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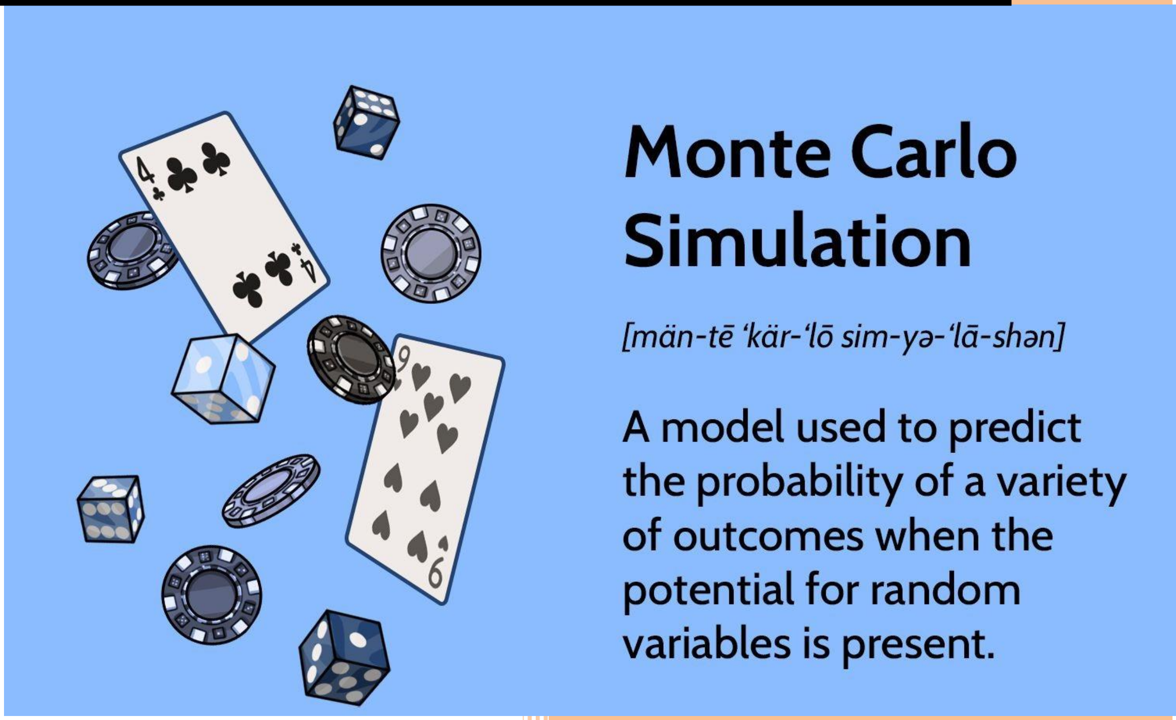
Benefit-Cost Analysis of Dam Construction Projects



Introduction

The evaluation of potential projects often involves a comprehensive benefit-cost analysis (BCA). This analysis assesses both the estimated benefits and costs associated with a project to determine its overall viability and priority relative to other projects. The purpose of this report is to conduct a BCA for two proposed dam construction projects: Dam #1 in southwest Georgia and Dam #2 in North Carolina. The analysis includes estimating annual benefits and costs, performing simulations, and evaluating the results to recommend the more feasible project.

Part 1: Simulation of Benefit-Cost Ratios

For both Dam #1 and Dam #2, the benefits are categorized into six areas:

1. Improved navigation
2. Hydroelectric power
3. Fish and wildlife
4. Recreation
5. Flood control
6. Commercial development

The costs are divided into two categories:

1. Annualized capital cost
2. Operations and maintenance

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

Figure 1 Dam 1 Benefit and cost values.

The above table presents a comprehensive breakdown of the estimated benefits and costs associated with the construction of Dam #1. For each category, three estimates are provided: minimum, mode (most likely value), and maximum.

The benefits are divided into six categories. Improved navigation is estimated to provide benefits ranging from 1.1 million dollars at a minimum to 2.8 million dollars at a maximum, with a most likely value of 2 million dollars. The hydroelectric power benefits are projected to be between 8 million dollars and 14.9 million dollars, with a mode value of 12 million dollars. The benefits for fish and wildlife are estimated to have a minimum and mode value of 1.4 million dollars, while the maximum is projected at 2.2 million dollars. Recreation benefits are expected to range from 6.5 million dollars to 14.6 million dollars, with a most likely value of 9.8 million dollars. Flood control benefits are estimated between 1.7 million dollars and 3.6 million dollars, with a mode value of 2.4 million dollars. Finally, commercial development benefits range from 0 million dollars to 2.4 million dollars, with a most likely estimate of 1.6 million dollars.

The costs associated with the dam project are categorized into annualized capital costs and operations and maintenance costs. The annualized capital cost is estimated to range from 13.2 million dollars to 19.1 million dollars, with a most likely value of 14.2 million dollars. The operations and maintenance costs are projected to be between 3.5 million dollars and 7.4 million dollars, with a mode value of 4.9 million dollars.

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

Figure 2 Dam 2 Benefit and cost values.

The above table provides a detailed breakdown of the estimated benefits and costs associated with the construction of Dam #2. For each category, three estimates are presented: minimum, mode (most likely value), and maximum.

The benefits of Dam #2 are categorized into six areas. Improved navigation is expected to yield benefits ranging from 2.1 million dollars at a minimum to 4.8 million dollars at a maximum, with a most likely value of 3 million dollars. The hydroelectric power benefits are projected to be between 8.7 million dollars and 13.6 million dollars, with a mode value of 12.2 million dollars. The benefits for fish and wildlife are estimated to have a minimum, mode, and maximum value of 2.3 million dollars and 3 million dollars, respectively. Recreation benefits are anticipated to range from 5.9 million dollars to 15 million dollars, with a most likely value of 8.7 million dollars. Flood control benefits are projected to be 3.4 million dollars, with no variation between the mode and maximum values. Finally, commercial development benefits range from 0 million dollars to 1.8 million dollars, with a most likely estimate of 1.2 million dollars.

The costs associated with the dam project are divided into annualized capital costs and operations and maintenance costs. The annualized capital cost is estimated to range from 12.8 million dollars to 20.1 million dollars, with a most likely value of 15.8 million dollars. The operations and maintenance costs are projected to be between 3.8 million dollars and 8 million dollars, with a mode value of 5.7 million dollars.

These estimates are critical for performing a benefit-cost analysis (BCA) of the dam project. By comparing the expected benefits across various categories with the associated costs, this analysis aids in evaluating the project's economic feasibility. The mode values represent the most likely outcomes, while the minimum and maximum values provide a range for sensitivity analysis. This approach helps to understand potential variability and uncertainty in the project's financial projections, thereby supporting informed decision-making regarding the project's implementation.

For each benefit and cost, three estimates are provided: minimum, most likely (mode), and maximum. Using these estimates, we conducted simulations to generate 10,000 benefit-cost ratios for each dam project. Such data suits precisely the requirements of a triangular distribution.

(i)

The simulation

The random values of the triangular distribution were generated using the following formula after deploying the RAND () function to generate a random variable from a uniform distribution:

$$x = \begin{cases} a + \sqrt{r(b-a)(c-a)} & if \;\; r \le \frac{c-a}{b-a} \\ b - \sqrt{(1-r)(b-a)(b-c)} & if \;\; r > \frac{c-a}{b-a} \end{cases}$$

Figure 3 Random value generation formula.

Where *x* is the random variable, *a* is the minimum, *b* the maximum value of the variable and c the mode or the most likely value.

Similarly, based on the properties of the triangular distribution the Cumulative Density Function that helps in the calculation of the observed frequencies of the variable in question (in our case the benefit-cost ratio) was calculated using the following:

$$F(x) = \begin{cases} \frac{1}{(b-a)(c-a)}(x-a)^2 & if \;\; x \le c \\ 1 - \frac{1}{(b-a)(b-c)}(b-x)^2 & if \;\; x > c \end{cases}$$

Figure 4 Cumulative Density Function formula.

Where *x* is the random variable, *a* is the minimum, *b* the maximum value of the variable and c the mode or the most likely value.

As seen above, the Triangular distribution has unique properties that make it, at once, a desirable and difficult choice of distribution.

It is desirable and eminently applicable in areas such as business analytics, space engineering, genomics, chemical and pharmaceutical sciences where there is a lack of actual data and estimates of a range and most likely value are sufficient to generate a triangular distribution model.

On the other hand, what makes the Triangular distribution particularly difficult to compute is its piece-meal nature. As the probability density and cumulative probability functions are both piece-meal in nature, i.e. they have different values depending upon their relationship with the designated most likely value(c).

Describing the benefit-cost Ratio of the two Dams projects after the simulation (designated α1 and α2 based on the assignment rubric)

α1					
min	0.907		Estimate		
max	2.083		a	0.907	
range	1.176		b	2.083	
classes/bins	100		c	1.313	
class width	0.012		note* c=3* mean-a-b		
count	10000		A	0.477	
			B	0.906	

Figure 5 Observed values of the BCR of Dam 1.

A =(b-a) * (c-a)	B = (b-a) * (b-c)

Figure 6 Formula terms useful for theoretical modelling in the next section.

The above table provides a detailed statistical summary of the benefit-cost ratio, denoted as α1, after conducting 10,000 simulations for Dam #1. The minimum value observed for α1 is 0.907, while the maximum value is 2.083, indicating a range of 1.176. The simulations are divided into 100 classes or bins, which were calculated by taking the square root of the number of simulations (n=10,000), with each class having a width of 0.012.

The parameters of the triangular distribution used for the simulations are also provided. The lower limit (a) is 0.907, the upper limit (b) is 2.083, and the mode (c) is 1.313. These parameters are essential in defining the shape of the triangular distribution applied in the simulations.

Additionally, the table includes a note explaining that the mode (c) is calculated using the formula $c=3\times\text{mean}-a-b$. This formula helps in adjusting the mode to reflect the central tendency of the simulated data accurately.

The variables A and B, highlighted in red, have values of 0.477 and 0.906, respectively. These values represent specific constants used in further calculations to fit a Triangular distribution on the simulated values in the forthcoming section of this assignment.

Overall, this statistical summary provides a comprehensive view of the variability and distribution of the benefit-cost ratio for Dam #1, highlighting the use of a triangular distribution to model the potential outcomes based on the defined parameters. This information is crucial for understanding the economic feasibility and potential financial performance of the dam project.

	DAM 2:
α2	
min	0.898
max	2.110
range	1.212
classes/ bins	100
class width	0.012
count	10000
Estimate	
a	0.898
b	2.110
c	1.199

Figure 7 Observed BCR values for Dam 2 after simulation.

The table provides a comprehensive summary of the benefit-cost ratio, denoted as α2, following 10,000 simulations for Dam #2. The minimum observed value for α2 is 0.898, while the maximum value reaches 2.110, indicating a range of 1.212. The simulations are categorized into 100 classes or bins, each with a class width of 0.012.

The parameters of the triangular distribution used in these simulations are also detailed. The lower limit (a) is set at 0.898, the upper limit (b) is 2.110, and the mode (c) is 1.199. These parameters are critical in defining the shape of the triangular distribution applied in the simulations

(ii)

Graphical Frequency Distributions of α1 and α2

As required by the rubric I have included and commented only on the graphical distribution of the α1 and α2 in this report with the tabular distribution included in the Excel workbook.

2.1 Frequency Distributions

Dam #1: Benefit-Cost Ratio Distribution

- **Graphical Distribution:**

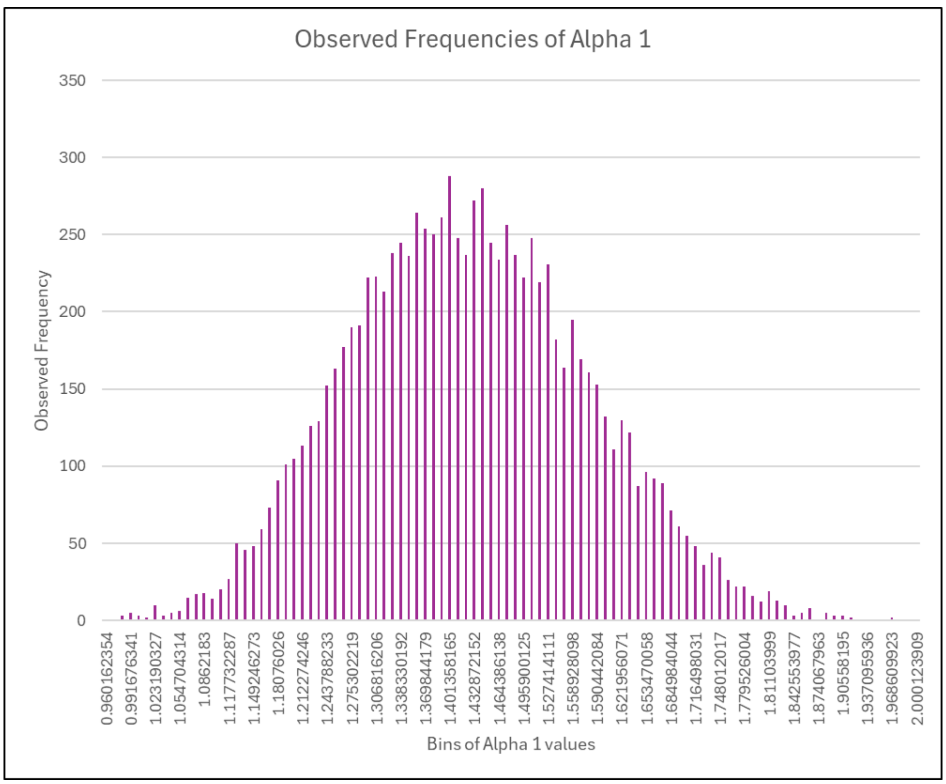


Figure 8 Graphical Frequency Distribution of the BCR of Dam 1.

Commentary: The frequency distribution of α1 , representing the benefit-cost ratio of Dam #1, presents a comprehensive statistical profile. The distribution has a minimum value of 0 and a maximum value of 259, with a mean of 100.000, indicating that the average benefit-cost ratio is centered around this value. The standard deviation is 89.961, reflecting a significant spread around the mean, while the variance of 8092.970 further underscores the extent of this dispersion.

The skew of the distribution is 0.377, suggesting a slight positive skew, meaning the tail on the right side of the distribution is slightly longer or fatter than the left. This positive skewness indicates that there are more instances of higher benefit-cost ratios, but they are not excessively dominant. The kurtosis is -1.425, indicating a platykurtic distribution, which means the distribution has lighter tails and a flatter peak compared to a normal distribution.

The observed frequency histogram depicts a unimodal shape, centered approximately around the mean value. The distribution of α1 is relatively symmetric with a slight right skew.

Alpha 1 Frequency Distribution		
Min	0.000	
Max	259.000	
Kurtosis	-1.425	
Skewness	0.377	
Mean	100.000	
Std Deviation	89.961	
Variance	8092.970	

Figure 9 Statistics for the frequency distribution of BCR of Dam 1.

Dam #2: Benefit-Cost Ratio Distribution

- **Graphical Distribution:**

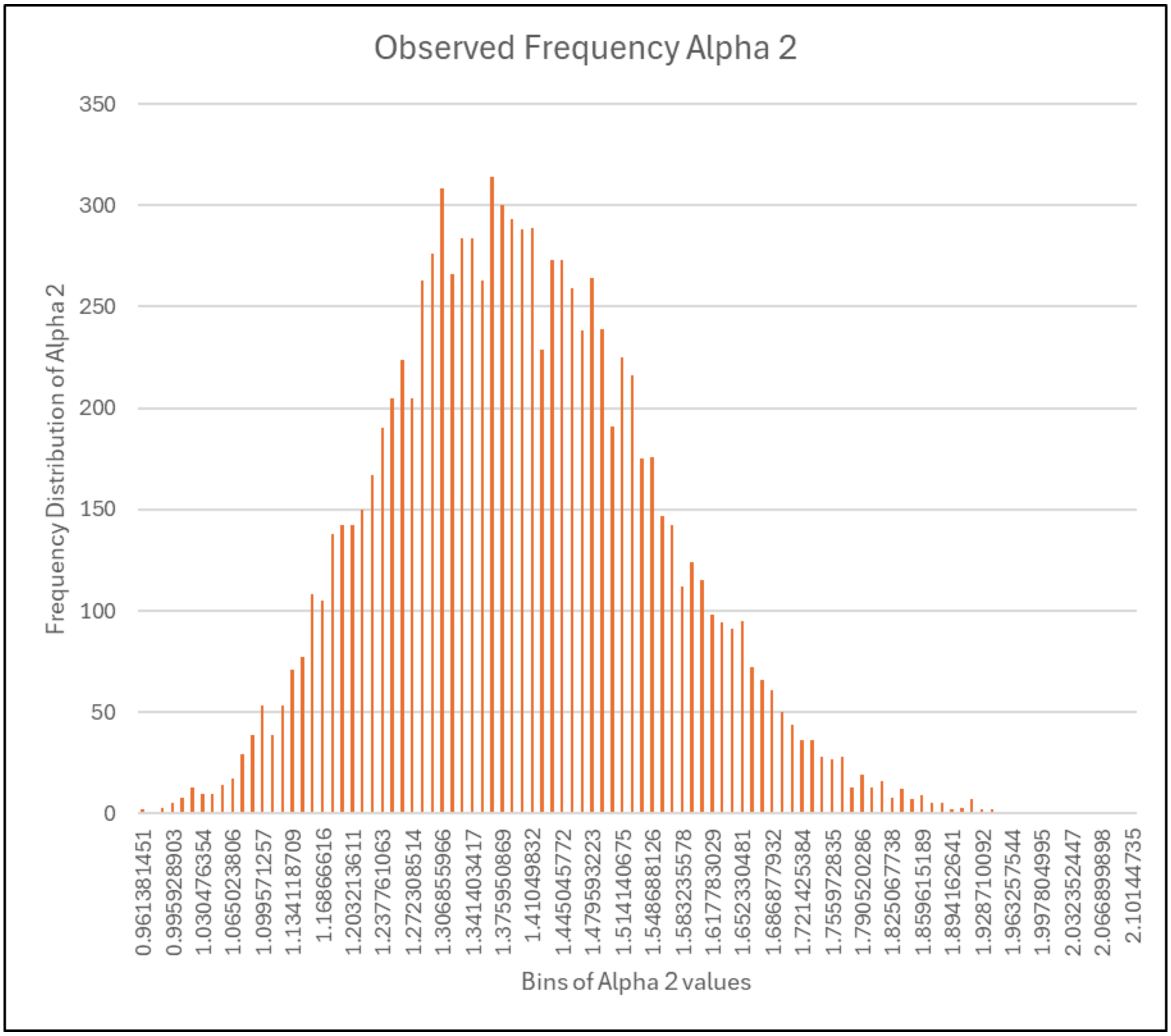


Figure 10 Frequency distribution of Alpha 2 (BCR of Dam2)

Commentary: The frequency distribution of Alpha 2, representing the benefit-cost ratio of Dam #2, is analyzed using various statistical measures. The minimum value recorded is 0, and the maximum value is 323, indicating the range within which the benefit-cost ratios vary. The mean value of 100 suggests that, on average, the benefit-cost ratio hovers around this central point. The standard deviation is 109.771, reflecting a broad spread of values around the mean, while the variance of 12049.697 further emphasizes this wide dispersion.

The skewness of 0.761 indicates a moderate positive skew, suggesting that the distribution has a longer or fatter tail on the right side. This positive skewness implies that there are more instances of higher benefit-cost ratios, albeit they are less frequent. The kurtosis value of -0.996 denotes a platykurtic distribution, meaning the distribution has lighter tails and a flatter peak compared to a normal distribution.

The histogram depicting the observed frequencies of Alpha 2 shows a unimodal distribution, with a single prominent peak. The shape of the histogram is relatively symmetric around the peak but exhibits a longer right tail, consistent with the positive skewness noted. The central tendency of the data aligns closely with the mean, and the gradual tapering off of frequencies towards the extremes is evident.

Given the statistical properties and the visual representation of the distribution, the normal distribution might be considered as a theoretical fit due to its symmetrical nature around the mean. However, the positive skewness and the platykurtic nature of the distribution suggest that a normal distribution may not capture all nuances.

	Alpha 2 Frequency Distribution
Min	0.000
Max	323.000
Kurtosis	-0.996
Skewness	0.761
Mean	100.000
Std Deviation	109.771
Variance	12049.697

Figure 11 Frequency Distribution statistics of Alpha 2

(iii)

This part of the assignment rubric requires us to fill a provided pre-formatted table comparing the observed and theoretical values of both the Dam projects.

1.3 Observed vs. Theoretical Values

For each dam project, we calculated the observed mean and standard deviation (SD) of the total benefits and costs, as well as the benefit-cost ratio. These values were then compared to their theoretical counterparts derived from the provided estimates.

Dam # 1:

Dam 1	Observed	Theoretical
Mean of the Total Benefits	29.463	29.467
SD of the Total Benefits	2.334	2.307
Mean of the Total Cost	20.739	20.767
SD of the Total Cost	2.075	1.521
Mean of the Benefit-cost Ratio	1.435	X
SD of the Benefit-cost Ratio	0.181	X

Figure 12 Observed vs Theoretical values for Dam 1 BCR.

The above table presents a comparison of observed and theoretical statistics for Dam 1, focusing on the total benefits, total costs, and the benefit-cost ratio. The mean of the total benefits for Dam 1 is observed to be 29.463, closely matching the theoretical mean of 29.467, indicating an accurate theoretical model for the total benefits. The standard deviation (SD) of the total benefits is observed at 2.334, compared to a theoretical standard deviation of 2.307, showing a slight but negligible difference, reinforcing the reliability of the theoretical model in predicting the variability of benefits.

For the total cost, the observed mean is 20.739, while the theoretical mean is 20.767, again demonstrating a close alignment between observed and theoretical values. The standard deviation of the total cost shows a more noticeable difference, with the observed SD being 2.075 and the theoretical SD being 1.521. This indicates that the theoretical model underestimates the variability in the total costs.

Regarding the benefit-cost ratio, the observed mean is 1.435, with a standard deviation of 0.181. The close alignment of the values suggests a robust simulated model. However, the greater standard deviation of costs in the observed values suggests that the theoretical model fails to capture the variation of extreme values of cost.

Dam # 2

Dam 2	Observed	Theoretical
Mean of the Total Benefits	30.724	30.700
SD of the Total Benefits	2.420	2.410
Mean of the Total Cost	22.043	22.067
SD of the Total Cost	1.730	1.727
Mean of the Benefit-cost Ratio	1.403	X
SD of the Benefit-cost Ratio	0.158	X

Figure 13 Observed vs Theoretical values for Alpha 2 (BCR of Dam2)

The above table presents a comparative analysis of observed and theoretical statistics for Dam 2, focusing on total benefits, total costs, and the benefit-cost ratio. The mean of the total benefits for Dam 2 is observed to be 30.724, which closely aligns with the theoretical mean of 30.700, indicating that the theoretical model accurately predicts the central tendency of the benefits. The standard deviation (SD) of the total benefits is observed at 2.420, compared to the theoretical SD of 2.410, demonstrating a minimal discrepancy and suggesting that the variability in benefits is well captured by the theoretical model.

For the total cost, the observed mean is 22.043, while the theoretical mean is 22.067, again showing a close alignment. The standard deviation of the total cost shows a remarkable similarity, with the observed SD being 1.730 and the theoretical SD being 1.727. This near-perfect match indicates that the theoretical model effectively estimates both the mean and the variability of the total costs.

Regarding the benefit-cost ratio, the observed mean is 1.403 with a standard deviation of 0.158.

Part 2:

Fitting a theoretical probability distribution and Chi-Squared Goodness-of-Fit Test

2.1 Theoretical Probability Distribution Selection

Based on the observed frequency distributions in Question (ii) of Part 1 I examined the frequency distribution of α1 provided in the above section (ii) of Part 1, closely to arrive at a decision as to which theoretical probability distribution would be the best candidate for a fit. I provide below the considerations that reflect my final decision.

1. **Normal Distribution**:

    - **Consideration**: The normal distribution was considered due to its symmetric properties around the mean and its applicability to many natural phenomena. The mean (100) and standard deviation (89.961) could make it a candidate for fitting.

    - **Rejection**: The skewness (0.377) indicates a slight positive skew, and the kurtosis (-1.425) indicates a platykurtic distribution, meaning the tails are lighter and the peak is flatter than a normal distribution. These deviations from normality suggest that a normal distribution would not adequately capture the observed skewness and kurtosis, leading to inaccuracies in modeling the data.

2. **Poisson Distribution**:

   - **Consideration**: The Poisson distribution is typically used for count data and is characterized by its mean being equal to its variance. It might be considered if the data represented counts of events. Here, even though the data is divided into discrete bins as a frequency distribution, the underlying data is a ratio. So this goes against a Poisson distribution as described below.
   - **Rejection**: The data here represents continuous benefit-cost ratios, not discrete count data. Additionally, the variance (8092.970) is significantly higher than the mean (100), which is inconsistent with the properties of a Poisson distribution, where mean equals variance.

3. **Exponential Distribution**:

   - **Consideration**: The exponential distribution is considered for modeling the time between events in a Poisson process, often applicable to skewed data with a positive skew.

- **Rejection**: The exponential distribution is unbounded on the high end but starts at zero, which might match the minimum value of the data (0). However, it assumes a constant rate of decay, leading to a single parameter defining the distribution. The observed data has a more complex structure with a specific mean, standard deviation, and non-constant rate of decay, as seen in the variance and kurtosis values. This makes the exponential distribution a poor fit.

4. **Triangular Distribution**:

- **Reason for Choice**: The triangular distribution is defined by a minimum, maximum, and mode, making it a simple and flexible choice for data with known bounds and a single peak. The minimum (0) and maximum (259) values fit the distribution well, and the observed mode can be approximated from the mean. The slight skewness (0.377) and platykurtic nature (-1.425) are better accommodated by the triangular distribution's ability to model asymmetric data with a known peak and bounded range.

In conclusion, the normal distribution was rejected due to its inability to accommodate the observed skewness and kurtosis. The Poisson distribution was rejected due to its nature of modeling count data and its mean-variance equality property. The exponential distribution was rejected because it could not capture the complex variability and shape of the data. The triangular distribution was chosen for its simplicity and flexibility in handling the observed characteristics of the data, such as known bounds and a single peak, making it a more appropriate fit for the benefit-cost ratio of Dam #1.

Fitting a triangular distribution

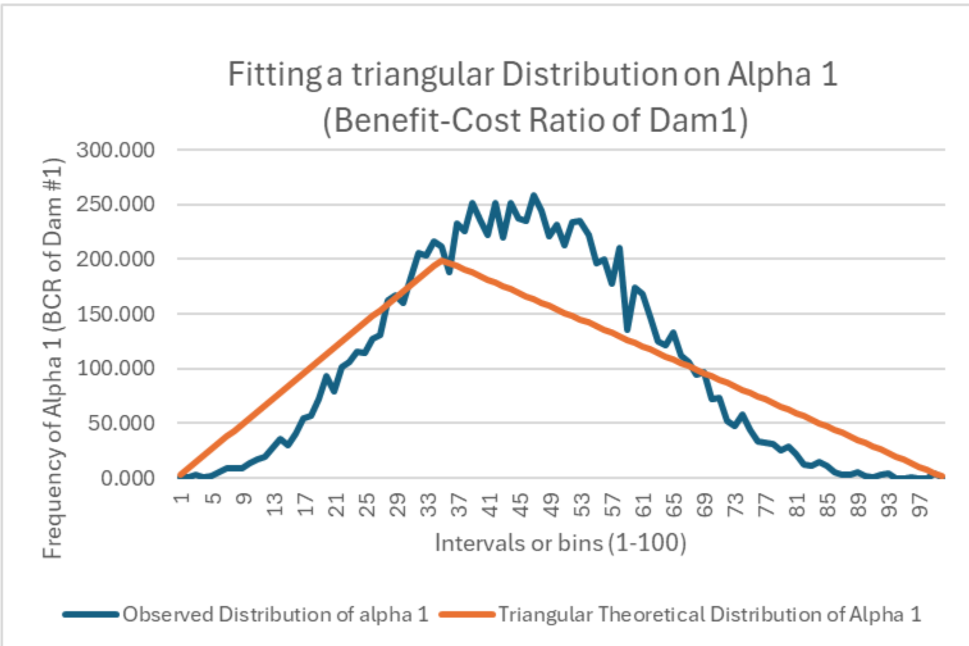


Figure 14 Fitting a triangular distribution for Alpha 1.

The above visualization illustrates the fitting of a triangular distribution to the observed frequency distribution of α1, which represents the benefit-cost ratio of Dam #1. The observed distribution is shown in blue, while the triangular theoretical distribution is represented by the orange line.

The frequency distribution of α1 shows a minimum value of 0.000 and a maximum value of 259.000. The mean is 100.000, with a standard deviation of 89.961, and the variance is 8092.970. The skewness of the distribution is 0.377, indicating a slight positive skew, while the kurtosis is -1.425, suggesting a platykurtic distribution, which means the distribution has lighter tails and a flatter peak compared to a normal distribution.

The visualization represents the observed frequencies of the benefit-cost ratio of Dam #1. The observed distribution is unimodal, showing a single peak around the mean value. The frequencies gradually increase to this peak and then decrease, displaying a relatively symmetric shape with a slight right skew.

The triangular distribution, defined by the minimum value, the mode (peak), and the maximum value, is superimposed on the observed data. The mode appears to be centered around the highest observed frequency, aligning closely with the mean of the distribution.

The triangular distribution was chosen for its simplicity and flexibility in modeling data with known bounds and a single peak. The minimum value of 0 and maximum value of 259 fit within the observed data range, and the peak of the triangular distribution aligns with the mode of the observed frequencies. The slight positive skewness and platykurtic nature of the observed data are accommodated by the triangular distribution's ability to model asymmetric data with a known peak and bounded range.

The fit of the triangular distribution to the observed data suggests that it provides a reasonable approximation, capturing the central tendency and spread of the benefit-cost ratio. However, the observed data shows more variability and complexity, particularly in the tails, which the simple linear increase and decrease of the triangular distribution may not fully capture.

In conclusion, while the triangular distribution offers a practical and straightforward fit for the observed data, further analysis with more complex distributions, such as log-normal or gamma distributions, might be necessary to capture all the nuances of the benefit-cost ratio distribution for Dam #1. This initial fit, however, provides a solid foundation for understanding the central tendencies and variability in the data.

2.2 Chi-Squared Test Results

To validate the fit, a Chi-squared Goodness-of-Fit test was conducted for the selected triangular distribution against the observed benefit-cost ratios.

Hypotheses:

Null Hypothesis (H0): The triangular distribution is a good fit for the observed data.

Alternative Hypothesis (H1): The triangular distribution is NOT a good fit for the observed data.

Alpha Value:

The level of significance (alpha) is set at 0.05.

Null Hypothesis: H0: The triangular distribution is a good fit

Alternative Hypothesis: H1: The triangular distribution is NOT a good fit.

Chi-squared Test Statistic	**1769.903**
Degrees of Freedom	**96**
Chi-squared P-value:	**0.000000000**

Result:

The Chi-squared test statistic is 1769.903 and the p-value of nearly zero (0.0000000) which is far below the 0.05 (level of significance) . Therefore we reject the null hypothesis and accept the alternative hypothesis that the data does not follow a triangular distribution.

Figure 15 Chi-Square Goodness of Fit test.

Test Statistic:

Dam #1:

- Chi-squared test statistic: 1769.903
- Degrees of freedom: 96
- P-value: 0.000000000

Decision:

Since the p-value is significantly lower than the alpha value of 0.05, we reject the null hypothesis.

Interpretation:

The p-value of 0.000000000 indicates that there is a statistically significant difference between the observed data and the triangular distribution. Therefore, we conclude that the triangular distribution does not fit the observed data for Dam #1's benefit-cost ratios.

Result and Interpretation:

The Chi-squared test statistic is 1769.903 and the p-value is nearly zero (0.0000000), which is far below the 0.05 level of significance. Therefore, we reject the null hypothesis and accept the alternative hypothesis that the data does not follow a triangular distribution. This suggests, as reported in the previous section, that, while the triangular distribution is a sound choice to model this distribution, its full complexity, owed to larger variation in values might be captured by a more complex modelling system beyond the purview of the present assignment.

Part 3: Probability Analysis and Recommendation

(i) Comparison of BCR of Dam #1 and Dam#2 and Probability Analysis

	1	2
Minimum	0.907	0.898
Maximum	2.083	2.110
Mean	1.435	1.403
Median	1.432	1.395
Variance	0.032667869	0.024847376
Standard Deviation	0.180742548	0.157630504
SKEWNESS	0.117237637	0.314243244
P($_i$ > 2)	0.0007	0.0004
P($_i$ > 1.8)	0.0227	0.0108
P($_i$ > 1.5)	0.3624	0.2563
P($_i$ > 1.2)	0.899	0.9112
P($_i$ > 1)	0.9971	0.9988
P($_1$ > $_2$)	**0.560**	

Figure 16 Probability Analysis of BCR of Dam 1 and Dam 2.

The above table provides a comparative statistical analysis of Alpha 1 and Alpha 2, which represent the benefit-cost ratios (BCR) of Dam #1 and Dam #2, respectively.

For Alpha 1, the BCR has a minimum value of 0.907 and a maximum value of 2.083. The mean BCR is 1.435, and the median is 1.432, indicating a relatively symmetric distribution around the central values. The variance for Alpha 1 is 0.032, and the standard deviation is 0.180, showing moderate dispersion around the mean. The skewness for Alpha 1 is 0.117, suggesting a moderate positive skewness, meaning there is a longer tail on the right side of the distribution.

For Alpha 2, the BCR has the same minimum value of 0.898 but a slightly higher maximum value of 2.110, indicating a wider range. The mean BCR for Alpha 2 is 1.403, and the median is 1.395, which, being lower than the corresponding values for Alpha 1, also suggests a relatively symmetric distribution. The variance for Alpha 2 is 0.024, and the standard deviation is 0.157, indicating lesser variability compared to Alpha 1. The skewness for Alpha 2 is 0.314, which also points to a moderate positive skewness but higher than that of Alpha 1.

The table also provides probabilities for the BCR exceeding specific values. For Alpha 1, the probability of the BCR being greater than 2 is 0.0007, greater than 1.8 is 0.0227, greater than 1.5 is 0.3624, greater than 1.2 is 0.899, and greater than 1 is 0.9971. For Alpha 2, the probabilities are slightly lower in comparison. The probability of the BCR being greater than 2 is 0.0004, greater than 1.8 is 0.0108, greater than 1.5 is 0.2563, greater than 1.2 is 0.9112, and greater than 1 is 0.9988.

In conclusion, while both Dams #1 and #2 have positively skewed BCR distributions, Dam #1 has a higher proportion of BCR values greater than 1.5, compared to Dam #2. This suggests that Dam #1 tends to have more consistently favorable economic outcomes compared to Dam #2. This comparative analysis is essential for evaluating the relative economic performance of the two dams, guiding resource allocation, and decision-making processes.

(ii) Recommendation

Based on the benefit-cost analysis, including the observed and theoretical means and standard deviations, and the probability calculations, **Dam #1 is**

recommended for selection. The mean benefit-cost ratio of Dam #1 is slightly higher than that of Dam #2, and the probability of achieving higher benefit-cost ratios is also higher for Dam #1. This is reflected in the probability **0.56** showing 56% of the values of the BCR of Dam # 1 are greater than Dam # 2.

Conclusion

In summary, this report presents a thorough benefit-cost analysis for two dam construction projects, employing simulations, frequency distribution analysis, and statistical testing to evaluate their viability. The analysis recommends Dam #1 as the more feasible project based on its higher benefit-cost ratio (BCR). This recommendation is grounded in a detailed assessment of the available data and statistical validations.

References

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