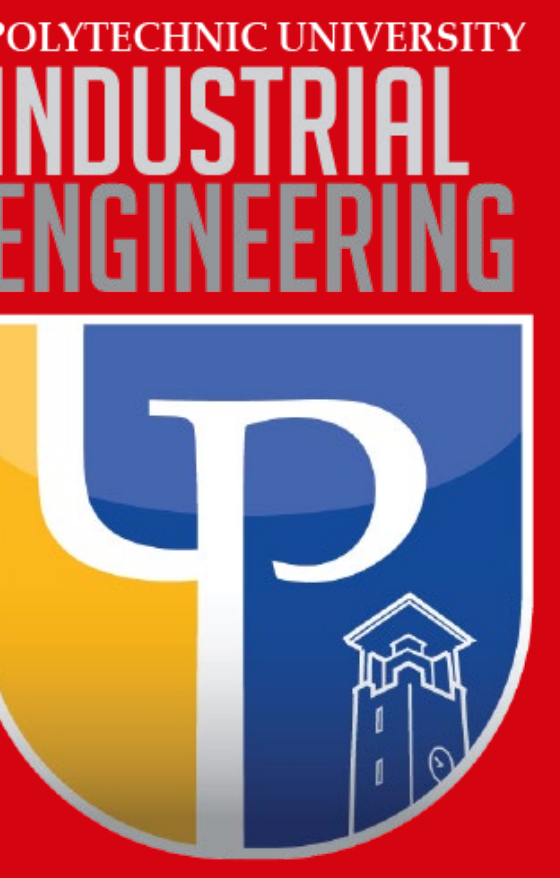


# Optimizing Transportation and Pallet Stability

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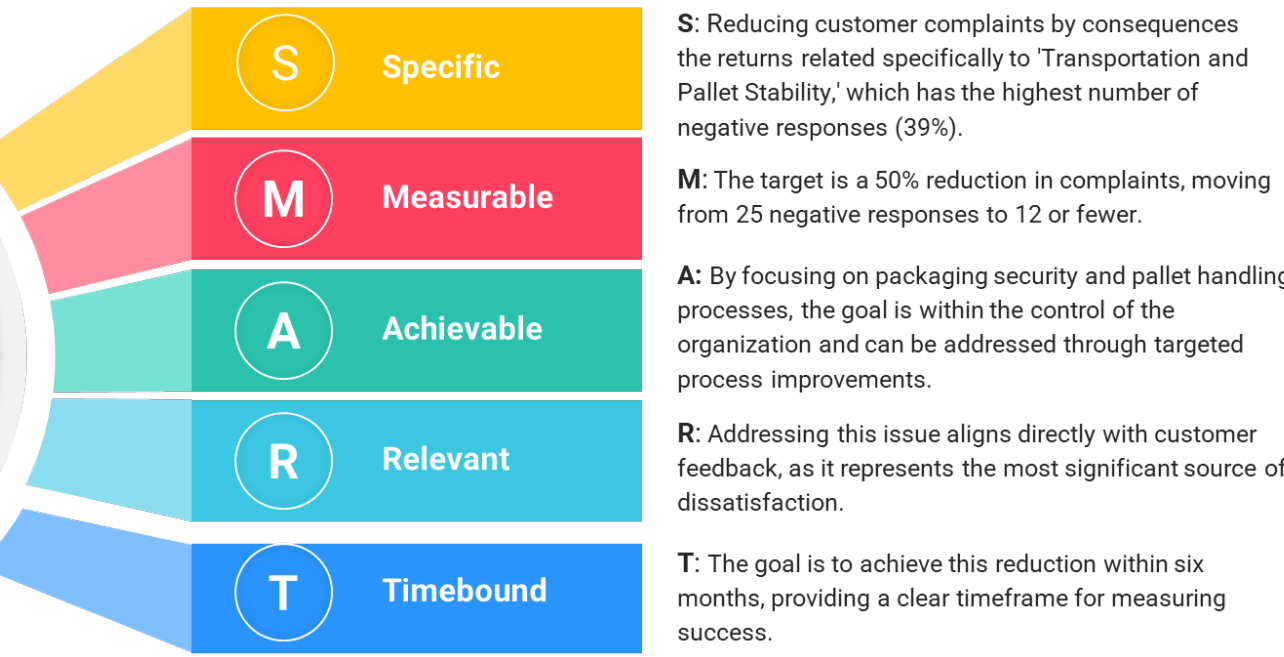
## Define

### Introduction

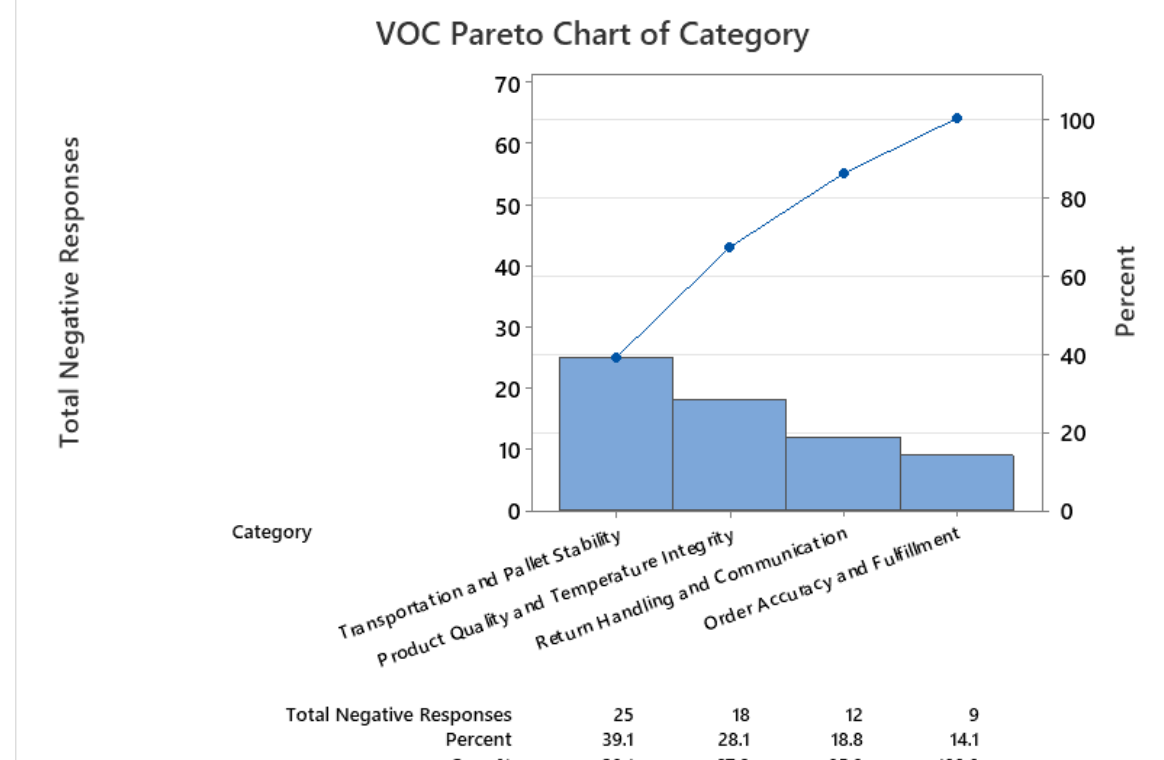
Using the DMAIC methodology, the project identified critical issues in temperature compliance, pallet handling, and transportation systems. By implementing IoT monitoring and enhanced pallet stability techniques, the initiative achieved a projected 50% reduction in returns, leading to \$240,000 in annual savings and a 187% ROI. The findings demonstrate how Lean Six Sigma, combined with innovative technologies, drives process optimization, reduces returns, and enhances supply chain efficiency in temperature-controlled logistics.

### Problem Statement

PROBLEM STATEMENT USING SMART

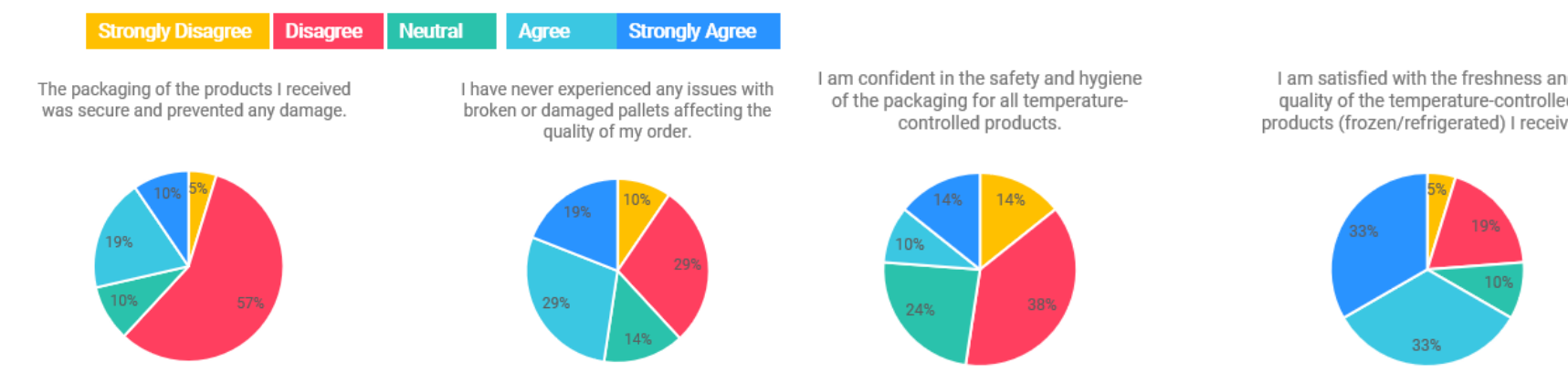


### VOC

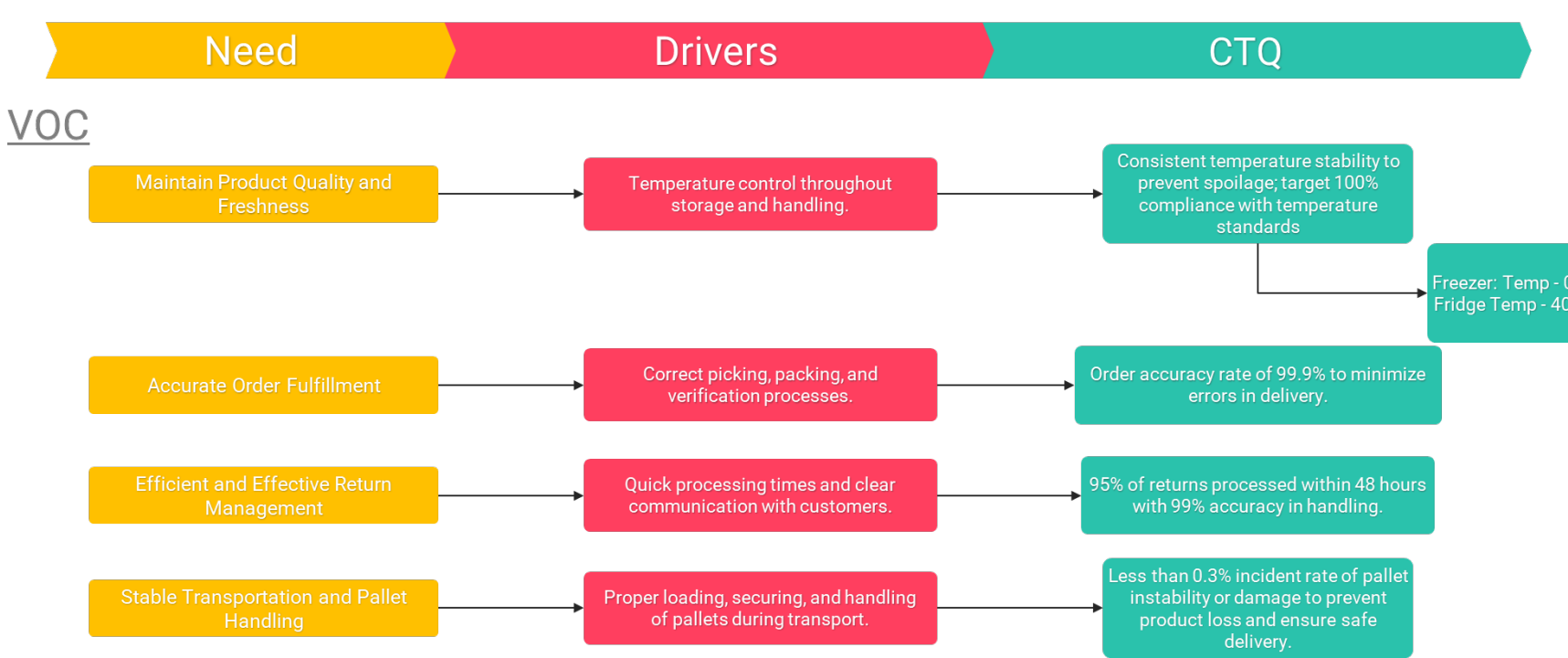


- Transportation and Pallet Stability (39% Cumulative Percentage, 25 Negative Responses). This category has the highest number of negative responses, accounting for 39% of all customer complaints.
- Product Quality and Temperature Integrity (28% Cumulative Percentage, 18 Negative Responses). This category has a large number of negative responses, accounting for 28% of all customer complaints.

- Return Handling and Communication (19% Cumulative Percentage, 12 Negative Responses). Customers expressed dissatisfaction with the return process and the communication surrounding returns.
- Order Accuracy and Fulfillment (14% Cumulative Percentage, 9 Negative Responses). Although this category received the fewest negative responses, there are still concerns about order accuracy and fulfillment, specifically regarding missing or incorrect items.

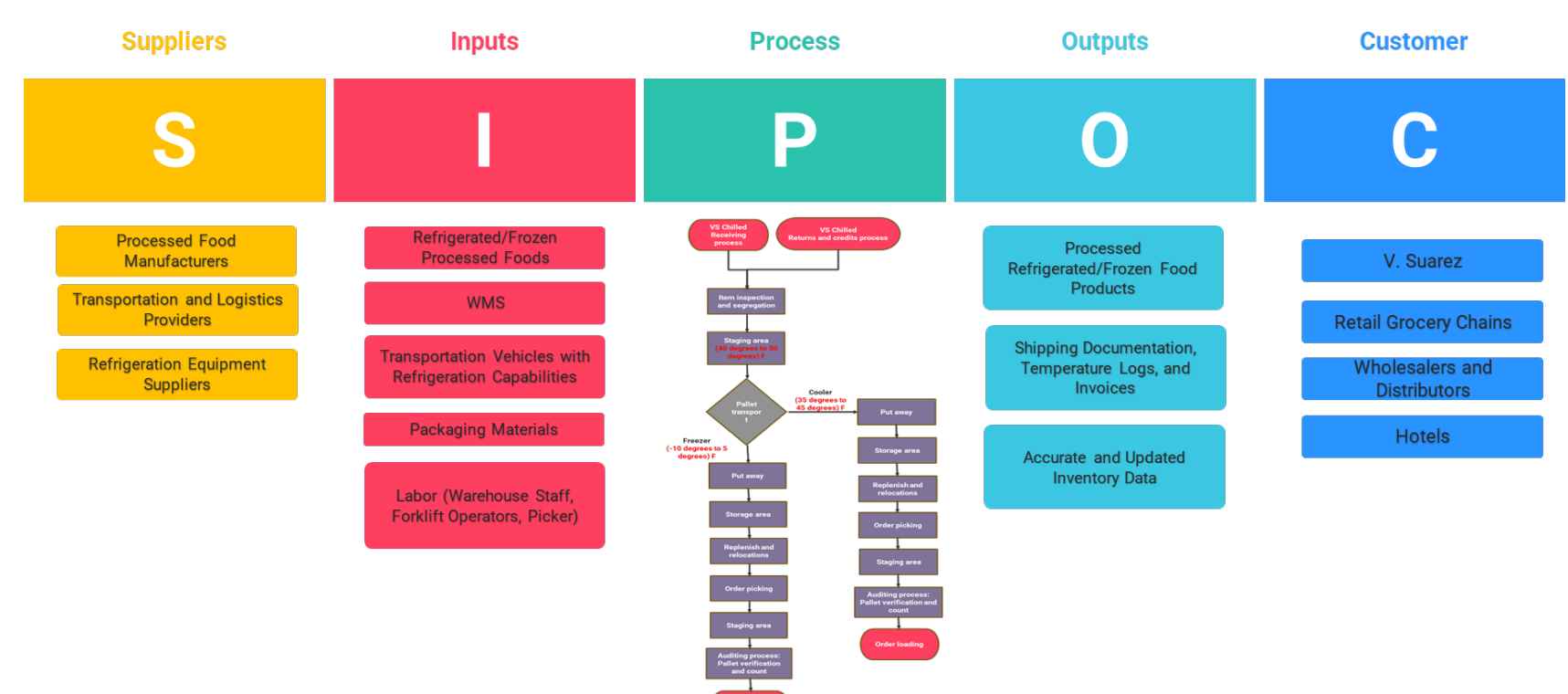


### CTQ



Critical to Quality (CTQ) have therefore been derived from the actual Voice of the Customer (VOC) feedback for this project; The integrity, accuracy and efficiency of the product during the distribution process. These characteristics are consistent with customers' expectations for quality and timely delivery of products as well as management of returns in cold chain logistics.

### SIPOC



SIPOC diagram maps Suppliers, Inputs, Process, Outputs, and Customers of the refrigerated and frozen food distribution process. Every section depicts the flow from suppliers through the final customers, identifying the major elements of input, process and output that are needed to support the effective and quality distribution. This SIPOC defines the main process and interconnections in the cold and frozen food distribution chain, with all the steps aimed at preserving the product quality, safety, and timely delivery to the consumer.

## Measure

### Data Collection

Dependent	Independent
<b>Cases</b> Operational Definition: Number of cases returned (per defect category) Variable Type: Continuous Unit of Measurement: Case or Cases Measurement Tool: SAP WMS  <b>Sales Orders</b> Operational Definition: Number of Sales Orders returned (per defect category) Variable Type: Continuous Unit of Measurement: Order or Orders Measurement Tool: SAP WMS	<b>Temperature</b> Operational Definition: Required temperature range for frozen and cold food products during storage and transportation Variable Type: Continuous Unit of Measurement: Degrees (°F) Measurement Tool: Temperature Return Log  <b>Order Date</b> Operational Definition: Specific calendar date on which a customer order is placed and requested Variable Type: Categorical (Ordinal) Unit of Measurement: Date Format (mm/dd/yyyy) Measurement Tool: SAP WMS  <b>Carrier</b> Operational Definition: Transportation provider or company responsible for the shipment and delivery Variable Type: Categorical (Nominal) Unit of Measurement: Identifier/Carrier Code Measurement Tool: Return Log

Collection Plan	Sampling Plan																														
<table border="1"> <thead> <tr> <th>Variable</th> <th>Data Source</th> <th>Method</th> <th>Frequency</th> <th>Stakeholder</th> </tr> </thead> <tbody> <tr> <td>Temperature</td> <td>Log</td> <td>Manual entry</td> <td>Per shipment</td> <td>Warehouse Team</td> </tr> <tr> <td>Carrier</td> <td>WMS</td> <td>Automated entry</td> <td>Per shipment</td> <td>Logistics Team</td> </tr> <tr> <td>Order Date</td> <td>WMS</td> <td>Automated entry</td> <td>Per order</td> <td>Sales Team</td> </tr> <tr> <td>Order Cases</td> <td>WMS</td> <td>System generated</td> <td>Per order</td> <td>Logistics Team</td> </tr> <tr> <td>Returned Cases</td> <td>WMS</td> <td>Manual entry</td> <td>Daily</td> <td>Customer Service</td> </tr> </tbody> </table>	Variable	Data Source	Method	Frequency	Stakeholder	Temperature	Log	Manual entry	Per shipment	Warehouse Team	Carrier	WMS	Automated entry	Per shipment	Logistics Team	Order Date	WMS	Automated entry	Per order	Sales Team	Order Cases	WMS	System generated	Per order	Logistics Team	Returned Cases	WMS	Manual entry	Daily	Customer Service	Population: 2600 (2,6M Cases) (24,775 Sales Orders) Z: 1.95 (Z-value for 95% confidence level) P: 0.5 (Estimated proportion) E: 0.05 (Margin of error) $n = \frac{Z^2 \cdot P \cdot (1 - P)}{E^2}$ Sample: 384 Orders
Variable	Data Source	Method	Frequency	Stakeholder																											
Temperature	Log	Manual entry	Per shipment	Warehouse Team																											
Carrier	WMS	Automated entry	Per shipment	Logistics Team																											
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Order Cases	WMS	System generated	Per order	Logistics Team																											
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### Descriptive Statistics

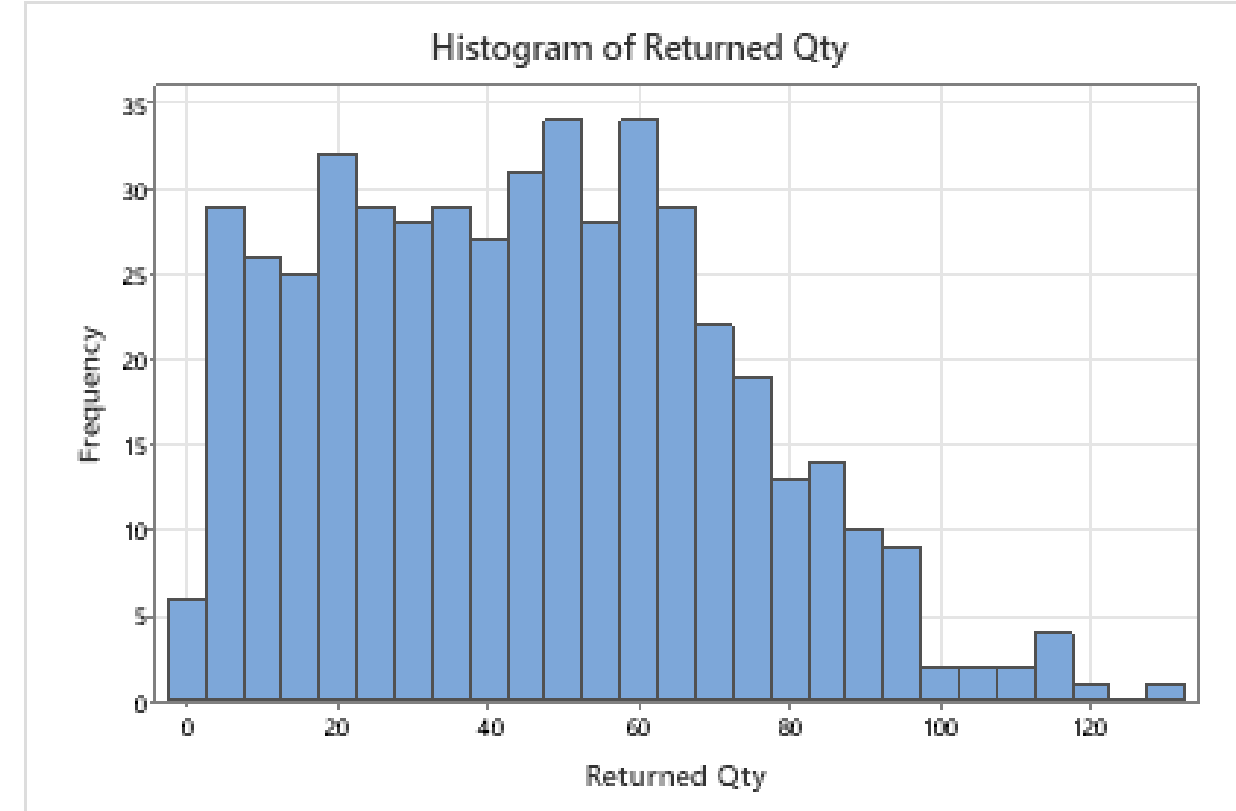
#### Statistics

Variable	N	N <sup>*</sup>	Mean	SE Mean	StDev	Variance	Minimum	Q1	Median	Q3
Order Cases	2600	0	0.89776	3.40	173.16	29982.85	344.00	766.25	884.00	1005.00
Returned Cases	2600	0	8.433	0.412	21.006	441.241	0.000	0.000	0.000	0.000

The large variations in the returned quantities mean that while many orders have no returns, there are some orders with high returns, which may call for further analysis.

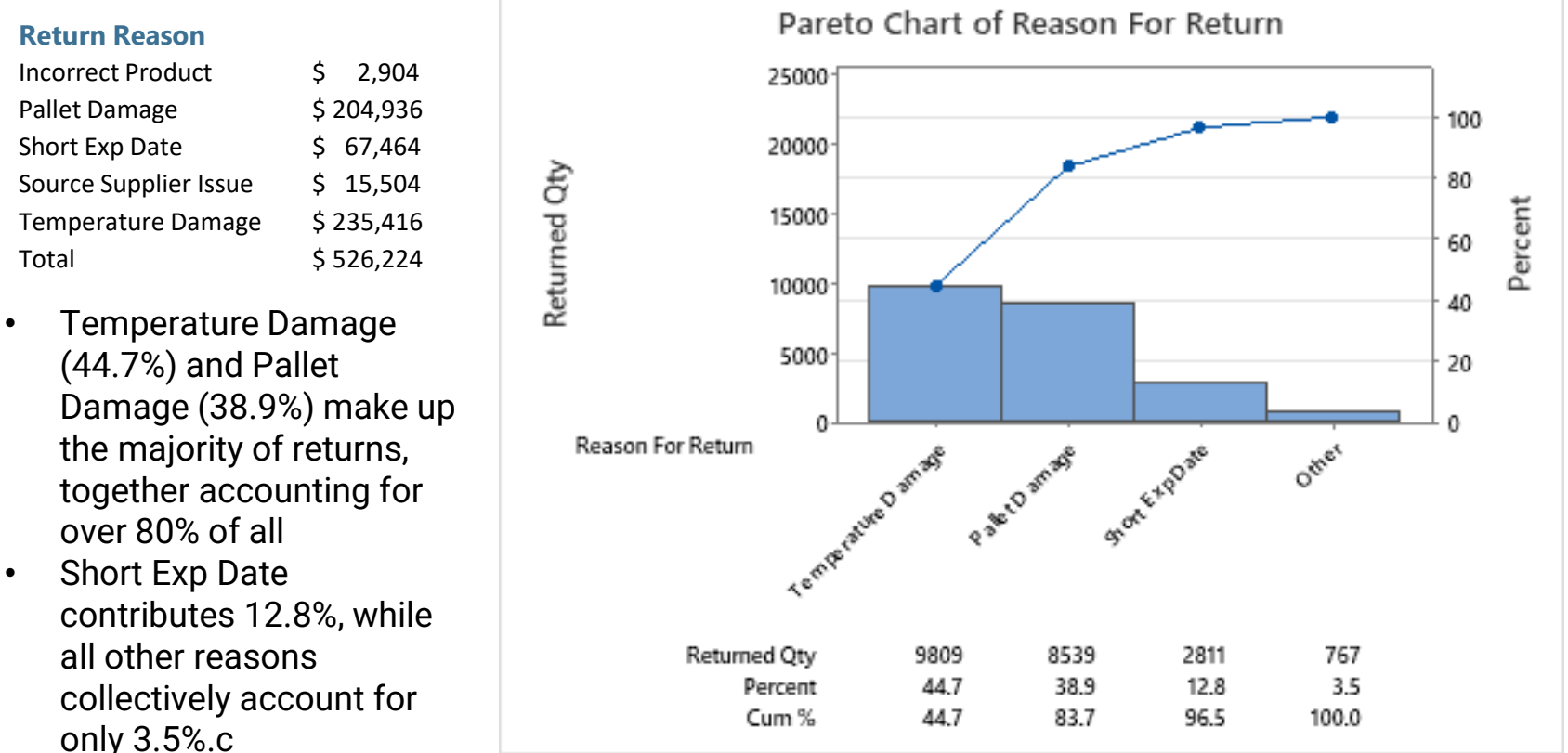
### Histograms

The distribution suggests that though most orders have little or no returns, there are enough high returns to consider, especially with regard to understanding the cause of greater returns.

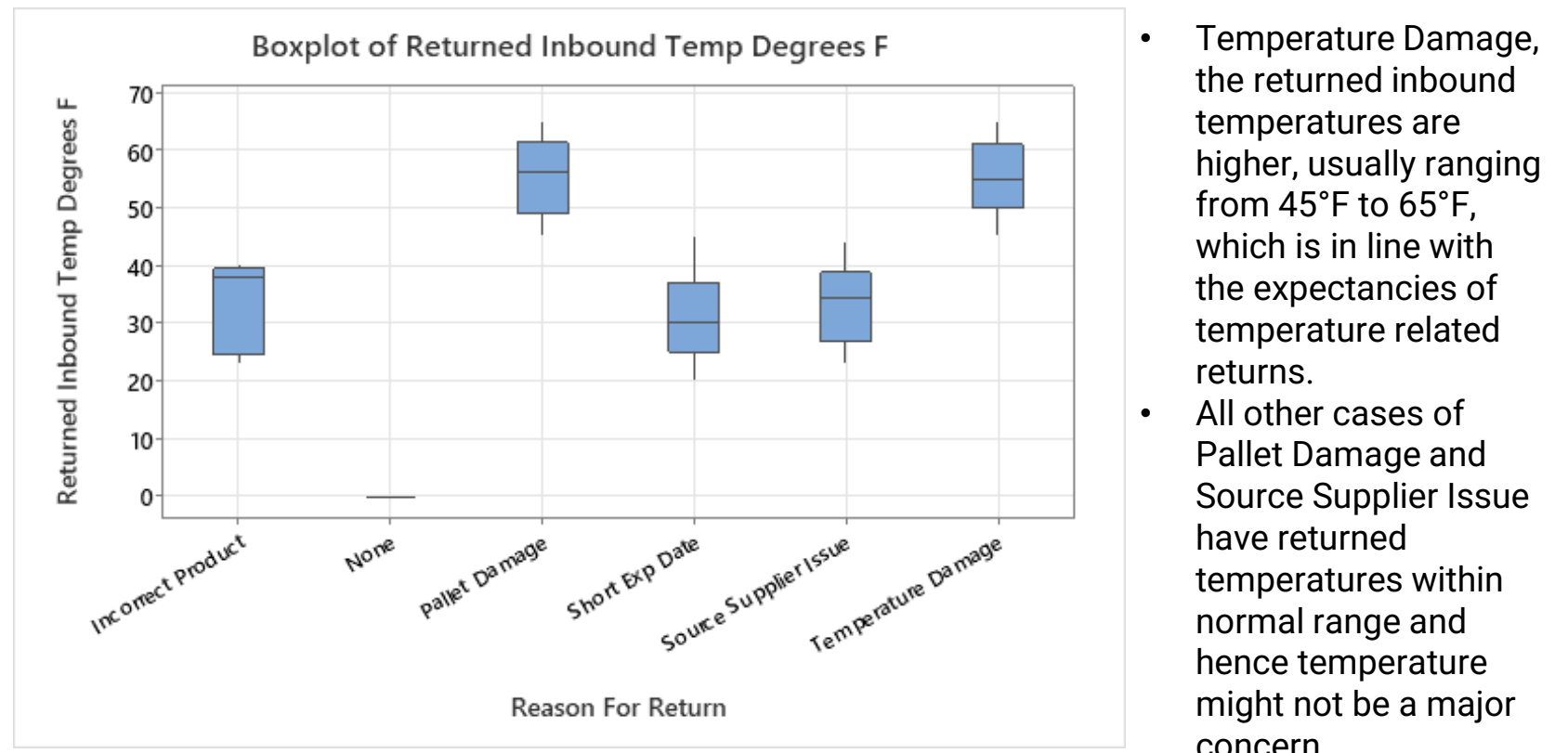


- Most return quantities are concentrated between 0 and 60 cases.
- There is a tapering off as return quantities increase, with fewer occurrences as the numbers get higher, confirming that most returns are relatively small in volume.

### Pareto



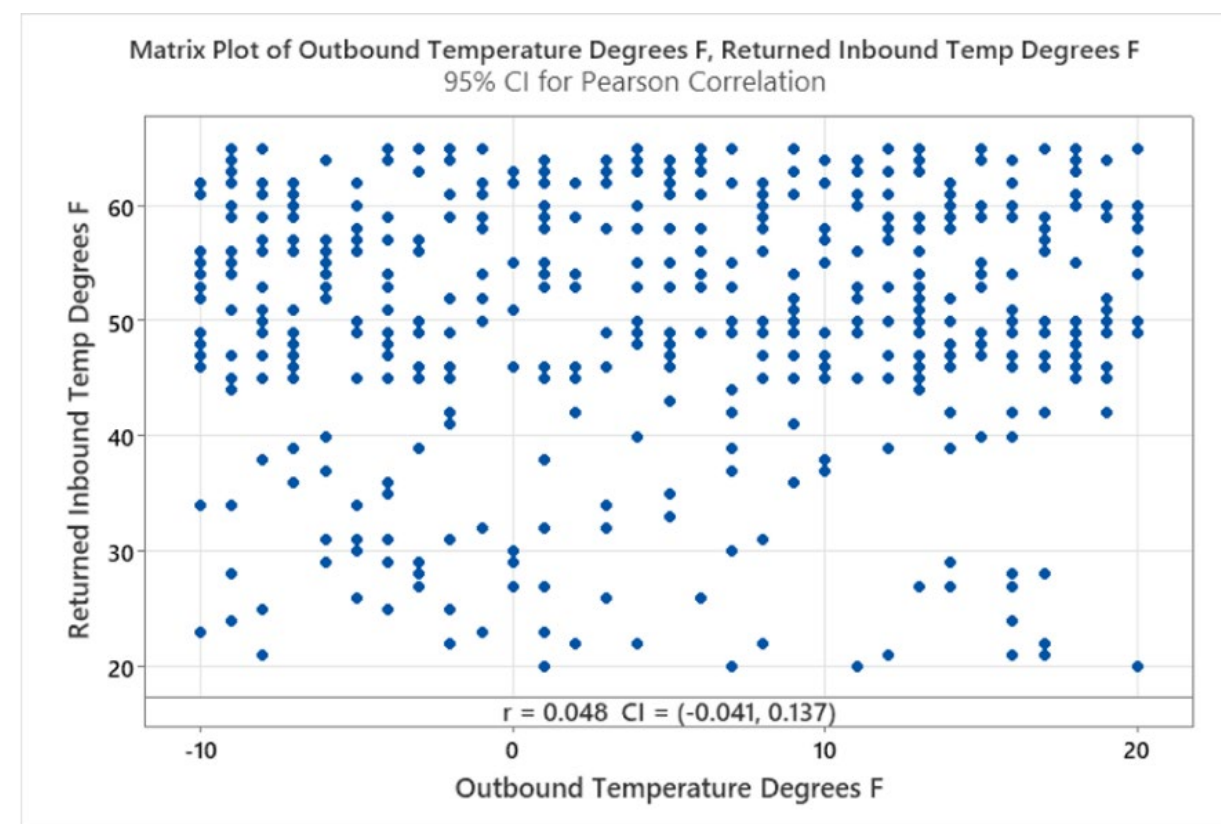
### Boxplot for Temperature



The temperature ranges are in harmony with what is anticipated of various types of defect. This supports the accuracy of temperature data and establishes that temperature variations are associated with certain return types (particularly Temperature Damage).

## Analyze

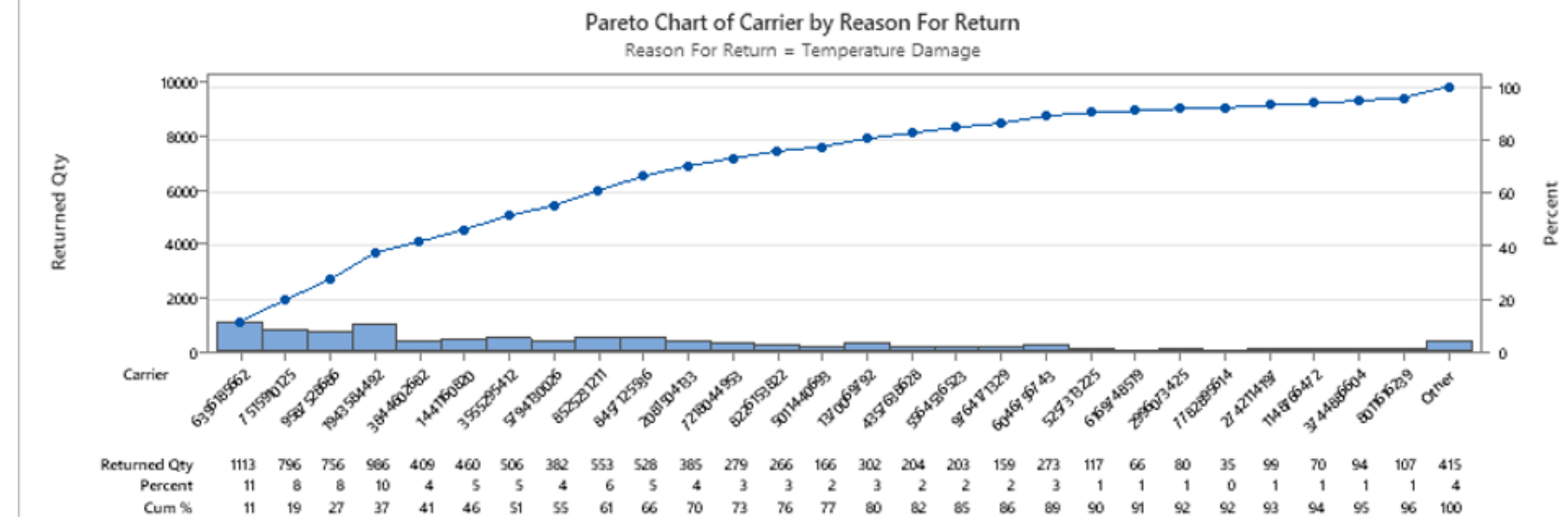
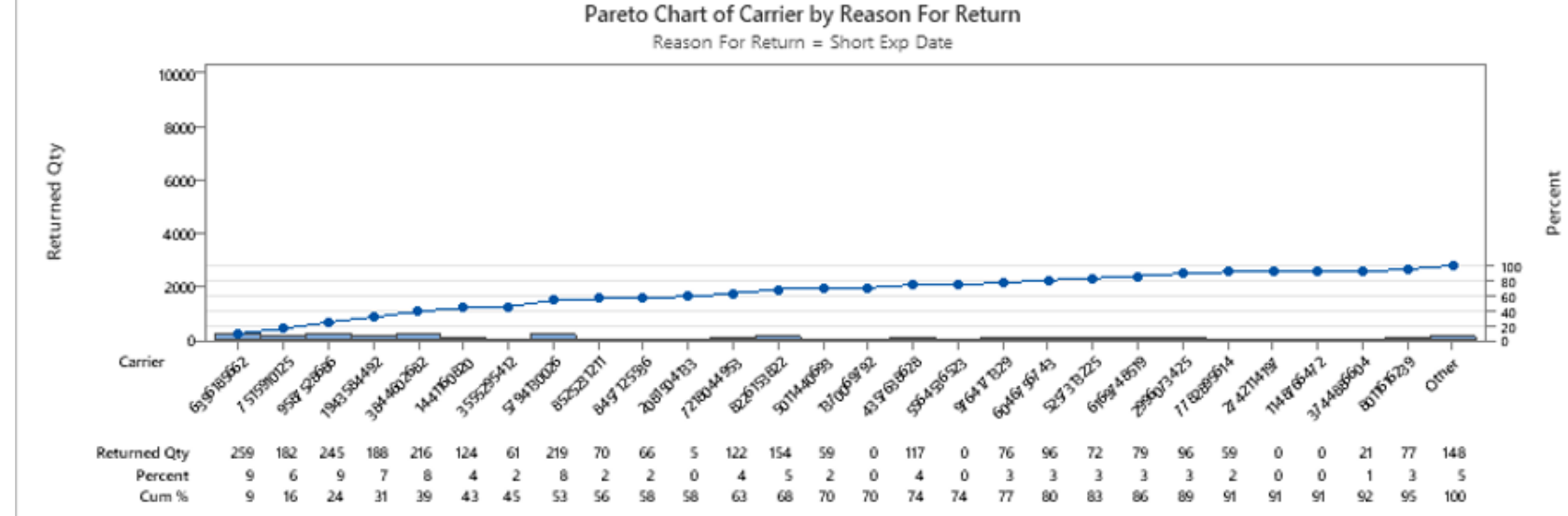
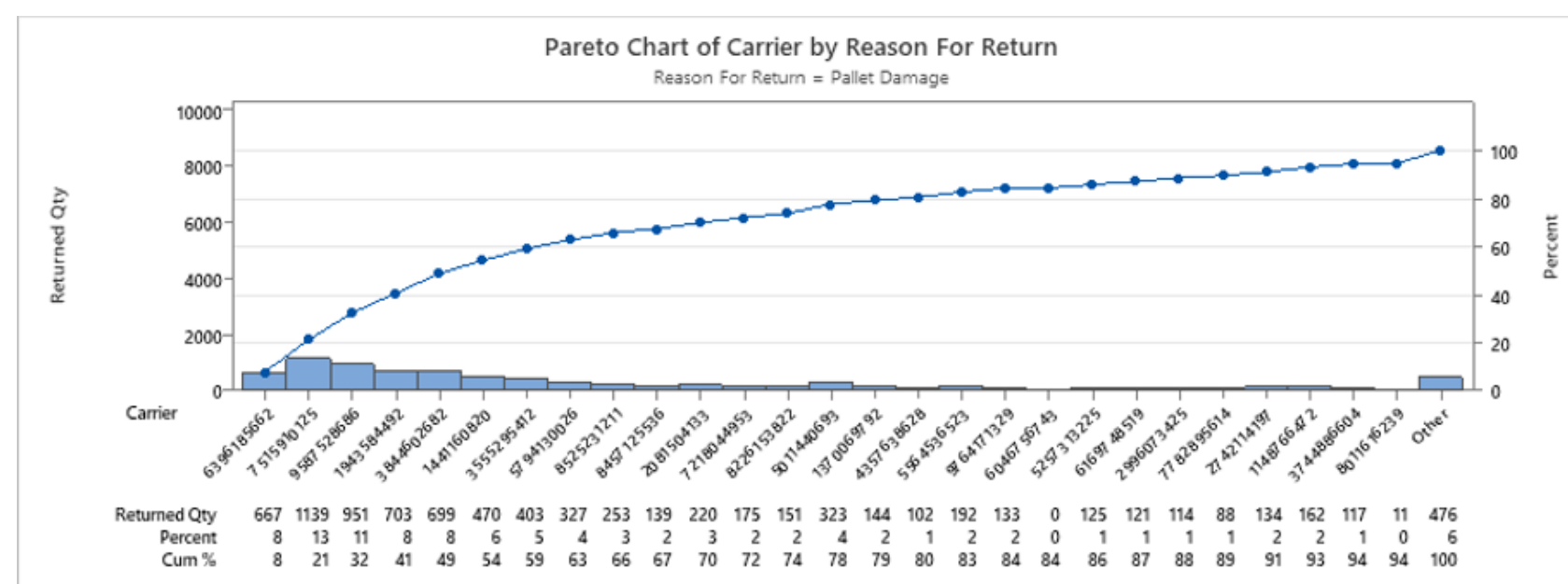
### Correlation Analysis



There is no strong relationship between the initial outbound temperature conditions and the temperature conditions upon return. This suggests that there may be other factors that are affecting these temperature variations such as handling during transit.

### Pareto Analysis (Carrier & Return Reasons)

The analysis classified the impact of each carrier, identifying key contributors to returns based on pallet damages, temperature compliance issues, and short expiry dates. This approach facilitated the identification of problematic carriers, an understanding of their financial impact, and the prioritization of those requiring further monitoring and corrective actions.



Carrier	Return Valuation	Carrier	Return Valuation
6359185602	\$ 52,032	5257131225	\$ 7,920
7515910125	\$ 51,504	6169748519	\$ 7,752
9587528686	\$ 47,136	2996073425	\$ 6,960
1943584092	\$ 46,656	7783956514	\$ 5,664
3844602682	\$ 31,776	2742114197	\$ 5,592
1441160820	\$ 28,272	1148766472	\$ 5,568
3555295412	\$ 23,280	3744886604	\$ 5,568
5794130026	\$ 22,272	8031616289	\$ 4,880
8525231211	\$ 21,504	5945111613	\$ 4,512
8457125536	\$ 19,032	4053792800	\$ 3,960
2081504133	\$ 14,640	7730483511	\$ 3,936
7238044953	\$ 14,520	612944297	\$ 3,744
8226153822	\$ 14,328	2280935565	\$ 3,120
5011440693	\$ 13,152	1950534684	\$ 2,112
1370099792	\$ 12,528	5885767468	\$ 1,968
4537638028	\$ 10,584	6466918869	\$ 1,368
5564536523	\$ 9,480	7787852073	\$ 984
9764171329	\$ 9,024	3628156580	\$ 740
6946756743	\$ 8,856	Total	\$ 526,224

### Regression

Regression Return QTYS Vs Outbound and Returned Temperatures (Damaged Pallets)

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	50.2	17.2	2.92	0.024	
Outbound Temperature Degrees F	-0.298	0.219	-1.36	0.177	1.00
Returned Inbound Temp Degrees F	-0.051	0.309	-0.17	0.869	1.00

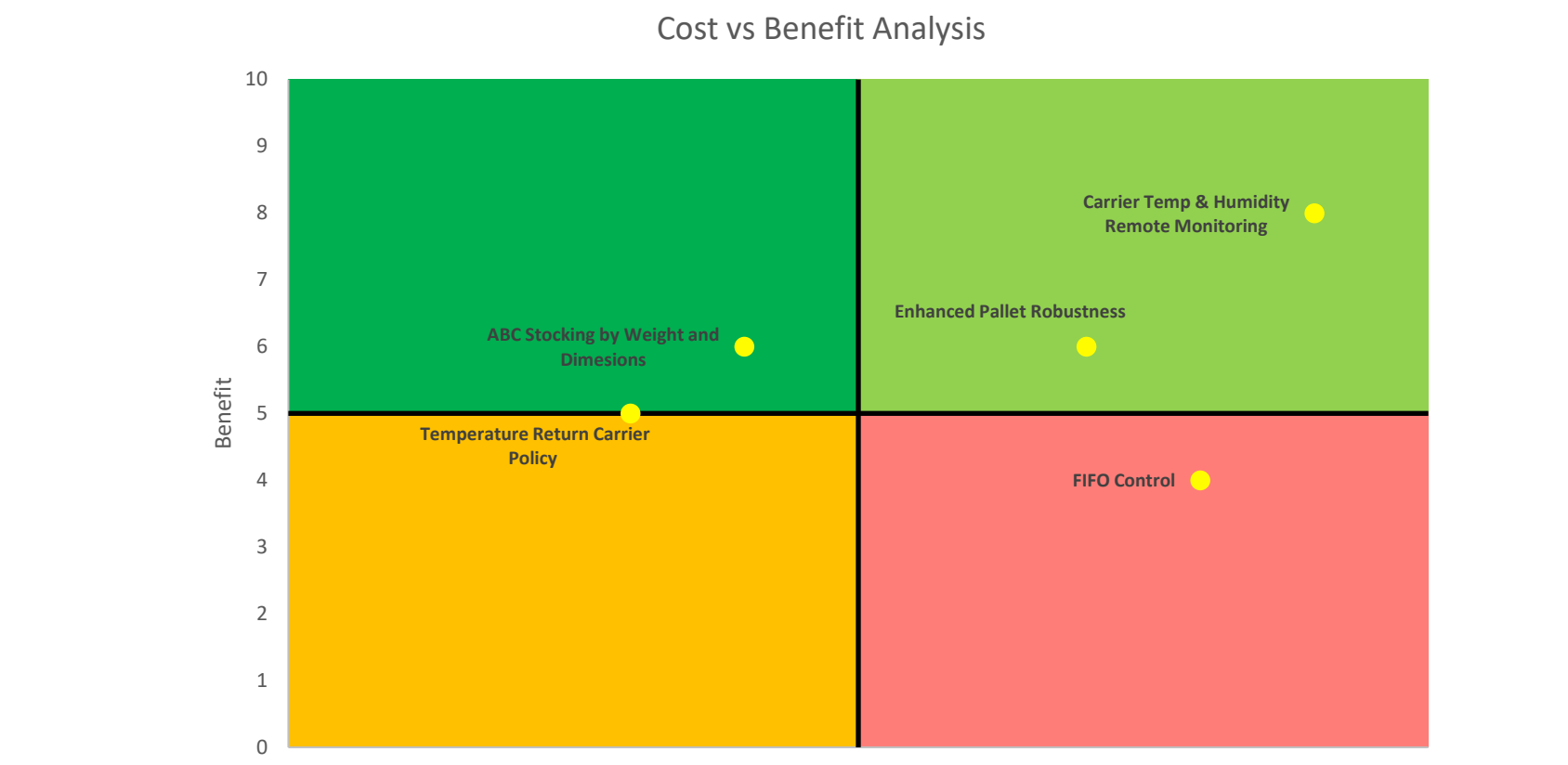
  

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	2	1451	725.38	0.94	0.393
Outbound Temperature Degrees F	1	1420	1420.04	1.84	0.177
Returned Inbound Temp Degrees F	1	21	21.21	0.03	0.869
Error	183	141901	772.13		
Lack-of-Fit	151	103724	686.92	0.58	0.983
Pure Error	32	37577	1174.27		
Total	185	142751			

Temperature is not a significant factor: Neither Outbound nor Returned Inbound Temperatures significantly influence the returned quantities as Damaged Pallets. Low predictive power: The model has a very low R-squared value, suggesting that other factors (e.g., product type, carrier, pack & handling processes) are likely more important in determining returns.

## Improve

### Suggestions Cost & Benefits



#	Suggestion Name	Impact	Description	Cost	Cost	Benefit
1	Temperature Return Carrier Policy	Reduce Temperature Returns	Establish contractual policies requiring carriers to maintain specified temperature conditions during transit. Regular audits ensure compliance.	\$5,000 annually	3	5
2	Carrier Temp & Humidity Remote Monitoring	Reduce Temperature Returns	Install IoT devices for real-time temperature and humidity tracking in carrier trucks. Alerts notify deviations, enabling corrective action during transit.	\$25,000 (initial)	9	8
3	ABC Stocking by Weight and Dimensions	Reduce Pallet Damage Returns	Reorganize warehouse stocking to group products based on weight and dimensions, optimizing pallet stability. Heavy or bulky items are placed on lower tiers, while lighter items occupy upper tiers.	\$12,000 (training and implementation)	4	6
4	Enhanced Pallet Robustness	Reduce Pallet Damage Returns	Reinforce pallets using floor cardboard, corner protectors, stretch wrap, and tighter banding. This mitigates damage from shifting or moisture exposure during transit and handling.	\$15,000 (materials and training) \$8,000 (materials annually)	7	6
5	FIFO Control	Reduce Short Exp Date Returns	Implement a strict First-In-First-Out (FIFO) system using barcoding and inventory tracking. Ensure older products are picked and shipped first, reducing expired stock returns.	\$22,000 (system upgrades and training)	8	4

### Improvements

Improvement	Return Reason Addressed	Returns Reduction (%)	Returns Reduction (Qty)	Improvement (\$)
Temperature Return Carrier Policy	Temperature Returns	30%	2,943	\$ 70,625
Carrier Temp & Humidity Remote Monitoring	Temperature Returns	20%	1,962	\$ 47,083
ABC Stocking by Weight and Dimensions	Pallet Damage Returns	25%	2,195	\$ 51,234
Enhanced Pallet Robustness	Pallet Damage Returns	30%	2,562	\$ 61,481
FIFO Control	Short Exp Date Returns	15%	422	\$ 10,120
Total			10,023	\$ 240,542

### ROI

Investment	Occurrence	\$ USD
	One-Time	\$79K
	Annually	\$13K
Improvement	One-Time	\$240K
	Annually	\$227K

ROI 187% Payback ~ 4 Months

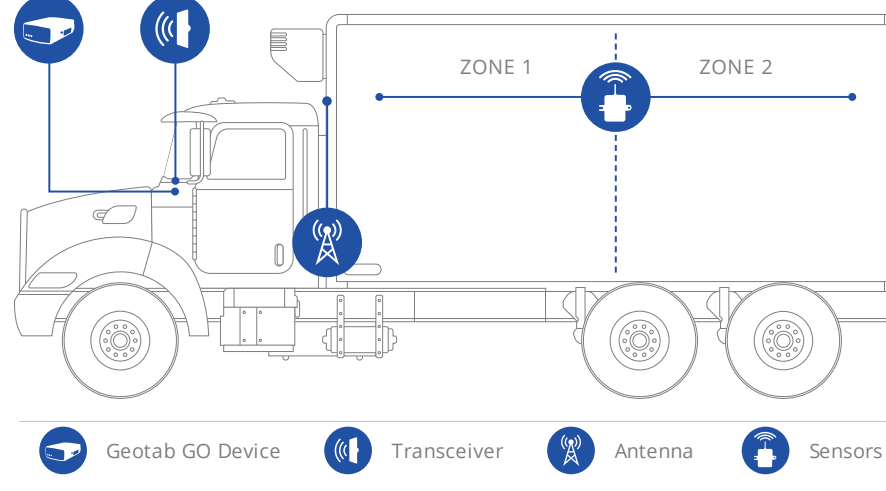
### Scamper

Letter	Action	Description
S	Substitute	•Substitute standard agreements with stricter temperature compliance contracts to ensure accountability.
C	Combine	•Combine IoT temperature monitoring with GPS tracking for better shipment control.
A	Adapt	•Adapt lean warehouse principles to tailor slotting based on weight, volume, and fragility.
M	Modify	•Modify pallet wrapping techniques by incorporating automated stretch-wrapping systems.
P	Put	•Apply FIFO tracking methodology to supplier shipments to ensure inventory integrity and reduce to shelf-life standards.
E	Eliminate	•Eliminate reliance on manual temperature checks by automating alerts through IoT.
R	Rearrange	•Reverse product placement logic by testing alternative stocking methods (e.g., based on pick frequency or demand clustering).

## Control

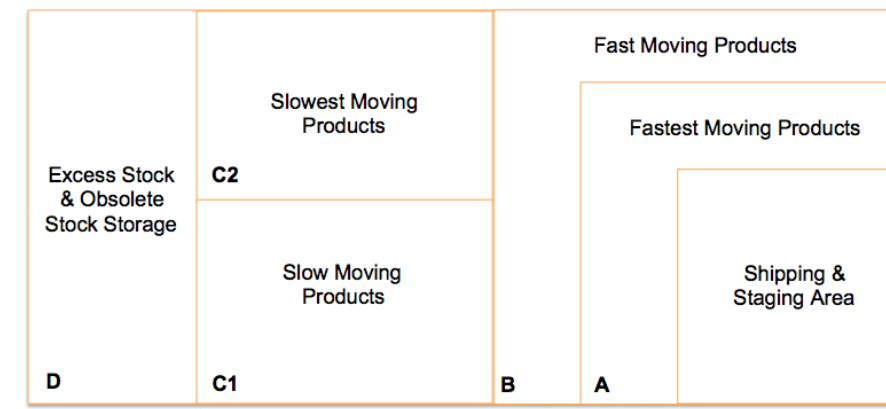
### Monitoring Temperature & Humidity

- Maintain and oversee IoT systems for real-time temperature and humidity monitoring to ensure compliance with the Temperature Return Carrier Policy.
- Use automated alerts to identify deviations and trigger corrective actions promptly.



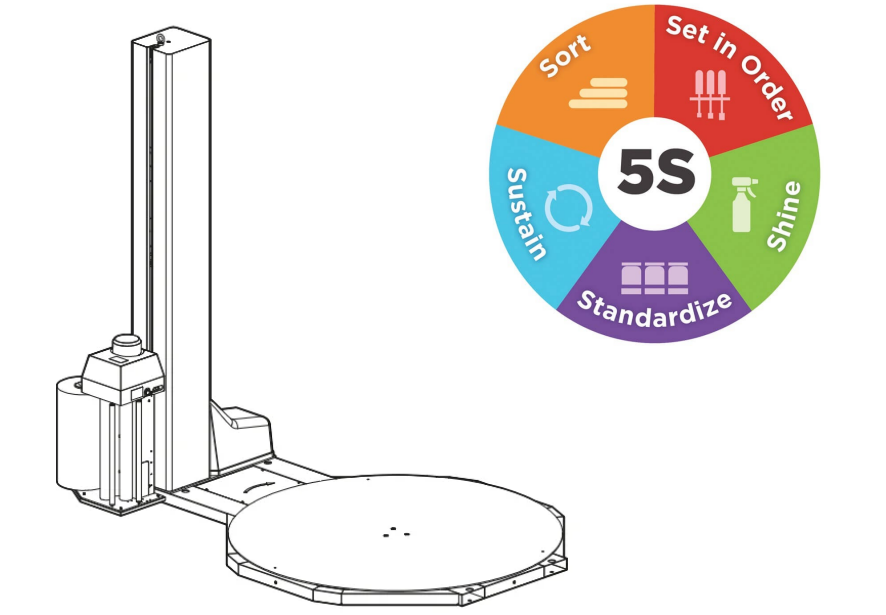
### Sustaining Warehouse Organization

- Conduct regular audits of ABC stocking procedures to ensure compliance with weight- and dimension-based placement.
- Train warehouse staff to follow updated stocking protocols, minimizing pallet instability and damage.



### Pallet Robustness Checks

- Schedule routine inspections to verify the use of corner protectors, stretch wraps, and tight banding.
- Ensure consistent application of pallet reinforcement standards to prevent damage during transit.



### FIFO Control System

- Monitor FIFO system performance using barcoding and inventory tracking.
- Regularly update training for staff to prevent errors in the picking and shipping processes, ensuring reduced expired stock returns.



### Performance Metrics and Feedback

- Track key metrics such as returns reduction, product stability, and cost savings, ensuring improvements deliver ongoing ROI.
- Use dashboards and regular reporting to maintain visibility of performance trends.



### Employee Training and Engagement

- Continue education programs focused on the new systems and procedures implemented during the Improve Phase.
- Gather employee feedback to address any challenges or resistance to maintaining the improvements.

