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Linear Programing Models

Solving Optimization

Introduction

Working with a hardware company opening a new distribution center, we are consulting to help maximize the companies profit while staying within their constraints of budget, space and their marketing departments set specification for demand of products needed. Using these constraints, we will use the excel solver to determine how many of each product to sell and make further recommendations on pricing, space needed and additional budget recommendations.

Analysis

**Part 1**

To begin, we first determine the mathematical model to calculate a maximized profit.

Maximized Profit = 169.99x1 + 359.99x2 + 289.99x3 + 142.99x4.

Each X represents a product type and the multiplier is the profit for each of the product types. In this model we need to determine how much of each project to order for the warehouse each month and multiply that by the profit for each product.

**Part 2**

As with any real-life model, there are constraints which need to be calculated for. The first is the budget being $170,000 monthly. Given the purchase price of each item, we can calculate a constraint equation:

330x1 + 370x2 + 410x3 + 127x4 ≤ $170,000

with each x again representing the number of each of the types of products multiplied by the purchase price of each item.

Next, we formulate the space constraint equation with each multiplier representing the space needed for each of those products.

25x1 + 40x2 + 25x3 + 1.25x4 ≤ 12300

Following that we calculate two additional constraints based off the marketing departments recommendations of the number of products to hold.

.7x1 + .7x2 -.3x3 -.3x4 ≥ 0

X3 ≥ 2\*x4 --> 2x4 - x3 ≤0

These two constrains are to model the need to allocate at least 30% of its inventory to pressure washers and Go-karts and sell twice as many generators as water pumps.

**Part 3**

Once we have determined all our constraints along with out maximization formula, we can ask Excel solver to come to a solution for us.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | x1 | x2 | x3 | x4 | P= 169.99x1 + 359.99x2 + 289.99x3 + 142.995x4 |
| Number of products | 0 | 155 | 238 | 119 | 141813.93 |
| Profit | 169.99 | 359.99 | 289.99 | 142.99 |  |

**Part 4**

As we can see, the maximized profit given our constraints is $141,813.93 monthly. The excel solver took all our constraints into account. It is recommended to keep an inventory or 155 Go-karts, 238 Generators and 119 water pumps. One thing to notice is the x1 product, Pressure Washers, has a recommendation of zero.

**Part 5**

We can take a closer look at the issue by looking into the sensitivity report generated with the solver solution.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Variable Cells | | |  |  |  |  |  |
|  |  |  | **Final** | **Reduced** | **Objective** | **Allowable** | **Allowable** |
|  | **Cell** | **Name** | **Value** | **Cost** | **Coefficient** | **Increase** | **Decrease** |
|  | $I$2 | Number of products x1 | 0 | -109.653921 | 169.99 | 109.653921 | 1E+30 |
|  | $J$2 | Number of products x2 | 155.179067 | 0 | 359.99 | 204.2792683 | 77.52020063 |
|  | $K$2 | Number of products x3 | 237.7692613 | 0 | 289.99 | 99.20490541 | 130.8664063 |
|  | $L$2 | Number of products x4 | 118.8846306 | 0 | 142.99 | 198.4098108 | 89.76546154 |
|  |  |  |  |  |  |  |  |
| Constraints | | |  |  |  |  |  |
|  |  |  | **Final** | **Shadow** | **Constraint** | **Allowable** | **Allowable** |
|  | **Cell** | **Name** | **Value** | **Price** | **R.H. Side** | **Increase** | **Decrease** |
|  | $M$10 | Requirement 2 LHS | -2.84217E-14 | 33.9274772 | 0 | 974.1201949 | 27.91666667 |
|  | $M$11 | Space LHS | 12300 | 3.880620061 | 12300 | 6078.378378 | 30.94688222 |
|  | $M$8 | Purchase budget LHS | 170000 | 0.553419453 | 170000 | 428.8 | 56225 |
|  | $M$9 | Requirement 1 LHS | 1.629179331 | 0 | 0 | 1.629179331 | 1E+30 |

This report gives us a lot of information, but initially we are looking into just the product x1 on top. The sensitivity report tells us that the pressure washers are not profitable in comparison to the other products and we would need to increase our profit by $109.65 for this product for it to compare to the other products being sold and to turn that value from a non-zero amount. This means the new selling price for the pressure washers would have to be set at $609.99 to maximize the profit of the warehouse.

**Part 6**

The sensitivity report also determines if any additional increase in space or budget could continue to maximize our profit. We can start by looking at the purchase budget. The report tells us that we could increase the budget by up to $428 and still bring in an additional $.55 to each of those additional dollars spent.

**Part 7**

The report also suggests that an increase of around 6080 square feet could bring in an additional $3.88 per square foot as well. Considering these two suggestions, I would advise to find a larger warehouse space up to 18500 square feet which could bring our total profit up another $23,590 per month. The additional purchase budget does not have as much of a return on investments so I would not recommend increasing the budget at all.

Conclusion

The excel solver works effortlessly to determine optimization problems which are used throughout retail enterprises and beyond. For larger problems with more constraints the models could take some time to complete, but overall a great solution to any optimization business problem.