**Module Five Project**

**Using Linear Programming Models To Maximize Profits**

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1. **Overview:**

This report presents the analysis using a linear programming model designed to optimize the monthly profitability of a northern hardware company seeking to establish a new distribution center in the northeastern region. The company's plan involves leasing a warehouse space accompanied by an adjacent office facility to distribute four core products (pressure washers, lawn mowers, snow blowers, and water pumps). The primary objective of this analysis is to identify the ideal inventory levels for these products, taking into account various constraints such as the available budget, storage capacity, and marketing requirements.

1. **Analysis & Findings:**

Based on the given data, the mathematical formulation of the problem is as follows:

**Decision Variables:** Let P, L, S, and W represent the number of pressure washers, lawn mowers, snow blowers, and water pumps, respectively.

**Objective Function:**

|  |
| --- |
| Maximum Net Profit = Selling Price - Buying Price |

Therefore,

(569.99 \* P) + (679.99 \* L) + (909.99 \* S) + (259.99 \* W)

**-** (349.99 \* P) - (379.99 \* L) - (529.99 \* S) - (125.00 \* W)

**Constraints:**

**1.** **Budget Constraint:** (349.99 \* P) + (379.99 \* L) + (529.99 \* S) + (125.00 \* W) ≤ 130,000

* This constraint remains the same, ensuring that the total purchasing cost for the four products does not exceed the company's monthly purchasing budget of $130,000.

**2.** **Storage Constraint:** (25.00 \* P) + (40.00 \* L) + (25.00 \* S) + (5.00 \* W) ≤ 10,500

* This constraint has been updated to reflect the correct storage space requirement for water pumps.
* According to the problem description, "*a 5 ft by 5 ft pallet is used to store five cases of water pumps.*" Therefore, the storage space required for each case of water pumps (W) is 5 square feet.
* The left-hand side of the inequality represents the total storage space required, calculated by multiplying the number of units for each product (P, L, S, W) by their respective storage space requirements.
* The right-hand side of the inequality is the total available storage space of 10,500 square feet.

**3**. **Inventory Constraint:** (P + L) ≥ 0.35 \* (P + L + S + W)

* This constraint remains the same, ensuring that at least 35% of the total inventory (by item numbers) is allocated to pressure washers and lawn mowers, as per the company's marketing department's requirement.

**4.** **Sales Constraint:** S ≥ 1.5 \* W

* This constraint remains the same, ensuring that the number of snow blowers (S) is at least 1.5 times the number of water pumps (W), as per the company's marketing department's requirement.

The linear programming formulation was set up in an Excel workbook, and the Solver tool was used to obtain the optimal solution.

The sensitivity report generated by the Solver provides insights into the impact of changing specific parameters on the optimal solution.

The optimal solution obtained from the analysis is as follows:

* Pressure Washers (P) = 0
* Lawn Mowers (L) = 200.24
* Snow Blowers (S) = 87.90
* Water Pumps (W) = 58.60

|  |
| --- |
| This solution yields a **maximum monthly profit of $101,384.14** |

**Excel Solver O/P:**

|  |  |  |
| --- | --- | --- |
| **Objective Parameters** |  |  |
|  | **Solver (Optimal Solutions)** | **SP - BP (Data)** |
| P | 0 | $220.00 |
| L | 200.24 | $300.00 |
| S | 87.9 | $380.00 |
| W | 58.6 | $134.99 |
| **Maximum Monthly Profit** | **Profit = (220\*P) + (300\*L) + (380\*S) + (134.99\*W)** |  |
| **$101,384.14** |  |

**Final Analysis based on the sensitivity report:**

**V)** The decision variable P (Pressure Washers) has an optimal value of 0. Got from the sensitivity report, the selling price of P can be reduced by $51.67 (an allowable increase) so that the optimal zero values change to non-zero values.

**VI)** The sensitivity report shows the budget constraint has an allowable increase of $26,008.87 and a shadow price of $0.75. This shadow price means that for each additional $1 invested in the budget, the company can expect an $0.75 increase in profit. Therefore, if the company invests the additional allowable amount of $26,008.87, the expected increase in monthly profit is $26,008.87 \* $0.75 = $19,507 (rounded to the nearest dollar).

**VII)** The allowable storage increase is 3,184.57 sqft. Increasing warehouse size by this amount, to 13,684.57 sqft total, would increase monthly profit by $3,184 ($1 per extra sqft). I recommend renting a large 13,684.57 sqft warehouse.

1. **Conclusion:**

To summarize, I am concluding the report of the analysis with an optimal inventory mix of 200 lawn mowers, 88 snow blowers, and 59 water pumps, generating a maximum monthly profit of $101,384. I am also recommending increasing the budget by $26,009 for around $19,500 more in profits and renting a larger 13,685 sqft. warehouse for an additional $3,184 in monthly profits.

1. **Citation(s):**

* Linear Algebraic Modeling of LP Problems: *ALY-6050, Module 5, Lab Video.*