Northeastern University
ALY6050
2024 Winter B

ALY6050 Module Two Project

Project: *Benefit-Cost Analysis of Dam Construction Projects*

The project consists of three parts. The submission of this project will consist of two attachments:

1. A Word document that is prepared according to the APA standards of formatting. In the Word document, explain the experiments and their respective conclusions, and additional information as indicated in each problem. Save your word document in the format: ALY6050_MOD2Project_ LastNameFirstInitial.docx
2. Either an Excel workbook or an R script file (.R file) that contains <u>all the work and the calculations indicated in parts 1-3 of the project</u>. 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:
   Excel: ALY6050_MOD2Project_ LastnameFirstinitial; for example, ALY6050_MOD2Project_ HeR.

- **<u>Problem:</u>**

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 of benefit – a minimum possible value, a most likely value (i.e., a mode or peak), and a maximum possible value.

For the costs, **three 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), other costs, the annual operations and maintenance costs.

These benefits and costs estimations for both dam projects (in millions of dollars) are as follows:

Dam #1: Benefits & Costs

	Estimate		
Benefit	***Minimum***	***Mode***	***Maximum***
Improved navigation **B1**	1	2	3
Hydroelectric power **B2**	6	8	9
Fish and wildlife **B3**	1	4	7
Recreation **B4**	0	2	3
Flood control **B5**	4	7	8
Commercial development **B6**	8	12	15

Cost	***Minimum***	***Mode***	***Maximum***
Annualized capital cost **C1**	8	9	11
Other costs **C2**	1	2	5
Operations & Maintenance **C3**	1	2	3

Table 1: Benefits and costs for the Dam #1 construction project in millions of dollars

Dam # 2: Benefits & Costs			
	Estimate		
Benefit	***Minimum***	***Mode***	***Maximum***
Improved navigation **B1**	6	8	10
Hydroelectric power **B2**	5	7	8
Fish and wildlife **B3**	2	7	8
Recreation **B4**	3	6	7
Flood control **B5**	1	3	5
Commercial development **B6**	4	7	8
Cost	***Minimum***	***Mode***	***Maximum***
Annualized capital cost **C1**	5	6	8
Other costs **C2**	3	4	5
Operations & Maintenance **C3**	2	3	7

Table 2: Benefits and costs for the Dam #2 construction project in millions of dollars

- **Part 1**:

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

(ii) Construct both a **tabular** and a **graphical frequency distribution** for α_1 and α_2 separately (a tabular and a graphical distribution for α_1, and a tabular and a graphical distribution for α_2- a total of 4 distributions). In your report, include only the graphical distributions and comment on the shape of each distribution.

(iii) For each of the two dam projects, perform the necessary calculations to complete the following table. Excel users should create the table in Excel with all cells being occupied by the appropriate formulas, and R users should display the table as a "data frame". Remember to create two such tables – one table for Dam #1 and another table for Dam #2. Include both tables in your report.

Dam 1	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

Dam 2	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

- **Part 2**:

Use your observation in Question (ii) of Part 1 to select a theoretical probability distribution that, in your judgement, is a good fit for the distribution of α_1. Next, use the **Chi-squared Goodness-of-fit test** to verify whether your selected distribution was a good fit for the distribution of α_1. 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. Please list your hypotheses and summarize the results.

- **Part 3**:

(i) Use the results of your simulations and perform the necessary calculations to complete the table below. Excel users should create the table in Excel with all cells being occupied by the appropriate formulas, and R users should display the table as a "data frame". Include the completed table in your report.

	α_1	α_2
Minimum		
Maximum		
Average		
Variance		
Skewness		
Kurtosis		
$P(\alpha_i > 2.75)$		
$P(\alpha_i > 2.50)$		
$P(\alpha_i > 2.25)$		
$P(\alpha_i > 2.00)$		
$P(\alpha_i > 1.75)$		
$P(\alpha_1 < \alpha_2)$		

(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 final conclusion of your report an estimate for the probability that α_1 will be smaller than α_2.

Note: **Please follow the APA format**

Northeastern University
ALY6050
2024 Winter B

Project Rubric

Project Rubric					
Criteria	**Ratings**				**Pts**
R (or Excel): Problem Modeling & Set-up	20.0 pts Completely and concisely modeled the problem in Excel (or R) for each method	16.0 pts Accurately modeled the problem in Excel (or R) for each method	10.0 pts 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.	5.0 pts Modeled the problem in Excel (or R) for each method, but there are some gaps in the problem modeling and setup	20.0 pts
R (or Excel): Problem Solution & Accuracy	40.0 pts Efficiently obtained correct and accurate solutions in Excel (or R) by using the appropriate analytic tools of the software	32.0 pts Obtained complete and accurate solutions in Excel (or R) by using the appropriate analytic tools of the software	20.0 pts Obtained correct solutions in Excel (or R) using the appropriate analytic tools of the software, but the application of the tool is awkward.	10.0 pts Obtained a solutions in Excel (or R) by using the appropriate analytic tools of the software, but the solution is not complete.	40.0 pts
Word/Report: Problem Description & Introduction	10.0 pts Provides a thorough and concise summary of the problem descriptions and introduced the problem using rich and significant ideas	8.0 pts Provides an accurate and succinct summary of the problem descriptions and problem introduction	5.0 pts Provides an accurate summary of the problem descriptions and problem introduction, but the description is too wordy or not succinct	2.5 pts Provided a summary of the problem descriptions and problem introduction, but it is inaccurate or incomplete	10.0 pts
Word/Report: Description of Problem Analysis	10.0 pts Provides a thorough and precise description of the analytic concepts and theories used in analyzing the problem	8.0 pts Accurately describes the analytic concepts and theories used in analyzing the problem	5.0 pts Describes the analytic concepts and theories used in analyzing the problem, but description lacks appropriate detail or precision	2.5 pts Describes the analytical concepts and theories used in analyzing the problem, but descriptions are incorrect or the analytical concepts and theories are incorrect	10.0 pts
Word/Report: Description of Conclusions	10.0 pts Provides conclusions and results obtained in the project using a high level of critical thinking and reasoning	8.0 pts Provides relevant conclusions and results obtained in the project that reflect critical thinking and reasoning	5.0 pts 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	2.5 pts Provides conclusions and results obtained in the project, but they are irrelevant and reflect a lack of critical thinking	10.0 pts
Word/Report: Writing Mechanics, Title Page, & References	10.0 pts 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	8.0 pts 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	5.0 pts 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	2.5 pts 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	10.0 pts
					Total Points: 100.0