



MIT Supply Chain
M A N A G E M E N T

Planning for Peak Demand in Reverse Logistics

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Agenda



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Returnable Transport Items (RTIs)

Examples:

- Bins
- Kegs
- Pallets
- Racks



Uses:

Internal & external movement

- Raw materials
- Semi-finished products
- Finished goods

Returnable Transport Items (RTIs) : Objects used for the purpose of “transportation, storage, handling, and product protection in the supply chain, which are returned for further usage”

Returnable Transport Items (RTI): Examples



High Volumes of RTIs used in Logistics Industry



Active RTIs in US: **>2 bn units**

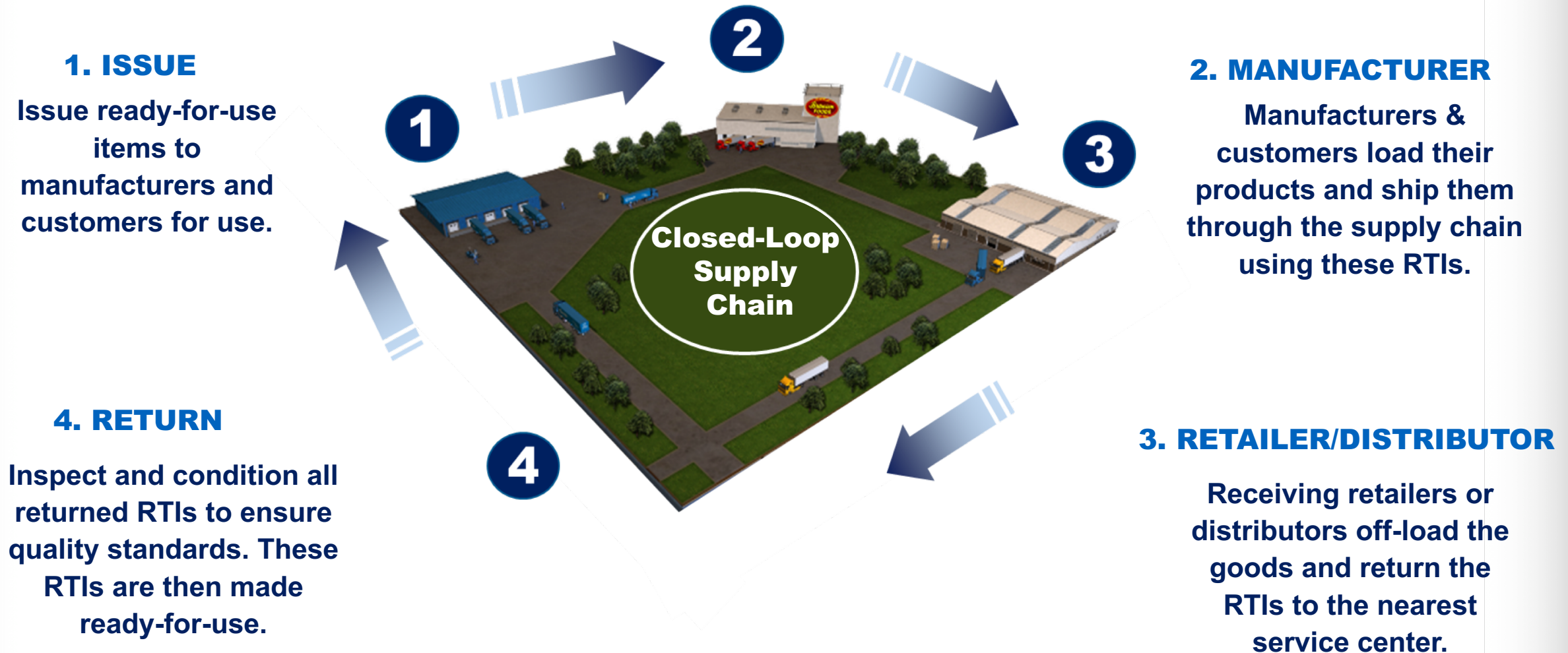
Transport trade: **80%** of the country's trade

Global sales: **>5 bn units**

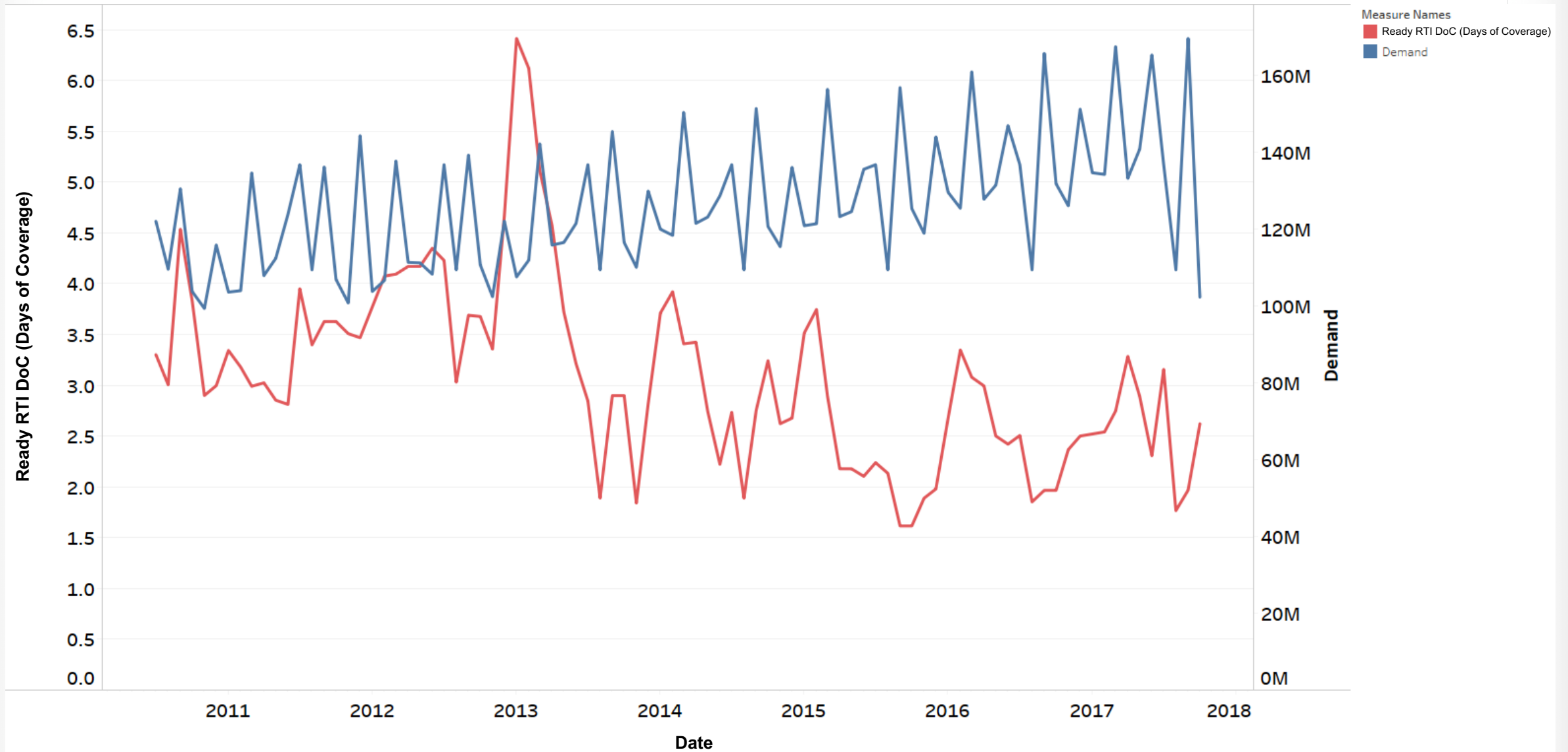
Global growth: **5%**

With such significant dependency on the RTI platform to move their materials, a ready supply of empty RTIs is vital to ensuring users' operational readiness.

Flow of RTI in a Closed-Loop Supply Chain



Demand is growing and supply is not keeping up



Project Objectives

Key Question

- How does inventory position (days of coverage) affect supply chain costs and service levels?

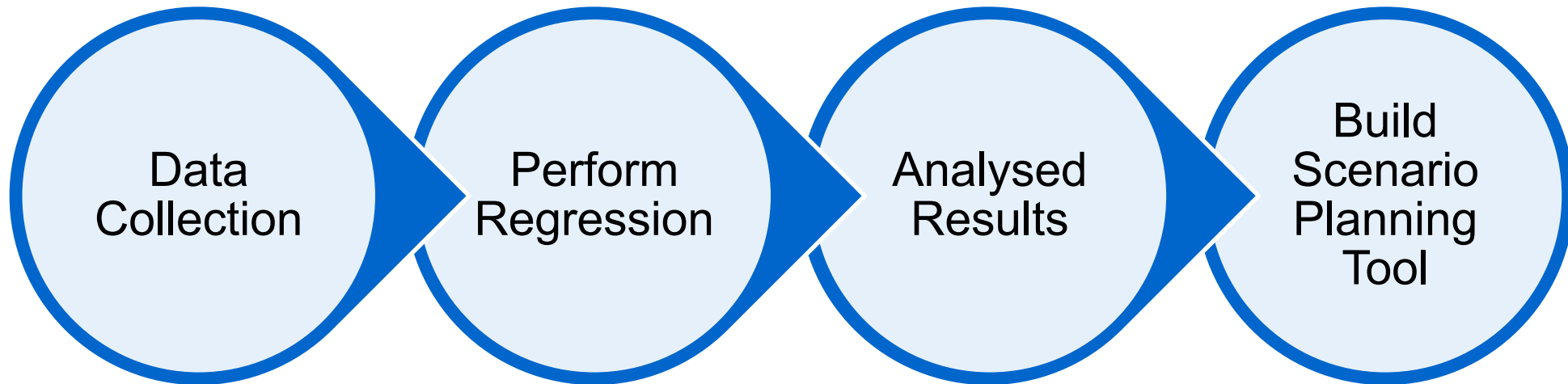
Objective:

- Analyze historical key performance indicators
- Identify key drivers that impact service and cost
- Recommend inventory policy to minimize cost and achieve service levels
- Quantify the improvements in terms of cost and service levels

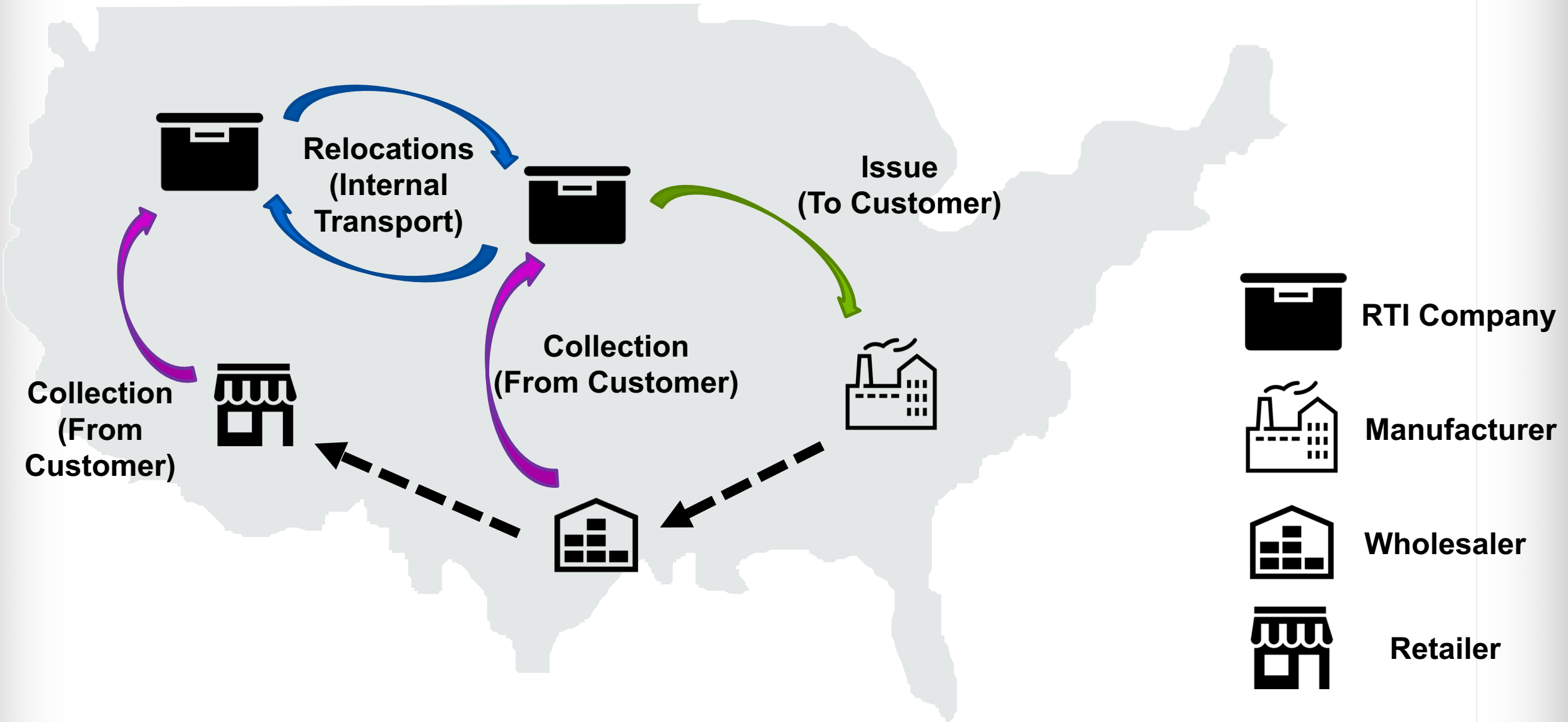
Project Contributions

- A regression model to identify correlations between cost, service levels and inventory position.
- Scenario Planning Tool (SPT) to find optimal inventory position to minimize supply chain costs and maximize service levels.

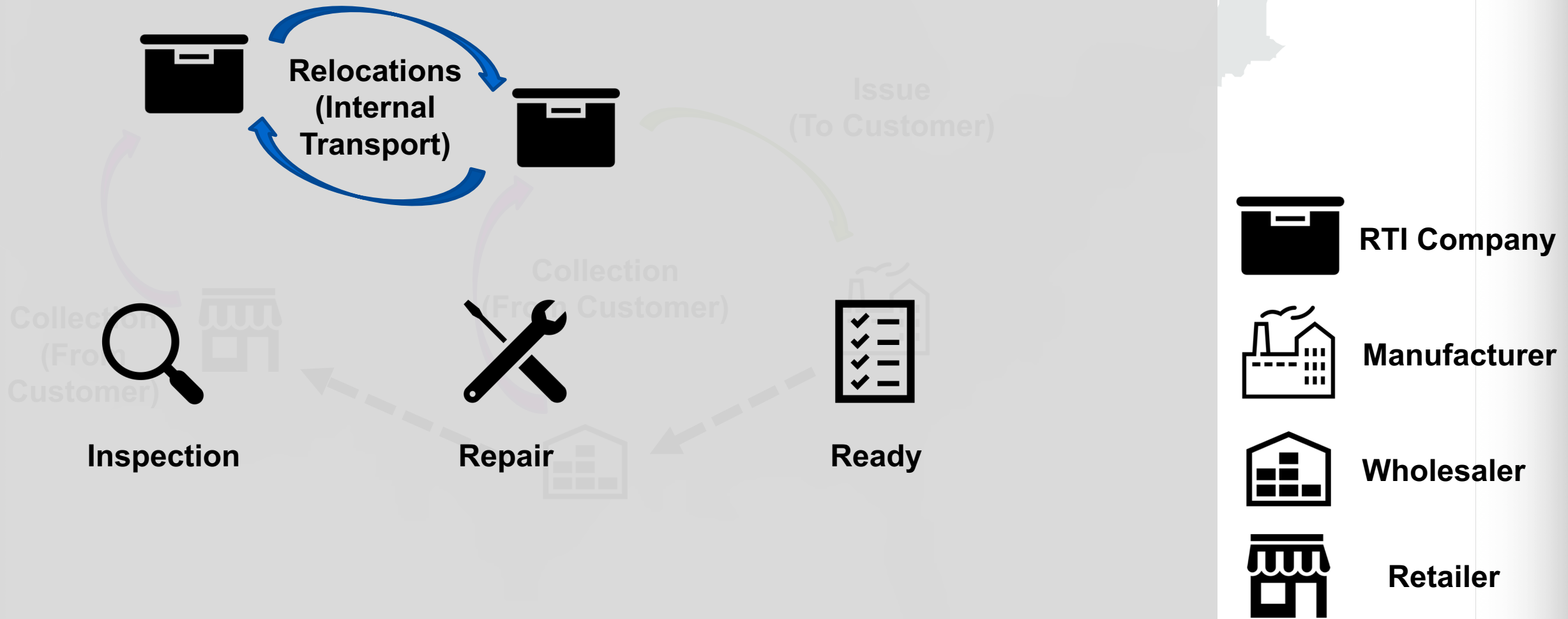
Methodology



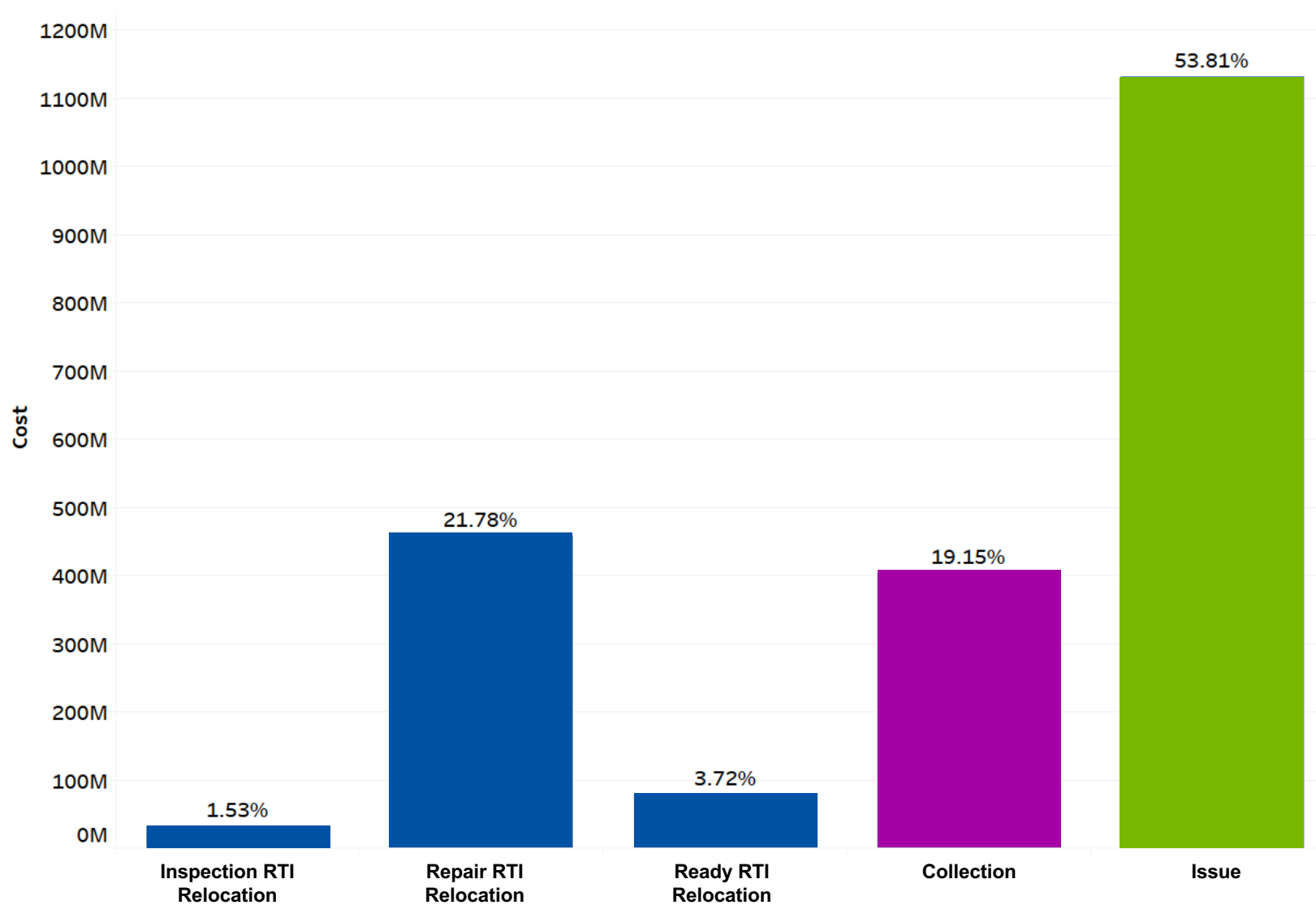
Main cost factors in a closed loop supply chain



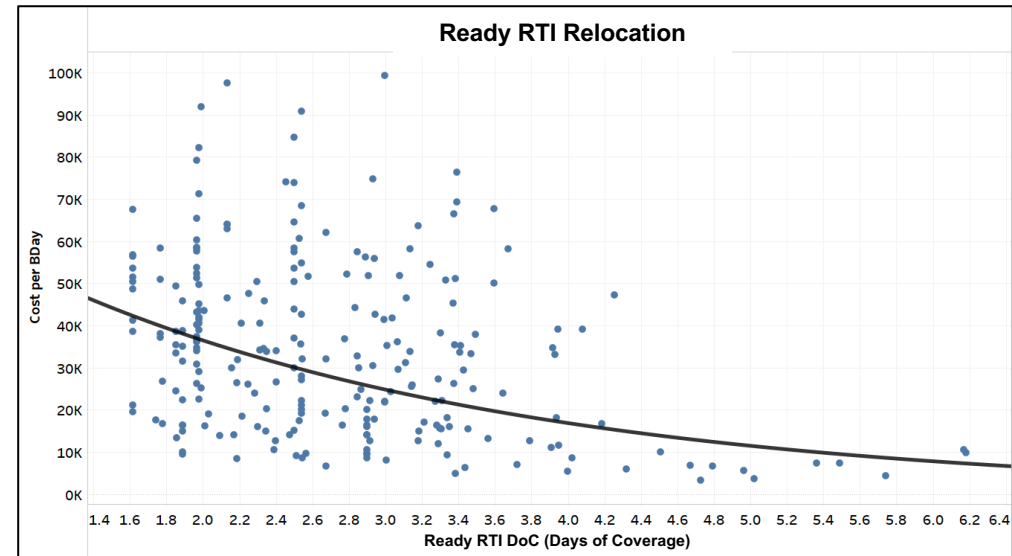
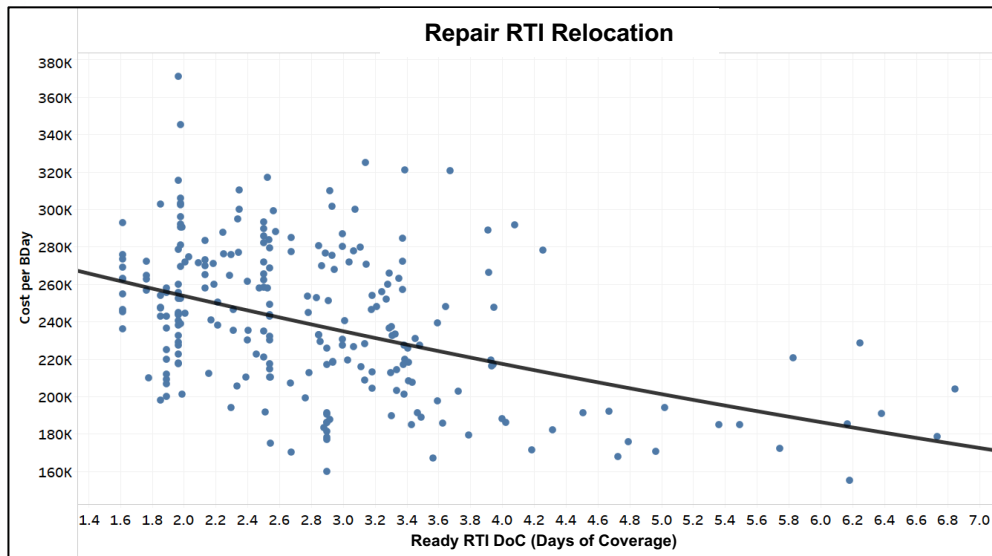
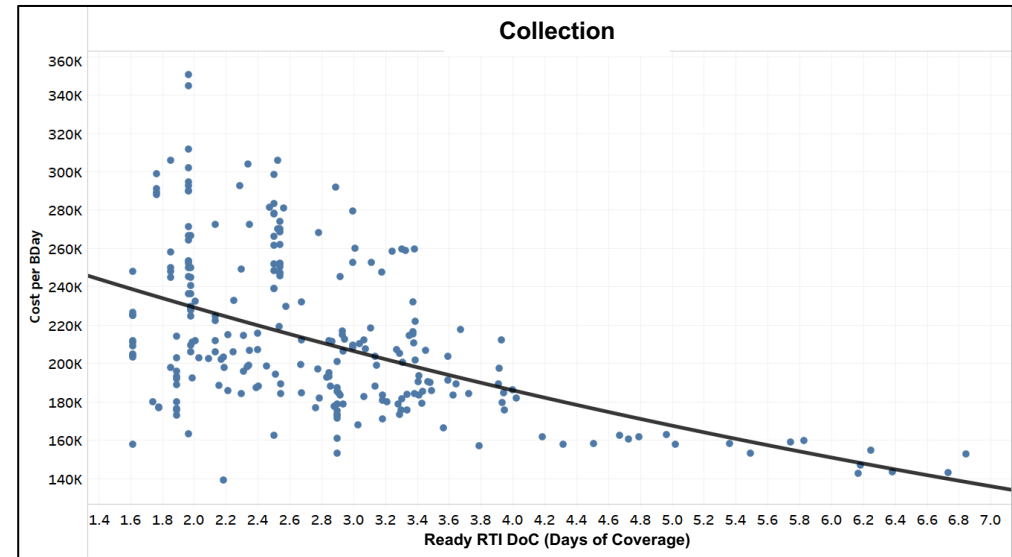
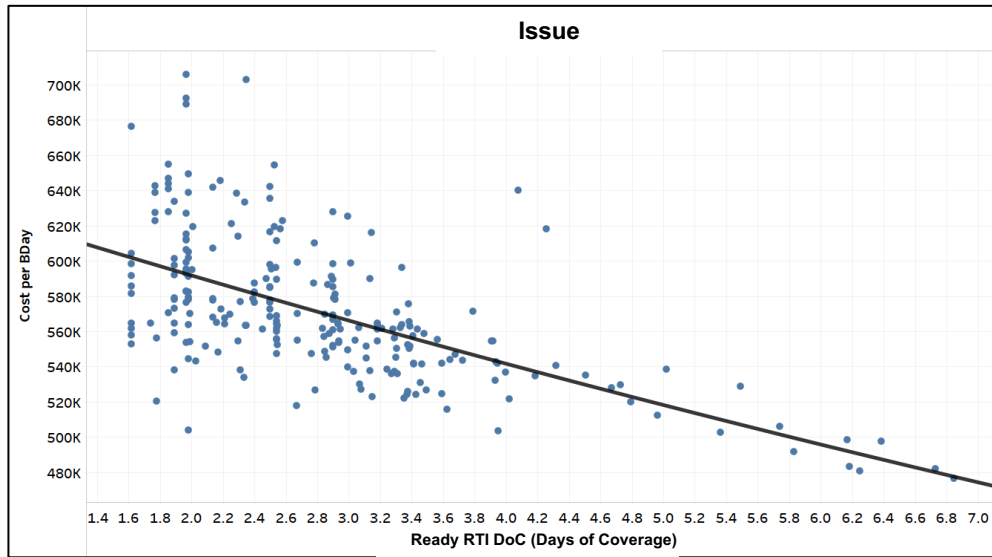
Main cost factors in a closed loop supply chain



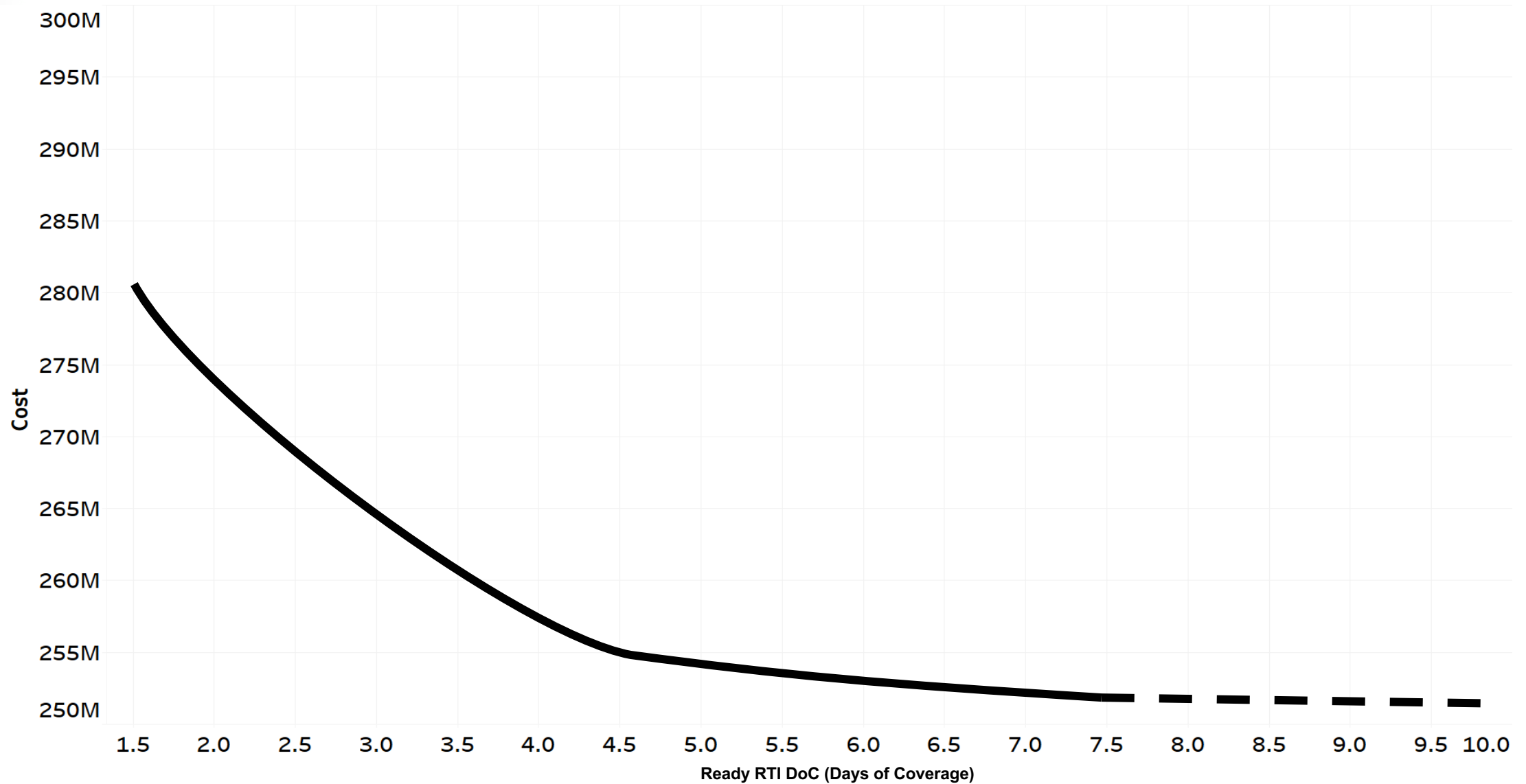
Cost factors have various weights of impact on total cost



Increasing days of coverage reduces logistics cost

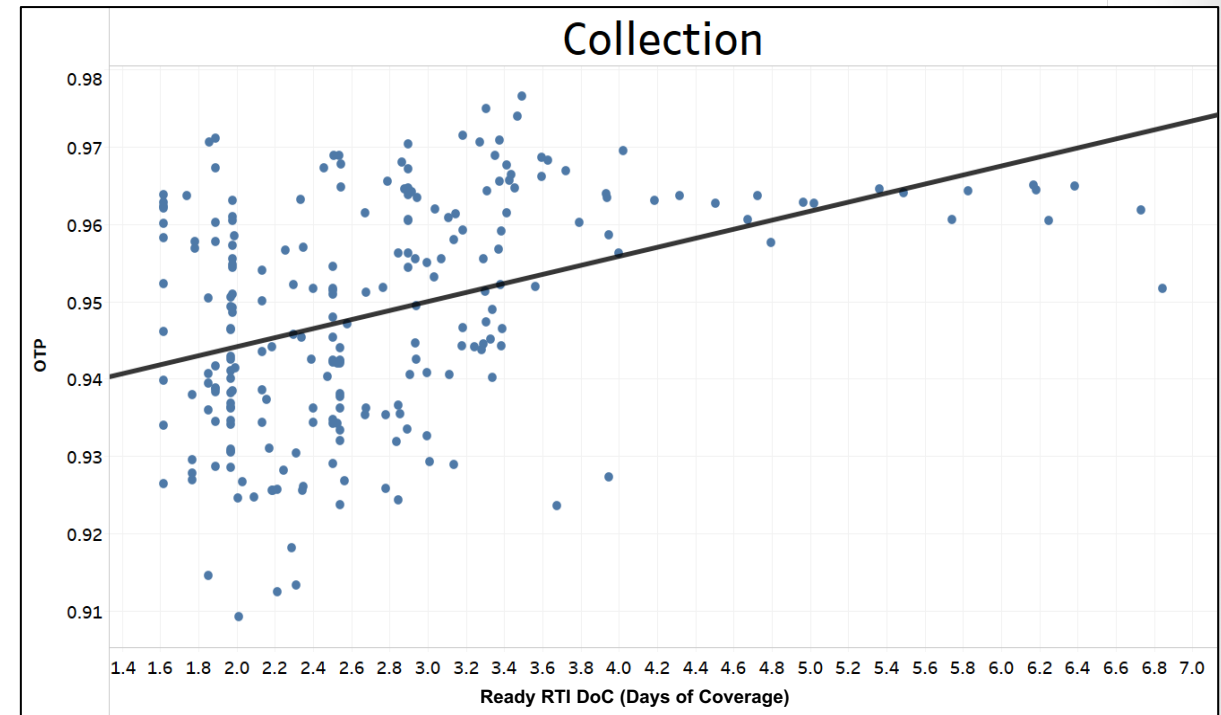
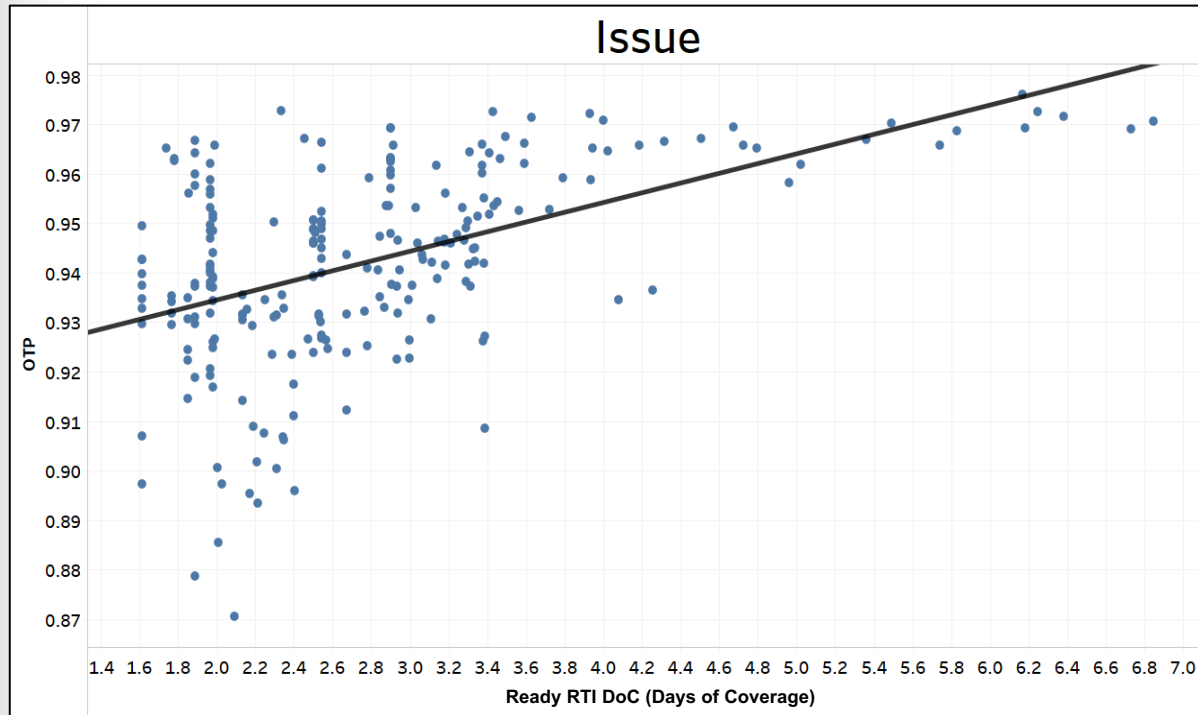


Opportunity to optimize minimal logistics supply chain cost

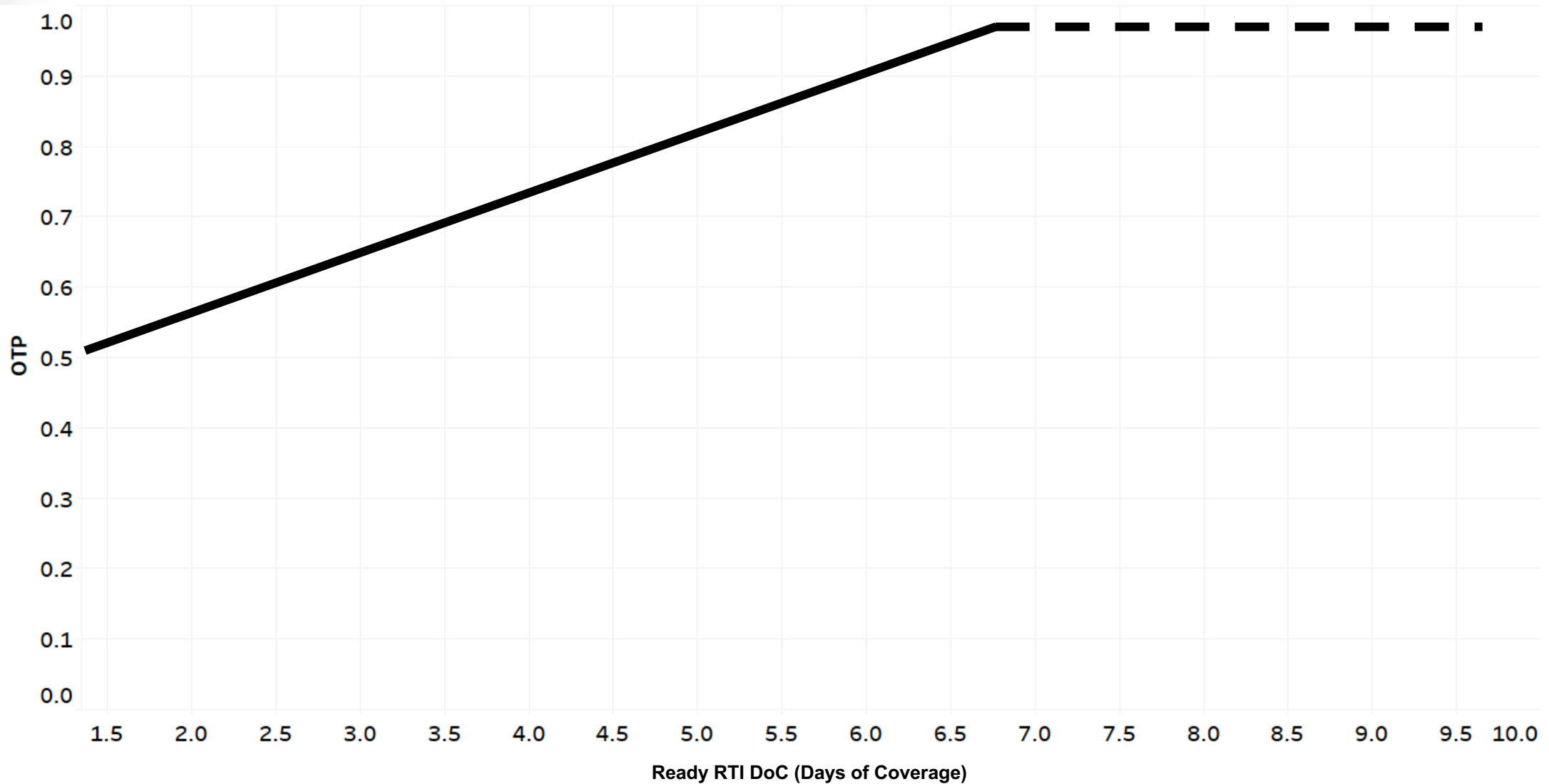


Increasing days of coverage increases service levels

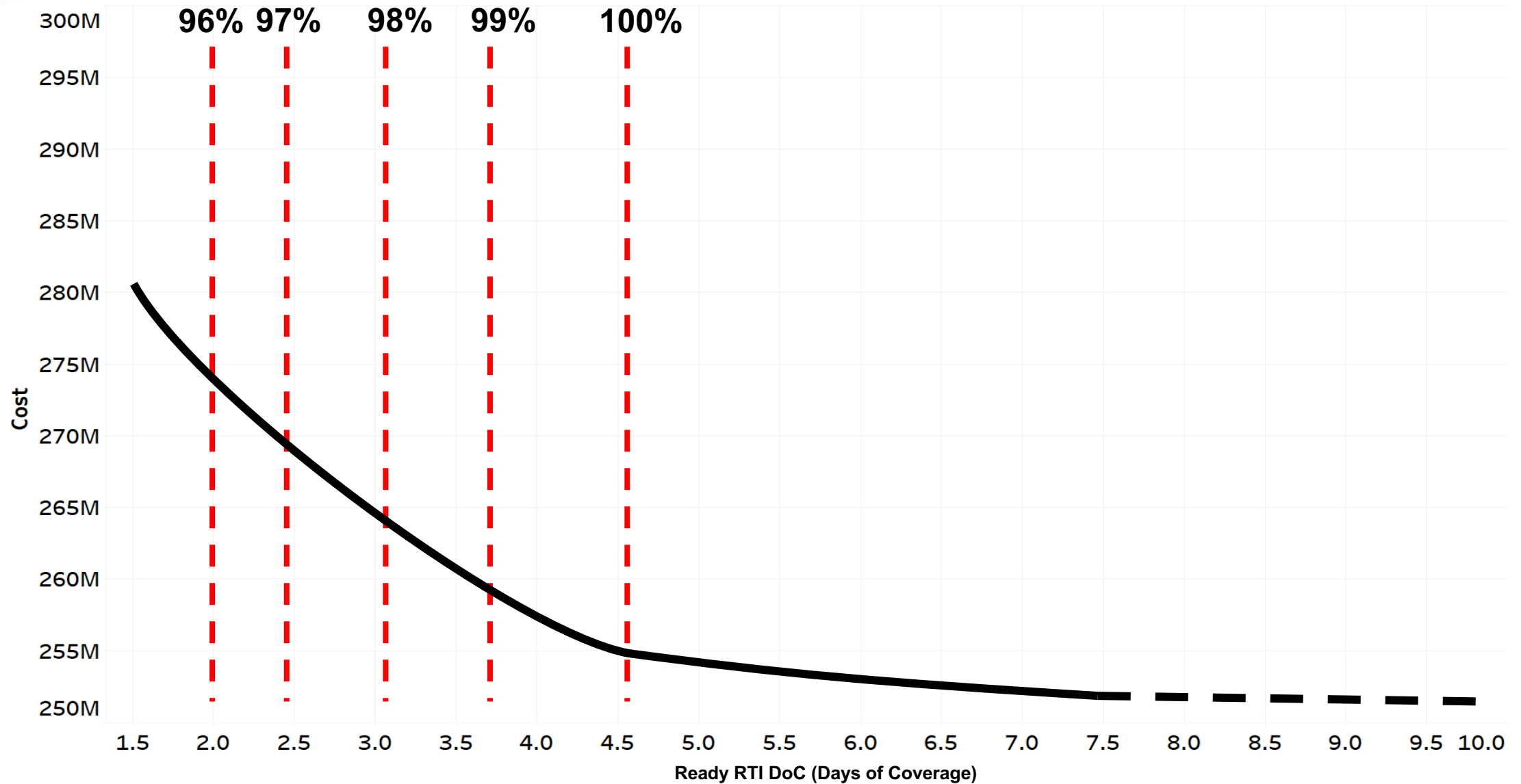
Service Level: On Time Performance (OTP) is a ratio of successful orders fulfilled over total orders fulfilled and measures success when an RTI is delivered on time, failure if late (>3 days)



Diminishing marginal benefit on service levels



Service levels are met before minimum logistics costs are attained



Scenario Planning Tool

SCENARIO PLANNING TOOL

Input

| Month | January | February | March | April | May | June | July | August | September | October | November | December | |
|---------------|---------|-----------|----------|----------|----------|----------|-----------|-----------|-----------|----------|----------|----------|-----------------------------|
| C DoC | 4.2645 | 4.2933398 | 4.259326 | 4.105608 | 3.243406 | 3.154708 | 3.0341592 | 2.0191526 | 2.3971364 | 3.340966 | 3.340966 | 3.340966 | Decision Variables |
| Baseline Year | 2016 | | | | | | | | | | | | Solver Constraints |
| | | | | | | | | | | | | | % changes are over baseline |

Output

| Cost Factors (Monthly) | January | February | March | April | May | June | July | August | September | October | November | December |
|-------------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Issue OTP | 98.0% | 98.0% | 98.0% | 97.8% | 95.6% | 98.0% | 94.4% | 93.2% | 94.1% | 96.8% | 97.1% | 97.1% |
| Collection OTP | 97.0% | 96.9% | 97.7% | 98.0% | 98.0% | 98.0% | 98.0% | 98.0% | 98.0% | 98.0% | 98.0% | 98.0% |
| B Relocation Cost | \$ 4,930,068.55 | \$ 1,129,672.85 | \$ 2,967,140.07 | \$ 3,876,460.39 | \$ 3,853,134.42 | \$ 3,910,741.90 | \$ 4,262,350.50 | \$ 5,405,187.89 | \$ 5,245,639.42 | \$ 3,250,084.74 | \$ 2,060,330.66 | \$ 2,403,139.05 |
| % Change (B Relo)* | -22% | -79% | -61% | -35% | -39% | -37% | -39% | -1% | -24% | -33% | -60% | -64% |
| C Relocation Cost | \$ 334,225.00 | \$ 300,146.84 | \$ 182,292.60 | \$ 357,210.18 | \$ 495,828.11 | \$ 513,110.10 | \$ 537,567.57 | \$ 795,617.08 | \$ 705,793.33 | \$ 259,153.78 | \$ 477,490.91 | \$ 477,490.91 |
| % Change (C Relo)* | -73% | -28% | -79% | -51% | -36% | -53% | -74% | -8% | -31% | -78% | -39% | -66% |
| Issue Cost | \$ 11,188,299.01 | \$ 11,351,038.23 | \$ 11,514,658.93 | \$ 11,542,970.45 | \$ 12,036,937.91 | \$ 12,088,938.35 | \$ 12,159,972.08 | \$ 13,092,560.36 | \$ 13,162,180.89 | \$ 11,663,668.96 | \$ 11,456,450.03 | \$ 11,584,850.94 |
| % Change (Issue)* | -6% | -3% | -24% | -4% | -13% | -11% | -20% | -7% | -24% | -9% | -13% | -20% |
| Collection Cost | \$ 3,984,377.97 | \$ 3,747,925.93 | \$ 3,657,323.25 | \$ 3,689,391.73 | \$ 4,109,328.70 | \$ 4,224,318.15 | \$ 4,205,371.53 | \$ 4,735,852.42 | \$ 4,833,691.21 | \$ 3,680,176.99 | \$ 3,587,028.02 | \$ 4,123,515.14 |
| % Change (Collection)* | -21% | -18% | -37% | -20% | -20% | -22% | -38% | -14% | -35% | -33% | -35% | -38% |
| Monthly Total (Predicted) | \$ 21,001,439.93 | \$ 17,093,253.26 | \$ 18,885,884.27 | \$ 20,030,502.16 | \$ 21,059,698.56 | \$ 21,301,577.91 | \$ 21,729,731.09 | \$ 24,593,687.16 | \$ 24,511,774.27 | \$ 19,417,553.89 | \$ 18,145,769.03 | \$ 19,153,465.46 |
| Monthly Baseline (Historical) | \$ 24,895,983.89 | \$ 22,314,834.93 | \$ 29,680,851.21 | \$ 23,618,477.35 | \$ 26,233,462.65 | \$ 26,804,921.15 | \$ 31,652,522.38 | \$ 26,456,300.14 | \$ 33,388,572.47 | \$ 24,690,765.78 | \$ 25,083,554.19 | \$ 29,983,511.79 |
| % Change (Monthly Total)* | -16% | -23% | -36% | -15% | -20% | -21% | -31% | -7% | -27% | -21% | -28% | -36% |

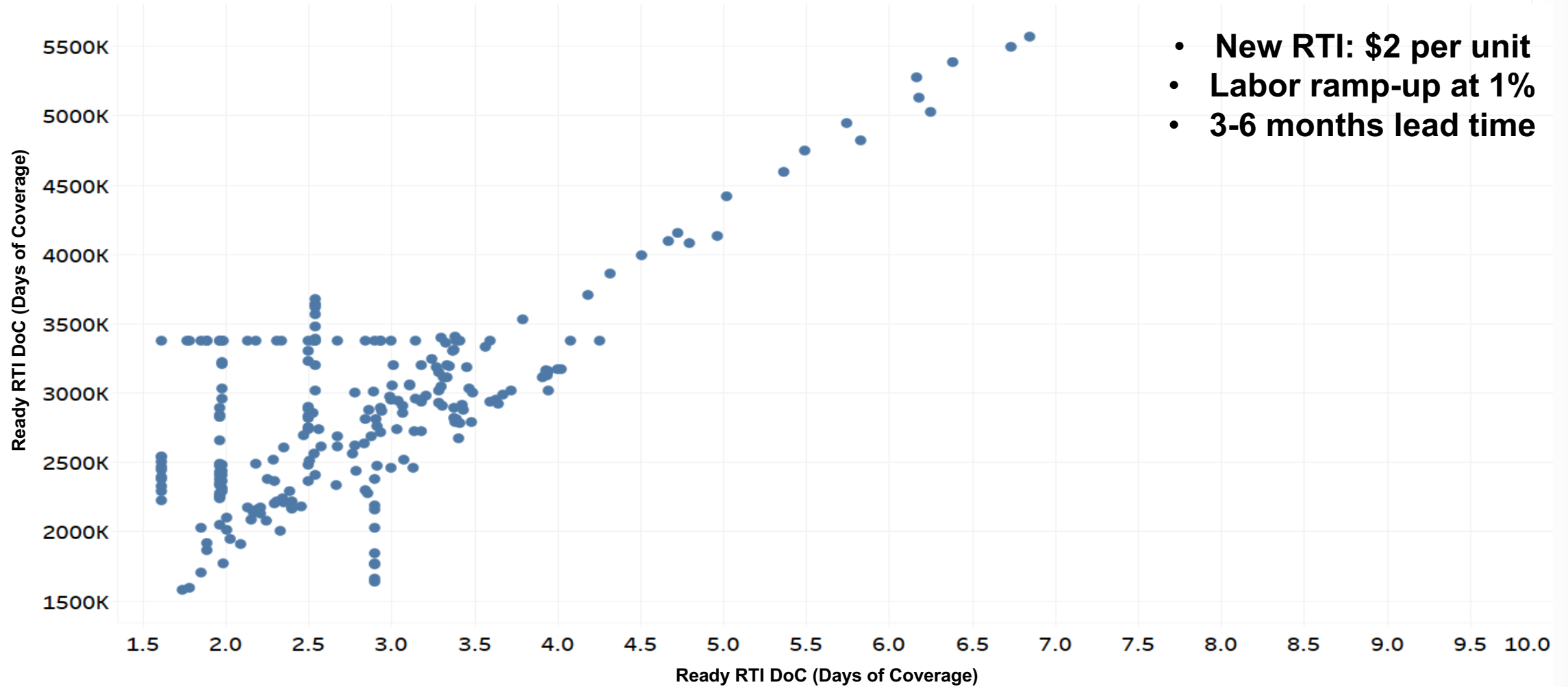
| Annual Summary | Cost | Baseline | % Difference |
|----------------------|--------------------------|--------------------------|---------------|
| A Relocation Cost | \$ 6,773,633.00 | \$ 5,203,914.52 | 30.2% |
| B Relocation Cost | \$ 43,293,950.43 | \$ 73,715,142.06 | -41.3% |
| C Relocation Cost | \$ 5,435,926.40 | \$ 12,451,433.50 | -56.3% |
| Issue Cost | \$ 142,842,526.12 | \$ 165,406,898.01 | -13.6% |
| Collection Cost | \$ 48,578,301.03 | \$ 68,026,369.84 | -28.6% |
| Subtotal Cost | \$ 246,924,336.99 | \$ 324,803,757.93 | -24.0% |
| Inventory Cost | \$ 16,157,090.46 | \$ 13,042,623.57 | 23.9% |
| Grand Total | \$ 263,081,427.45 | \$ 337,846,381.50 | -22.1% |

| | | |
|--------------------------|----------|----------|
| Average Issue OTP | 96.5% | 95.0% |
| Average Collection OTP | 97.8% | 93.9% |
| Issue Cost per Unit | \$ 0.474 | \$ 0.538 |
| Collection Cost per Unit | \$ 0.317 | \$ 0.599 |

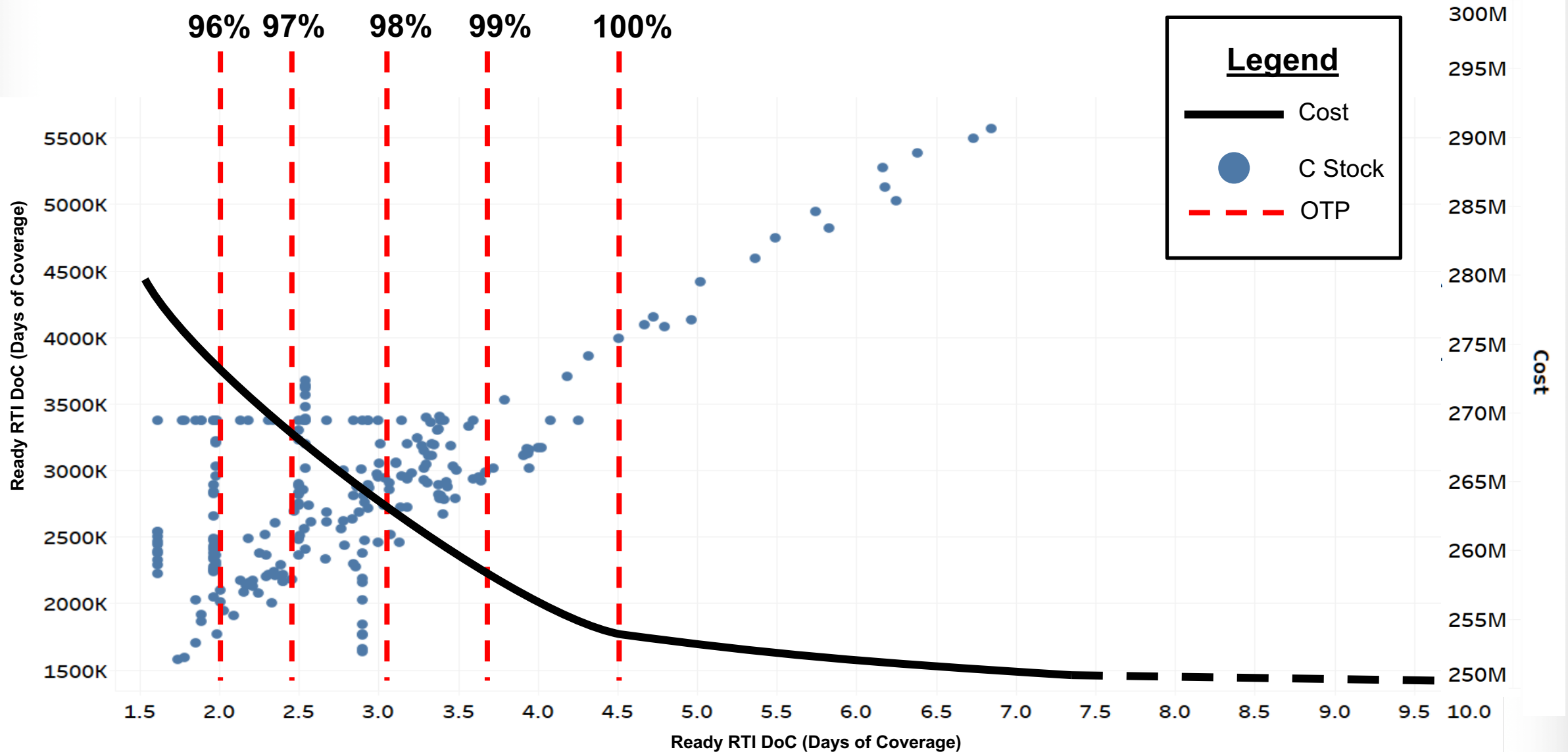
Key Takeaways

- 1. Minimum logistics cost does not necessarily mean an optimal supply chain plan**
- 2. Correlation between inventory policies and supply chain costs provides opportunity to minimize cost while achieving service level objectives**
- 3. Planning horizon for supply has to be longer to account for high seasonality in demand and mitigate bullwhip effect**

Challenges faced in increasing days of coverage



Trade-off between new RTI cost and logistics cost



Benefits

- 1. Planning for peak demand for entire year, taking into account inventory policies when managing supply chain cost factor**
- 2. Quantifying and justifying increase in inventory and service levels against costs**
- 3. Optimal supply chain plan could have improved logistics cost up to 24% and service levels up 5%**

THANK YOU