



IPIC 2023

9th International
Physical Internet Conference

June 13-15, 2023
Athens, Greece



Enhancing Circular Logistics of Unit Loads by Leveraging Physical Internet Modularization and Consolidation Principles

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Expanding the logistics Scope

Table of Contents



01

Industry Context

Flow of items across a Supply Chain
RTI Operational Workflow inside Facility
Main Challenges in the Industry



02

Proposed Framework and Simulation Design



03

Simulation Implementation

Implementation of Model with Maturity Level 1
Implementation of Model with Maturity Level 2
Implementation of Model with Maturity Level 3



04

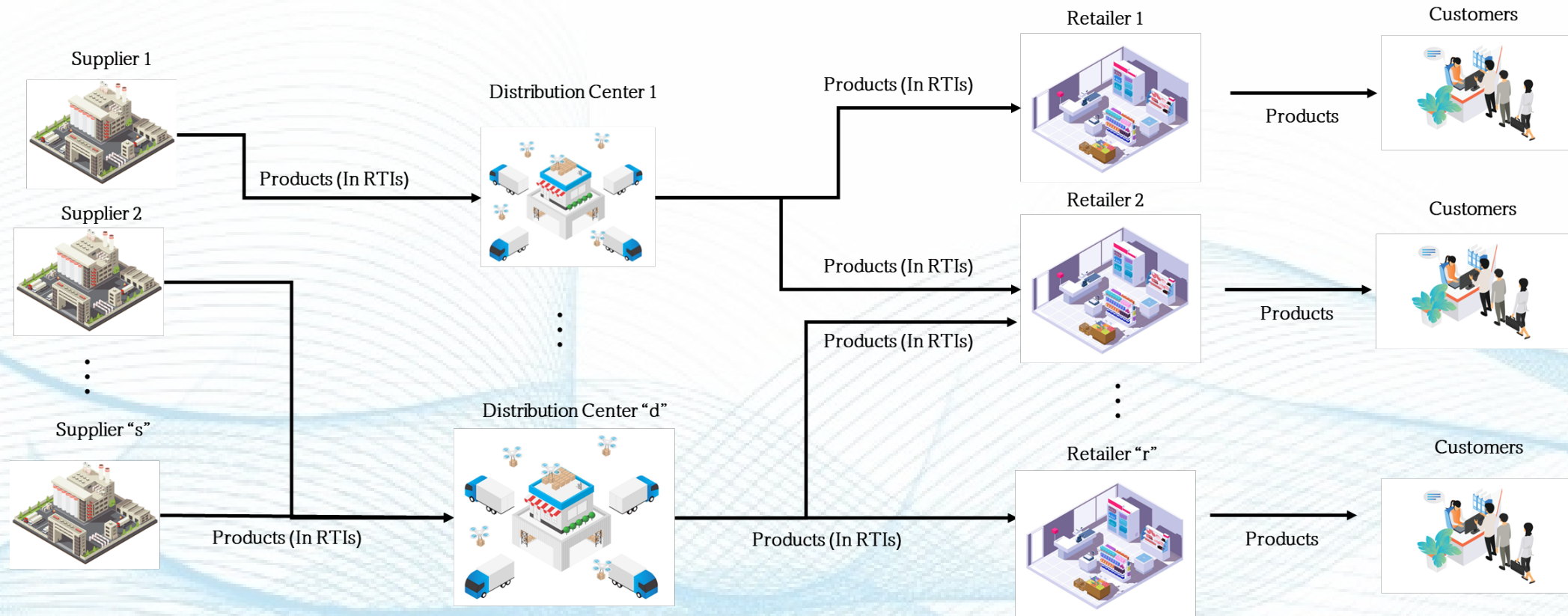
Simulation Results



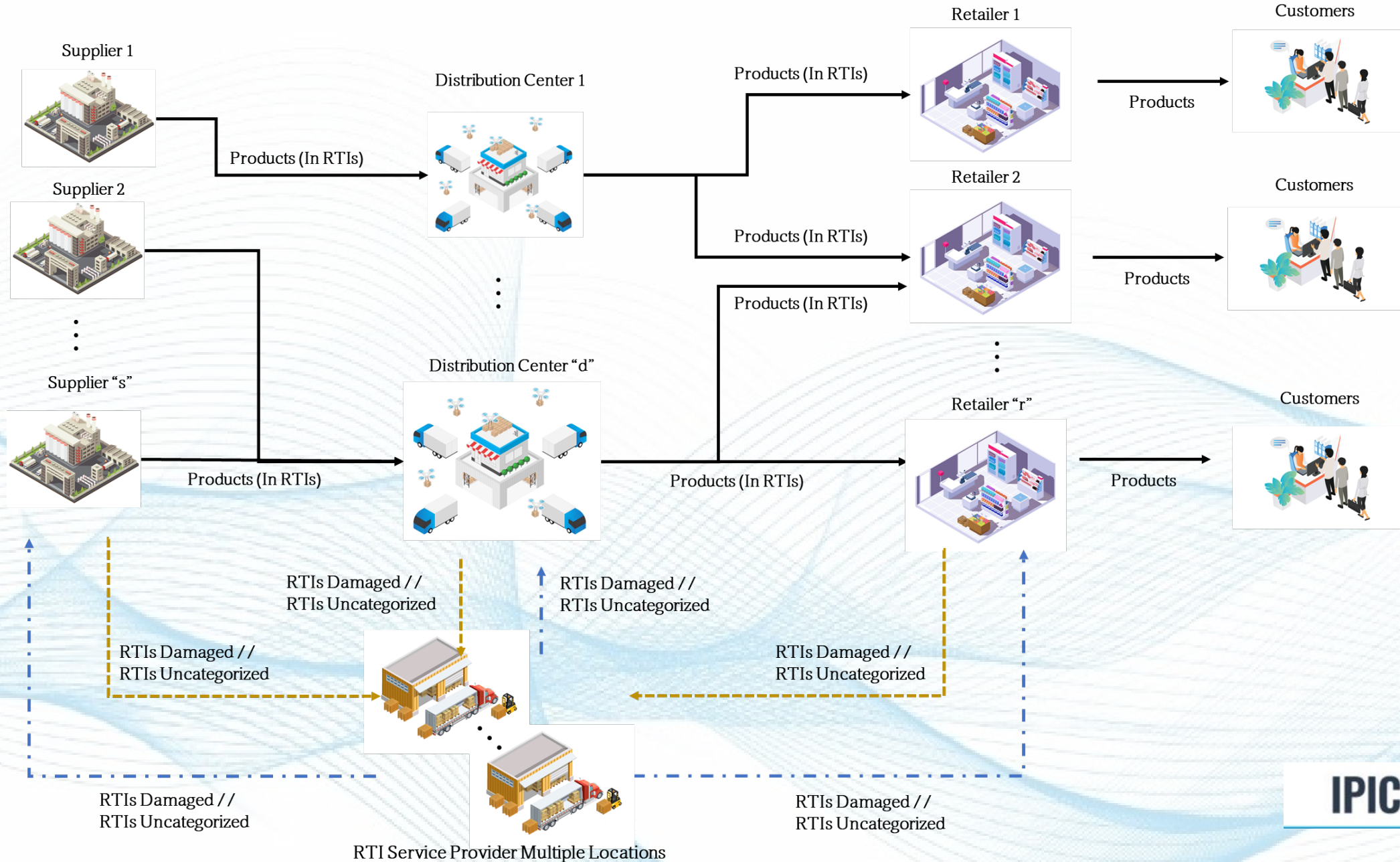
05

Conclusions

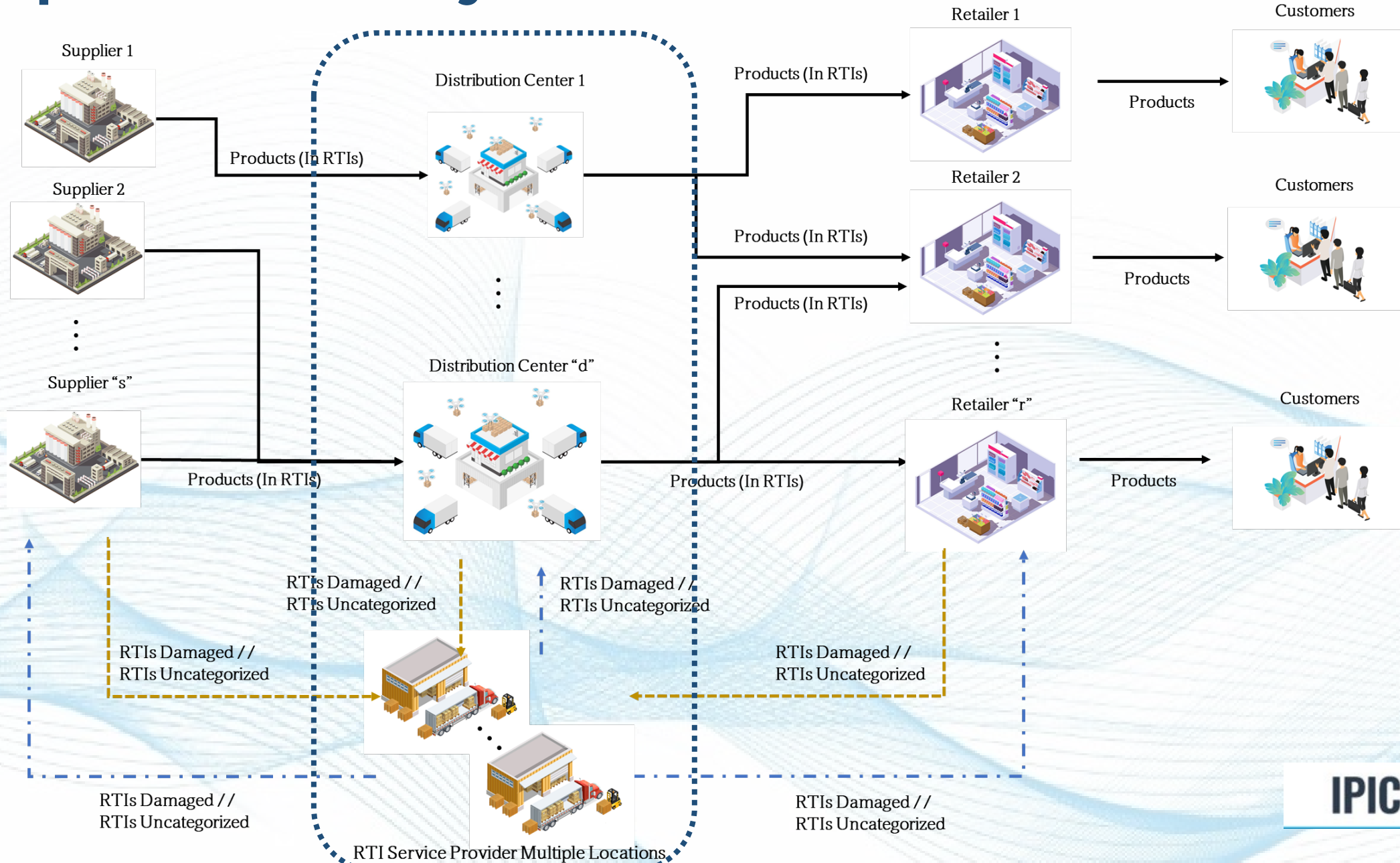
Flow of items across a Supply Chain



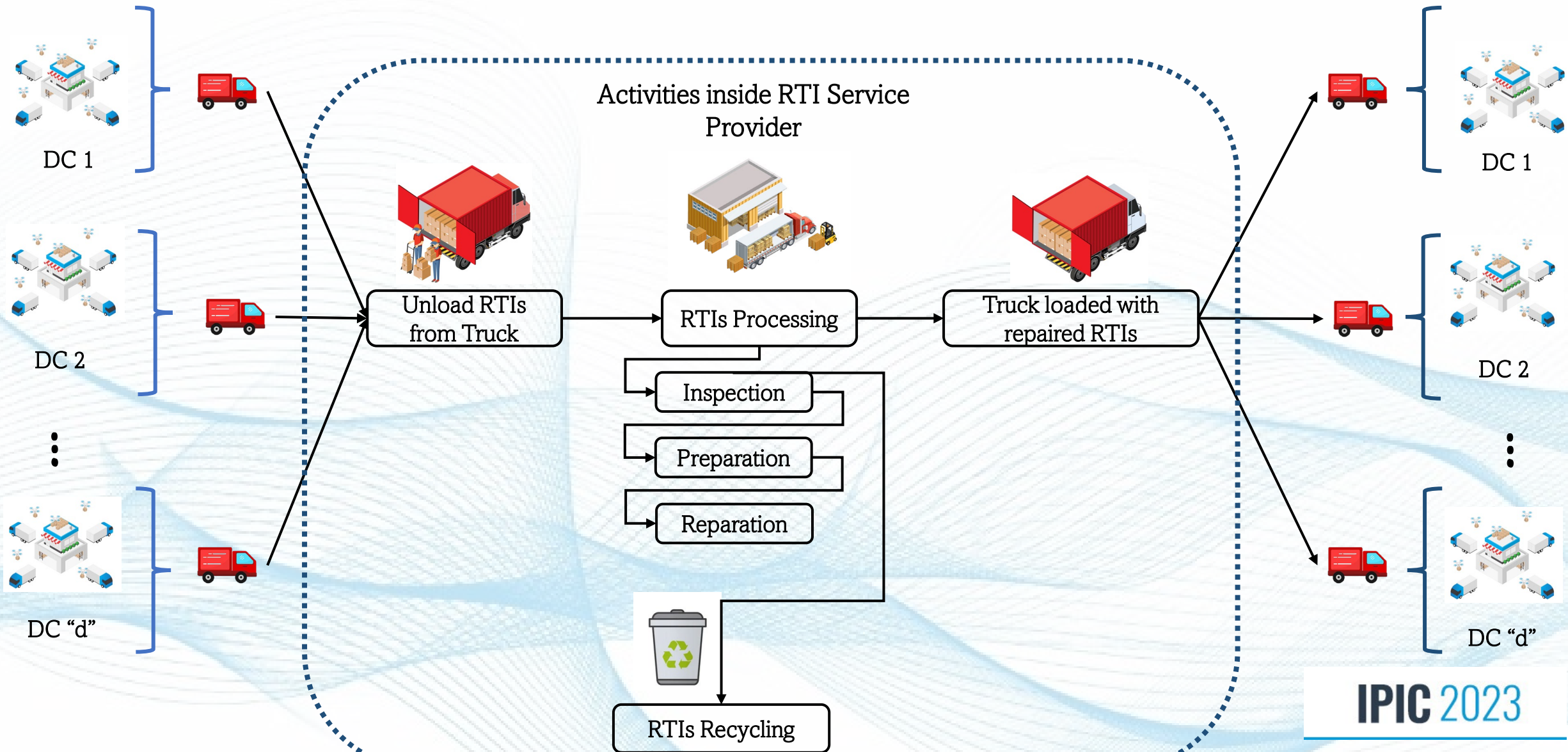
Flow of items across a Supply Chain



Scope of the Study Case



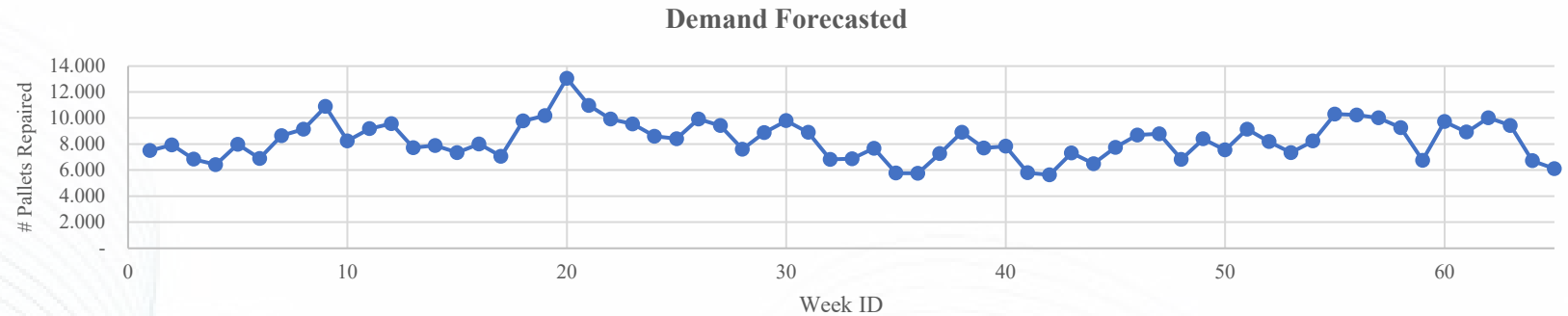
RTI Operational Workflow inside Facility



Main Challenges

1

Demand Fluctuation of RTIs



2

Suboptimal unloading/loading practices

- All RTIs are unloaded and complete the process.
- Shipment delays despite the availability of material.



3

Inefficiencies in time processes

- Workflows not designed to minimize distance walked.
- Workstations do not have standard set of tools
- Inventory levels hide inefficiencies in the productive capacity



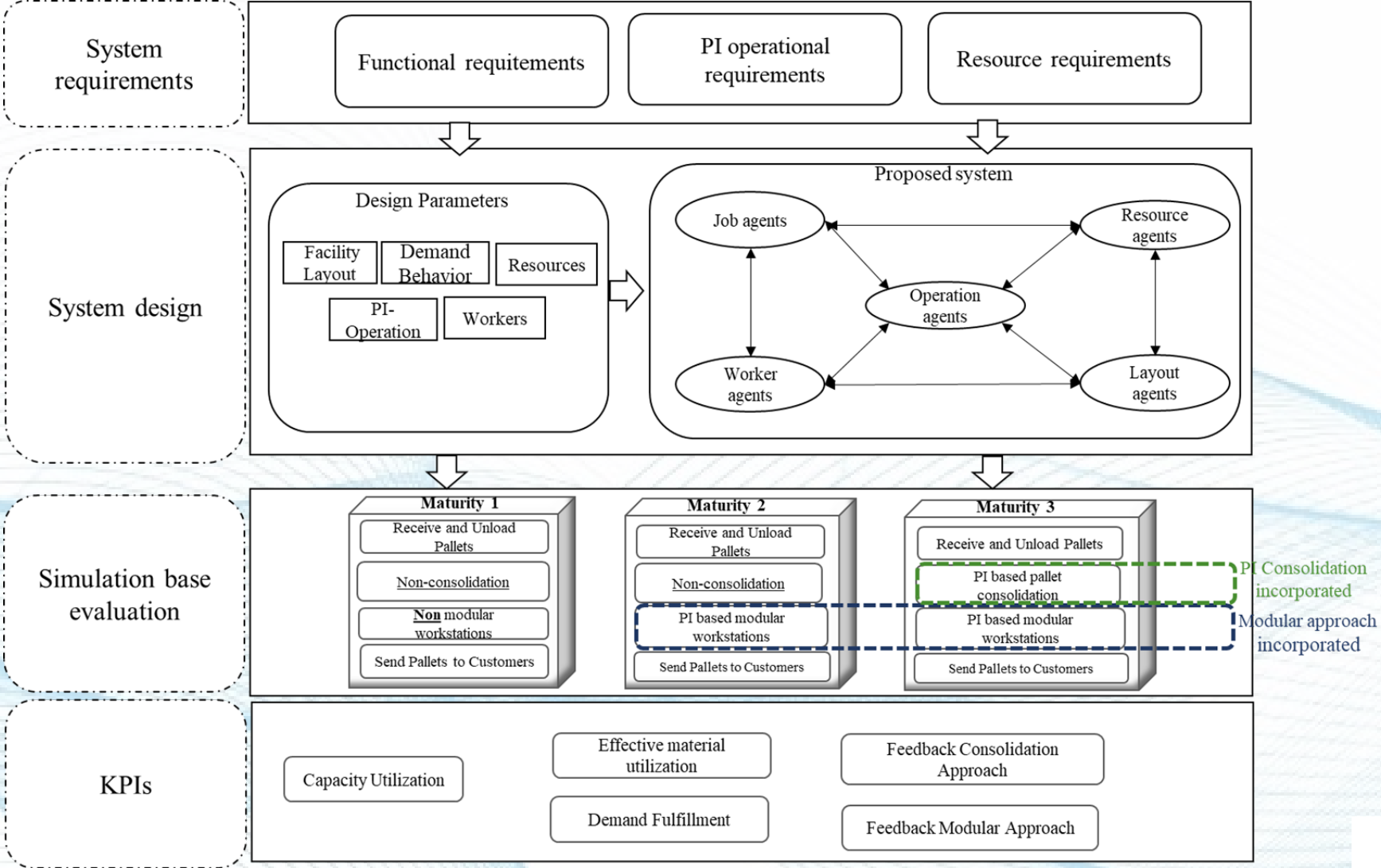
Sources:

(1) From: <https://blog.unicarriereurope.com/material-handling-blog/loading-unloading-lorry-warehouse-pallet-trucks-or-counterbalance-forklifts-advice-analysis>

(2) From: <https://www.shutterstock.com/es/search/inefficient>

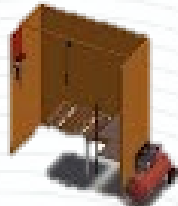
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Proposed Framework Solution



PI Concepts Involved in the Solution

Modularity



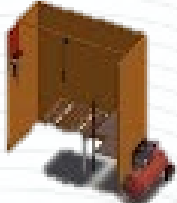
- Independent and self-contained units
- Adaptable to multiple locations
- Flexible to operating conditions
- Ergonomic

Consolidation



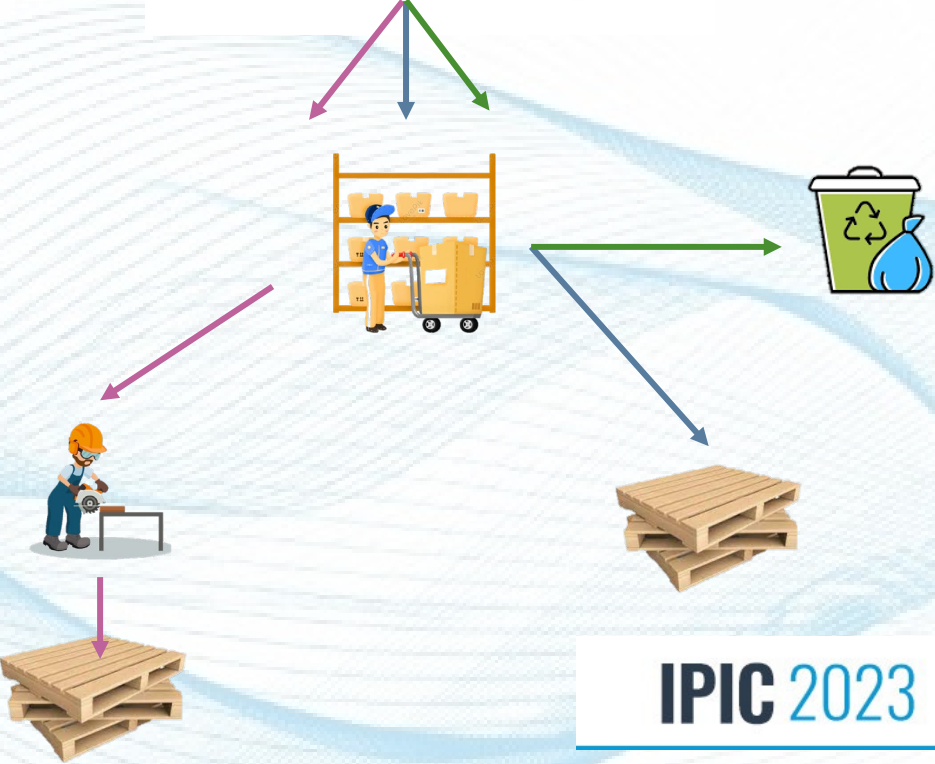
PI Concepts Involved in the Solution

Modularity

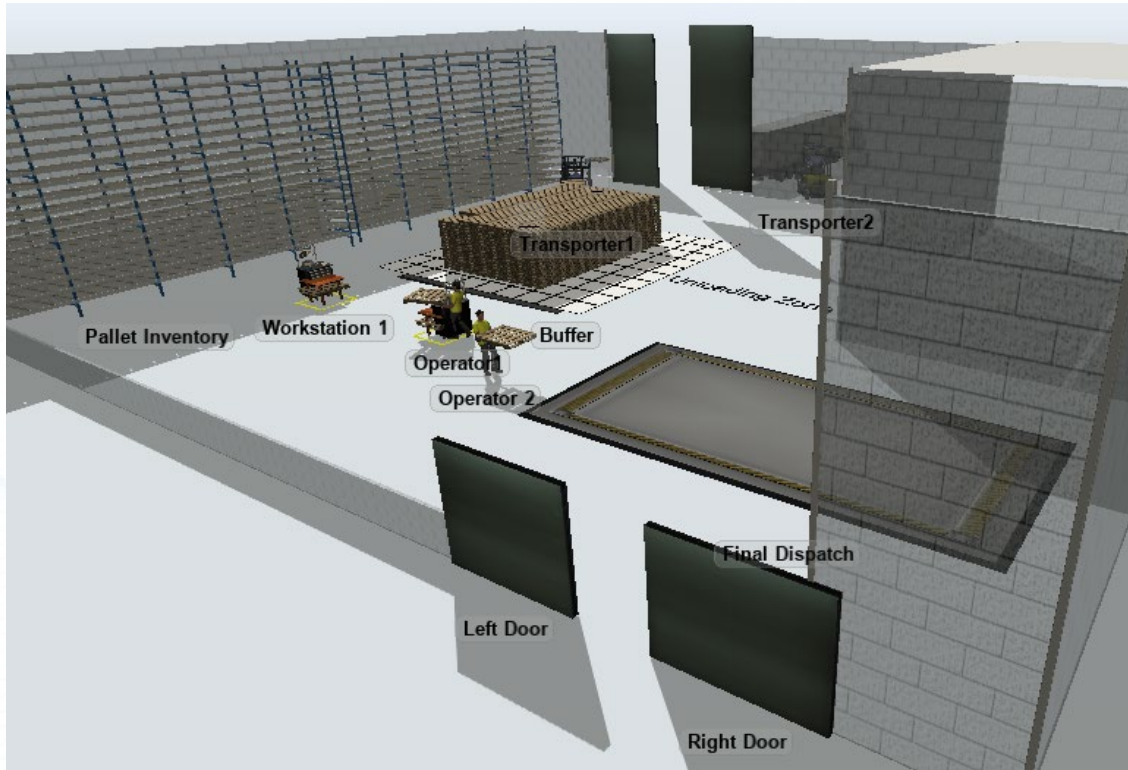


- Independent and self-contained units
- Adaptable to multiple locations
- Flexible to operating conditions
- Ergonomic

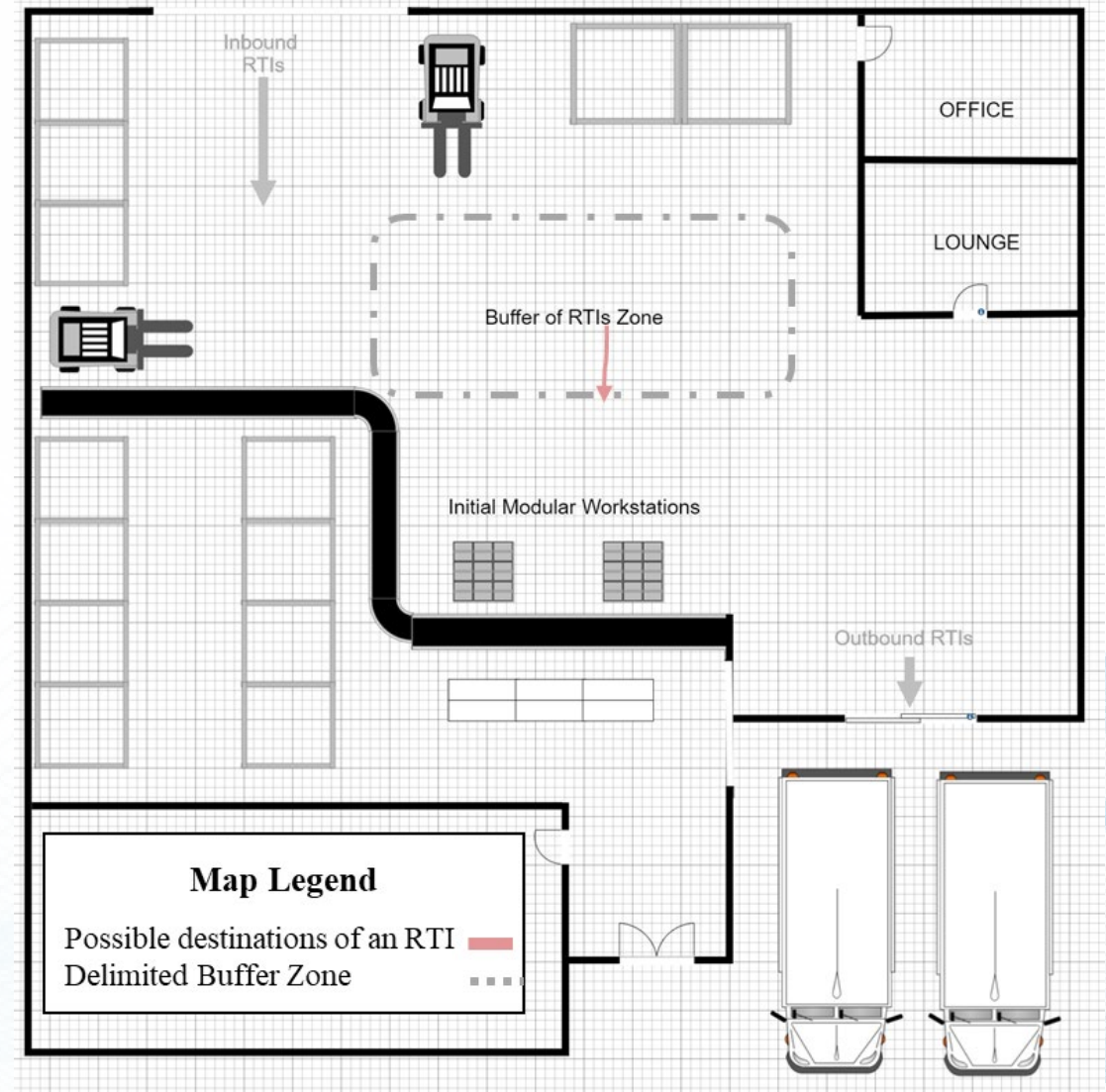
Consolidation



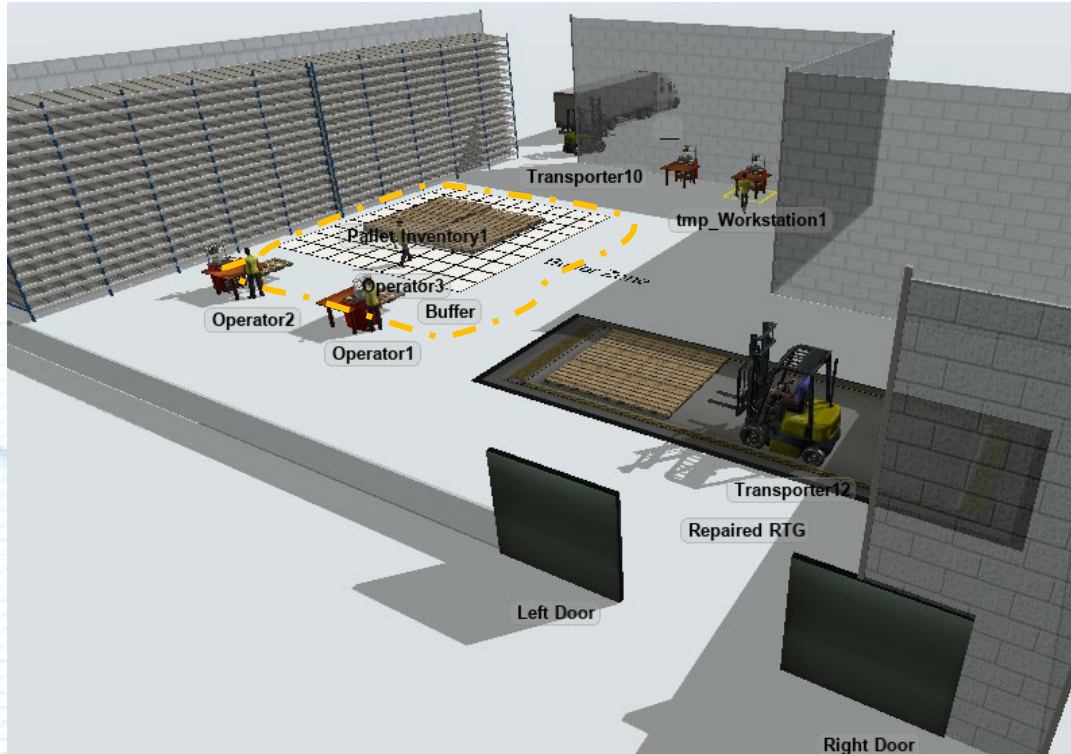
Maturity Level 1



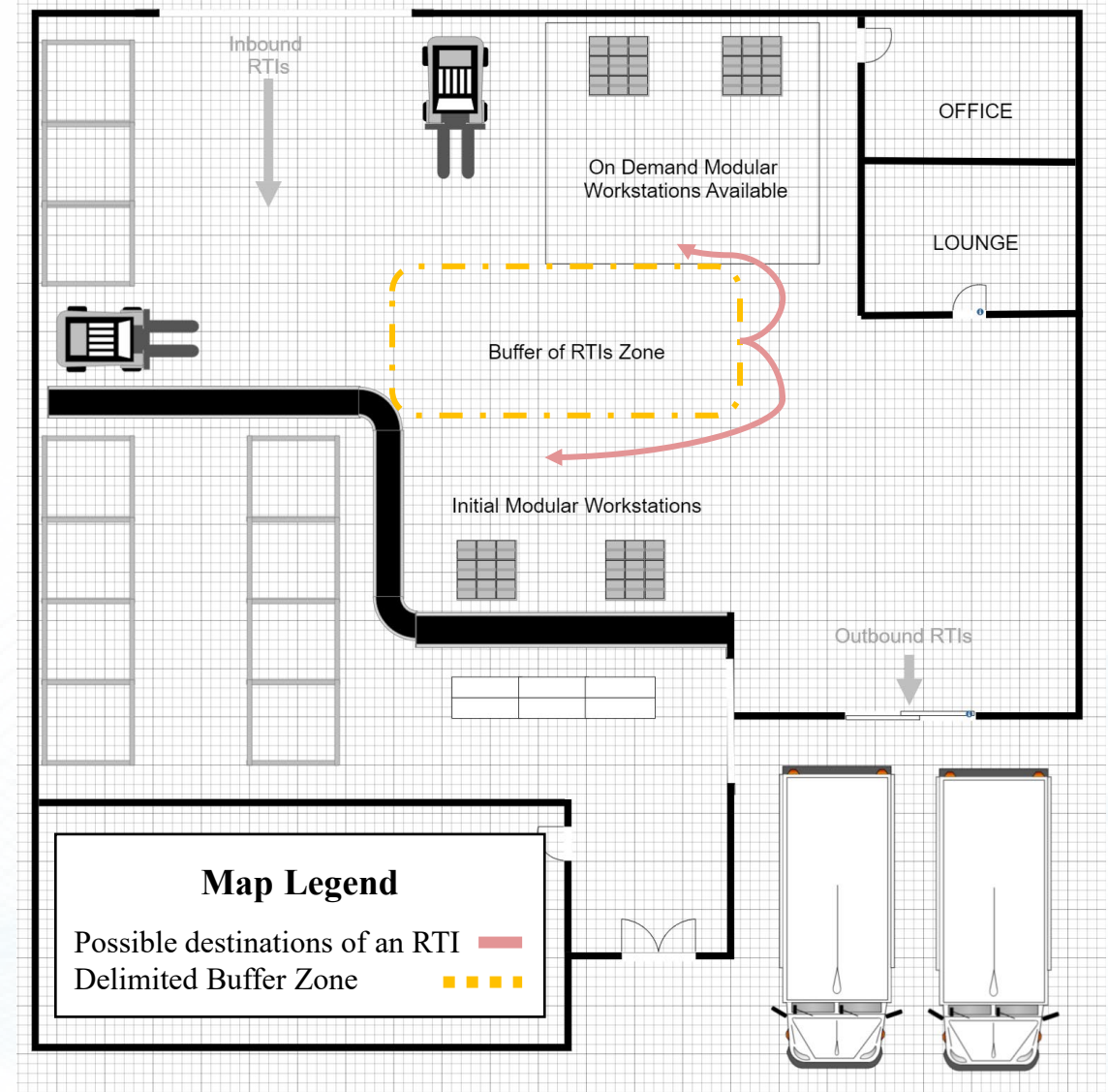
- Fix Capacity Production through time horizon.
- All RTIs will complete the whole process.
- Time spend in workstation is not under control.



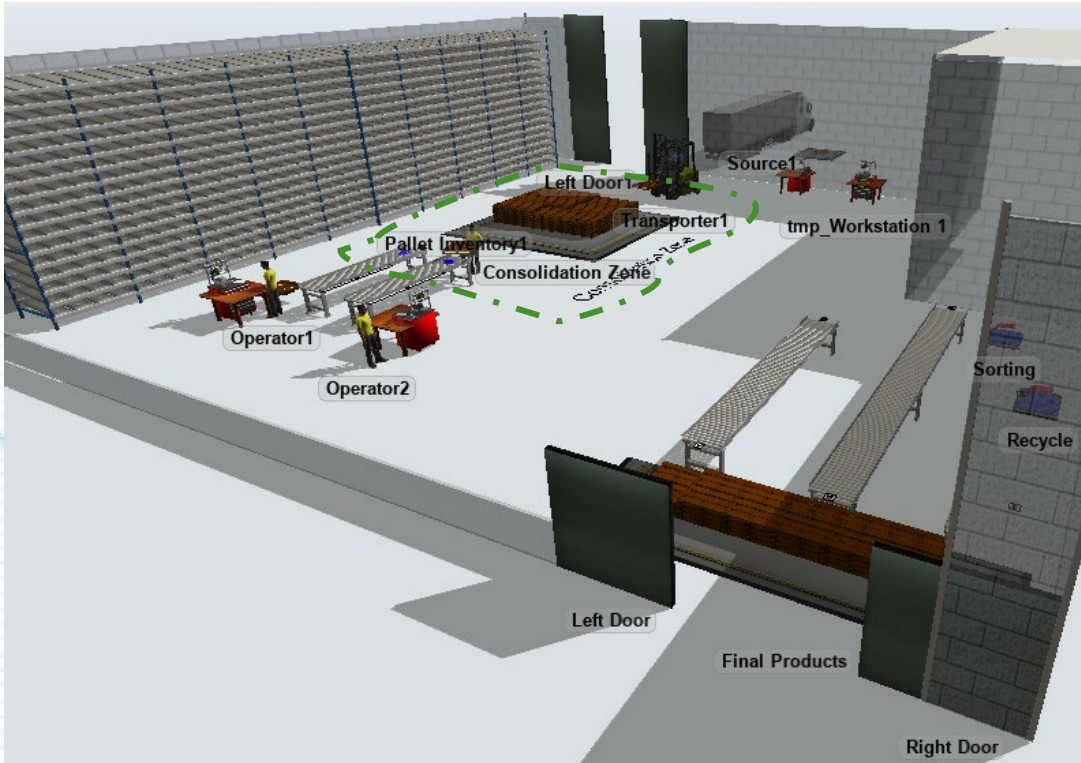
Maturity Level 2



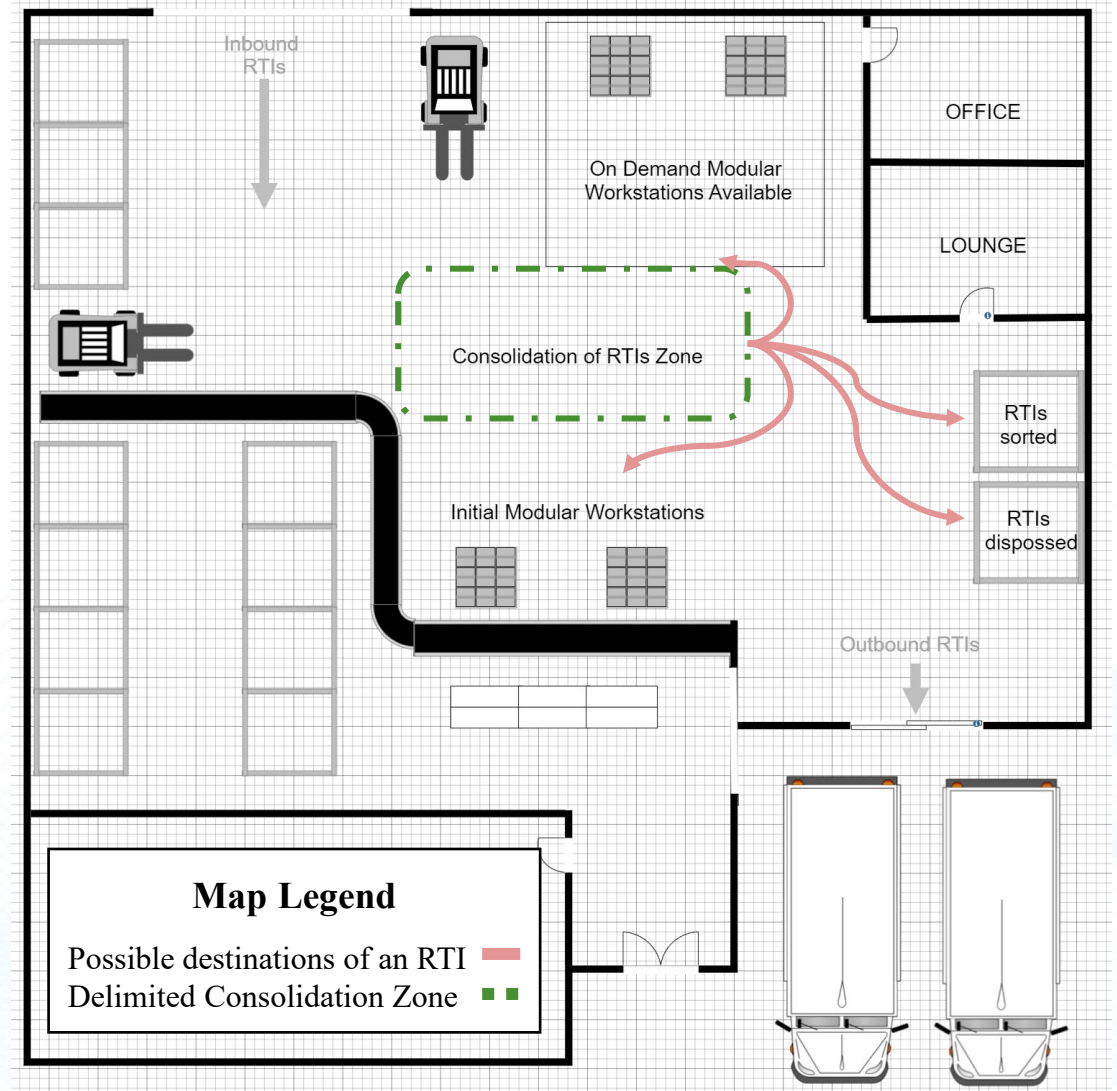
- Flexible Capacity Production through time horizon.
- All RTIs will complete the whole process.
- Time spend in workstation is under control.



Maturity Level 3

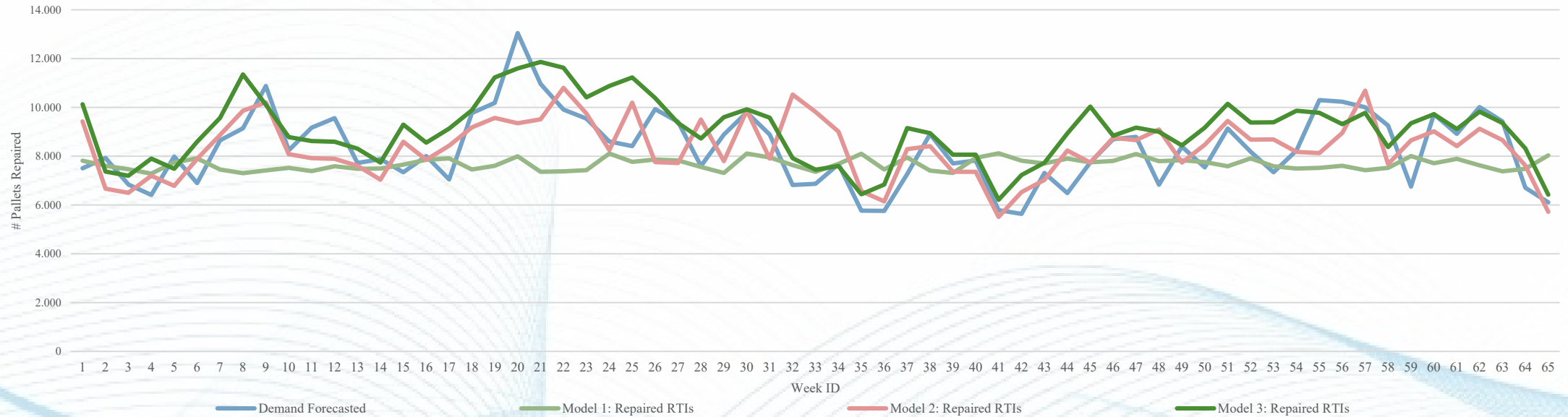


- Flexible Capacity Production through time horizon.
- Cargo consolidation is integrated into the operation.
- Time spend in workstation is under control.

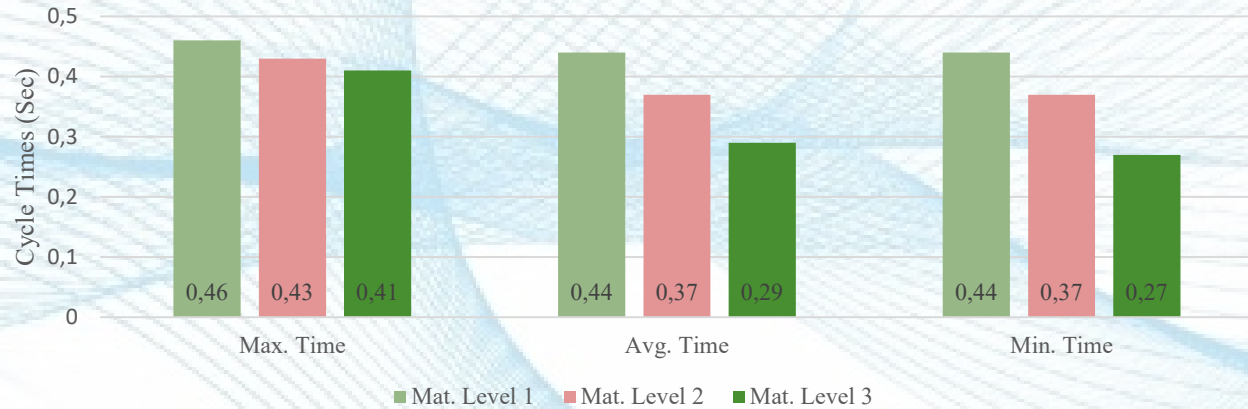


Simulation Results

Demand Repairs Forecast vs Performance of the Maturity Models (Smaller Size Layout)

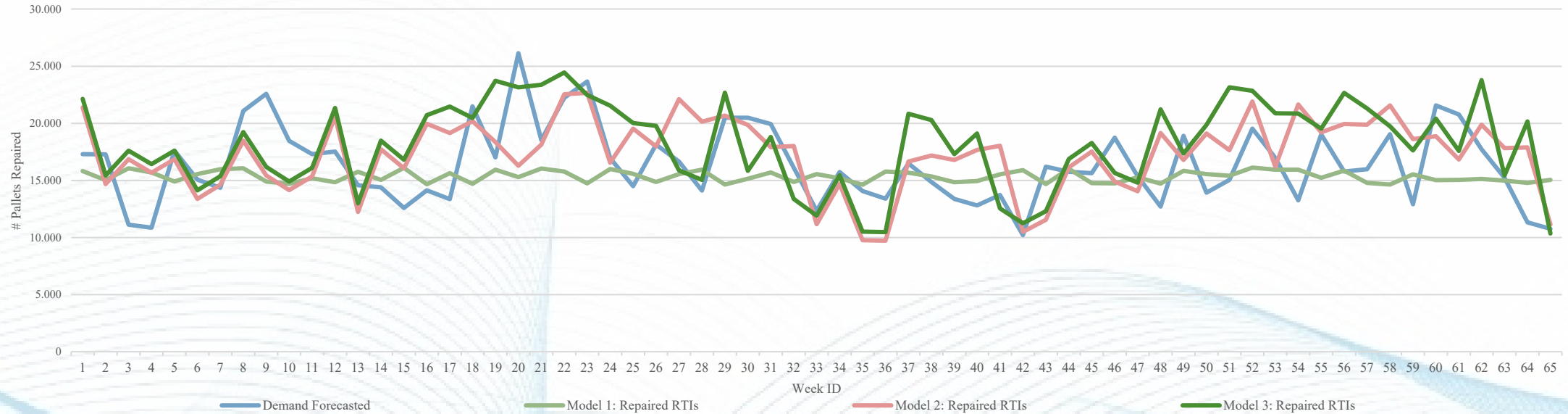


Comparisson of Cycle Times per Maturity Level (Small Layout)

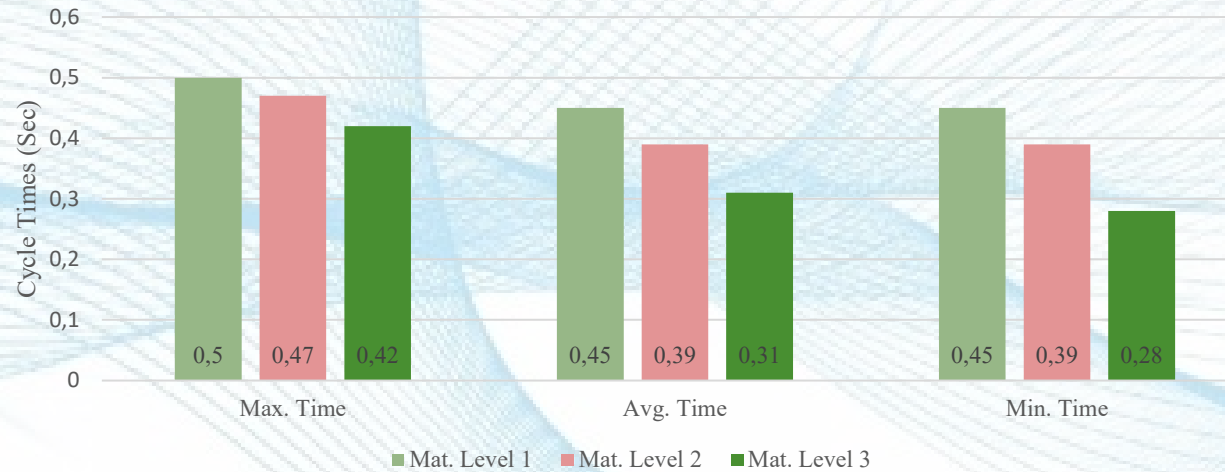


Simulation Results

Demand Repairs Forecast vs Performance of the Maturity Models (Larger Size Layout)



Comparison of Cycle Times per Maturity Level (Large Layout)

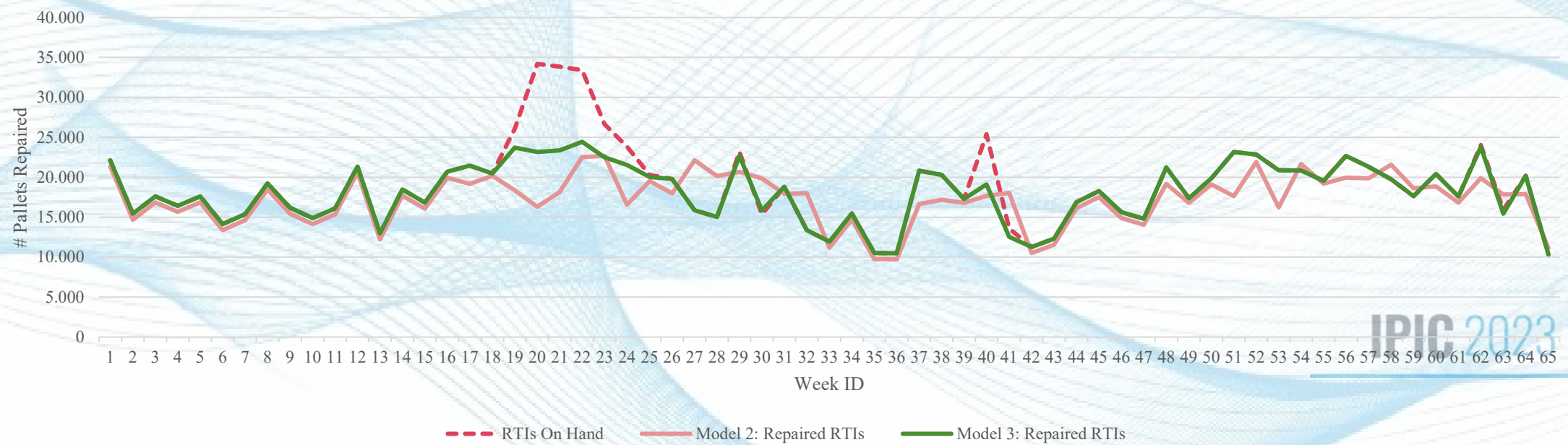


Simulation Results

RTI availability vs Performance of the Models (Smaller Size Layout)



RTI availability vs Performance of the Models (Larger Size Layout)



Conclusion

When faced with variable demand and the need for prompt management of this variability, PI offer significant competitive advantages.

Modularity offers the freedom to adapt production levels in accordance with fluctuations in demand, mitigating the risks associated with shortages and overproduction.

Modularity significantly reduces dependencies on inventory levels of finished Returnable Transport Items (RTIs), leading to a substantial reduction in holding costs.

Modularity significantly enhances the capability to convert available inventory into finished products that are ready for dispatch.

Cargo consolidation greatly enhances the capacity to consolidate Returnable Transport Items (RTIs) in advance, resulting in expedited shipments to customers.

Cargo consolidation shifts the primary constraint within the system from capacity to the availability of incoming materials.

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Thanks !

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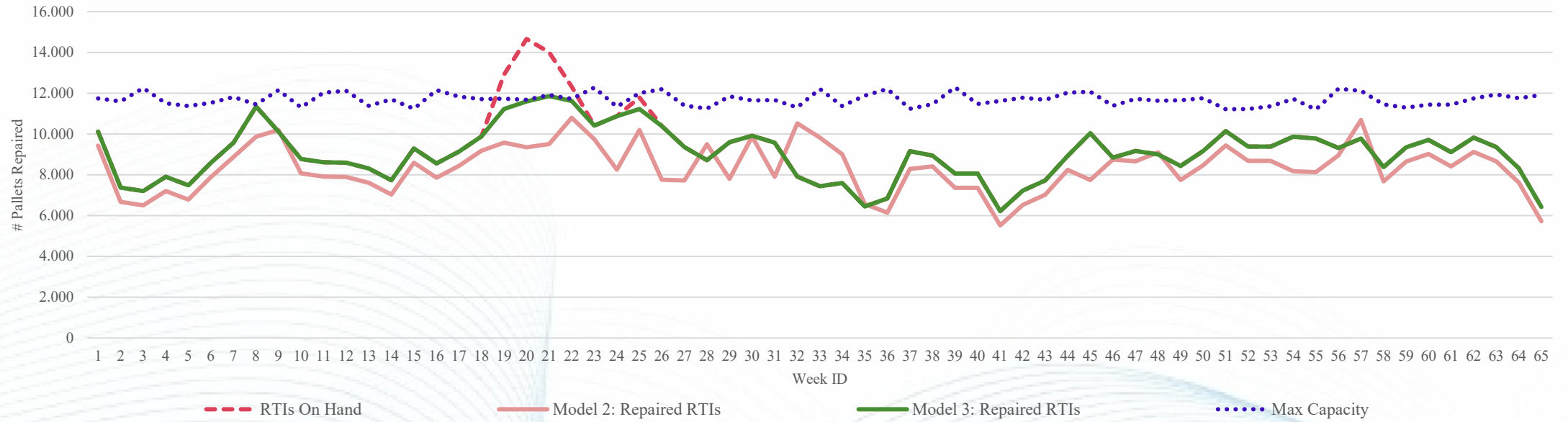
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Additional Information

KPI's	MLs	Max. Value	Average Value	Min Value
1. Number of pallets repaired per week (Smaller Layout)	Level 1	8,120	7,710	7,281
	Level 2	11,388	9,051	6,215
	Level 3	12,294	9,051	6,215
2. Number of pallets repaired per week (Larger Layout)	Level 1	16,010	14,298	13,440
	Level 2	22,472	18,154	10,353
	Level 3	24,638	18,154	10,353
3. Inventory on Hand Utilization (Smaller Layout)	Level 1	95.21%	63.06%	52.79%
	Level 2	97.68%	92.93%	88.83%
	Level 3	99.63%	99.38%	99.17%
4. Inventory on Hand Utilization (Larger Layout)	Level 1	92.01%	59.66%	49.31%
	Level 2	96.14%	91.88%	85.59%
	Level 3	98.77%	98.57%	98.25%

RTI availability vs Maximum Capacity (Smaller Size Layout)



RTI availability vs Maximum Capacity (Larger Size Layout)

