Northeastern University
ALY 6050

ALY 6050 Module 2 Project

Project: Benefit-Cost Analysis of Construction Projects

The submission of this project will consist of two attachments:

1. A Word document that is prepared according to the APA standards of formatting. Explain the experiments and their respective conclusions, and additional information as indicated in each problem. Save your word document as: **LastName_Project2.docx**
2. Submit an Excel workbook (.xlsx) or an R script file (.R) that contains **all** of the work and the calculations required of parts 1 – 3. If using Excel, all work should be completed in the Excel workbook provided. Furthermore, they should be completed in the designated cells as instructed in the workbook. Please save your Excel workbook or R script file in the following format: **LastName_Project2.xlsx or (.R)**

Problem:

Corporations must select among many projects that are under consideration by the management. Their primary instrument for evaluating and selecting among the available projects is the *benefit-cost analysis*. In this analysis, both the annual benefits and the annual costs deriving from a project are estimated in several different categories. Then the total benefit is divided by the total cost to produce a benefit-cost ratio. This ratio is then used by corporations to compare numerous projects under consideration. A benefit-cost ratio greater than 1.0 indicates that the benefits are greater than the costs, and the higher a project's benefit-cost ratio, the more likely it is to be selected over projects with lower ratios.

Currently, the JET Corporation is evaluating two dam project constructions, one in southwest Georgia (Dam #1) and the other in North Carolina (Dam #2). The company has identified six areas of benefits: improved navigation, hydroelectric power, fish and wildlife, recreation, flood control, and the commercial development of the area. Furthermore, there are three estimates available for each type benefit – a minimum possible value, a most likely value (i.e., a mode or peak), and a maximum possible value. For the costs, two categories associated with a construction project of this type have been identified: the total capital cost, annualized over 30 years (at a rate specified by the creditors and the government), and the annual operations and maintenance costs. These benefits and costs estimations for both dam projects (in millions of dollars) are as follows:

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Dam #1: Benefits & Costs

	Estimate		
Benefit	***Minimum***	***Mode***	***Maximum***
Improved navigation **B1**	1.1	2	2.8
Hydroelectric power **B2**	8	12	14.9
Fish and wildlife **B3**	1.4	1.4	2.2
Recreation **B4**	6.5	9.8	14.6
Flood control **B5**	1.7	2.4	3.6
Commercial development **B6**	0	1.6	2.4

Cost	***Minimum***	***Mode***	***Maximum***
Annualized capital cost **C1**	13.2	14.2	19.1
Operations & Maintenance **C2**	3.5	4.9	7.4

Dam # 2: Benefits & Costs

	Estimate		
Benefit	***Minimum***	***Mode***	***Maximum***
Improved navigation **B1**	2.1	3	4.8
Hydroelectric power **B2**	8.7	12.2	13.6
Fish and wildlife **B3**	2.3	3	3
Recreation **B4**	5.9	8.7	15
Flood control **B5**	0	3.4	3.4
Commercial development **B6**	0	1.2	1.8

Cost	***Minimum***	***Mode***	***Maximum***
Annualized capital cost **C1**	12.8	15.8	20.1
Operations & Maintenance **C2**	3.8	5.7	8

Table 1 Benefits and costs for the Dam construction projects in millions of dollars

Part 1 Creation and Analysis of a Monte Carlo Simulation:

(i) Simulate 10,000 benefit-cost ratios for the Dam #1 project and 10,000 benefit-cost ratios for the Dam #2 project. Note that the two simulations are independent of each other. Let these two ratios be denoted by α_1 and α_2 for the two projects respectively.

(ii) Construct a tabular frequency distribution and a histogram for α_1 and then for α_2 Include the graphical distributions in the report and comment on the shape of each distribution. To create a frequency distribution for a

continuous distribution, you will need to determine a discrete set of intervals within which to bin your data.

(iii) Compute the information required in the tables below and include as a component of the report.

Dam #1 Project	Observed	Theoretical
Mean of the Total Benefits		
SD of the Total Benefits		
Mean of the Total Cost		
SD of the Total Cost		
Mean of the Benefit-cost Ratio		X
SD of the Benefit-cost Ratio		X

Table 2 Descriptive Statistics of Dam #1 Project

Dam #2 Project	Observed	Theoretical
Mean of the Total Benefits		
SD of the Total Benefits		
Mean of the Total Cost		
SD of the Total Cost		
Mean of the Benefit-cost Ratio		X
SD of the Benefit-cost Ratio		X

Table 3 Descriptive Statistics of Dam #2 Project

Part 2: Analysis of a probability distribution

Select a theoretical probability distribution that may be a good fit for the distribution of α_1. Create a theoretical frequency table for this distribution based on the same intervals you utilized in part 1 for your bins. Compare the sample and theoretical frequency distributions with the Chi-squared Goodness-of-fit test Explain the result. Describe the rational for your choice of the probability distribution and a description of the outcomes of your Chi-squared test in your report. Indicate the values of the Chi-squared test statistic and the P-value of your test in your report and interpret those values.

Part 3: Comparison of the results.

(i) Complete the table below and include it with analysis as a part of the report. In this table, **$P(\alpha_i > 2)$** is interpreted as the probability that in your simulation

the value of α is greater than 2. When comparing the benefit-cost ratios against one another, it is reasonable to compare the outcome of simulation 1, then simulation 2, and so on.

	α_1	α_2
Minimum		
Maximum		
Mean		
Median		
Variance		
Standard Deviation		
SKEWNESS		
P(α_i > 2)		
P(α_i > 1.8)		
P(α_i > 1.5)		
P(α_i > 1.2)		
P(α_i > 1)		
P(α_1 > α_2)		

Table 4 Comparisons between alpha values

(ii) In your report, use your observations of the results obtained in parts 1-3 to recommend one of two projects to the management. Explain all your rationales for the project that you have recommended. Include with the conclusion of your report an estimate for the probability that α_1 will be greater than α_2.

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ALY 6050 Rubric Project 2

Category Score	Characteristics
A Range ***Excellent*** **90–100 points**	• **R/Excel** Accurate completion of 90%–100% of all R/Excel requirements. Code and/or excel is well formatted and easily readable. • **Report (Content)** Complete presentation and analysis of key results. Contains all required tables, and visualizations. Provides a precise description of the analytical concepts and theories used in the analysis. • **Report (Style and Submission)** Title page, introduction and conclusion/recommendation included; accurate APA citations; minor grammar or spelling errors; page numbers.
B Range ***Good*** **80–90 points**	• **R/Excel.** Accurate completion of 80%–90% of all requirements. Code and/or Excel is poorly formatted or difficult to read. • **Report (Content)** At most one major required component missing. Report shows gaps in reasoning or conclusions not supported by the data. • **Report (Style and Submission)** Missing one of the required elements (introduction, conclusion, etc.); incomplete or incorrect citations; occasional grammar or spelling errors. Imprecise.
C Range ***Satisfactory*** **70–80 points**	• **R/Excel.** Accurate completion of 70%–80% of all requirements. Major deficiencies in readability. • **Report (Content)** Report missing major required elements; evidence for recommendations is unclear or inaccurate; lack of organization. • **Report (Style and Submission)** Missing more than one of the required elements; few or no citations; frequent grammatical and spelling mistakes.
F Range ***Unsatisfactory*** **0–70 points**	• **R/Excel.** Accurate completion of fewer than 70% of all requirements. Disorganized and incomplete code. • **Report (Content)** Mostly missing. • **Report (Style and Submission)** Missing most required elements; major formatting or grammatical errors.

Table 5 Project 3 Rubric