Module 5 Project: Using Linear Programming Models to maximize profits.

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**Introduction**

This report is about a hardware company from the north that is discussing setting up a new distribution facility in the southeast. Pressure washers, snowblowers, generators, and water pumps are among the major items that the business intends to supply to regional dealers. The firm is concerned with the amount of space in the warehouse, which has 45 shelves, and has set aside a monthly budget of $150,000 for purchases. Also, the marketing division has agreed to sell at least 1.3 times as many generators as water pumps and assign pressure washers and snowblowers to at least 55% of the company's entire inventory (measured by item numbers). A linear programming model will be employed to examine the ideal buying and selling methods to increase the company's net profit.

**Analysis**

As the company has started to initially start with 4 main products : Pressure washers,

Snow blowers, Generators, and Water pumps. To maximize the profit in the southeast we need to evaluate the number of units to maintain in the inventory for each product. For which we will be allocating the four product’s unit as the decision variable. Therefore, Pressure washers = X1, Snow blowers = X2, Generators = X3, and Water pumps = X4. Next, we know the cost price and selling price for each product. Using this we calculate the profit each product would make. Now, to maximize profit we will primarily set an objective function.

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| **Constraint Equations** | |
| **Month Budget** | 690X1 + 575X2 + 570X3 + 760X4 <= 150,000 |
| **Space in Storage** | 30(x1)+25(x2)+30(x3)+5(x4) <= 6750 |
| **55% of the inventory to Washer and snow blower** | x1+x2>= 0.55\*(x1+x2+x3+x4) |
| **Generators 1.3 times as many as water pumps** | x3 >= 1.3\*x4 |
| **non-negative** | x1,x2,x3,x4 >= 0 |

The company has stated that to maximize profit the total budget for the first month should not exceed $150,000. Along with this, we have other constraints, that is the space allocation in the warehouse, for promotion company has decided to keep 55% of the total inventory as pressure washers and snow blowers and sell generators at least 1.3 times as water pumps. These constraints can be written in the equation form given below.

A non-negative constraint is also applied as inventory cannot be negative. After performing the monthly analysis using a linear programming model in Excel Solver to maximize the company's net profit. We obtain the following outputs given below.

The sensitivity report for the above linear programming analysis is provided below.

The allowable increase in the price of the Pressure Washer unit that can be made while still preserving the current ideal solution can be calculated using the sensitivity report. The Variable Cells part of the report's Variable Cells section contains the Allowable Decrease value for cell $C$3 (Pressure Washer Unit).

Hence, $799.99 - $10.02693243 = $789.9630676 is the lowest selling price for the Pressure Washer unit that would cause the optimal solution to move from zero to a non-zero number.

Based on our sensitivity report, the company has utilized $148,221.07 out of the $150,000 budget. This states that the company still has $1,778.92 remaining in the budget to maximize the budget. But we can see that the shadow price for the total budget is hence, there is no need to allocate anymore budget. Furthermore, the "Total Req. Space (Sq.Ft)" constraint has a shadow price of 5.0054, which suggests that if the corporation raises the size of its warehouse by one square foot, it can improve its profit by $5.0054. But if the company decides to expand the warehouse the company just has $1,778.92 remaining in the current budget. Keeping this constraint in mind the company, the existing warehouse size of 6750 square feet is the optimal size, and expanding the warehouse would result in a net loss.

**Conclusion**

To maximize net profit, the company should retain 0 units of Pressure Washers, 166 units of Snow Blowers, 76.79 units of Generators, and 59.07 units of Water Pumps in stock. A net profit of $33,786.36 will arise from this. Based on the report we can say that for an increase in 1 sq.ft. of the warehouse the company would see a profit of $5 but the remaining budget constraint doesn’t allow the company to expand the warehouse. Hence, it is suggested that the company should continue to operate in the existing warehouse of 6750 sq.ft to maximize a profit of $33,786.36.

**Reference**

1. *Module 5 Lab 1 Linear Algebraic Modeling of LP Problems* <https://northeastern.instructure.com/courses/131431/pages/module-5-lab-1-linear-algebraic-modeling-of-lp-problems?module_item_id=8233809>
2. *Lesson 5-3 — Instructor's Perspective* <https://northeastern.instructure.com/courses/131431/pages/lesson-5-3-instructors-perspective?module_item_id=8233814>