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

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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

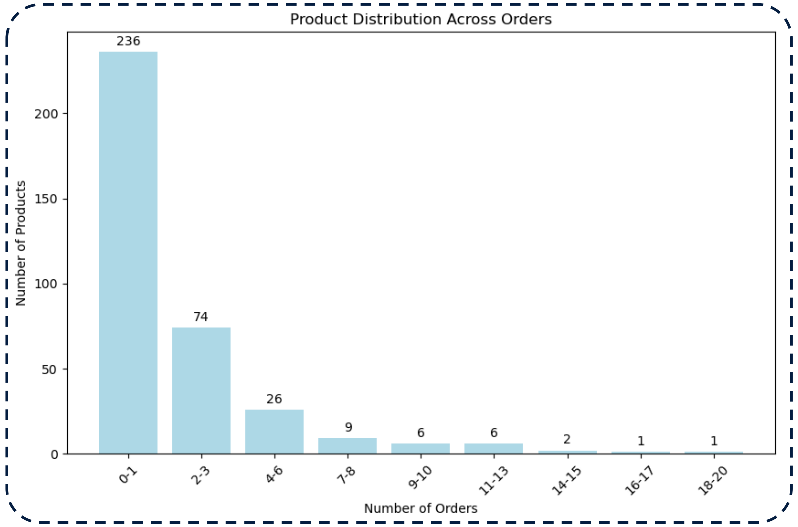
VmiCustomers

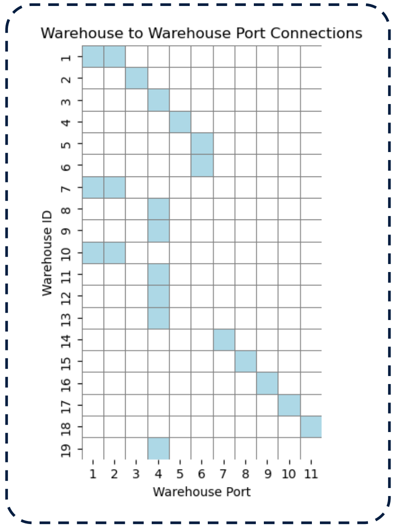
- Plant Code : string
- Customers : string

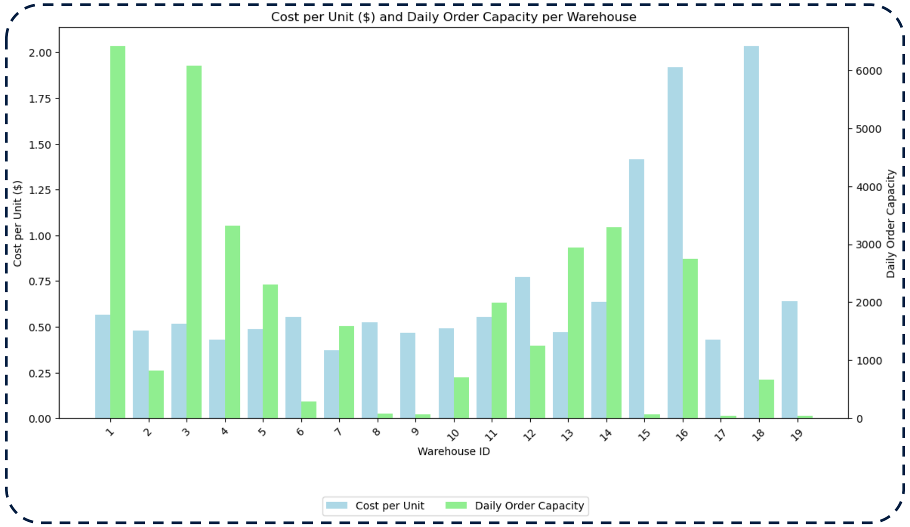
PlantPorts

- 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 order_k from 1 to n_{order} **do**
  for warehouse_i from 1 to $n_{warehouse}$ **do**
    for freight_j from 1 to $n_{freight}$ **do**
      if warehouse_i can produce order_k's product **then**
        if warehouse_i can serve order_k's customer **then**
          if warehouse_i has capacity **then**
            if freight_j has capacity **then**
              if warehouse_i can transport products to freight_j's warehouse port **then**
                if freight_j's transportation time satisfy order_k's demanding time **then**
                  Assign order_k to warehouse_i and 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 warehouse_i from 1 to $n_{warehouse}$ **do**
  $WC = WC + \text{warehouse}_i\text{'s cost}$
end for
for freight_j from 1 to $n_{freight}$ **do**
  $TC = TC + \text{freight}_j\text{'s cost}$
end for
for order_k from 1 to n_{order} **do**
  if 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 →
$$\text{s.t.} \quad \sum_{i=1}^{n_{\text{warehouse}}} X_{ki} = 1, \forall k; \quad \sum_{j=1}^{n_{\text{freight}}} Y_{kj} = 1, \forall k$$

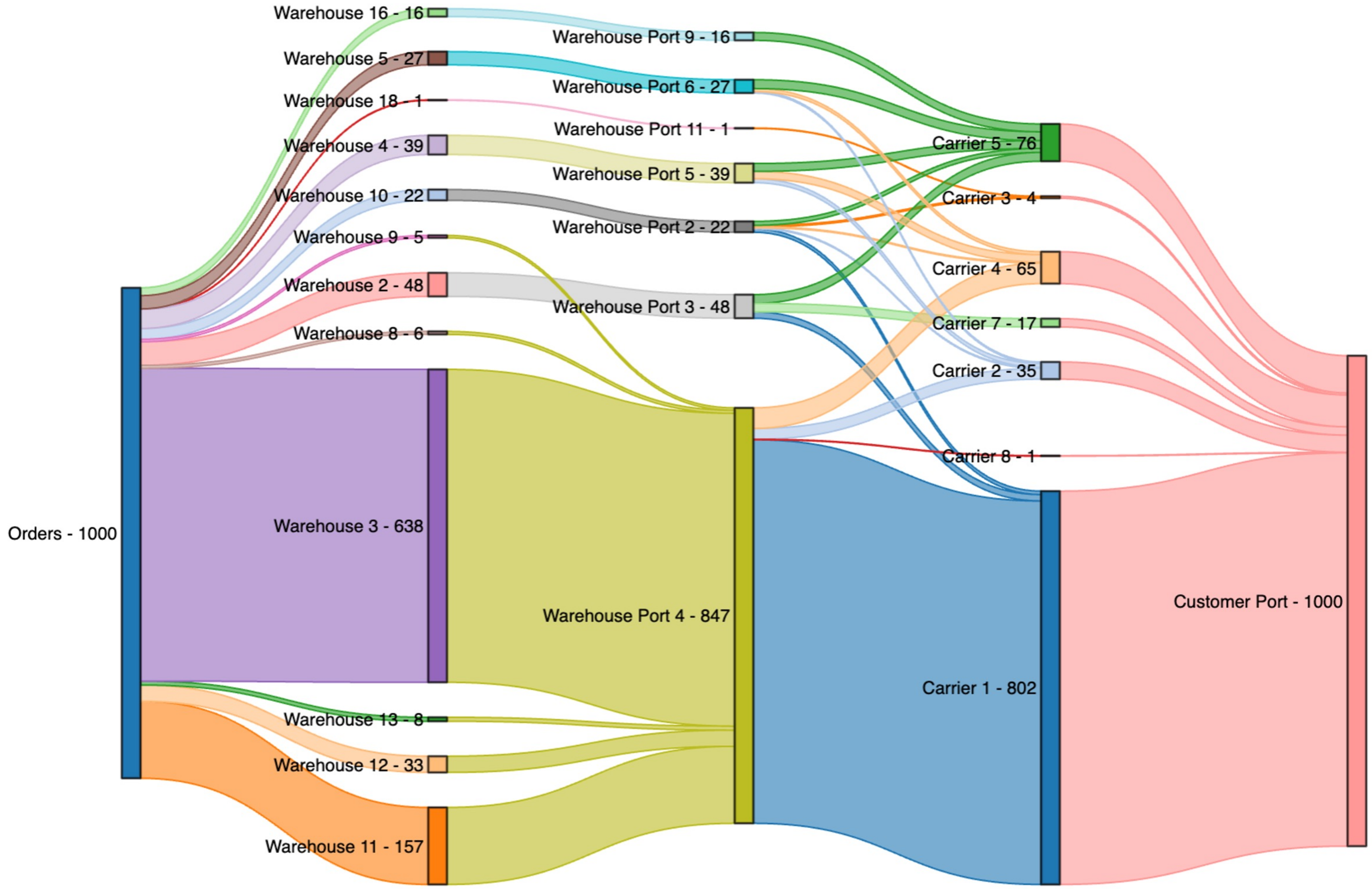
Capacity Constraint →
$$\sum_{k=1}^{n_{\text{order}}} X_{ki} \leq cap_i, \forall i; \quad \sum_{k=1}^{n_{\text{order}}} Y_{kj} \cdot ow_k \leq maxw_j, \forall j$$

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

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

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

RESULT | COST EFFECTIVE STORAGE & WELL-CONNECTED FREIGHT PATHS



Economical Storage
80% Warehouse 3

Dual Transportation
80% Carrier 1

High Connectivity
85% WPort 4

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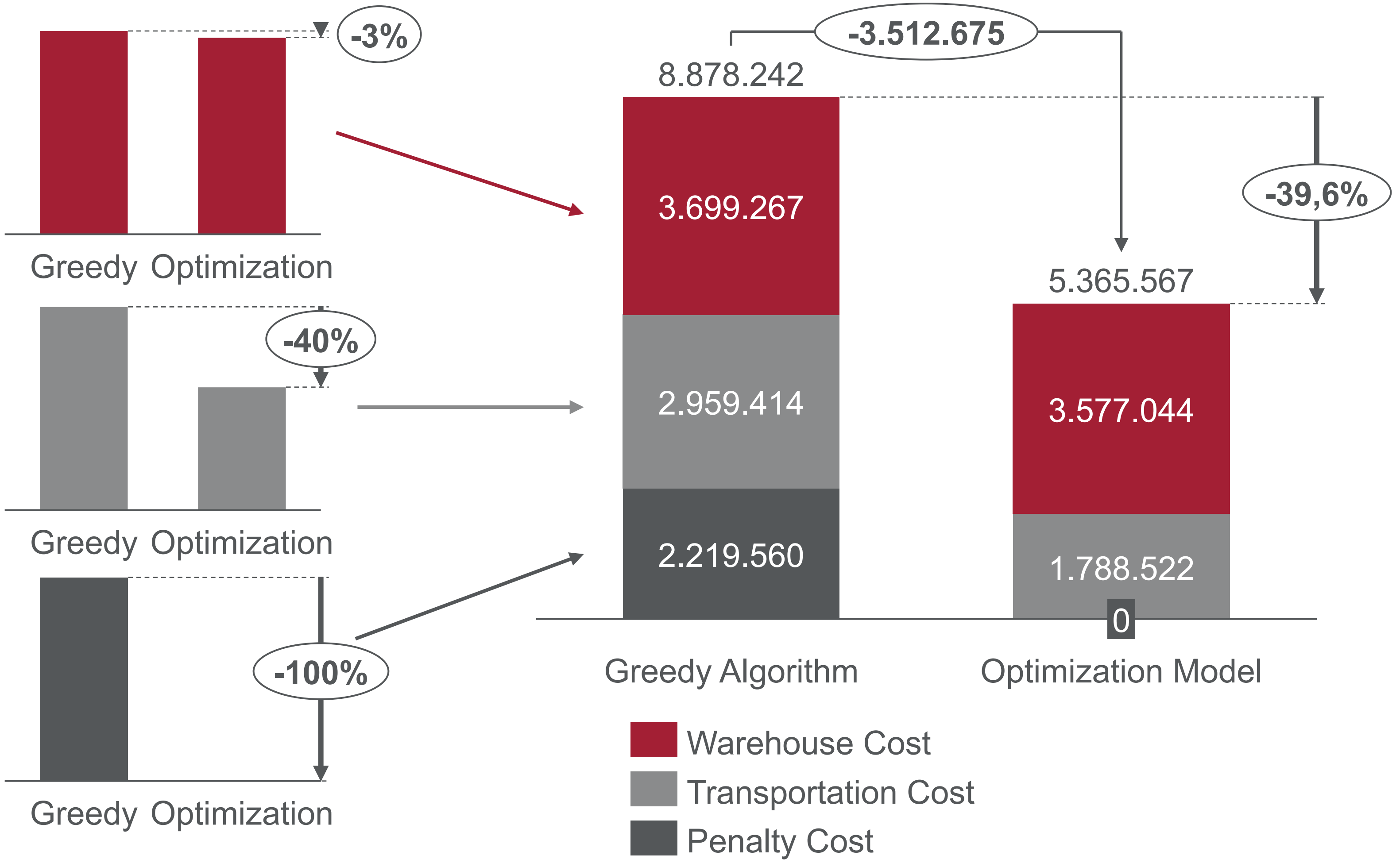
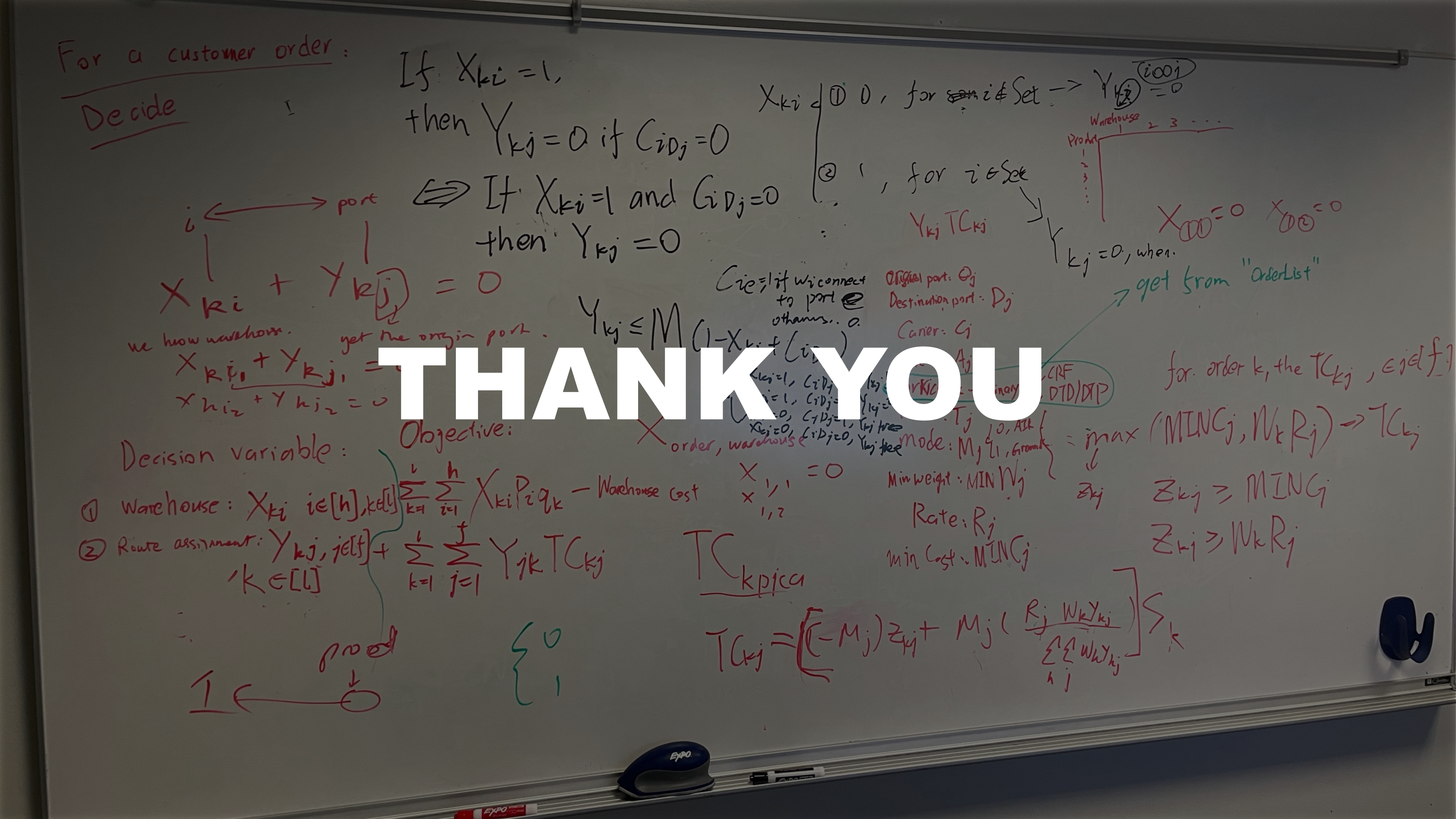
BUSINESS IMPACT | NOTABLE COST REDUCTION & TRACTABLE SOLVING TIME



Cost Reduction
~ $3.5M

Cost Saving
~ 40%

Solving Time
< 2 Minutes


THANK YOU
For a customer order:
Decide
then Ykj = 0 if CiDj = 0
then Ykj = 0
Objective:
Decision variable:
① warehouse: Xki i∈[h], k∈[l]
② Route assignment: Ykj, j∈[f]
Warehouse cost
Original port: Oj
Destination port: Dj
Carrier: Cj
Mode: Mj
Min weight: MINWj
Rate: Rj
min Cost: MINCj
get from "OrderList"