Logistics Optimization Model

Sets and Indices

- S: Set of suppliers, indexed by s
- W: Set of warehouses, indexed by w
- I: Set of items, indexed by i
- Q: Set of quantity IDs for each item i, indexed by q

Parameters

- d_{sw}: Travel distance from supplier s to warehouse w
- $inventory_{s,i}$: Available inventory of item i at supplier s
- $demand_{w,i}$: Required quantity of item i at warehouse w

Decision Variables

- $x_{swiq} \in \{0, 1\}$: Binary variable, equals 1 if item i with quantity ID q is shipped from supplier s to warehouse w

Objective Function

Minimize the total travel distance:

$$\text{Minimize} \quad \sum_{s \in S} \sum_{w \in W} \sum_{i \in I} \sum_{q \in Q} x_{swiq} \cdot d_{sw}$$

Constraints

1. Supply Constraints The total quantity of items shipped from a supplier cannot exceed its inventory:

$$\sum_{w \in W} \sum_{i \in I} \sum_{q \in Q} x_{swiq} \leq \sum_{i \in I} inventory_{s,i}, \quad \forall s \in S$$

2. Demand Constraints Each warehouse must receive the required quantity of each item:

$$\sum_{s \in S} \sum_{q \in Q} x_{swiq} = demand_{w,i}, \quad \forall w \in W, \forall i \in I$$

3. Assignment Constraint Each item with a specific quantity ID must be assigned exactly once:

$$\sum_{s \in S} \sum_{w \in W} x_{swiq} = 1, \quad \forall i \in I, \forall q \in Q$$