**Linear Programming Models**

**Overview and Rationale**

This assignment is designed to provide the students with hands-on experiences utilizing the Excel Solver to optimize profits or costs via linear programming models in real-life applications. You are provided with a business scenario and you are asked to create a model to optimize profits and costs.

**Course Outcomes**

This assignment is directly linked to the following key learning outcomes from the course syllabus:

* Use descriptive, Heuristic and prescriptive analysis to drive business strategies and actions
* Incorporate general industry practices in end-to-end analytics development cycles, including data management, data engineering, analytics modeling, optimization, and strategic development

**Assignment Summary**

**A Profit and Cost Model**

A northern hardware company is studying a plan to open a new distribution center in southeast. The company plans to rent a warehouse and an adjacent office, and distribute its main products to the local dealers. The company has decided to initially start with four of its main products: Pressure washers, Go karts, Generators, and Water pumps. The table below describes how much each of the products will cost the company (including transportation costs):

|  |  |
| --- | --- |
| **Item** | **Cost (in Dollars)** |
| Pressure Washer | 330 |
| Go-kart | 370 |
| Generator | 410 |
| Case of 5 Water Pumps | 635 |

The company has set aside a purchasing monthly budget of $170,000 for the new location. The selling prices (per unit) for each item are given in the table below:

|  |  |
| --- | --- |
| **Item** | **Cost (in Dollars)** |
| Pressure Washer | 499.99 |
| Go-kart | 729.99 |
| Generator | 699.99 |
| Case of 5 Water Pumps | 269.99 |

Other than the budget, another of the company’s concern is the available space in the warehouse. The warehouse has 82 shelves and each shelf is 30 ft long and 5 ft wide. Pressure washers and generators each are stored on 5 ft by 5 ft pallets whereas each Go Kart is stored on an 8 ft by 5 ft pallet. Furthermore, a 5 ft by 5 ft pallet is used to store four cases of water pumps

For promoting its brand products, the company’s marketing department has decided to allocate at least 30% of its inventory to pressure washers and Go Karts, and sell at least twice as many generators as water pumps.

As a consultant, your task is perform a monthly analysis using a linear programming model to maximize the company's net profit. As a guide, consider the following:

1. In a Word document, write the mathematical formulation of the problem.
2. Set up the linear programming formulation in an Excel workbook.
3. Use the Excel Solver to solve the problem, and generate a Solver sensitivity report.
4. Describe the optimal solutions obtained in the Word document. These will consist of the inventory level for all four products and the optimal monthly profit.
5. One of the decision variables has an optimal value of zero. Use the Solver sensitivity report to determine the smallest selling price for that item so that this optimal zero solution value changes to a non-zero value.
6. In the word document explain whether, in addition to the $170,000 allocated to the purchasing budget during the first month, the company should allocate additional money. If yes, calculate the amount of additional investment do you recommend, and how much should the company expect its net monthly profit to increase as a consequence of this increase?
7. In the word document, explain whether you recommend that the company should rent a smaller or a larger warehouse. In any case, indicate the ideal size of your recommended warehouse in square feet, and indicate how much this change in the size of the warehouse will contribute to the monthly profit.

**Format & Guidelines**

Submissions should consist of an Excel workbook and a Word document. The report should follow the following format:

1. Introduction
2. Analysis
3. Conclusion

And be 1000 - 1200 words in length, not including the title page, and presented in the APA format.

**Rubric**

| **Category** | **Exceeds Standard** | **Meets Standards** | **Approaching Standards** | **Below Standards** |
| --- | --- | --- | --- | --- |
| **Excel (or R): Problem Modeling & Set-up**  ALY6050-CO1 | Completely and concisely modeled the problem in Excel (or R) for each method | Accurately modeled the problem in Excel (or R) for each method | Correctly modeled the problem in Excel (or R) for each method, but the model lacks detailed insight into the problem or the set-up is awkward. | Modeled the problem in Excel (or R) for each method, but there are some gaps in the problem modeling and setup |
| **Excel (or R): Problem Solution & Accuracy**  ALY6050-CO4 | Efficiently obtained correct and accurate solutions in Excel (or R) by using the appropriate analytic tools of the software | Obtained complete and accurate solutions in Excel (or R) by using the appropriate analytic tools of the software | Obtained correct solutions in Excel (or R) using the appropriate analytic tools of the software, but the application of the tool is awkward. | Obtained a solutions in Excel (or R) by using the appropriate analytic tools of the software, but the solution is not complete. |
| **Word/Report: Problem Description & Introduction**  ALY6050-CO4 | Provides a thorough and concise summary of the problem descriptions and introduced the problem using rich and significant ideas | Provides an accurate and succinct summary of the problem descriptions and problem introduction | Provides an accurate summary of the problem descriptions and problem introduction, but the description is too wordy or not succinct | Provided a summary of the problem descriptions and problem introduction, but it is inaccurate or incomplete |
| **Word/Report: Description of Problem Analysis**  ALY6050-CO4 | Provides a thorough and precise description of the analytic concepts and theories used in analyzing the problem | Accurately describes the analytic concepts and theories used in analyzing the problem | Describes the analytic concepts and theories used in analyzing the problem, but description lacks appropriate detail or precision | Describes the analytical concepts and theories used in analyzing the problem, but descriptions are incorrect or the analytical concepts and theories are incorrect |
| **Word/Report: Description of Conclusions**  ALY6050-CO4 | Provides conclusions and results obtained in the project using a high level of critical thinking and reasoning | Provides relevant conclusions and results obtained in the project that reflect critical thinking and reasoning | Provides conclusions and results obtained in the project, but not all conclusions or results are relevant to the problem or not all conclusions reflect good reasoning | Provides conclusions and results obtained in the project, but they are irrelevant and reflect a lack of critical thinking |
| **Word/Report: Writing Mechanics, Title Page, & References** | Completely free of errors in grammar, spelling, and punctuation; and completely correct usage of title page, citations, and references. The report contains a minimum of 1000 words | There are no noticeable errors in grammar, spelling, and punctuation; and completely correct usage of title page, citations, and references. The report contains a minimum of 1000 words | There are very few errors in grammar, spelling, and punctuation; and completely correct usage of title page, citations, and references. The report contains a minimum of 1000 words | There are more than five errors in grammar, spelling, and punctuation; or the usage of title page, citations, and references are incomplete; or the report contains less than 1000 words |