VIRGINIA COMMONWEALTH UNIVERSITY

PRESCRIPTIVE ANALYSIS

ASSIGNMENT 3 PART B

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SUBMITTED TO-

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Problem

Brendamore Sports needs to plan its football and soccer ball production for the next six months to meet projected monthly demand. The company can manufacture up to 32,000 balls (football and soccer combined) per month and store a maximum of 20,000 balls at the end of each month. Currently, the company has an inventory of 7,000 footballs and 5,000 soccer balls, and by the end of the six-month period, it must maintain at least 3,000 of each in stock. The objective is to create a production and inventory strategy that minimizes both production and storage costs, while satisfying monthly demand and ensuring the required inventory levels at the end of the period.

Data

Category	Footballs	Soccer Balls	Total
Current Inventory (Month)	7,000	5,000	12,000
End-of-Period Inventory Goal	3,000	3,000	6,000
Production Capacity (per month)			32,000
Storage Capacity (per month-end)			20,000
Production Cost	Given in the excel file		
Holding Cost	Given in the excel file		
Demand Forecast	Given in the excel file		

LET

m = {1,2,3,4,5,6} a six-month period starting in January.

$P = \{$football, soccer_ball$\}$ be the set of products,

$demand_{im} = $ the demand for product i in each month, $i \in C$ and $m \in \{1, 2, 3, 4, 5, 6\}$

$prod_cost_{im} = $ the production cost of product i in each month, $i \in C$ and $m \in \{1, 2, 3, 4, 5, 6\}$

$hold_cost_{im} = $ the inventory holding cost of product i in each month, $i \in C$ and $m \in \{1, 2, 3, 4, 5, 6\}$

$initial\_inventory_i$
$ = $ the initial inventory of product i at the beginning of the planning period, $i \in C$,

   $ending_{inventory_{required_i}}$
   $ = $ tthe required ending inventory of product i at the end of the sixth month, for i $\in C,$

$prod\_capacity$
$=$ the total production capacity in balls per month, for both products combined
$inv\_capacity$
$=$ *the total inventory storage capacity in balls per month, for both products combined.*

Objective in Words
Decide the optimal number of footballs and soccer balls to produce and store each month in order to minimize the total production and inventory holding costs over a six-month period. This is subject to the following constraints:

- The demand for each product in each month must be met either through production during that month or from existing inventory.
- The total production in any given month must not exceed the maximum production capacity.
- The total inventory at the end of each month must not exceed the available storage capacity.
- The initial inventory levels are provided, and the desired inventory levels at the end of the six-month period must be met.

Decision Variables

Let:

x_{im} = the number of units of product i produced in month m, for $i \in C$ and $m \in M$.

$y_{im} =$ *the number of units of product i held in inventory at the end of month m, for i $\in C$ and $m \in M$.*

1 Algebraic Formulation

The total inventory at the end of each month cannot exceed the storage capacity

$$\min \sum_{i \in C, m \in M} (prod\_cost_{im} * x_{im} + hold\_cost_{im} * y_{im})$$

such that:

$$initial\ inventory_i * x_{i1} - demand_{i1} = y_{i1}, i \in C \text{ (first\_month\_demand\_constraint)}$$

$$y_{i(m-1)} + x_{im} - demand_{im} - y_{im}, i \in C, m \in M \text{ where } t > 1$$
(subsequent_month_demand_constraint)

$$\sum_{i \in C} x_{im} \leq prod_{capacity}, m \in M \text{ (production\_capacity\_constraint)}$$

$$\sum_{i \in C} y_{im} \leq inv\_capacity, m \in M \text{ (inventory\_capacity\_constraint)}$$

$$y_i \geq ending\_inventory\_required_i, i \in C \text{ (ending\_inventory\_constraint)}$$

$$x_{im} \geq 0, i \in C \text{ and } m \in M$$
$$y_{im} \geq 0, i \in C \text{ and } m \in M \text{ (non\_negativity\_constraint)}$$

Implementation

An implementation and solution of the model using Python, and AMPL is available below,

https://drive.google.com/drive/folders/1m0i0_41lFx4zxEi9T77vdlonMXy3-5IF

Results

The optimal solution for Brendamore Sports involves producing footballs and soccer balls as follows, with a total cost of $1,448,750.

Total cost is: 1448750.0

Production Plan (x):
x :=
Football 1   16000
Football 2   17000
Football 3   20000
Football 4   5000
Football 5   2500
Football 6   8000

Soccer 1   5000
Soccer 2   15000
Soccer 3   10000
Soccer 4   5000
Soccer 5   5000

Soccer 6   10500
;

Inventory Levels (h):
h :=
Football 1   8000
Football 2   0
Football 3   0
Football 4   0
Football 5   0
Football 6   3000

Soccer 1   0
Soccer 2   0
Soccer 3   0
Soccer 4   0
Soccer 5   0
Soccer 6   3000
;

AI TRAINING

Model - ChatGPT 4o

https://chatgpt.com/share/66fe156d-20d4-800e-a1d1-282f59307efe