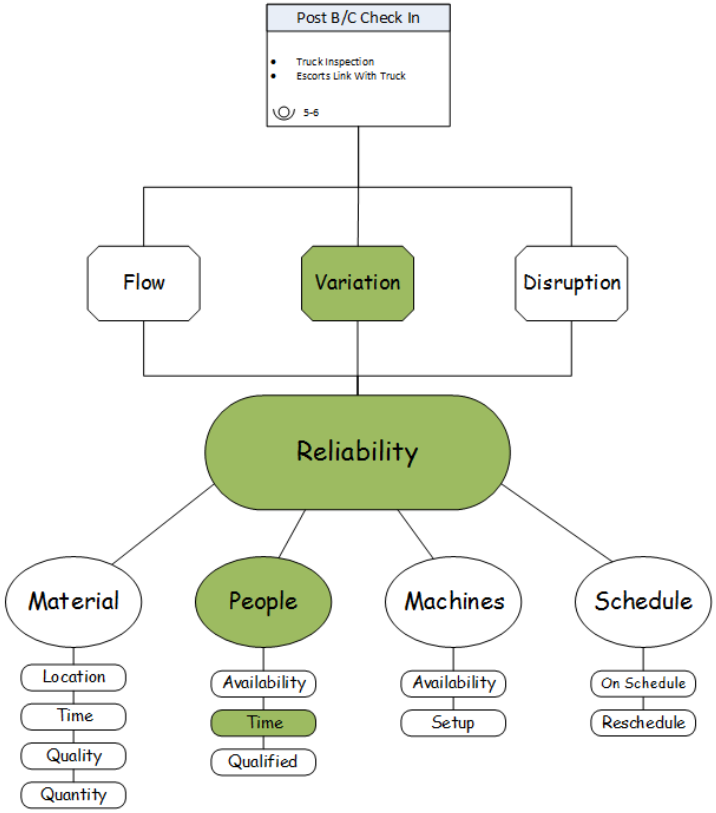
$$1\ Truck\ per\ 2\ Hours$$

Baseline System Capacity

$$Throughput = \frac{WIP}{Cycle\ Time} = \frac{1\ Truck}{160\ Minutes} = .0063\ \frac{Trucks}{min}$$

$$or$$

$$.75\ Truck\ per\ 2\ Hours$$



Phase 4-Reliability

Weibull Plot

Post B/C Check In	
People	
Time to Failure (Hours)	Failure order Number
47	1
55	2
60	3
62	4
66	5
67	6

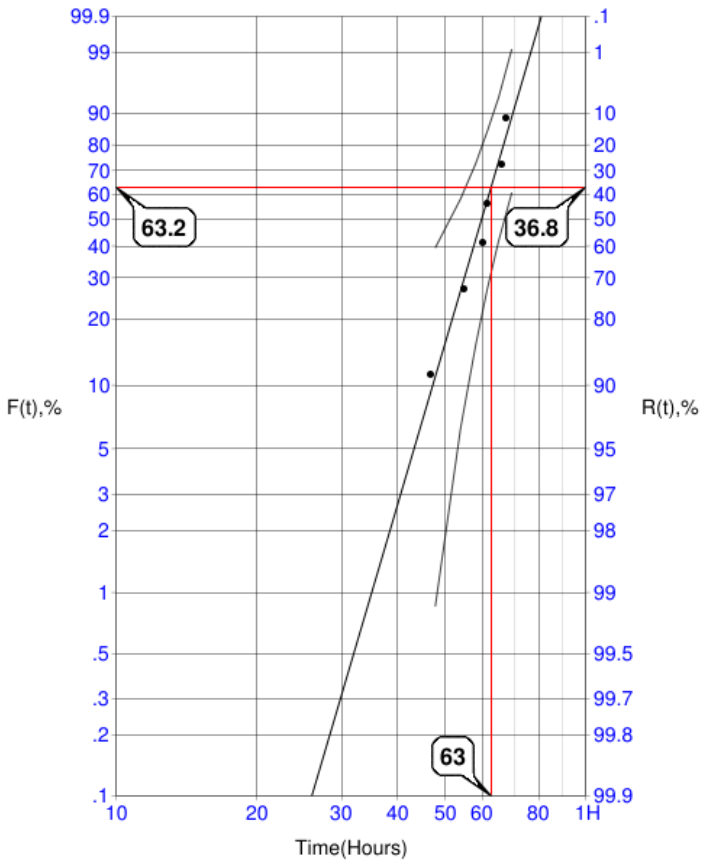
$$MR\% \sim \frac{i - 0.3}{N + 0.4} \times 100$$

i = Failure Number

N = Total Sample Size

Post B/C Check In	
People	
Time to Failure (Hours)	Median Rank, %
47	10.94%
55	26.56%
60	42.19%
62	57.81%
66	73.44%
67	89.06%

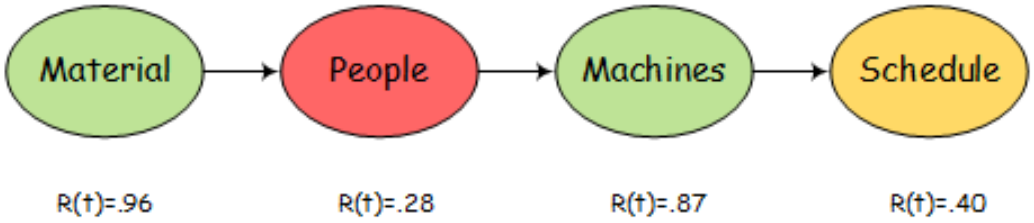
Weibull Plot Results	
Beta:	7.85
η:	62.4



Phase 4-Reliability

Post B Reliability

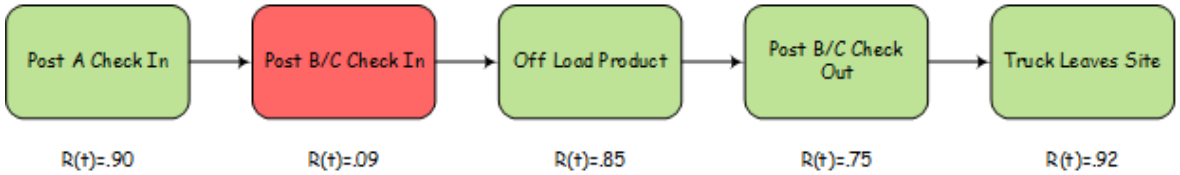
$$R(t) = e^{-\left(\frac{t}{\eta}\right)^{\beta}} \qquad R(t)_{People} = e^{-\left(\frac{65}{62.97}\right)^{7.85}} = .277 \; or \; 27.7\%$$



$$R(t) = (.96) \times (.28) \times (.87) \times (.40) = .094 \; or \; 9.4\%$$

Phase 4-Reliability

Overall Reliability



$$Overall\ R(t) = (.90) \times (.09) \times (.85) \times (.75) \times (.92) = .047\ or\ 4.7\%$$

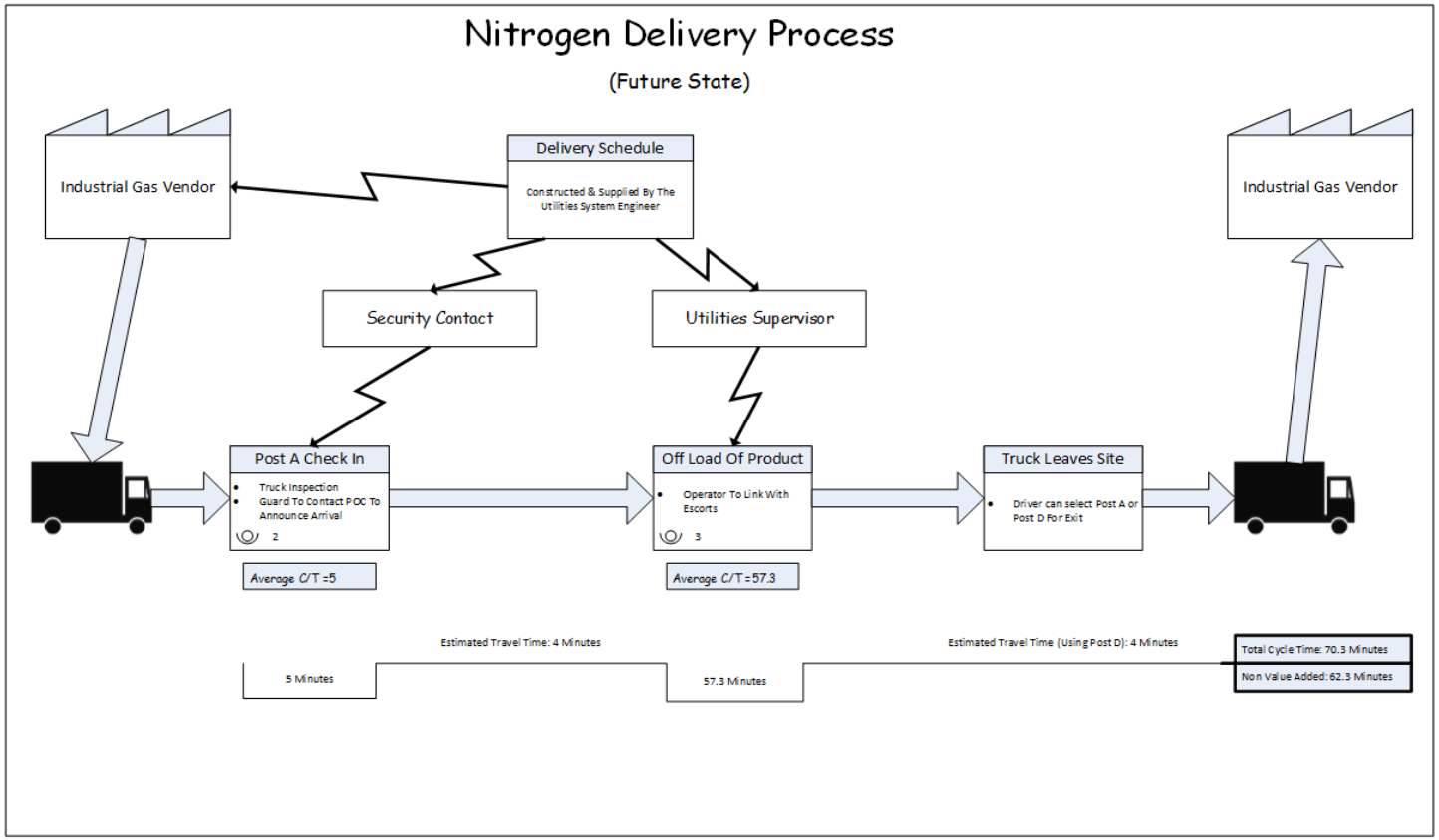
Phase 5-Cost Benefit

Recommended Changes

- Replace alternate off load station.
- Allow the trucks to have priority at the post.
- Contract changes with vendor penalties.
- Employee incentive program.

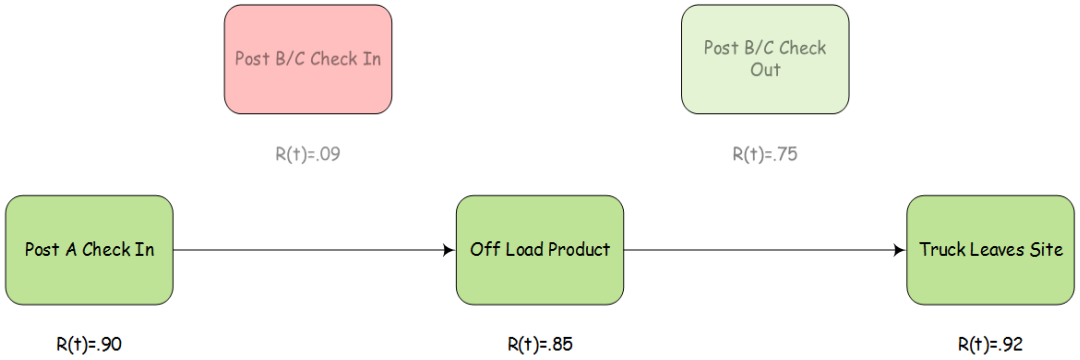
Phase 5-Cost Benefit

Future State



Phase 5-Cost Benefit

Reliability/ Throughput Gains



$$Overall\ R(t) = (.90) \times (.85) \times (.92) = .70\ or\ 70\%$$

$$Throughput = \frac{WIP}{Cycle\ Time} = \frac{1\ Truck}{80\ minutes} = .0125\frac{Trucks}{min}\ or\ 1.5\ Truck\ per\ 2\ Hours$$

Phase 5-Cost Benefit

Financial Gains

Personnel Cost Without Offload Station

Post A

	Rate	Hours	Cost Per Hour
Guard 1	100	0.08	8
Guard 2	100	0.08	8
		Total:	16

Post B

	Rate	Hours	Cost Per Hour
Guard 1	100	0.03	3
Guard 2	100	0.08	8
Guard 3	100	0.16	16
Guard 4	100	0.25	25
Operator	100	0.25	25
Escort	100	0.25	25
		Total:	102

Offload

	Rate	Hours	Cost Per Hour
Guard 1	100	1.1	110
Operator	100	1.1	110
Escort	100	1.1	110
		Total:	330

Grand Total: $448.00

Personnel Cost With Offload Station

Post A

	Rate	Hours	Cost Per Hour
Guard 1	100	0.08	8
Guard 2	100	0.08	8
		Total:	16

Offload

	Rate	Hours	Cost Per Hour
Operator	100	1.1	110
		Total:	110

Grand Total: $126.00

- Reducing number of personnel from 11 to 3 will yield a 28% Savings in Personnel Costs.
- 4 year payback period on investment.

Conclusions

Benefits

- 2 Times Throughput
- 57% Reducing in Cycle Time

Current State Of Project

- Management Aware
- Not Funded In FY18

Future Work

- Approved Budget
- 2nd Iteration