



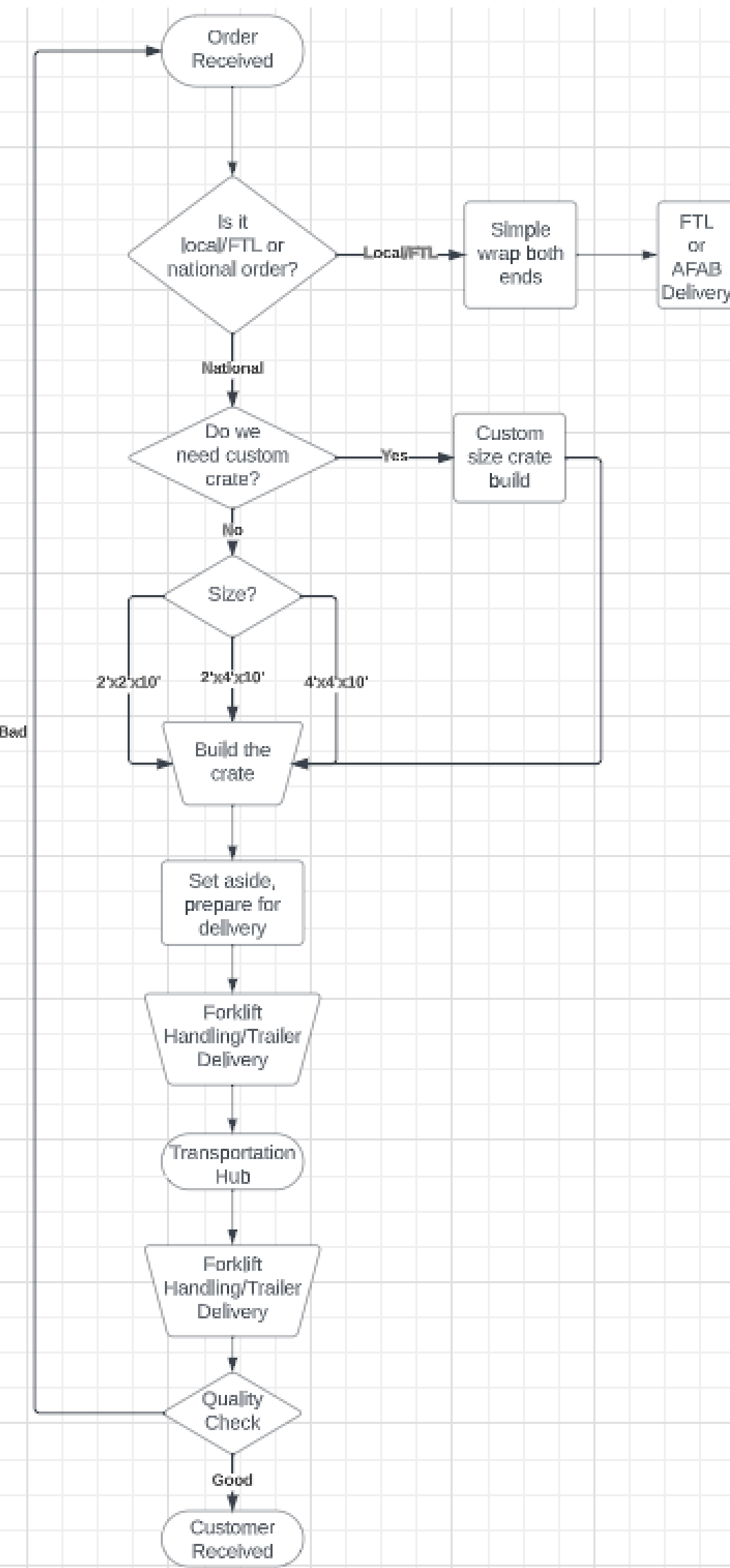
### Client Background:

Applied Fabricators, Inc. (AFAB) is a family-owned architectural sheet metal shop in Greenfield, Indiana. The company specializes in fabricating metal for various building exterior components.

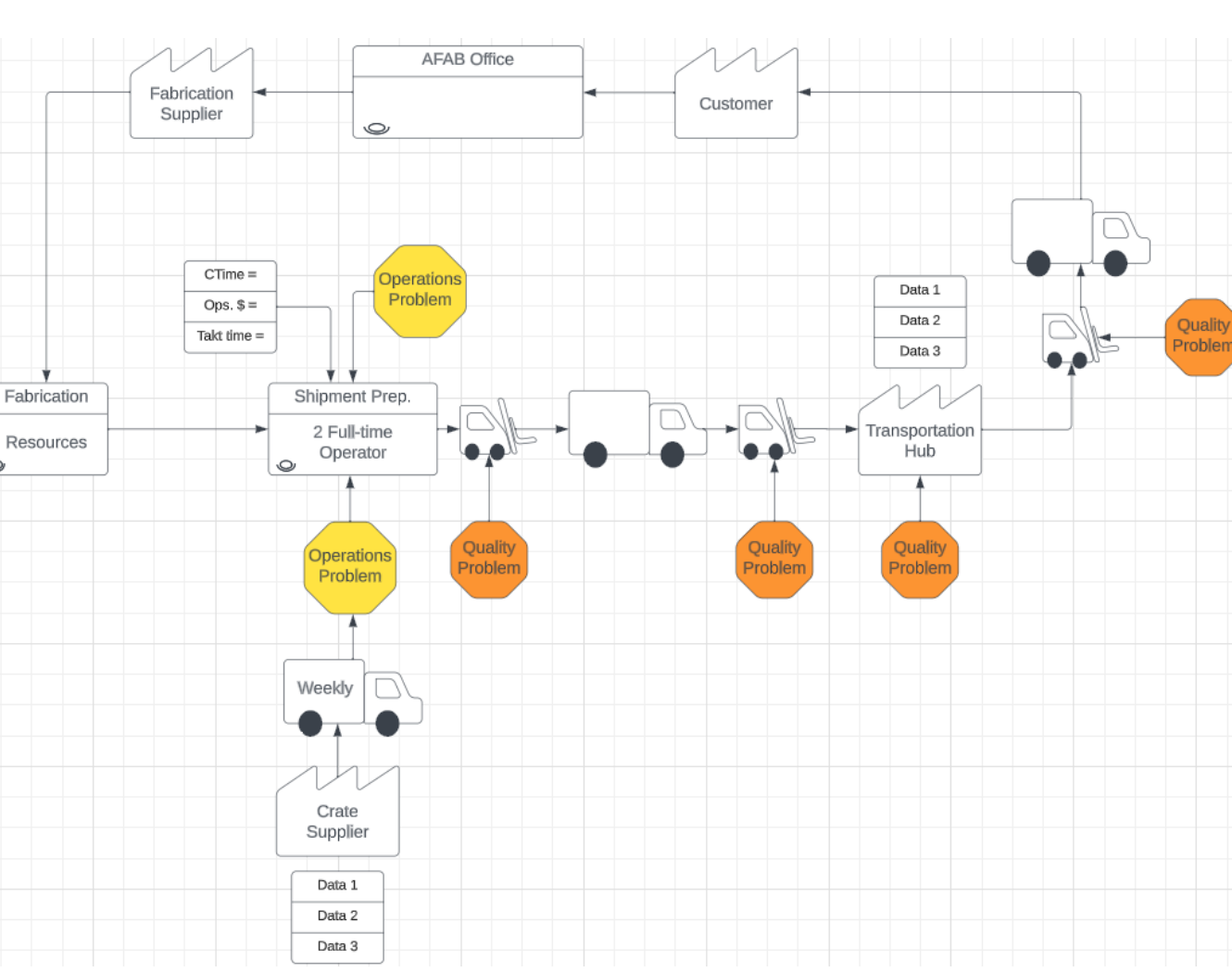
### Problem Statement:

AFAB current packaging process costs the company \$180,300.00 annually in labor and material cost. However, the crates built for shipment have had multiple reports on failing during transportation. Hence, the company is looking for a more cost-effective and efficient solution, considering either a new automation process or an improved packaging method while maintaining the protection of their shipments.

## System Model



### Flow Chart of AFAB's process



Value Stream Map

## Methodology

### Quantitative Analysis:

- **5-Why Analysis:** Identify the **root causes** of our client's problem.
- **ROI Analysis:** Understand the **profitability** of each machine.
- **WDM:** Compare **cost, quality, and performance** of each machine to identify the best solution.

### Qualitative Analysis:

- **FMECA:** Analyze **potential risks, their effects, and solutions** for each type of machine.

## Root-cause Analysis

### High operation cost:

- 1) Why are we having **high operational costs**?
  - o Need 1-2 full-time operators for the job.
  - o Constantly buying new material.
- 2) Why are we buying new material (why can't we recycle the material)?
  - o Current material choice (Oriented strand board).
  - o Shipping policy makes it cheaper to buy new than to ship material back to reuse.
- 3) Why are we using OSB to build the crate?
  - o Cheapest material and easily purchased.

=> Find a **more cost-effective method** to build the crate or convert to an **automated solution** to reduce the needed manual labor.

### Damaged packages:

- 1) Why are we having **quality issues** with the shipment?
  - o Packaging (crates) break down during transport.
- 2) Why did the crates break down during transportation?
  - o Forklift impacted the crate when handling, causing damages.
- 3) Why did the forklift impact the crate?
  - o Because the crate dimension matches the pallet it sit on exactly, leaving no room for buffer.

=> Find a **stronger material** to protect the goods or need to **change the design of the packaging** to avoid impacts during handling.



Current packaging



Damaged crates

## Results (Cont.)

- All options with no protective layer have positive ROI % in 10 years.
- Foam option is rejected due to its high cost, negative ROI %.
- Bubble wrap is the most superior solution with highest ROI %.
- Overall, the Eagle 2000 with the bubble wrap was the best option with an ROI of roughly 160% over 10 years.

Process:	ROI Over a 10 Year Period			
	ROI Without Protective Layer (10 Years):	ROI With Foam (10 Years):	ROI With Bubble Wrap (10 Years):	ROI With Shipping Blanket (10 Years):
Current	0.00%	0.00%	0.00%	0.00%
TAB WRAPPER	57.13%	-10.39%	52.59%	48.00%
Eagle 2000EB	174.36%	-31.69%	160.51%	146.50%
SA-200 NC	35.97%	-6.93%	33.09%	30.17%
SA-200 C	20.01%	-3.64%	18.42%	16.81%
1100 Semi-Auto	156.79%	-28.50%	144.34%	131.74%
TAB & Eagle	42.66%	-8.46%	38.97%	35.51%
SA-200 C & Eagle	17.80%	-3.53%	16.26%	14.81%

## Decision

DESIGN REQUIREMENTS (Criteria & Constraints)	Weight / Importance	Capital Cost	operational cost	Available warranty	ROI	reliability	expected lifetime	Automation	throughput	ease of use	unit protection
1 Cost	5	x	x	x	x						
2 Quality	10					x	x	x			
3 Performance	15								x	x	x

### BENCHMARKING (Unweighted)

Eagle 2000EB	Tab Tornado	SA-200 (with conveyor)	SA-200 (with conveyor) + Eagle 2000EB
4.6	3.4	4.6	2.7
4.5	3.7	4.7	4.7
4.1	3.5	3.8	4.6

### BENCHMARKING (Weighted)

Eagle 2000EB	Tab Tornado	SA-200	SA-200 (with conveyor) + Eagle 2000EB
23	17	23	13.5
45	37	47	47
61.5	52.5	57	69
129.5	106.5	127	129.5

Using a weighted decision matrix with ten different criteria, we narrowed our search to three potential solutions. We presented these solutions to AFAB along with our reasonings, and they showed preference toward the SA-200 with a conveyor in combination with the Eagle 2000EB. This was due to the second layer of protection given by two different directions of wrapping.

## Discussion & Future Work

After evaluating market options, we recommend the **Eagle 2000EB Stationary Turntable** and **SA200 wrapper with a conveyor belt** for optimal efficiency.

- The **Eagle 2000EB** is a cost-effective option, especially when paired with bubble wrap for added protection.
- Additionally, we recommend the **SA200 with conveyor belt**. Using a conveyor belt to move the pallet through the wrapping machine, SA200 offers better safety for the operators, better wrap quality compared to no conveyor varieties.
- We believe this investment to be good for the company, given it will be **paid off in two years** and the **return of investment** will be **higher than 10%** in ten years' time.



### Future works:

- AFAB **final evaluation**. Machines **purchases & implementation**. Set up **scheduled maintenance**.
- Implementation of **pallet size change**.

## Results

Failure Mode, Effect and Criticality Analysis (FMECA) for Vertical Wrap Machine								
Function	Possible Effect	Root Cause	Severity (S)	Occurrence Probability (O)	Detectability (D)	Risk Priority Number (RPN = S*O*D)	Criticality	Proposed Solution
Pallet hit objects during operations	Pallet hit operator/other items during operation	No safety barrier to prevent operators from standing closely	9	6	5	270	54	Keep a 8 feet clearance around the machine with clear marking on the ground. Add a step of pre-inspection of surrounding area into the standard work. Implementation of safety curtain to make sure nothing is in the machine operational zone.
	Wrapping column damaged	Pallet not centered on the table	8	6	3	144	48	Use marking system to make sure the pallet is load center or close to the center of the turntable for each size.
Conveyor belt stop working	Cannot access the machine to stretch wrap manually with forklift, has to wrap by hand, low quality wrap	Forklift put the pallet down too hard, damaging the conveyor	7	5	5	175	35	Proper training. Limited solution due to human factor.
	Cannot access the machine to stretch wrap manually with forklift, has to wrap by hand, low quality wrap	Forklift hit the conveyor belt while trying to align with the pallet	7	5	5	175	35	Guiding sign to tell operator how to align the forklift (fork height indicator alignment, mirror for better visibility...)
Machine is damaged during wrapping	Machine is damaged	Pallet sway during handling	8	5	8	320	40	Longer forks to support the pallet better, reducing sway.
	Machine is damaged	Pallet obstructs forklift's visibility	8	5	8	320	40	Additional mirror for better visibility and proper training

Shipping Cost Analysis					
Category	Old	New	Difference	Difference %	
Average Cost (1500lbs)	\$1,162.98	\$1,412.98	\$250.00	21.50%	
Max Cost (3000lbs)	\$1,723.15	\$1,973.15	\$250.00	14.51%	
<b>Annual Average Cost (1500lbs)</b>	<b>\$622,578.08</b>	<b>\$756,410.58</b>	<b>\$133,832.50</b>	<b>21.50%</b>	