

# ***Reduction of Demurrages Expenses During the Container Traffic Process***

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**Abstract** — *The project aims to reduce demurrage expenses by addressing delays in container returns to suppliers, improving cost-effectiveness, and financial performance in container traffic logistics. Through detailed analysis using tools like flowcharts, time series plots, Pareto charts, fishbone diagrams, and the 5 Whys method, key factors causing delays were identified, such as poor communication and lack of planning. In the Improve phase, solutions were implemented, including the Priorities tool developed using Excel and Power BI, resulting in a 95% success rate in reducing delays. The Control phase focused on sustaining improvements through clear metrics and validation processes. Overall, the project ensured long-term success in optimizing container traffic management.*

**Key Terms** – *Cost Reduction, DMAIC, Waste, Improvement*

## **PROBLEM STATEMENT**

This project will analyze in depth the traffic process of one of the largest companies in the distribution of consumer goods in Puerto Rico. The company is experiencing significant expenses associated with demurrages during the container traffic process. Demurrages occur due to delays in the delivery of containers to the supplier. These expenses not only increase operating costs but also disrupt the supply chain, affecting the timely delivery of goods to customers. During the past year, the company incurred substantial financial losses due to demurrage expenses, adversely impacting profitability and operational efficiency.

Addressing this issue is critical to reducing operating expenses, improving supply chain resilience, enhancing customer satisfaction, and safeguarding the company's profitability. Therefore, a comprehensive analysis and improvement

initiative are necessary to identify and mitigate the root causes of demurrage expenses during the container traffic process.

## **Research Description**

Currently, the company is incurring expenses due to delays in the delivery of containers to the supplier. These expenses increase operating expenses and therefore reduce operating profits. During 2023, the company incurred expenses of more than \$450,000 in fines from one of their suppliers due to delays in the delivery of containers. During this research, the DMAIC tool was used to identify possible failures within the company's traffic process.

## **Research Objectives**

The objective of the proposed design project is to streamline the container traffic process to mitigate demurrage expenses from 10% to 15%, thereby enhancing operational efficiency, reducing costs, and improving customer satisfaction. The objective for this design project is to reduce demurrage expenses during the traffic process and will be completed in a period of 30 days.

## **Research Contributions**

By effectively managing demurrage expenses, the company can achieve significant cost savings, thereby improving profitability and financial stability. Streamlining container traffic processes will enhance operational efficiency, reduce turnaround times, and ensure timely deliveries, thereby improving overall supply chain performance. By addressing root causes of delays and inefficiencies, the company can mitigate risks associated with supply chain disruptions, enhancing resilience and agility in responding to market changes and challenges.

## LITERATURE REVIEW

The concept of Lean Six Sigma represents an innovative integration of Lean Techniques into the Six Sigma framework, aimed at achieving broad-based innovation and superior financial performance. By combining Lean methods with Six Sigma approaches, Lean Six Sigma drives organizations to not only improve existing processes but also to identify and implement superior practices. This project will adopt the problem-solving process proposed by Lean Six Sigma, utilizing the DMAIC (Define, Measure, Analyze, Improve, Control) tool to guide its various stages and steps effectively.

Six Sigma emphasizes optimizing processes by analyzing input-output relationships and utilizing statistical methods to address inefficiencies [1]. In the project, implementing Six Sigma would involve centralizing traffic processes and conducting statistical studies to enhance efficiency. Emphasizing gradual and continuous improvement, adapting Lean Six Sigma are key for successful implementation [2]. For the implementation can be proposed a management plan with statistical control measures to improve cost savings [3].

## METHODOLOGY

To develop the design project the DMAIC tool was used. DMAIC is a structured problem-solving methodology commonly used in Six Sigma and Lean management methodologies. It stands for Define, Measure, Analyze, Improve, and Control. DMAIC provides a systematic approach for organizations to improve their processes and solve problems effectively. Figure 1 shows these five phases of DMAIC.



Figure 1

### DMAIC Methodology

Applying the DMAIC methodology to address demurrage expenses during the container traffic process involves systematically identifying, analyzing, and improving the underlying factors contributing to delays and additional costs. It is a cyclical methodology, meaning that once the Control phase is completed, the process can start again with the Define phase to address new opportunities for improvement. Here's how DMAIC was applied to this design project.

#### Define

- Identify the specific issues leading to demurrage charges on containers. This could include delays in unloading/loading containers at warehouse, inefficient logistics processes, or inaccurate scheduling.
- Set specific objectives for the project, such as reducing demurrage costs by a certain percentage, improving container turnaround times, and enhancing communication and coordination among stakeholders.

#### Measure

- Gather data on demurrage charges, container movement dates, warehouse congestion, scheduling accuracy, and other factors contributing to delays.
- Identify key performance indicators (KPIs) related to demurrage expenses, such as average demurrage costs per container, total demurrage expenses incurred, frequency of delays, and impact on operating profits.
- Analyze historical data to establish baseline measurements for the identified metrics and understand the current state of the container traffic process.

#### Analyze

- Use tools such as process mapping, 5 Whys, and Pareto analysis to identify the root causes of delays and demurrage expenses. Common factors may include inefficient scheduling, poor communication, inadequate infrastructure, and regulatory compliance issues.

- Determine which factors have the most significant impact on demurrage costs and container delays. Brainstorm potential solutions and interventions to address the root causes identified.
- Analyze collected data to validate hypotheses and identify patterns or trends that contribute to demurrage costs.

### **Improve**

- Develop potential solutions or interventions to address the root causes identified during the analysis phase. This may involve optimizing scheduling processes, improving communication between stakeholders, or implementing technology solutions such as predictive analytics.
- Implement proposed changes on a small scale to evaluate their effectiveness before full-scale implementation. Monitor key metrics to assess the impact of the improvements.

### **Control**

- Establish procedures and protocols to ensure that improvements are sustained over time. This may include developing standardized operating procedures, implementing performance monitoring systems, and providing training to relevant personnel.
- Document lessons learned, successes, and challenges encountered throughout the DMAIC process. Conduct regular reviews to assess the effectiveness of implemented solutions and identify opportunities for further improvement.

## **RESULTS AND DISCUSSION**

In the Define phase the primary objective was to clearly articulate the problem statement, project scope, and objectives. This phase lays the foundation for the entire improvement initiative and ensures alignment among stakeholders. To identify the company's needs, a Voice of the Customer

survey was carried out, which was used later to identify the problem to be analyzed. A Flowchart was created in which the process and activities were explained. The objectives of the project and the results that were expected to be achieved were also identified, demonstrating the use of DMAIC process tools and a project charter were also presented for the project summary.

Through the VOC tool, the goal was to identify needs. This goal was achieved through a survey capable of representing current conditions in container traffic delays and capable of identifying any other factors that may be critical to generating meaningful conclusions. A survey was conducted with 15 employees of the Purchasing Department and Traffic Department, since these were the departments impacted by the project that was being executed.

### **Problem Statement**

Based on the results of the VOC, the researcher identified the main problem in the container traffic logistics process. For this reason, the problem selected to analyze was the time it takes the warehouse to return the containers to the supplier. This task was assigned to the company's Traffic Department. By clearly defining the problem, the company can focus its efforts on analyzing the root causes and implementing targeted solutions to improve efficiency and reduce delays in container management.

During the months of January to December 2023, 1,050 of the containers received in the warehouse took more than 10 days to be returned to the Supplier. This resulted in demurrage charges of more than \$450,000. These demurrage charges increased the company's operational costs, resulting in a loss of revenue. For this reason, the possible variables that influence were analyzed and identified.

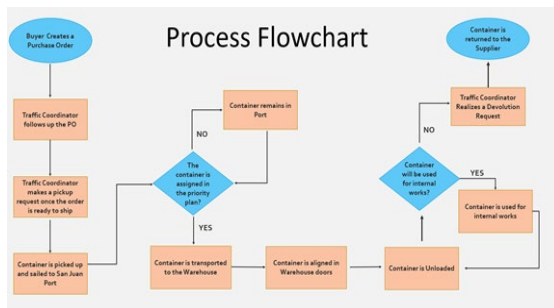
### **Variables to Analyze**

- Total number of excess days that containers are delivered.
- Total containers delivered late to the supplier.

- Container delay charges.

### Project Objectives

The objective of this project was to analyze and reduce demurrage expenses incurred due to delays in returning containers to the supplier. By identifying fundamental issues and optimizing operational workflows, the goal is to reduce demurrage charges and their associated expenses, consequently enhancing general cost efficiency and financial sustainability. Also, identify the root causes of delays and inefficiencies in the container traffic process by conducting a thorough analysis of the collected data.



**Figure 2**  
**Process Flow Chart**

The process begins when the buyer places the order. Then the Traffic Coordinator follows up on the order. Once the order is ready, the Traffic Coordinator makes a pick-up request to ship the container to the port of San Juan. When the container arrives in Puerto Rico, the Traffic Coordinator makes a pick-up request to the dock to pick up the container. If the merchandise that the container brings is a priority, the container is collected; if it is not a priority, the container remains at the dock. The container is then transported to the warehouse and is parked at the warehouse's unloading doors to be unloaded. Once the container is unloaded, a decision is made whether the warehouse will use the container for internal use. If it is not going to be used internally, a request is made to return the container and the container is returned to the supplier.

### Project Charter

The Project Charter provides a clear overview of the project, including its objectives, scope, problem statement, and goals. It serves as a roadmap for the project team, guiding their efforts towards achieving the desired improvements in the container traffic process.

Project Charter					
Project Name: Reduction of Demurrages Expenses During the Container Traffic Process					
Background / Problem Statement: Currently, the company is incurring in annual demurrage payments of more than \$450,000 to its suppliers because the merchandise containers are not returned to the suppliers within the established return date. In addition, by not returning the containers on time, the 33 stations with doors to discharge the containers at the warehouse and 38 parking lots are not used efficiently. The container traffic process needs to be improved with better logistics during the receiving of merchandise. Successfully configuring the container traffic will eliminate the current demurrage charges costs of more than \$450,000, therefore, providing substantial savings to the company. The savings obtained with the implementation of this project will allow the company to be more competitive with their products by providing better prices to its customers.					
Business Objectives: The mission of the company is to be the main supplier of consumer goods products in Puerto Rico and the Caribbean. Having an effective traffic logistics will guarantee that consumers have their products available on time at an affordable price.					
Measures	Focus (Select)	Benefit (Select)	UOM (e.g. \$, %, #)	Baseline	Target
1) Financial	Financial		\$	\$450,000 in demurrage fees	Annual savings costs of \$450,000
2) Increase warehouse a available space for containers	Space		Number of stations available to discharge containers	Average stations occupied by containers not returned on time to the supplier	Increase number of stations available to receive new containers with merchandise
Project Scope, Risks/Assumptions					
In Scope: Eliminate the demurrage costs and number of container stations available.					
Out of Scope: Analysis and elimination of other unnecessary costs during the container traffic process.					
Assumptions: Suppliers schedule of receiving containers can not be modified or changed.					
Project Team & Timeline					
Project Lead	Jennifer Barnard				
Sponsor(s)	Juan Carlos Martinez				
Proposed Team Members	Jennifer Barnard				
Stakeholder(s)	Traffic and Purchasing Department				
Project Start	13 Mar 24				
Estimated Project End	12 Apr 24				
Milestone Dates					
	Planned Phase Start		Planned Phase End		
Define	12 Mar 24		15 Mar 24		
Measure	15 Mar 24		22 Mar 24		
Analyze	22 Mar 24		29 Mar 24		
Improve	29 Mar 24		12 Apr 24		
Control	12 Apr 24		31 Dec 24		

**Figure 3**  
**Project Charter**  
**Measure**

In the Measure phase, the primary objective is to collect and analyze data to quantify the current state of the container traffic process and understand the factors contributing to demurrage expenses. This phase is crucial for gaining valuable insights into the existing process and identifying areas for improvement.

### Variable Measurement

After having analyzed the container traffic process, three variables were selected and analyzed with the purpose of identifying the problem that currently affects the company. The variables analyzed were:

- Total number of excess days that containers are delivered.

- Total containers delivered late to the supplier.
- Container delay charges.

The correct measurement of the variables is critical for the subsequent analysis of the problem, identification of the correct root cause(s), and the implementation of corrective actions that culminate in the permanent solution of the problem.

### Data Collection Plan

The data collection plan was obtained from the company's Traffic Department, where the demurrage data from year 2023 was used. Figure 4 was counted for the months of January to December 2023. By following this data collection plan, the personnel systematically collect, analyze, and interpret delay data from the Traffic Department to gain insights into the factors contributing to demurrage expenses during the container traffic process. This information provided a solid foundation for identifying improvement opportunities and implementing targeted interventions to reduce delays and associated costs.

Month	2023				Reasons for Late Delivery						
	Containers Unloaded	Total Days Late	Containers Returned Late	% Of Containers Returned Late	Late Fee Charges (\$)	Not a Priority	Used By Client	Lack of Parking Space	Documentation	Otherr	
January	674	1674	93	14%	\$ 412,950.00	71	5	10	2		
February	354	79.6	49	14%	\$ 192,500.00	41	3	5			
March	596	81.2	67	11%	\$ 251,050.00	58	7			2	
April	432	1899	127	29%	\$ 442,000.00	118	5	2	1	1	
May	360	2022	141	39%	\$ 618,235.00	124	11	5		1	
June	566	2476	164	29%	\$ 741,900.00	138	15	10	1		
July	460	801	64	14%	\$ 269,000.00	54					
August	591	1206	88	15%	\$ 528,000.00	80		8			
September	387	79.2	57	15%	\$ 220,350.00	52	3		2		
October	410	72.1	51	12%	\$ 191,500.00	49		2			
November	482	98.9	78	16%	\$ 365,750.00	78					
December	635	97.4	71	11%	\$ 297,000.00	68				3	
<b>Total</b>	<b>5947</b>	<b>15102</b>	<b>1050</b>	<b>18%</b>	<b>\$453,185.00</b>	<b>941</b>	<b>49</b>	<b>42</b>	<b>6</b>	<b>7</b>	

Figure 4  
Data Collection Plan

### Process Data Collection Plan

The Process Data Collection Plan contains a summary of the steps to be followed to carry out data collection, its graphic presentation, and the tools to be used for its measurement.

**Process Data Collection Plan** Project: Reduction of Demurrages Expenses During the Container Traffic Process

What are the causes for containers demurrages?  
There are many factors that could determine the containers demurrages. One of the factors could be the lack of space or excess of inventory in the warehouse so the container is used for storage regardless the days of demurrages this may cause. Another factor could be the lack of coordination of the priority plan between the departments that manage the containers traffic. As part of this project, we will identify and analyze the variables that are causing the demurrages charges (late fee charges), identify the root cause of the delays, and implement corrective actions in order to reduce or eliminate these operational costs to the company.

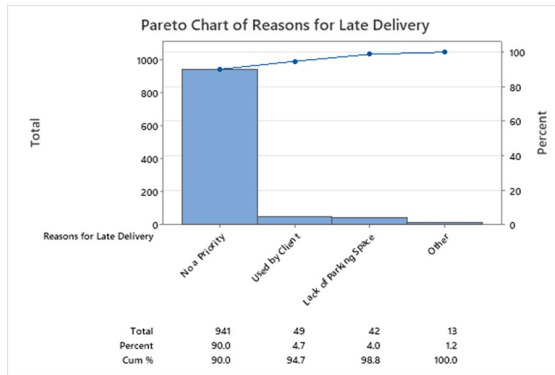
Data		Operational Definition and Procedures			
What	Measure type/ Data type	How is measured?	Related conditions to record	Sampling notes	How/where recorded
1. Containers received each month - Continuous Data		1. Time Series Plot	The data will be collected, measured, and monitor by month in order to understand the behavior with time.	Data collected and used for this project is verified and certified by the Traffic Department.	Data recorded and provided by the Traffic Department
2. Container's delays in days - Attribute Data		2. Pareto Chart			
3. Amount of containers returned late per month - Attribute Data		3. Fishbone			
4. Late fee charges per month - Attribute data		4. 5 Why's 5. Time Value Map			
How will you ensure consistency?		What is your plan for starting data collection?			
Consistency can be achieved as long as there is an effective communication within the departments responsible for containers traffic coordination. The departments include Sales, Purchasing, and Warehouse.		The data will be collected using historical and current data from the Traffic Department. How will the data be displayed? The data will be displayed in tables and graphs in order to analyze the main factors that are contributing to the demurrages charges (late fee charges).			

Figure 5  
Project Charter  
Analyze

In the Analyze phase, the primary objective was to delve deeper into the root causes of delays and inefficiencies identified in the Measure phase. This phase involves rigorous data analysis, statistical modeling, and root cause analysis to uncover insights into the factors contributing to demurrage expenses and identify opportunities for improvement.

### Pareto Chart

Pareto Charts were used to identify and prioritize the most significant factors contributing to a problem or outcome. The bars represent individual categories or factors, sorted in descending order by frequency or magnitude, while the line graph represents the cumulative percentage of the total.



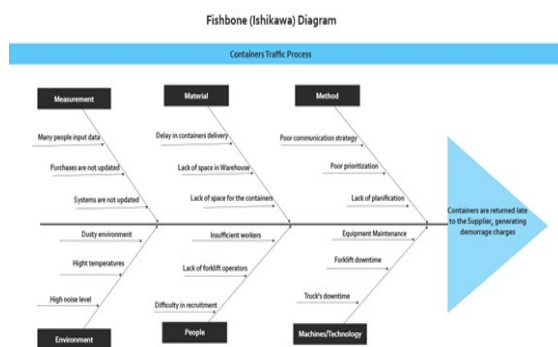
**Figure 9**

**Time Series Plot**

When performing the Pareto Chart of the factors that delay the container return process, it can be observed that the mark on the graph of the broken line close or approximate to the value corresponding to 80% of the cumulative percentage, the following defects in the process were identified container delivery:

- Merchandise is not a priority.
- Container used by a client.
- Lack of parking space.

Based on the evaluation and results of the Pareto Chart, these were the three (3) main causes of the delays in the traffic processing process, resulting in 98.7%.



**Figure 8**

**Fishbone Diagram**

For the cause-and-effect diagram, also called Fishbone Diagram, the problem identified was containers that are returned late to the supplier, incurring delay charges. A total of six (6) categories were evaluated, which were Measurements,

Materials, Method, Environment, People and Machines/Technology.

In the Measure category, three possible causes were identified that may affect the charge for container delays, including purchase orders that are not up to date, the system is not updated, and many people work on the same data; this can cause an excess of orders of purchases that are currently not necessary to order.

In the Materials category, it was possible to identify the delay in the arrival of containers for the warehouse to unload. The lack of space in the warehouse could also be identified; many times, the containers are not unloaded due to excess inventory of that product in the warehouse. Another cause found in this category was the lack of parking at the company.

In the Method category, it was identified that the causes of the problem may be poor communication between the Sales, Purchasing, and Warehouse departments. Another identified cause was the strategy of how to carry out the priority plan and the lack of planning between departments.

In the Work Environment category, it was found that the causes could be a dusty environment, high noise levels, and high temperatures that have the effect of a lack of concentration in the employee who unloads the containers, which can cause lower efficiency and delays in the process.

In the People category, the lack of personnel in the warehouse, lack of operators, and difficulty in recruiting employees for the warehouse could be identified as possible root causes of the delays in the container unloading process.

On the other hand, in the Machine category it was possible to identify that a conceivable cause of the problem was equipment maintenance, forklift downtime, and truck downtime.



**Figure 9**

**Five Whys**

The results obtained from the 5 Why's tool related to delay charges during container traffic identify the lack of planning between the Sales, Purchasing, and Warehouse departments as the main root cause of the problem. This causes a delay in the unloading of the containers since they are not unloaded according to their arrival, but rather according to the priority determined by the Purchasing Department. It is recommended to carry out systematic planning between the three departments that are a key element so that the containers are unloaded and delivered in the time stipulated by the supplier to avoid demurrage charges.

**Improve**

The Improve phase of the project to reduce demurrage expenses in the container traffic process is a pivotal stage where insights from earlier phases are transformed into actionable strategies. By focusing on optimizing container unloading priorities, the project aims to tackle delays and minimize demurrage costs effectively. Leveraging an Excel file integrated with Power BI, daily inventory data is analyzed to establish download priorities based on potential lost sales. This prioritization process, overseen by management and communicated to warehouse personnel, has resulted in a significant improvement, with a 95% success rate observed over a 15-day trial period. By enhancing communication, streamlining operations,

and ensuring timely action, the project was successfully mitigated delays and upheld supplier timelines, ultimately reducing demurrage expenses.

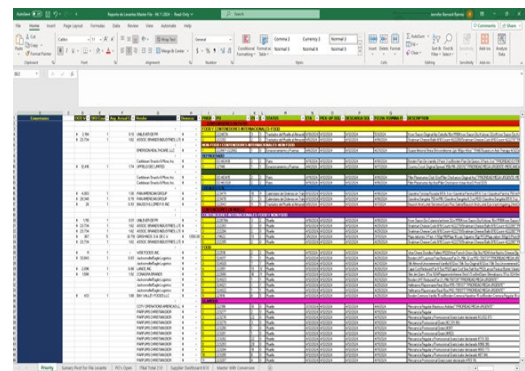
**Objective and Purpose**

The objective of the Priorities tool is to optimize the container unloading process by providing clear priorities based on daily inventory data. By ensuring that containers are unloaded in the order of priority, the tool aims to minimize delays and prevent demurrage charges.

**Tool Design**

An Excel file was designed to leverage daily inventory data, which was obtained and processed using the Power BI tool. This data was used to generate a list of download priorities for containers, filtered daily by lost sales associated with pending orders.

The Excel file serves as a centralized platform for managing and communicating priorities to the warehouse team responsible for container unloading.



**Figure 10**

**List Of Containers Waiting to be Unloaded**

**Implementation Process**

- The Priorities tool was integrated into the daily operations of the container traffic process. It was updated and maintained regularly to reflect the latest inventory data and download priorities.
- The tool was managed by designated personnel responsible for compiling and analyzing

inventory data, generating priority lists, and communicating them to the warehouse team.

### Testing and Validation

A testing phase was conducted over a period of 15 days to assess the effectiveness of the Priorities tool. During this period, the tool successfully achieved a 100% success rate in ensuring that containers at the dock and warehouse were unloaded within the stipulated timeframes set by suppliers.

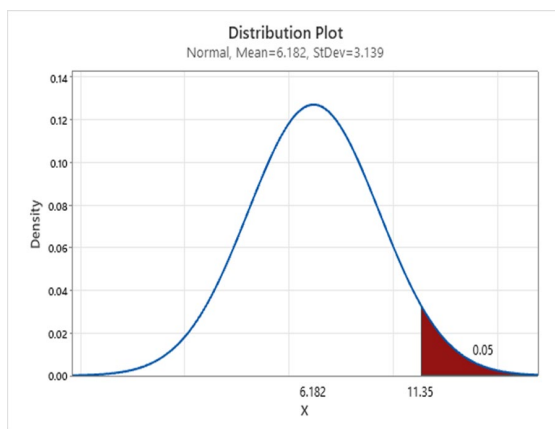
The positive outcome of the test validated the efficacy of the Priorities tool in addressing delays and optimizing container unloading processes.

### Results and Impact

As a result of implementing the Priorities tool, delays in the container unloading process have been significantly reduced. Containers were now unloaded according to priority, minimizing the risk of demurrage charges, and ensuring timely delivery to customers. The successful implementation of the tool has led to improved efficiency, operational performance, and cost savings for the company.

Graph 1

Control



The implementation of the new process was effective, since the hypothesis test has shown that the difference is significant. By having a  $p$ -value less than 0.05, there is strong evidence to reject the null hypothesis, indicating that the change in the process has had a positive impact on the delivery of the containers. Maintaining an average delivery of

6 containers in less than 10 days was a significant achievement and will help the company to reduce the operational costs currently incurred.

### Sustainability of the New Process

Once the design was implemented, a long-term sustainability plan for the new process must be created to guarantee its success and permanence, making the necessary adjustments over time. The plan must contain the following elements, which must be planned, documented, and executed at a more detailed level, as provided by the company's management:

#### Implementation and Monitoring of Productivity Metrics

- Define clear and measurable productivity metrics for the Purchasing, Sales, Traffic, and Warehouse departments that align with the objectives of the new process.
- Establish baseline metrics to assess the current performance levels and set targets for improvement.
- Regularly review and analyze productivity data to identify trends, patterns, and areas for optimization, and take corrective actions as necessary to ensure alignment with project expectations and company goals.

#### Data Measurement, Analysis, and Control

- Identify key performance indicators (KPIs) and critical process data points to measure and analyze before and after the implementation of the new process.
- Implement data collection mechanisms and systems to capture relevant data accurately and efficiently, ensuring data integrity and reliability.
- Use statistical tools and techniques, such as Pareto analysis, control charts, and regression analysis, to analyze process performance, identify root causes of variability, and make data-driven decisions.
- Establish control mechanisms and protocols to monitor process stability and prevent

deviations from established standards or targets, implementing corrective actions when necessary to maintain control and sustain improvements over time.

### Validation and Review Processes

- Conduct a comprehensive validation exercise 6 to 12 months after the implementation of the new process to assess its effectiveness and impact on business performance.
- Evaluate the financial results, operational efficiencies, and customer satisfaction metrics to determine the success of the new process in achieving its intended objectives.
- Improve and ensure the continued sustainability and success of the new process.

### CONCLUSION

This project was focused on the reduction of demurrage expenses stemming from delays in container returns, crucial for enhancing cost-effectiveness within the organization. Through rigorous analysis and targeted interventions, identify and mitigate root causes of delays in the container traffic process. By leveraging data-driven insights and implementing strategies to minimize demurrage charges, the project seeks to streamline operations and improve overall efficiency. An Excel file integrated with Power BI provided daily inventory data analysis, aiding in prioritizing container downloads, and optimizing resource allocation. These efforts were geared towards achieving significant cost savings and maintaining a competitive edge in the marketplace.

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