**ALY6050 80478 Intro to Enterprise Analytics SEC 09 Spring 2023 CPS**

**Module 1 Assignment — Analysis of a Betting Strategy in Sports REPORT**

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**NORTHEASTERN UNIVERSITY**

**College of Professional Studies, Boston, MA, 02215.**

**Submitted by**

Zihan Ma

ma.zihan1@northeastern.edu

**Instructor**

 Prof. Richard He

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

**Assignment Summary:**

In this project, we utilize benefit-cost analysis for two potential dam construction projects. Through simulations and statistical tests, we compare the projects' benefits and costs to recommend the most beneficial project to the JET Corporation.

**Part 1:**

1. In this section, we conducted two separate simulations of 10,000 benefit-cost ratios for each of the Dam 1 and Dam 2 projects. Using the data given for the benefits and costs of each dam project, we applied the random number generation process for each simulation. The random number generation process used the triangular distribution to generate values for benefit and cost variables.

For Dam 1, we calculated the total benefits and costs for each simulation by summing the individual benefits and costs resulting from the random number generation. We then divided the total benefits by the total costs to obtain the benefit-cost ratio, denoted as 𝛼1.

Similarly, for Dam 2, we calculated the total benefits and costs for each simulation and divided the total benefits by the total costs to obtain the benefit-cost ratio, denoted as 𝛼2.

The benefit-cost ratios for each dam project were calculated independently from one another to ensure the validity of the simulations. Through these simulations, we gained insights into the variability and potential outcomes of the benefit-cost ratios for each dam project.

1. In this segment, we generated frequency distributions for benefit-cost ratios 𝛼1 and 𝛼2 of Dam 1 and Dam 2 projects respectively, using both tabular and graphical methods. For brevity, only the analysis based on the graphical distributions is presented here.

Dam 1: The distribution of 𝛼1 appears to be approximately normally distributed, with a slight left-of-center peak. This suggests that most of the benefit-cost ratios for Dam 1 project simulations are moderately high, with a substantial number centered around the median value. The symmetry of the graph indicates a balanced outcome, with almost equal chances of obtaining either lower or higher than average benefit-cost ratios.

Dam 2: The distribution of 𝛼2 is similarly normally distributed but centers more directly in the middle. This suggests a majority of the Dam 2 project simulations yield benefit-cost ratios around the mean. The evenly distributed outcomes suggest a balanced performance of the Dam 2 project with nearly equal probabilities for both lower and higher benefit-cost ratios.

The distributions show that while both dams present a balanced array of potential outcomes, Dam 1 has a slight tendency towards higher benefit-cost ratios compared to Dam 2. This offers a useful perspective on the relative potentials and risks associated with each project.

1. In this segment, we performed calculations for the Dam 1 and Dam 2 projects to populate the tables with the observed and theoretical values. The tables present the mean and standard deviation (SD) of the total benefits, total cost, and the benefit-cost ratio.  
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   Observations:

The observed means of total benefits and total costs for both dams closely match their theoretical values, indicating that the simulations accurately reflect the anticipated scenarios. However, the observed standard deviations (SD) of the total benefits and total costs deviate from the theoretical values, more so in Dam 1. This difference implies that the actual variability in the outcomes is less than expected. The mean benefit-cost ratios for Dam 1 and Dam 2 are roughly the same, with a slight advantage to Dam 2. Meanwhile, Dam 2's benefit-cost ratio has a smaller SD, implying less variability and therefore less risk.

**Part 2:**

In part 2, we identified a theoretical probability distribution to match the distribution of α1 (Benefit-Cost Ratios for Dam #1) observed in Part 1 (ii). Based on the shape of the frequency distribution, we selected a specific distribution. A Chi-squared goodness-of-fit test was then conducted to determine how well the selected distribution fit the observed data.

The Chi-squared test statistic is 448951.344, which seems to be quite high, suggesting a significant difference between the observed and expected frequencies under the selected distribution. However, the p-value of the test is 0.498 which is greater than the typical significance level of 0.05. This implies that we fail to reject the null hypothesis that the observed distribution fits the expected distribution.

Hypotheses for the Test:

H0: The observed distribution fits the expected distribution.

H1: The observed distribution does not fit the expected distribution.

Conclusion:

Based on the test, we fail to reject the null hypothesis, suggesting that our chosen theoretical distribution is a good fit for the observed distribution of α1 (benefit-cost ratios for Dam #1). However, the high Chi-square statistic suggests further investigation might be necessary to confirm this. The model seems to be a decent fit, but it might not capture all features of the actual distribution.

**Part 3:**

1. The following table summarises key statistics for the two benefit-cost ratio distributions (𝛼1 and 𝛼2) from our simulations:  
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2. Based on the results from Parts 1-3, we need to evaluate the data and make a recommendation on which project to pursue.

Looking at the means of 𝛼1 and 𝛼2, Dam #2 has a slightly higher mean benefit-cost ratio than Dam #1. This suggests that, on average, Dam #2 may be a more cost-effective project to pursue.

In terms of risk, we can consider the standard deviation of the benefit-cost ratios. Dam #2 also has a lower standard deviation, which suggests that its benefit-cost ratio is more stable and predictable compared to Dam #1. This may be an attractive feature for the management team as it reduces uncertainty.

When comparing the probabilities of 𝛼i exceeding certain values, Dam #2 seems to perform better especially for the higher ratios, except for the case of 𝛼i > 2.25 where Dam #1 has a higher probability. However, considering the relatively high values of these thresholds, the management team may decide to focus more on the lower, more likely ratios.

Lastly, the probability of 𝛼1 being greater than 𝛼2 is approximately 0.394, which is less than 50%. This means it's less likely that Dam #1 will outperform Dam #2 in terms of benefit-cost ratio.

Therefore, considering all the data and factors, we recommend Dam #2 to the management for this project. It has a higher average benefit-cost ratio, less variability, and better performance across different thresholds. These factors make Dam #2 the more appealing project based on the data available. However, other factors that were not considered in this analysis may influence the final decision, and these should be considered as well.

**Conclusions:**

Based on our statistical analysis, Dam #2 appears to be the more promising project. It demonstrated a higher mean benefit-cost ratio and lower variability compared to Dam #1. Moreover, the likelihood of Dam #1's benefit-cost ratio exceeding Dam #2's was less than 50%. Considering probabilities at practical benefit-cost ratio thresholds, Dam #2 consistently outperformed.