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CB9088 Business Analytics

**Assessment 2: Individual Project**

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| Instructions  This assessment consists of two independent problems (see below). For each problem, you need to:   1. Develop a spreadsheet model 2. Describe your results in a concise writeup   For each problem, your report should contain a short description of the model solutions, answers to specific questions and your interpretations of the results. The main text of the report should not exceed three pages total of A4 (11 point, 1.5 spacing, approximately 1.5 pages per problem). However, it may well be useful to include appendices with tables, graphs, etc. These must be explained in the main text. The report should be clearly structured, communicate the outcomes of your analysis in an effective way, and avoid any technical jargon.  You will need to submit an electronic copy of the report along with your Excel file on Moodle by 12:00 (noon) on Wednesday 6 March 2024. Please, only submit one Excel model file and one .docx or .pdf report file with the answers to both questions. Note that there are two separate links for submitting the assessment: one for the Excel file and another for the report.  N.B. Although you must answer all of the questions posed, you may extend your analysis as you think best. Initiative will be rewarded. |

**Problem 1 – A Shipping Problem [50 marks]**

Shafer Office Supplies has four distribution centers, located in Atlanta, Lexington, Milwaukee, and Salt Lake City, and ships to 12 retail stores, located in Seattle, San Francisco, Las Vegas, Tucson, Denver, Charlotte, Minneapolis, Fayetteville, Birmingham, Orlando, Cleveland, and Philadelphia. The company wants to minimize the transportation cost of shipping one of its higher-volume produces, boxes of standard copy paper. The per-unit shipping cost from each distribution centre to each retail location and the amounts currently in inventory and ordered at each retail location are shown in the tables below.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Seattle | San Francisco | Las Vegas | Tucson | Denver | Charlotte | Minneapolis |
| Atlanta | $2.15 | $2.10 | $1.75 | $1.50 | $1.20 | $0.65 | $0.90 |
| Lexington | $1.95 | $2.00 | $1.70 | $1.53 | $1.10 | $0.55 | $0.60 |
| Milwaukee | $1.70 | $1.85 | $1.50 | $1.41 | $0.95 | $0.40 | $0.40 |
| Salt Lake | $0.60 | $0.55 | $0.35 | $0.60 | $0.40 | $0.95 | $1.00 |
| Demand | 5,000 | 16,000 | 4,200 | 3,700 | 4,500 | 7,500 | 3,000 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Fayetteville | Birmingham | Orlando | Cleveland | Philadelphia | Supply |
| Atlanta | $0.80 | $0.35 | $0.15 | $0.60 | $0.50 | 40,000 |
| Lexington | $1.05 | $0.60 | $0.50 | $0.25 | $0.30 | 35,000 |
| Milwaukee | $0.95 | $0.70 | $0.70 | $0.35 | $0.40 | 15,000 |
| Salt Lake | $1.10 | $1.35 | $1.60 | $1.60 | $1.70 | 16,000 |
| Demand | 5,000 | 16,000 | 4,200 | 3,700 | 4,500 |  |

Develop and solve an optimization model to minimize the total transportation cost and answer the following questions. Use the sensitivity report to answer parts c and d.

1. What is the minimum cost of shipping? [10]
2. What does the solution look like? Which distribution centres would operate at full capacity? Where are units of supply of copy paper at distribution centers being shipped to to fulfil demand at retail stores? [5]
3. Suppose that 500 units of extra supply are available (and that the cost of this extra capacity is a sunk cost). To which distribution center(s) should this extra supply be allocated and why? [10]
4. Suppose that the cost of shipping from Atlanta to Birmingham increased to $0.45 per unit. What would happened to the optimal solution? [10]
5. Rather than just minimize shipping cost, the company would also like to know how the optimal allocation of supply to demand would change if the objective were to minimize greenhouse gas emissions from shipping. Using the per-unit emissions in the tables below measured in kilograms of carbon dioxide equivalent (aka kg C02e), develop a revised allocation plan under this alternative objective. [5]

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Seattle | San Francisco | Las Vegas | Tucson | Denver | Charlotte | Minneapolis |
| Atlanta | 0.308 | 0.293 | 0.233 | 0.203 | 0.164 | 0.103 | 0.130 |
| Lexington | 0.285 | 0.279 | 0.225 | 0.209 | 0.138 | 0.169 | 0.332 |
| Milwaukee | 0.230 | 0.253 | 0.209 | 0.206 | 0.122 | 0.359 | 0.143 |
| Salt Lake | 0.350 | 0.311 | 0.178 | 0.327 | 0.222 | 0.238 | 0.144 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Fayetteville | Birmingham | Orlando | Cleveland | Philadelphia |
| Atlanta | 0.316 | 0.062 | 0.185 | 0.300 | 0.329 |
| Lexington | 0.296 | 0.171 | 0.347 | 0.140 | 0.268 |
| Milwaukee | 0.311 | 0.320 | 0.146 | 0.184 | 0.359 |
| Salt Lake | 0.153 | 0.207 | 0.270 | 0.204 | 0.250 |

1. Compare the cost and greenhouse gas emissions for the solutions produced in parts a) and e). What is your recommendation for shipping copy paper from distribution centers to retail stores? [10]

**Problem 2 – Drug Development [50 marks]**

A pharmaceutical company is developing a new vaccine to protect against Variant Creutzfeldt–Jakob disease (vCJD), the humane form of mad cow disease. Preliminary trials have gone well and now it is considering what to do next. There are three options available.

One option is to immediately commence human trials at a cost of £20 million and then seek regulatory approval to begin commercial sale of the vaccine assuming the trials are successful. It is estimated that there is a 10% chance that human trials will be a success. Should that be the case, an additional £10 million would be required to seek regulatory approval, with a 90% chance of approval being given. The present value of profits over the next 5-years would be £250 million if the vaccine is approved.

Another option is to invest £2 million in additional animal testing before deciding on whether or not to do human trials. Additional testing would help to confirm how effective the potential vaccine may be. Given a positive result from the animal testing, the chances of the human trials also being successful would rise to 20%. On the other hand, if animal testing shows a negative result then human trials would probably only stand a 5% chance of success. The chances that animal testing will prove successful are 1 in 4. If human trials are successful in either case, the company would still need to seek regulatory approval with the same cost and likelihood of success as above.

The last option available to the company is terminate the vaccine development program immediately at no additional cost.

To help structure your analysis, please answer the following. Marks for each question are shown in brackets.

1. Either use TreePlan or manually build your own decision tree in Excel to represent the pharmaceutical company’s decision problem. [15]
2. Solve the decision tree and determine the expected value of the preferred alternative. [5]
3. What are the pros and cons of your recommendation? In particular, how risky is it go with animal testing versus going straight to human trials? [10]
4. Perform a sensitivity analysis on the probability that animal testing will prove successful to examine the robustness of your recommendation to possible changes in this probability. How does the preferred decision and expected value change depending on the value of this probability? [10]
5. A rival pharmaceutical company is prepared to pay half of all costs associated with either commencing human trials immediate or carrying out additional animal testing first in return for half of all revenues. Under these circumstances what would you recommend the company do and why? [5]