# Enhancing Efficiency in Microchip Distribution
# Strategic Supply Chain Route Optimization

***Optimization Methods Final Project***

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# PROBLEM DESCRIPTION

## Allocate 1000 orders to a warehouse and assign freight paths

# DATA OVERVIEW | RELATIONAL DATABASE

| Order |
|---|
| Order ID : integer |
| Order Date : date |
| Origin Port : string |
| Carrier : string |
| TPT : integer |
| Service Level : string |
| Ship ahead day count : integer |
| Ship Late Day count : integer |
| Customer : string |
| Product ID : integer |
| Plant Code : string |
| Destination Port : string |
| Unit quantity : integer |
| Weight : float |

| FreightRates |
|---|
| Carrier : string |
| orig_port_cd : string |
| dest_port_cd : string |
| minm_wgh_qty : float |
| max_wgh_qty : float |
| svc_cd : string |
| minimum cost : float |
| rate : float |
| mode_dsc : string |
| tpt_day_cnt : integer |
| Carrier type : string |

| WhCosts |
|---|
| WH : string |
| Cost/unit : float |

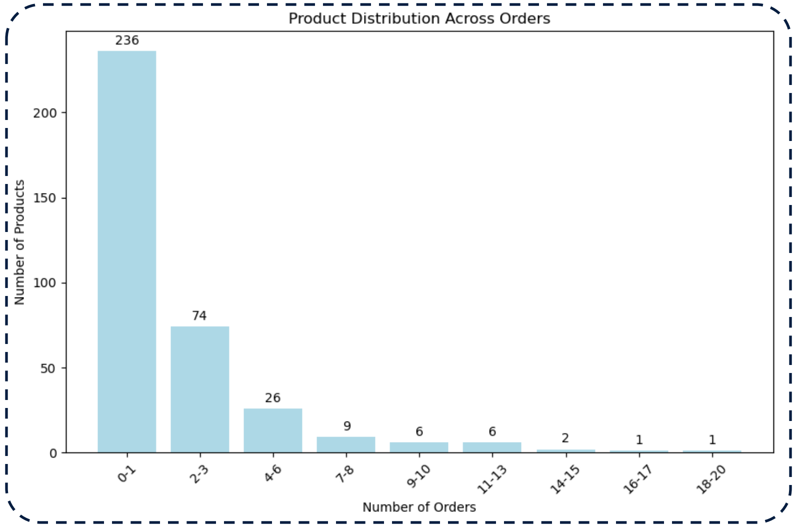
| WhCapacities |
|---|
| Plant ID : string |
| Daily Capacity : integer |

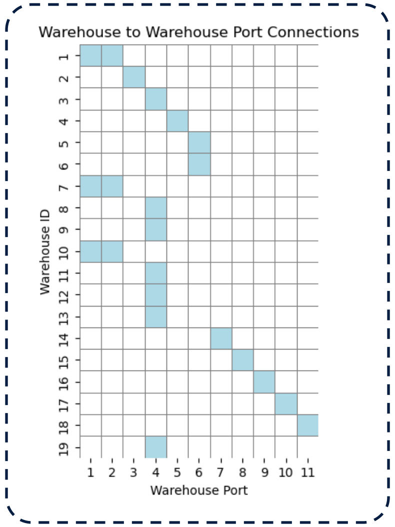
| ProductsPerPlant |
|---|
| Plant Code : string |
| Product ID : integer |

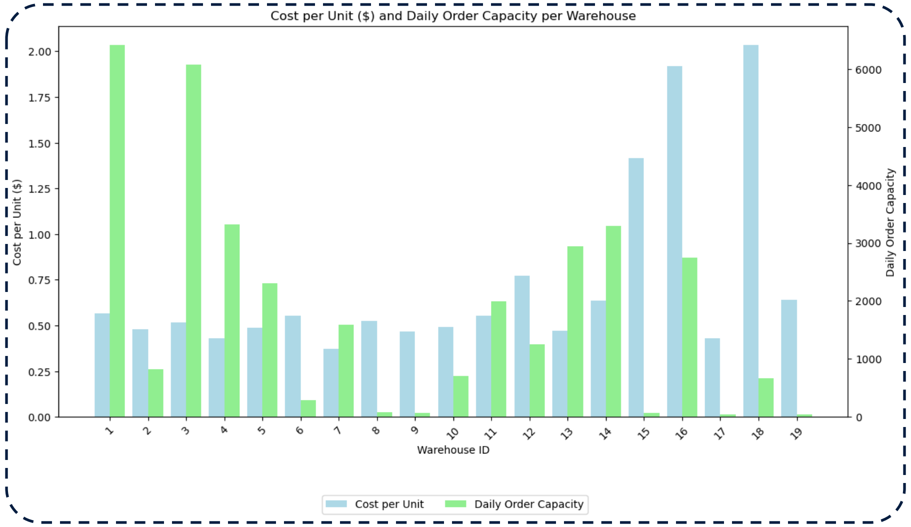
| VmiCustomers |
|---|
| Plant Code : string |
| Customers : string |

| PlantPorts |
|---|
| Plant Code : string |
| Port : string |

# EXPLORATION DATA ANALYSIS




Various types of products

Sparse supply ability

Lack of low-cost warehouse

**COMPLICATED!!!**

# BASELINE MODEL | YAN-TIAN GREEDY ALGORITHM

1. Traverse through all orders
2. Check constraints one by one
3. Assign orders to available place
4. Calculate costs

**Algorithm 1** Yan-Tian Greedy Algorithm For Order Assignment

// Assign orders to warehouse and freight
**for** $\text{order}_k$ from 1 to $n_{order}$ **do**
  **for** $\text{warehouse}_i$ from 1 to $n_{warehouse}$ **do**
    **for** $\text{freight}_j$ from 1 to $n_{freight}$ **do**
      **if** $\text{warehouse}_i$ can produce $\text{order}_k$'s product **then**
        **if** $\text{warehouse}_i$ can serve $\text{order}_k$'s customer **then**
          **if** $\text{warehouse}_i$ has capacity **then**
            **if** $\text{freight}_j$ has capacity **then**
              **if** $\text{warehouse}_i$ can transport products to $\text{freight}_j$'s warehouse port **then**
                **if** $\text{freight}_j$'s transportation time satisfy $\text{order}_k$'s demanding time **then**
                  Assign $\text{order}_k$ to $\text{warehouse}_i$ and $\text{freight}_j$
                  BREAK
                **end if**
              **end if**
            **end if**
          **end if**
        **end if**
      **end if**
    **end for**
  **end for**
**end for**
// Calculate transportation cost $TC$ and Warehouse Cost $WC$, Penalty Cost $PC$, and total cost $C$
Initialize $TC = 0$, $WC = 0$, $PC = 0$, and $C = 0$
**for** $\text{warehouse}_i$ from 1 to $n_{warehouse}$ **do**
  $WC = WC + \text{warehouse}_i\text{'s cost}$
**end for**
**for** $\text{freight}_j$ from 1 to $n_{freight}$ **do**
  $TC = TC + \text{freight}_j\text{'s cost}$
**end for**
**for** $\text{order}_k$ from 1 to $n_{order}$ **do**
  **if** $\text{order}_k$ is not assigned **then**
    $PC = PC + \text{unit penalty cost}$
  **end if**
**end for**
C = PC + TC + WC
// Output results

# FORMULATING OPTIMIZATION MODEL

Minimize Total Cost

$$\min \sum_{k=1}^{n_{\text{order}}} \sum_{i=1}^{n_{\text{warehouse}}} X_{ki} \cdot p_i \cdot q_k + \sum_{k=1}^{n_{\text{order}}} \sum_{j=1}^{n_{\text{freight}}} Y_{kj} \cdot TC_{kj}$$

Assignment Constraint

$$\text{s.t.} \quad \sum_{i=1}^{n_{\text{warehouse}}} X_{ki} = 1, \forall k; \quad \sum_{j=1}^{n_{\text{freight}}} Y_{kj} = 1, \forall k$$

Capacity Constraint

$$\sum_{k=1}^{n_{\text{order}}} X_{ki} \leq cap_i, \forall i; \quad \sum_{k=1}^{n_{\text{order}}} Y_{kj} \cdot ow_k \leq maxw_j, \forall j$$

Warehouse Constraint

$$\left\{ \begin{aligned} & X_{ki} \leq M(PW_{pro_k i}), \forall k, i \\ & X_{ki} \leq M(WC_{icus_k}), \forall k, i \\ & Y_{kj} \leq M(1 - X_{ki} + WP_{io_j}), \forall k, i, j \end{aligned} \right.$$

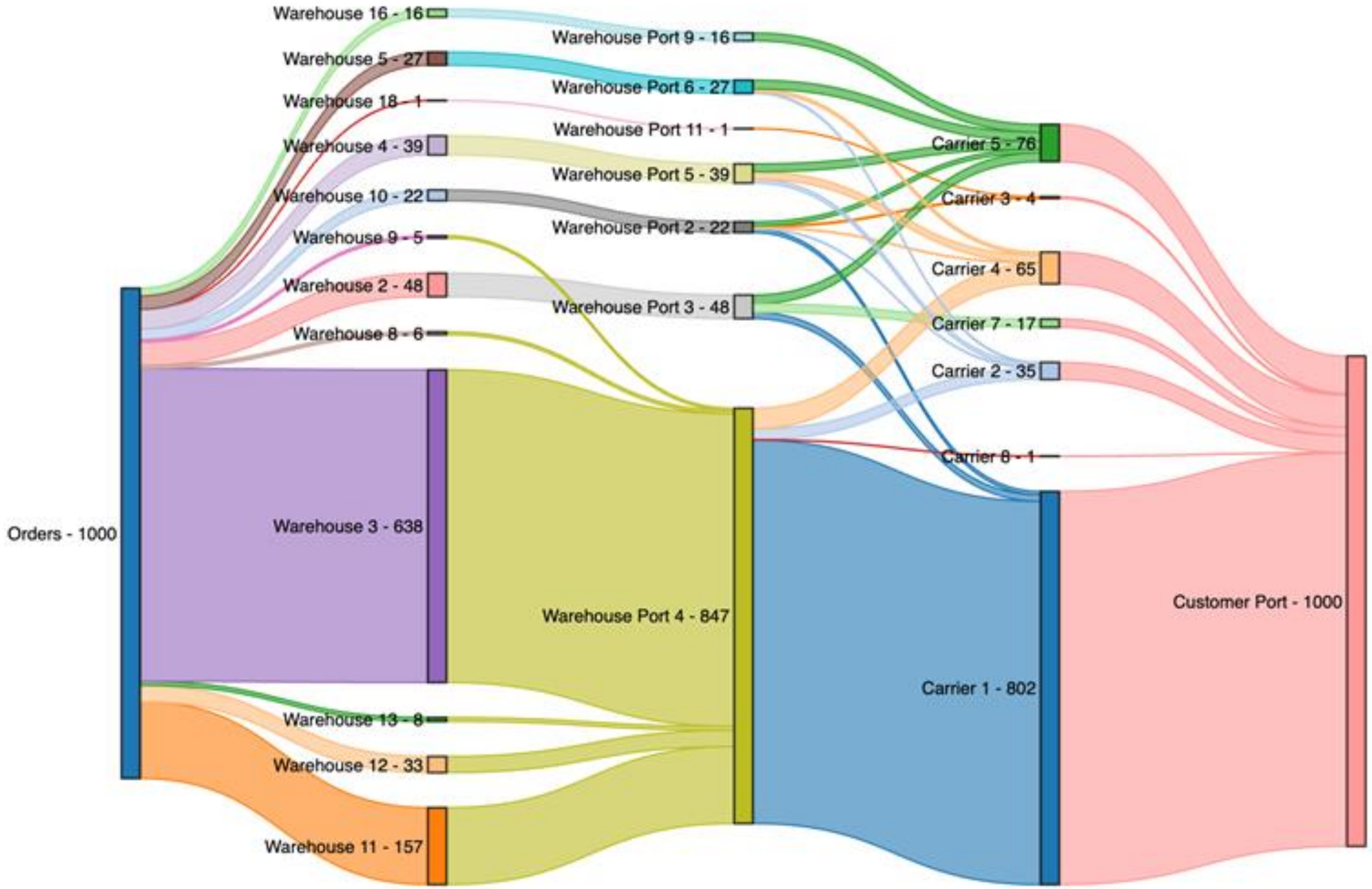
Delivery Time Constraint

$$\sum_{j=1}^{n_{\text{freight}}} Y_{kj} \cdot t_j \leq ot_k, \forall k$$

Cost Calculation

$$\left\{ \begin{aligned} & TC_{kj} \geq s_k[(1 - m_j) \cdot TCA_{kj} + m_j \cdot TCG_j], \forall k, j \\ & minc_j \leq TCA_{kj}, \forall k, j; \quad ow_k \cdot r_j \leq TCA_{kj}, \forall k, j \\ & z_j r_j \leq TCG_j, \forall j; \quad z_j \leq \sum_{k=1}^{n_{\text{order}}} Y_{kj}, \forall j; \quad Y_{kj} \leq z_j, \forall k, j \end{aligned} \right.$$

# RESULT | COST EFFECTIVE STORAGE & WELL-CONNECTED FREIGHT PATHS




**Economical Storage**

**80% Warehouse 3**

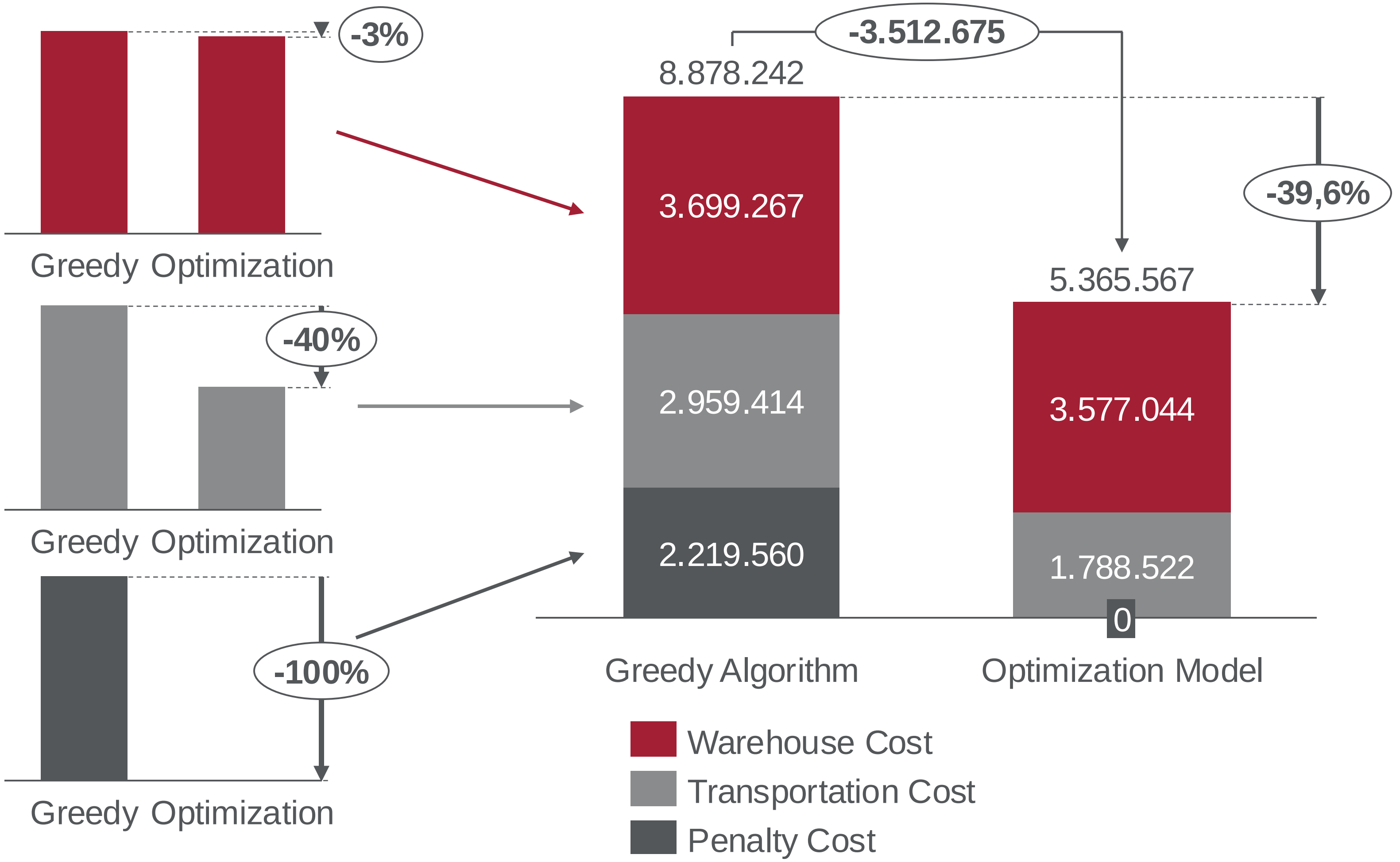
**Dual Transportation**

**80% Carrier 1**

**High Connectivity**

**85% WPort 4**

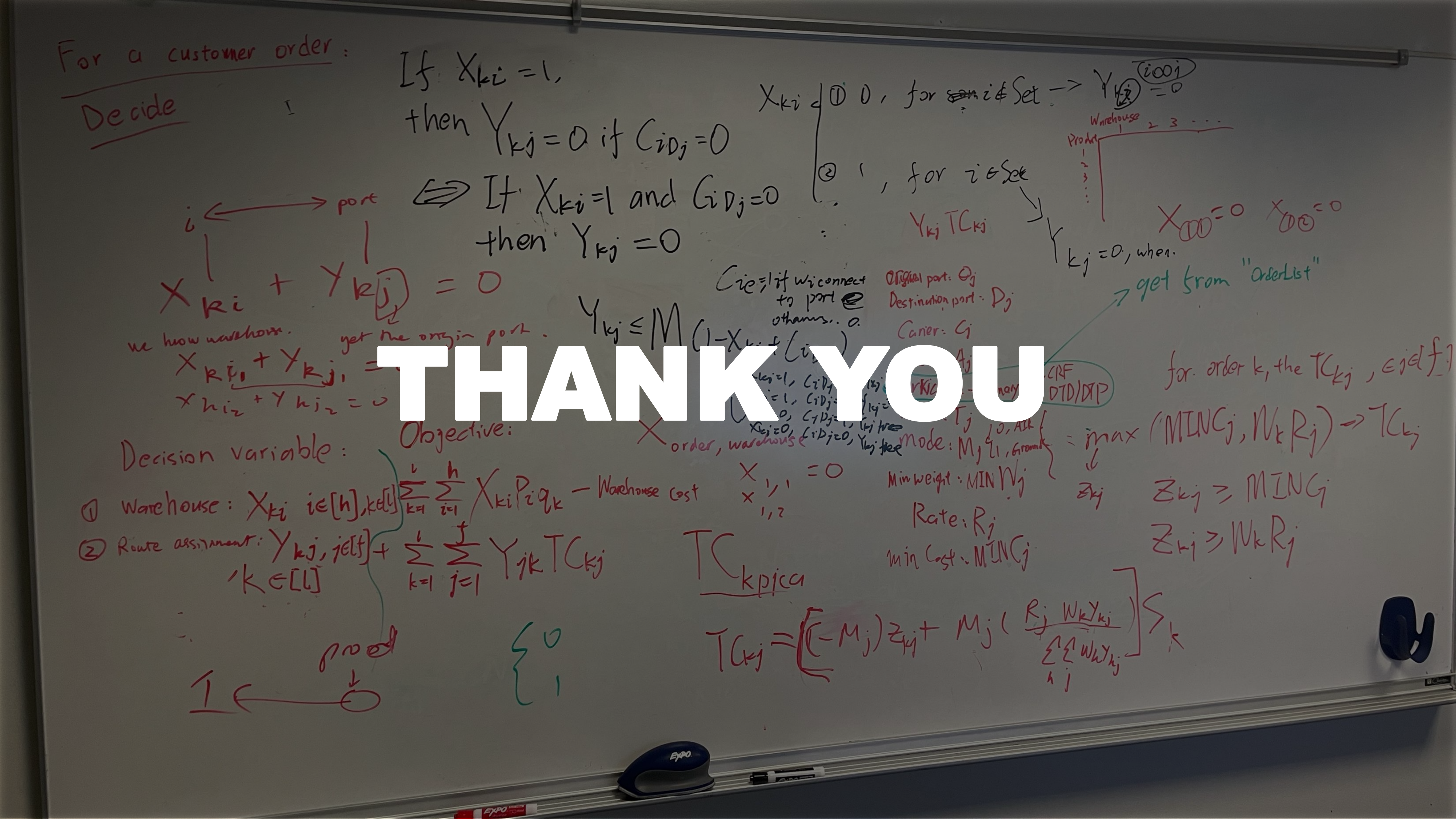
# BUSINESS IMPACT | NOTABLE COST REDUCTION & TRACTABLE SOLVING TIME




## Cost Reduction
**~ $3.5M**

## Cost Saving
**~ 40%**

## Solving Time
**< 2 Minutes**



THANK YOU
For a customer order:
Decide
Decision variable:
Objective:
Warehouse cost
get from "OrderList"