Washing Machine Production Optimization

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Logistics

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Report on Washing Machine Production Optimization

Introduction

This report presents the results of a company that produces three types of washing machines (typeA, typeB, and typeC). The objective of the problem was to determine the optimal production plan to maximize the company's revenue, taking into account the cost of manufacturing, the profit from selling each type of machine, and the availability of iron (constraint).

Problem Overview

The company needs to produce washing machines under certain constraints:

- **Profit per Machine:**
  - typeA: 27 Euros
  - typeB: 21 Euros
  - typeC: 33 Euros
- **Manufacturing Cost per Machine:**
  - typeA: 11 Euros
  - typeB: 6 Euros
  - typeC: 5 Euros
- **Iron Required per Machine:**
  - typeA: 1 kg
  - typeB: 1 kg
  - typeC: 2 kg
- **Constraints:**
  - Iron availability: up to 4800 kg at 4 Euros/kg.
  - Number of typeA machines must be at least twice the number of typeB machines.
  - Number of typeA machines must not exceed the number of typeC machines.

Objective

The objective is to maximize the company's revenue, which is defined as the total profit from selling the washing machines minus the total cost of manufacturing and the cost of purchasing iron.

Formulation

Decision Variables

- x_A: Number of typeA washing machines to produce.
- x_B: Number of typeB washing machines to produce.
- x_C: Number of typeC washing machines to produce.

Objective Function

The total profit from selling the washing machines minus the total manufacturing cost and the cost of iron:

$$\text{Maximize} \quad (27x_A + 21x_B + 33x_C) - (11x_A + 6x_B + 5x_C + 4(x_A + x_B + 2x_C))$$

Constraints

- **Iron Availability:**
$$x_A + x_B + 2x_C \leq 4800$$
- **Quantity Production Constraints:**
  - The number of typeA machines must be at least twice the number of typeB machines:
$$x_A \geq 2x_B$$
  - The number of typeA machines must not exceed the number of typeC machines:
$$x_A \leq x_C$$
- **Non-Negativity Constraint:**
$$x_A, x_B, x_C \geq 0$$

Results

Original Problem (without Extra Budget)

- **Production Plan:**
  - TypeA: 1372 machines
  - TypeB: 684 machines
  - TypeC: 1372 machines
- **Revenue:**
  - Total Revenue: 51,428 Euros

Problem with Extra Budget (800 Euros for Additional Iron)

The extra budget allows the purchase of an additional 114.29 kg of iron, increasing the total iron availability to approximately 4914.29 kg.

$$x_A + x_B + 2x_C \leq 4800 + 114.29$$

- **New Production Plan:**
  - TypeA: 1404 machines
  - TypeB: 702 machines
  - TypeC: 1404 machines
- **Revenue:**
  - Total Revenue: 52,650 Euros

Analysis

Original Scenario

- The optimal production plan maximizes revenue while adhering to the constraints on iron availability and the required production ratios.
- The total revenue achieved is 51,428 Euros with the production of 1372 typeA machines, 684 typeB machines, and 1372 typeC machines.

With Extra Budget

- With the additional 800 Euros, the company is able to purchase more iron, slightly increasing the production capacity.
- The optimal production plan shifts to producing 1404 typeA machines, 702 typeB machines, and 1404 typeC machines.
- The total revenue achieved an extra budget revenue of 52,650 Euros, indicating a beneficial impact from the additional iron purchase..

Conclusion

The provided solution effectively balances the manufacturing constraints and profit objectives, showing a clear path to improved financial performance through careful resource management.

Figures

Original Problem Results

```
Gurobi 11.0.1: optimal solution; objective 51428
4 simplex iterations
1 branching node
quantity [*] :=
type_A  1372
type_B   684
type_C  1372

Sales = 51428
```

Problem with Extra Budget Results

```
Gurobi 11.0.1: optimal solution; objective 52650
3 simplex iterations
1 branching node
quantity [*] :=
type_A  1404
type_B   702
type_C  1404
;

Sales = 52650
```