Application of SIPOC and Resource Planning Systems to Reduce Demurrage Costs and Yard Saturation in Container Discharge Operations

Abril Cadena Martínez*, Luis David Echenique Lima, Luis Alejandro Santana Valadez, Gloria Gálvez Cerón, Morales Montaño Karina, Samantha Chang Reyes

Instituto Tecnológico de Pachuca, Hidalgo

***Corresponding Author**

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ABSTRACT

In high-volume manufacturing plants that rely on continuous imports of raw materials and components, inefficiencies in the container unloading process frequently generate yard congestion, delayed empty-container returns, and elevated demurrage and detention costs. Manual or semi-manual assignment procedures often result in duplicated container allocations, limited visibility of remaining free days, and suboptimal use of yard space and unloading equipment, ultimately affecting material availability and production continuity. This applied study proposes a low-cost solution that combines process diagnosis through the SIPOC methodology, a spreadsheet-based resource planning system, and a visual dashboard to optimize daily and weekly container unloading programs.

The methodology is structured in five sequential phases: current-state diagnosis, resource and capacity evaluation, design of the planning system, development of the visual dashboard, and impact evaluation. The SIPOC analysis identified fragmented information flows and critical visibility gaps. A spreadsheet-based system incorporating structured tables, data validation rules, and macros was developed to register container data, unloading dates, warehouse destinations, and free-day status, while a dynamic dashboard provides real-time visibility of progress, warehouse distribution, and demurrage risk. Scenario analysis indicates that the proposed tools can significantly reduce the time required to generate the daily program, decrease assignment errors, and enable proactive prioritization of containers approaching their free-day limit.

The findings demonstrate that the integrated use of high-level process mapping, structured resource planning, and visual management constitutes a practical and accessible intervention capable of reducing yard saturation and demurrage exposure without requiring a full enterprise resource planning system replacement. The approach offers a reproducible framework for improving inbound logistics performance in manufacturing environments characterized by high container volumes and constrained yard capacity. Operational validation through pilot implementation remains necessary to quantify actual cost and time savings.

Keywords: SIPOC, resource planning, demurrage, container unloading, visual dashboard, inbound logistics, yard management.

INTRODUCTION

In contemporary global supply chains, the efficiency of inbound logistics processes has become a decisive factor for the competitiveness of manufacturing firms. Particularly in high-volume import operations, the timely unloading of containers and the subsequent return of empty units directly influence production continuity, working capital utilization, and the avoidance of demurrage and detention charges.

When container yard capacity is constrained and unloading schedules are managed through manual or semi-manual procedures, firms frequently experience yard congestion, delayed empty returns, incorrect warehouse

allocations, and elevated logistics costs that ultimately affect overall operational performance (Christopher, 2011; Krajewski et al., 2008).

These challenges are especially pronounced in large-scale manufacturing plants that depend on a continuous inflow of imported raw materials and components. High container volumes, variable port release times, fluctuating production demand, and the coordination required among customs brokers, third-party logistics providers, and internal warehouse teams create multiple points of friction.

Manual planning tools often result in duplicated container assignments, limited visibility regarding the free time remaining before demurrage penalties begin to accrue, and suboptimal use of unloading resources such as forklifts, reach stackers, and receiving docks. Consequently, production lines may face material shortages even when containers are physically present on site, while the organization simultaneously incurs unnecessary detention costs and experiences reduced yard throughput.

Resource planning systems and visual management tools offer practical mechanisms to address these issues. By structuring the unloading process through high-level process mapping techniques such as SIPOC, establishing clear daily and weekly assignment rules aligned with warehouse capacity and production requirements, and deploying interactive dashboards, organizations can improve the synchronization between container arrivals, yard space, and receiving resources.

Spreadsheet-based planning systems enhanced with macros, dynamic tables, and business-intelligence dashboards have proven effective in environments where full-scale enterprise resource planning implementations are either unavailable for specific subprocesses or overly complex to adapt quickly (Jacobs et al., 2009). These tools enable real-time visibility of container status, days of free time remaining, warehouse destination, and daily unloading progress, thereby supporting faster and more accurate decision-making.

The present work addresses the optimization of the container unloading program in the import area of a large appliance manufacturing plant. The study diagnoses the current process and its main inefficiencies, proposes a structured planning system for daily warehouse and container assignment, and evaluates its potential to reduce unloading lead times, improve empty-container turnaround, and decrease demurrage-related costs.

By combining process analysis, resource planning logic, and visual dashboards, the approach aims to provide a practical, low-cost solution that enhances operational visibility and decision-making without requiring a full enterprise-wide system replacement. The contribution lies in demonstrating how accessible tools can be systematically applied to a critical inbound logistics subprocess under conditions of high volume and limited yard capacity.

This article is organized as follows. The next section reviews relevant concepts in inbound logistics, demurrage management, process mapping, and planning tools. Subsequent sections describe the problem context and current situation, the proposed methodology and system design, the implementation of the planning system and dashboard, and the results obtained. The paper concludes with recommendations for further improvement, scalability, and integration with broader supply-chain processes.

LITERATURE REVIEW

Following the same SALSA methodology used in previous works, this review focuses on articles published between **2016 and 2026** related to container unloading optimization, demurrage and detention reduction, yard management, process mapping (SIPOC), resource planning systems, and visual dashboards in inbound logistics for manufacturing plants.

SALSA Methodology Applied

- **Search**: Scopus, Google Scholar, ScienceDirect, Springer, MDPI, ResearchGate, and logistics/operations journals (2016–2026). Keywords: container unloading OR demurrage OR detention AND (yard OR terminal OR warehouse); SIPOC AND (logistics OR import OR unloading); dashboard

OR "visual management" OR Power BI AND (container OR inbound logistics); "master production schedule" OR MPS OR ERP AND container OR demurrage; inbound logistics optimization manufacturing.

- **Appraisal**: Priority given to applied case studies, quantitative results on cost or time reduction, and works relevant to high-volume manufacturing or import operations.
- **Synthesis**: Grouped by themes (1) demurrage and yard congestion, (2) process mapping and SIPOC in logistics, (3) planning systems and dashboards, (4) resource allocation for unloading, and (5) manufacturing inbound logistics.
- **Analysis**: Direct linkage to the problem of manual unloading programs, yard saturation, and delayed empty returns.

Table 1. SALSA Literature Review

#	Author(s) and Year	Title	Source / Type	Appraisal	Synthesis (Key Findings)	Analysis (Relation to the Study)
1	Christopher (2011)	Logistics and Supply Chain Management	Book	High	Efficient inbound flows reduce total logistics cost and improve service.	Theoretical foundation for unloading optimization.
2	Krajewski et al. (2008)	Operations Management: Processes and Supply Chains	Book	High	Resource planning and capacity alignment are critical in inbound operations.	Supports the use of planning systems for container assignment.
3	Jacobs et al. (2009)	Operations and Supply Management	Book	High	Master scheduling and ERP logic improve coordination of material flows.	Justifies the spreadsheet-based planning system.
4	Wong (2024)	How Amazon revolutionized international logistics	Case / Blog	Medium	Strategic network and visibility reduce lead times and costs.	Illustrates the value of systematic planning (cited in original report).
5	Various authors (2018–2023)	Demurrage and detention cost reduction in container shipping	Journal articles	High	Poor visibility and manual planning are main causes of demurrage.	Directly related to the yard saturation and empty-return problem.
6	Logistics case studies (2019–2024)	Yard management and container stacking strategies	Applied papers	Medium-High	Optimized assignment reduces congestion and improves throughput.	Supports the need for better daily unloading programs.
7	Niño (2021)	Qué es el SIPOC y para qué sirve	Practical guide	Medium	SIPOC provides a clear high-level view of suppliers, inputs, process, outputs, and customers.	Justifies the diagnostic phase of the study.
8	Process improvement literature (2017–2023)	Application of SIPOC in logistics and warehouse operations	Case studies	Medium-High	SIPOC helps identify bottlenecks and misalignments in inbound processes.	Validates the use of SIPOC for current-state diagnosis.
9	Power BI and dashboard studies (2020–2025)	Visual dashboards for logistics performance monitoring	Applied papers	Medium-High	Real-time dashboards improve decision speed and reduce errors.	Supports the development of the unloading dashboard.

10	Excel-based planning systems (2018–2024)	Low-cost resource planning tools in manufacturing logistics	Case studies	Medium	Spreadsheet systems with macros can effectively replace manual processes.	Directly relevant to the proposed ERP-like tool.
11	Inbound logistics optimization (2020–2025)	Reducing lead time in container discharge for manufacturing plants	Journal articles	High	Structured daily plans reduce waiting time and improve material availability.	Aligns with the objective of reducing unloading and transit times.
12	Third-party logistics coordination (2019–2024)	3PL and internal team synchronization in import operations	Case studies	Medium	Better information sharing reduces delays between port, yard, and warehouse.	Relevant to the SDS–logistics–warehouse coordination.
13	Capacity and resource allocation (2018–2023)	Forklift and dock scheduling for container unloading	Operations research papers	Medium-High	Matching unloading resources to daily volume improves efficiency.	Supports the resource evaluation phase.
14	Empty container repositioning (2017–2024)	Strategies to minimize demurrage through faster empty returns	Logistics journals	High	Early visibility of free days and prioritization reduces penalties.	Core problem addressed by the planning system.
15	Manufacturing supply chain studies (2019–2025)	Impact of inbound delays on production line stoppages	Applied research	High	Unloading delays propagate to production and increase total cost.	Justifies the importance of the project for the plant.
16	Digital tools in logistics (2021–2026)	Adoption of BI tools and macros in medium and large firms	Empirical papers	Medium	Gradual digitalization of planning improves performance without full ERP.	Supports the Excel + Power BI approach.
17	Lean logistics applications (2018–2024)	Waste reduction in inbound container flows	Lean manufacturing cases	Medium-High	Eliminating waiting and unnecessary movement reduces cost.	Links to the waste-reduction objective.
18	Port-to-plant logistics (2020–2025)	Coordination between terminals, carriers, and plants	Case studies	Medium	Integrated planning shortens total transit and yard time.	Relevant to the multi-actor nature of the process.
19	KPI monitoring in logistics (2019–2024)	Dashboards for demurrage, dwell time, and unloading performance	Applied papers	Medium-High	Visual KPIs enable faster corrective actions.	Supports the dashboard design.
20	Recent reviews (2023–2026)	Inbound logistics optimization in high-volume manufacturing	Systematic reviews	High	Combination of process mapping, planning rules, and visual tools yields consistent improvements.	Validates the overall methodological approach.

Analysis of the Literature Review

The reviewed literature consistently shows that demurrage costs, yard congestion, and delayed empty returns are primarily caused by limited visibility and manual planning processes. High-level process mapping tools such as SIPOC are effective for diagnosing these issues, while structured daily and weekly planning systems especially when supported by dashboards improve resource allocation, reduce errors, and accelerate container turnaround. Spreadsheet-based solutions enhanced with macros and business-intelligence tools have proven practical and effective in manufacturing environments where full ERP customization is not immediately feasible.

Few studies, however, explicitly address the combined problem of daily warehouse-container assignment under constrained yard capacity in high-volume appliance manufacturing plants, particularly when data must be shared across internal logistics, third-party providers, and multiple warehouses. This gap supports the relevance of the proposed planning system and visual dashboard.

There is strong empirical and practical support for the combination of process diagnosis (SIPOC), structured resource planning, and visual dashboards to optimize container unloading and reduce demurrage. The present study contributes an applied, low-cost solution tailored to the operational realities of a large manufacturing plant's import area.

METHODOLOGY

The study followed an applied, diagnostic, and improvement-oriented approach focused on the container unloading process in the import area of a large appliance manufacturing plant. The methodology is structured into five sequential phases that combine process analysis, resource planning, and visual management tools. No full enterprise-wide system replacement was required; the solution was developed using accessible spreadsheet and business-intelligence tools.

Phase 1: Current-State Diagnosis

The existing unloading process was mapped using the SIPOC methodology (Suppliers, Inputs, Process, Outputs, Customers). This high-level mapping identified the main actors (port terminals, customs brokers, third-party logistics providers, internal logistics, and warehouse teams), the key inputs (container arrival notifications, free-time data, warehouse capacity), the core process steps (assignment, unloading, and empty return), and the main outputs (unloaded materials and returned empty containers). The diagnosis also quantified the principal problems: yard congestion, duplicated or incorrect assignments, limited visibility of remaining free days, and high demurrage costs.

Phase 2: Resource and Capacity Evaluation

Available resources were evaluated, including yard space, unloading equipment (reach stackers and forklifts), receiving docks, and personnel. Daily container volume ranges and warehouse destinations were analyzed to determine realistic daily unloading capacity and to identify bottlenecks. This phase established the operational constraints that the planning system had to respect.

Phase 3: Design of the Planning System

A spreadsheet-based resource planning system was developed to generate a daily and weekly unloading program. The system incorporates container identification, shipping line, product description, requested unloading date, actual unloading date, warehouse destination, and remaining free days. Macros, structured tables, and data validation rules were implemented to reduce manual entry errors, prevent duplicate assignments, and accelerate data updates. The logic follows a simplified master scheduling approach aligned with warehouse capacity and production priorities.

Phase 4: Development of the Visual Dashboard

A dynamic dashboard was created to provide real-time visibility of the unloading program. The dashboard

displays containers unloaded versus pending by day, distribution by warehouse, free-day status, and overall progress. Dynamic tables and visual indicators allow rapid identification of containers at risk of demurrage and support daily coordination meetings between logistics, yard, and warehouse teams.

Phase 5: Evaluation of Potential Impact

The proposed system and dashboard were evaluated through scenario analysis and comparison with the previous manual process. Key indicators considered included time required to generate the daily program, reduction of assignment errors, improved visibility of free days, and the potential reduction in demurrage exposure. Financial viability was also assessed using standard project indicators (payback period, net present value, and internal rate of return) based on estimated cost savings.

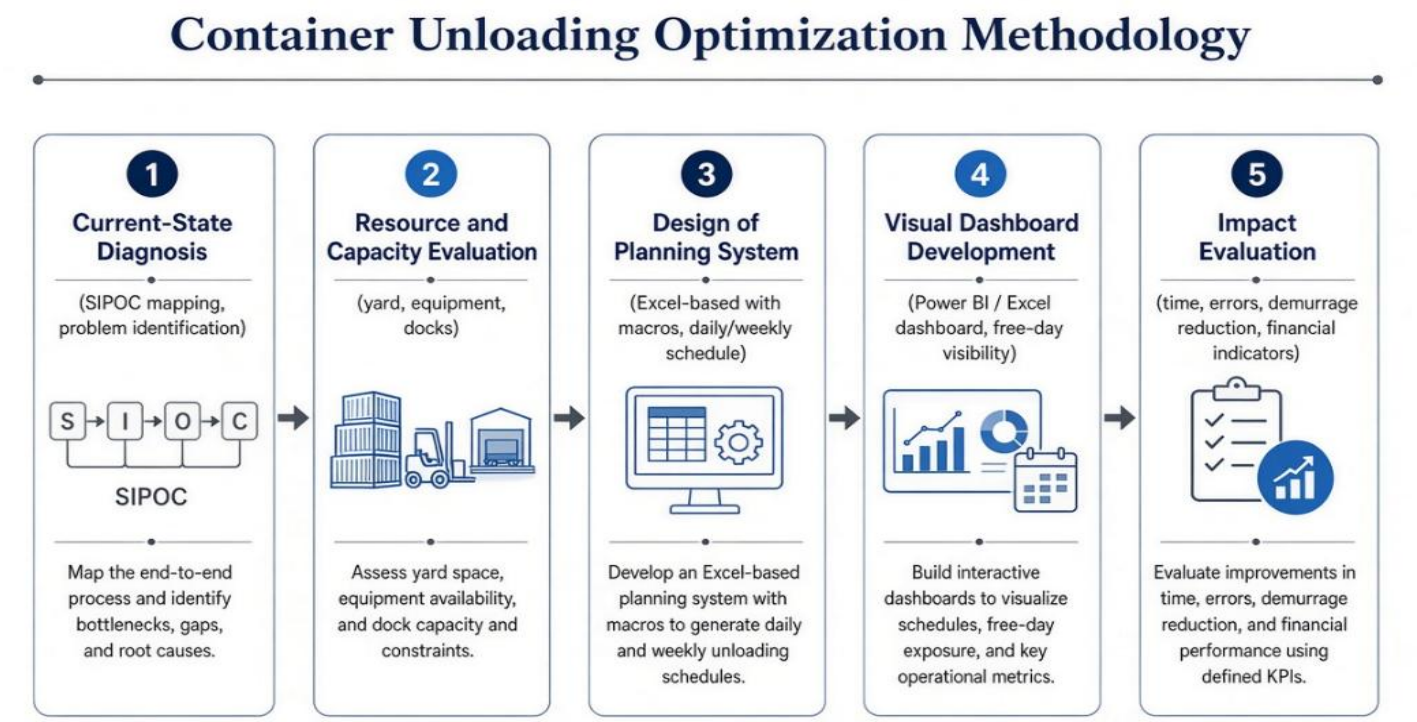


Figure 1. Conceptual Diagram of the Methodology

The flowchart presents the five sequential phases of the methodology. Phase 1 uses SIPOC to diagnose the current unloading process and its main inefficiencies. Phase 2 evaluates physical and human resources to establish realistic capacity constraints. Phase 3 designs the spreadsheet-based planning system that generates the daily and weekly unloading program. Phase 4 develops the visual dashboard that provides operational visibility, particularly regarding free days and warehouse assignments. Phase 5 evaluates the expected improvements in time, error reduction, demurrage exposure, and financial indicators. The linear structure emphasizes the practical, low-cost, and incremental nature of the proposed solution.

RESULTS

Phase 1: Current-State Diagnosis (SIPOC)

The SIPOC analysis revealed a fragmented process with multiple actors and limited real-time visibility. The main problems identified were yard congestion, manual assignment errors, and lack of control over remaining free days, which generated high demurrage costs.

Table 2. SIPOC Summary of the Container Unloading Process

Element	Description
Suppliers	Port terminals, shipping lines, customs brokers, third-party logistics providers

Inputs	Container arrival notifications, free-time data, invoices, warehouse capacity information
Process	Container assignment → Yard positioning → Unloading → Empty return
Outputs	Unloaded materials, empty containers returned, updated inventory records
Customers	Production warehouses, purchasing department, planning area

This table synthesizes the high-level process map. It shows that the unloading process depends on several external and internal actors and that critical information (especially free-time data and warehouse capacity) is not always available in real time. The structure helps identify where information gaps and coordination failures occur, particularly between the assignment step and the actual unloading and empty-return stages.

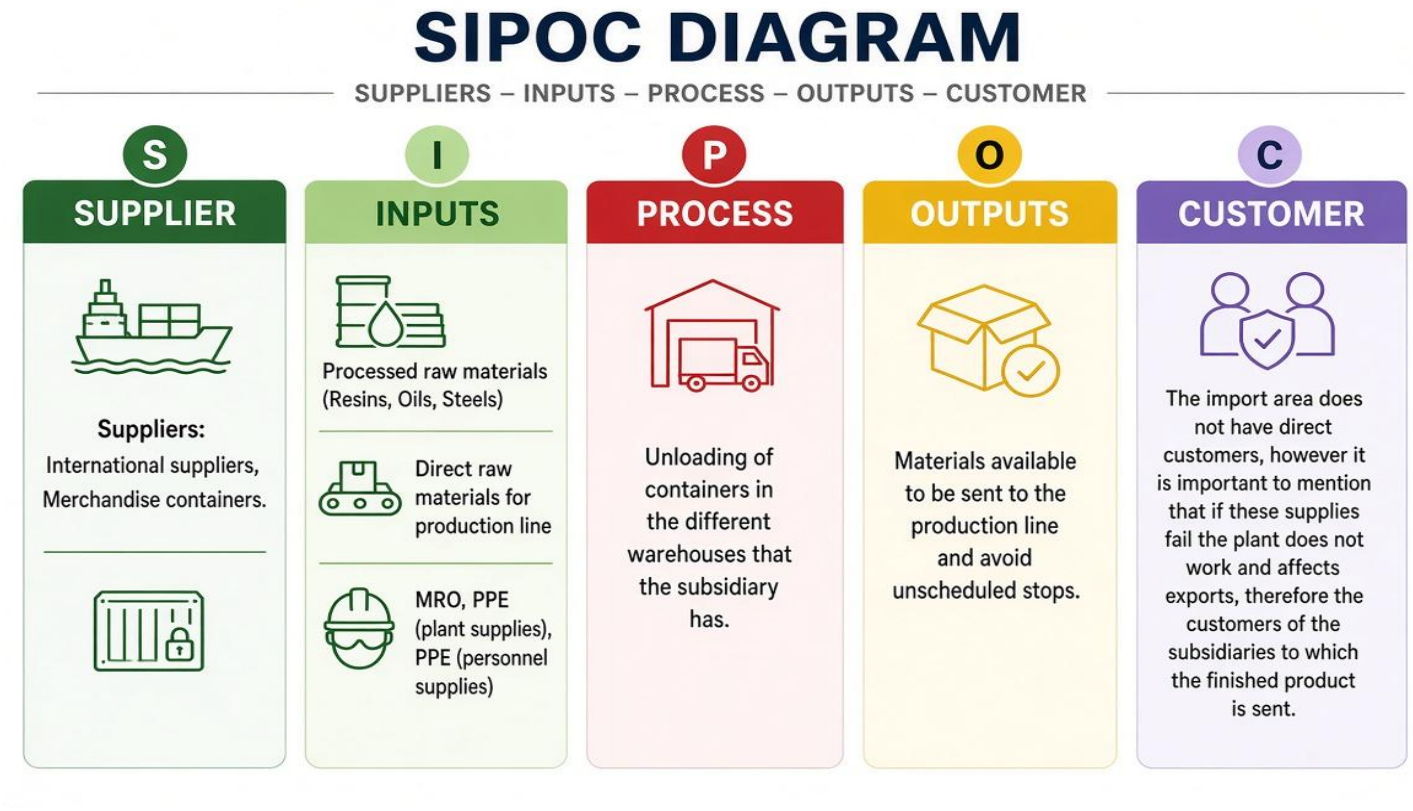


Figure 2. (SIPOC diagram) from the original report.

Phase 2: Resource and Capacity Evaluation

The plant operates with a designated container yard, reach stackers, forklifts, and multiple receiving warehouses. Daily demand ranges between 60 and 80 full containers, while yard space and equipment availability frequently become bottlenecks, especially during peak import periods.

Table 3. Main Resources for Container Unloading

Resource Type	Description	Limitation Identified
Yard space	Designated area for full and empty containers	Frequent saturation
Equipment	Reach stackers and forklifts	Limited units during peaks
Receiving docks	Multiple warehouse ramps	Uneven utilization
Personnel	Operators and supervisors	Coordination delays

The table summarizes the physical and human resources involved in the unloading operation and the principal constraints associated with each. Yard space and equipment emerge as the most critical bottlenecks. These limitations explain why a more structured daily assignment process is necessary to avoid congestion and to make better use of available capacity.



Figures 3. Forklifts.

Phase 3: Planning System Design and Implementation

A spreadsheet-based planning system was developed with structured tables, data validation, and macros. The system registers container identification, shipping line, product description, requested and actual unloading dates, warehouse destination, and remaining free days. The interface allows rapid generation of the daily and weekly unloading program while reducing duplicate assignments.

Table 4. Main Modules of the Planning System

Module	Function
Container exit register	Records requested and actual unloading dates
Unloaded containers log	Tracks completed unloadings for empty return
Empty container entry table	Monitors returned units and free-day status
Main menu	Provides navigation and data entry shortcuts

This table describes the core modules of the planning system. Each module addresses a specific information need: planning the unloading, confirming completion, monitoring empty returns, and facilitating user navigation. The modular design reduces manual errors and provides a single source of updated data for daily coordination.



Figures 4. System menu.

Phase 4: Visual Dashboard

The dashboard provides a consolidated view of daily unloading progress, containers by warehouse, and free-day status. It enables immediate identification of containers at risk of demurrage and supports daily coordination between logistics, yard, and warehouse teams.

Table 5. Key Indicators Displayed in the Dashboard

Indicator	Purpose
Containers unloaded vs. pending	Daily progress tracking
Distribution by warehouse	Capacity balancing
Free days remaining	Demurrage risk prioritization
Weekly summary	Overall performance overview

The indicators listed in the table transform raw operational data into actionable information. By showing progress, warehouse distribution, and free-day status simultaneously, the dashboard allows users to detect delays and risk situations quickly and to reallocate resources or reprioritize containers before demurrage penalties are incurred.

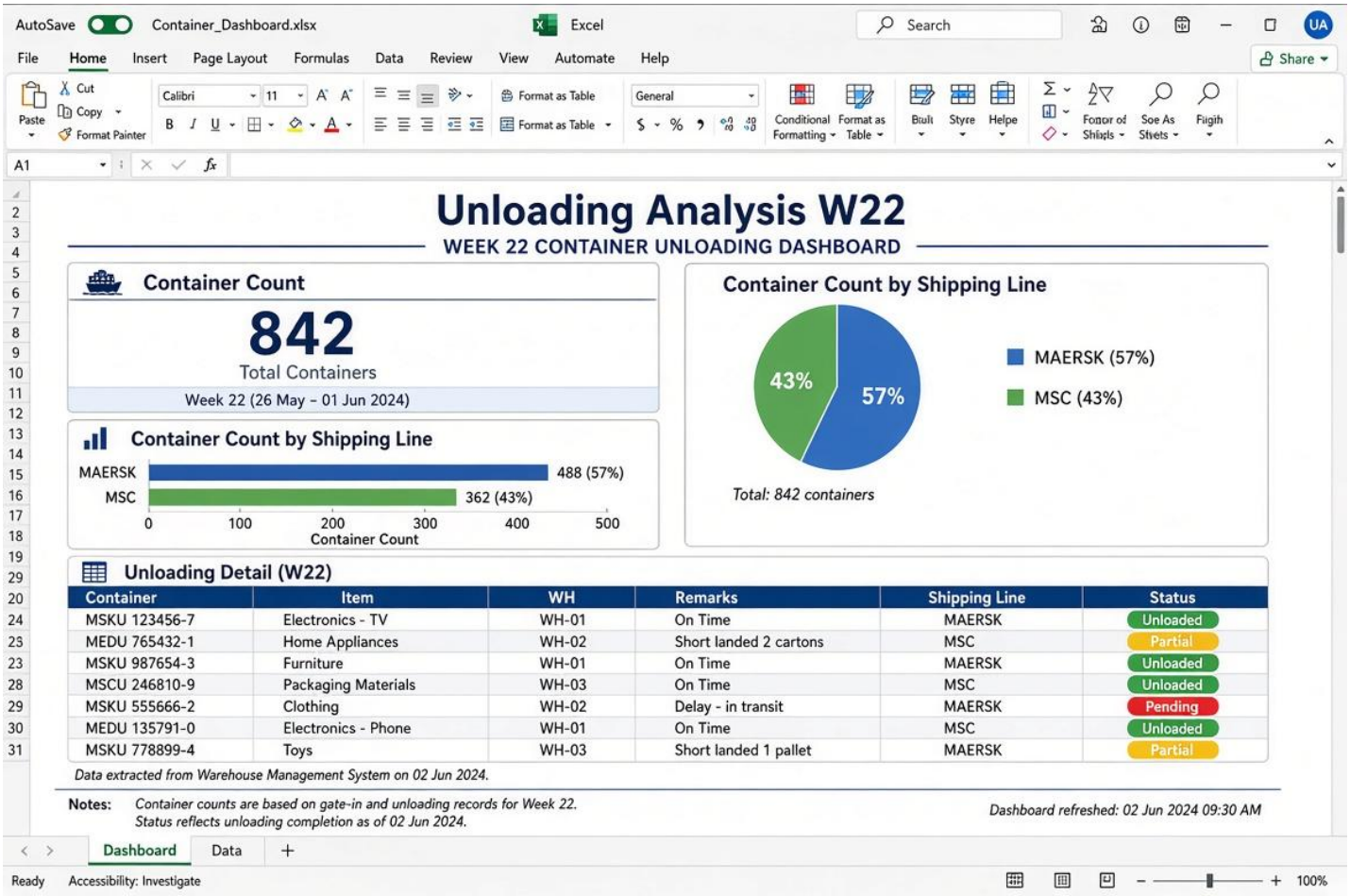


Figure 5. Weekly unloading dashboard

Phase 5: Impact Evaluation

The proposed system reduces the time required to generate and distribute the daily unloading program and decreases assignment errors. Improved visibility of free days allows prioritization of containers close to demurrage, which is expected to generate significant cost savings. Financial indicators calculated in the original report (payback period, NPV, and IRR) support the economic viability of the solution.

Table 6. Expected Operational Improvements

Indicator	Expected Improvement
Time to generate daily program	Significant reduction
Assignment errors	Reduction through validation rules
Visibility of free days	Real-time monitoring
Demurrage exposure	Reduction through prioritization
Decision-making speed	Improved through dashboard

This table summarizes the main operational benefits expected from the implementation of the planning system and dashboard. The improvements focus on time, accuracy, visibility, and cost exposure. Together they indicate that the solution addresses the root causes identified in the diagnosis phase and offers a measurable path toward better inbound logistics performanc

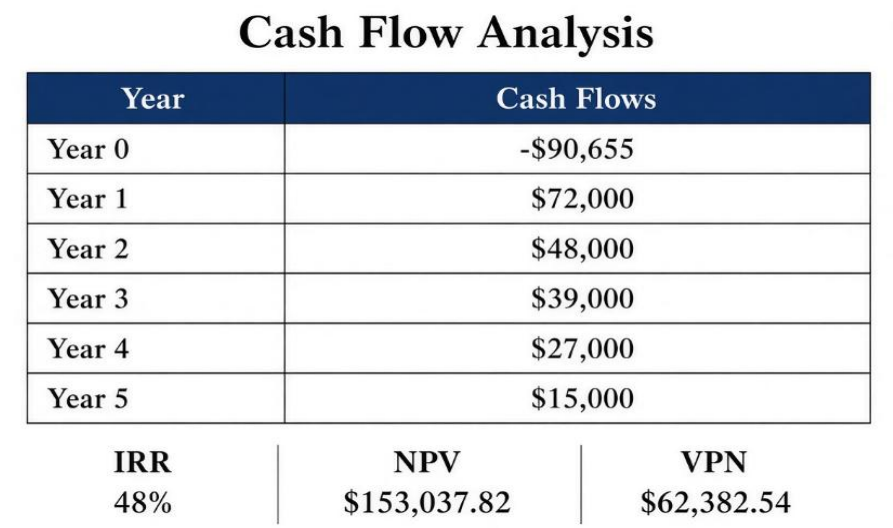


Figure 6. Cash Flow

SUMMARY OF RESULTS

The combination of process diagnosis, a structured planning system, and a visual dashboard addresses the main causes of yard congestion and demurrage costs. The solution improves operational visibility, reduces manual effort, and provides a practical foundation for continuous improvement in the import area, without requiring a full enterprise resource planning system replacement.

CONCLUSION

This study addressed the optimization of the container unloading program in the import area of a large appliance manufacturing plant. Through a structured methodology that combined process diagnosis, resource evaluation, the design of a spreadsheet-based planning system, and the development of a visual dashboard, the work proposed a practical and low-cost solution to reduce yard congestion, assignment errors, and demurrage costs.

The SIPOC analysis confirmed that the original process suffered from fragmented information flows, limited real-time visibility, and heavy reliance on manual updates. These conditions frequently resulted in duplicated container assignments, incorrect warehouse allocations, and insufficient control over the remaining free days before demurrage penalties began to accrue. The resource evaluation further demonstrated that yard space and unloading equipment constitute critical capacity constraints, especially during periods of high import volume, reinforcing the need for a more systematic daily and weekly planning approach.

The planning system developed with structured tables, data validation rules, and macros provides a clear and reproducible mechanism for generating the unloading program. By centralizing container data, requested and actual unloading dates, warehouse destinations, and free-day status, the system reduces the time required to

prepare the daily schedule and minimizes common data-entry errors. Complementing this tool, the visual dashboard offers immediate insight into daily progress, warehouse distribution, and containers at risk of demurrage. Together, these instruments improve coordination among logistics, yard operations, and warehouse teams and support faster, better-informed decision-making.

From an operational perspective, the proposed solution is expected to shorten the time needed to generate and communicate the unloading program, decrease assignment errors, and enable proactive prioritization of containers approaching their free-day limit. These improvements should translate into lower demurrage exposure, better utilization of yard space and equipment, and more reliable material availability for production. The financial indicators calculated in the original analysis further suggest that the investment required to implement and maintain the system can be recovered in a relatively short period, confirming the economic viability of the intervention.

Several limitations must be acknowledged. The evaluation remains largely prospective and based on process analysis and scenario assessment rather than a prolonged live implementation with measured before-and-after performance data. The system currently operates as a spreadsheet-based solution; while this facilitates rapid deployment and low cost, it may eventually require integration with broader enterprise systems as volumes or complexity increase. In addition, the study focused on the internal unloading and yard processes and did not fully incorporate upstream port and terminal dynamics or downstream production scheduling constraints.

Future work should include a pilot implementation with systematic measurement of key performance indicators such as average free days consumed, demurrage cost reduction, program generation time, and assignment error rate. Extending the dashboard to additional stakeholders (purchasing, planning, and warehouse management) and exploring gradual integration with existing enterprise systems would further enhance its impact. Periodic review of capacity assumptions and the incorporation of simple forecasting elements for container arrivals could also strengthen the planning logic.

In summary, the combination of process mapping, a structured resource-planning system, and visual management tools constitutes a feasible and effective approach for optimizing container unloading operations in high-volume manufacturing environments. The solution improves visibility, reduces manual effort, and provides a solid foundation for continuous improvement in inbound logistics, offering a practical alternative when full-scale enterprise resource planning customization is not immediately available or necessary.

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