**Maximizing Profit**

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**Introduction**

In this assignment, the linear programming is performed to solve a business question. The items, their cost and the selling prices are given for the Northern hardware company. By using this data, the budget, the space allocation information and other constraints the optimal maximum profit will be determined along with the quantity of items.

**Analysis**

The items, their cost price and the selling price was provided by the Northern hardware company.

The quantity and prices have been arranged appropriately and the profit from each item is calculated.

***Table-1***

|  |  |  |  |
| --- | --- | --- | --- |
| **x** | **Cost Price** | **Selling Price** | **Profit** |
| **Pressure washers** | 330 | 499.99 | 169.99 |
| **Go-Kart** | 370 | 729.99 | 359.99 |
| **Generator** | 410 | 700.99 | 290.99 |
| **Water Pump** | 127 | 269.99 | 142.99 |

The company has set aside a purchasing monthly budget of $170,000 for the new location.

So, we consider the decision variables for the analysis as the quantity of each item.

***Table-2***

|  |
| --- |
| **Decision Variables** |
| X1= Number of Units of Pressure washer |
| X2 = Number of Units of Go-Kart |
| X3 = Number of Units of Generator |
| X4 = Number of Units of Water Pump |

Warehouse has the 82 shelves, and each shelf is 5ft wide and 30ft long and so on. So based on this information. We have created the objective function.

***Table-3***

|  |
| --- |
| **Objective Function** |
| Objective Z = 169.99 X1 + 359.99 X2 + 290.99 X3 + 142.99 X4 |

***Table-4***

|  |
| --- |
| **Constraints** |
| 330 X1 + 370 X2 + 410 X3 + 127 X4  ≤ 170000 |
| (X1\*25) + (X2\*40) + (X3\* 25) + (X4\*1.25) ≤ 12300 |
| 0.7 X1 + 0.7 X2 - 0.3 X3 - 0.3 X4 ≥ 0 |
| X3 - 2 X4 ≥ 0 |
| X1 + X2 + X3 + X4 ≥ 0 |

Now, we have used the Excel solver to perform the Linear programming model using the above formulas and got the optimal values for items with the Maximum profit.

***Table-5***

|  |  |  |
| --- | --- | --- |
| ***LP Optimal Solution:*** |  | **Slack** |
| ***Optimal Monthly Profit:*** | ***$ 1,42,050.70*** |  |
| **Pressure Washers X1** | **0** | **0** |
| **Go-Karts X2** | **155.2** | **0** |
| **Generators X3** | **237.8** | **1.63** |
| **Water Pumps X4** | **118.9** | **0** |

And the generated Sensitivity report.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Variable Cells | | |  |  |  |  |  |
|  |  |  | **Final** | **Reduced** | **Objective** | **Allowable** | **Allowable** |
|  | **Cell** | **Name** | **Value** | **Cost** | **Coefficient** | **Increase** | **Decrease** |
|  | $D$2 | PART I Pressure Washers X1 | 0 | -110.0715237 | 169.99 | 110.0715237 | 1E+30 |
|  | $E$2 | PART I Go-Karts X2 | 155.179067 | 0 | 359.99 | 205.8402439 | 76.73878564 |
|  | $F$2 | PART I Generators X3 | 237.7692613 | 0 | 290.99 | 98.20490541 | 131.8664063 |
|  | $G$2 | PART I Water Pumps X4 | 118.8846306 | 0 | 142.99 | 196.4098108 | 89.11965734 |
|  |  |  |  |  |  |  |  |
| Constraints | | |  |  |  |  |  |
|  |  |  | **Final** | **Shadow** | **Constraint** | **Allowable** | **Allowable** |
|  | **Cell** | **Name** | **Value** | **Price** | **R.H. Side** | **Increase** | **Decrease** |
|  | $H$10 | Requirement 1 LHS | 1.629179331 | 0 | 0 | 1.629179331 | 1E+30 |
|  | $H$11 | Requirement 2 LHS | 0 | -33.68339104 | 0 | 27.91666667 | 974.1201949 |
|  | $H$8 | Cost/Budget LHS | 170000 | 0.557648341 | 170000 | 428.8 | 56225 |
|  | $H$9 | Warehouse Space LHS | 12300 | 3.841502841 | 12300 | 6078.378378 | 30.94688222 |

PART 5: Keeping the other per unit profit fixed, as long as the profit is between -1E+30 and 280.06 the optimal decision solution does not change. So, if the Profit is 280.07, the selling price will be 280.07 + 330 = $610.07

PART 6: According to the sensitivity report, the shadow price for the space constraint is $0.56 and the allowable increase is $ 428.8. This means that each additional $ (in excess of 170,000 and up to 428.8) will contribute $0.56 to the optimal profit. Thus the company should add an additional $ 428.8 to its available budget. Consequently, the total profit will increase by (428.8)(0.56)= $240.13.

This means that an ideal budget should be of $ 170,428.80. This budget will contribute an additional $240.13 to the monthly profit.

PART 7: According to the sensitivity report, the shadow price for the space constraint is $3.84 and the allowable increase is 6078.4 ft2. This means that each additional square-foot (in excess of 12,300 and up to 6078.4) will contribute $3.84 to the optimal profit. Thus the company should add an additional 6078.4 ft2 to its available space. Consequently, the total profit will increase by (6078.4)(3.84)= $23,350.11.

This means that an ideal warehouse should be of size 18,278.40 ft2. This size warehouse will contribute an additional $23,350.11 to the monthly profit.

**Conclusion**

The linear programming for the northern hardware company is done. From the analysis the optimal values for the decision variables have been found. Using those decision variables, the equations have been formulated and the Maximum profit of **$ 1,42,050.70**has been found. By analyzing the sensitivity table generated from the excel solver, some business questions have been answered successfully.