## Organic Food Supply-Chain Optimization

# Problem

# To decide the optimal transportation and preparation plan for organically grown apples, the produce company must determine the quantities of apples to be transported from the orchard to each preparation center and subsequently from each preparation center to the specialty stores. The goal is to minimize the total cost of transportation and preparation while ensuring that the demand at each specialty store is met and the capacities of the preparation centers are not exceeded.

# 2 Data

#### Transportation Costs, Preparation Costs, Monthly capacity (Orchard to Preparation Center)

**Table**

|  |  |
| --- | --- |
| **Preparation Center** | **Transportation Cost ($/pound). Preparation cost($/pound) Monthly capacity(pounds)** |
| 1 | $0.45 $0.15 300 |
| 2 | $1.00 $0.20 500 |
| 3 | $1.62 $0.18 800 |

#### Shipping Costs (Preparation Center to Specialty Stores)

**Table**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Preparation Center** | **Organic Orchard** | **Fresh & Local** | **Healthy Pantry** | **Season’s Harvest** |
| 1 | $0.80 | $1.10 | $0.70 | $1.40 |
| 2 | $1.20 | $1.10 | $0.50 | $1.40 |
| 3 | $0.20 | $1.40 | $1.30 | $1.70 |
| Monthly Demand(Pounds) | 300 | 500 | 400 | 200 |

# Objective

To decide the quantities of apples to be transported from the orchard to each preparation center and subsequently from each preparation center to the specialty stores and Minimize the total cost of transportation and preparation while meeting the demand at each specialty store.

# Decision Variables

Let,

Organic Orchard, Fresh & Local, Healthy Pantry, Season’s Harvest}

**Preparation\_cost Objective:**

**Transportation\_Cost Objective:**

The transportation cost from the orchard to the preparation centers can be formulated as follows:

**Shipping\_Cost Objective:**

The shipping cost from the preparation centers to the specialty stores can be formulated as follows:

**Total Cost Objective**

Combining the preparation cost, transportation cost, and shipping cost, the total cost objective can be formulated as:

# Constraints:

1 Supply constraints: The total amount transported from the orchard to each preparation center should not exceed the preparation center's capacity.

2 Demand constraints: The total amount transported to each specialty store should meet the store's demand.

3 Flow balance constraints: The amount of apples prepared at each center should equal the amount shipped from that center.

4 Non-negativity constraints: The decision variables should be non-negative.

# Algebraic Formulation

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Supply constraints =

Demand Constraints =

Flow balance constraints=

Non-negativity constraints=

# Implementation:

Please See the attached drive link which contains the Google Colab file, for the implementation and solution of the model using Python, AMPL, with the solution.

<https://colab.research.google.com/drive/1HTg4ulU4pW3Gu_MRxReCVb3jVGCYNs0R?usp=sharing>

# Result:

The optimal solution involves Center 1 delivering 200 pounds to Season's Harvest and 100 pounds to Fresh & Local. Center 2 will transport 400 pounds to Healthy Pantry and 100 pounds to Fresh & Local. Finally, Center 3 will supply 300 pounds to Organic Orchard and 300 pounds to Fresh & Local. This arrangement results in a total cost of $3,040.

# AI Training: (copilot)

<https://docs.google.com/document/d/1YoBLV0gyRAQiEPw8kZATGtnkkiGyL3jt/edit?usp=share_link&ouid=110383466093843515902&rtpof=true&sd=true>

<https://m365.cloud.microsoft/chat?fromcode=cmcv2&redirectid=CFE8C29922414ADB812679E0D2D13B53&auth=2>