Function and Performance Optimization of Kamijoro Dam Redesign through Value Engineering Analysis Application

R H Tristanto¹ and Sobriyah¹, R Hadiani¹, A Setyawan¹,²
¹Civil Engineering Postgraduate Department
Sebelas Maret University, Jl. Ir. Sutami 36 A Solo 57126 Indonesia
²Roadmate Research Group, Civil Engineering Department
Sebelas Maret University, Jl. Ir. Sutami 36 A Solo 57126 Indonesia

E-mail: ronyhimawan98@student.uns.ac.id

Abstract. The Kamijoro Dam is very useful to support increased agricultural production, especially to strengthen food self-sufficiency and supply of raw water. The authors redesigned the Kamijoro dam. Based on observations, there is a dam potential to increase its capacity and function by first redesigning the initial planning. In order to redesign the Kamijoro dam, value engineering analysis was applied. The value engineering results are compared with the initial design to obtain a better, more effective and efficient dam design. The way to compare it is to use the evaluation matrix method. From the planned peak length of the dam 161 meters, dam discharge of 13.171 m³/second/m, the fulfillment of raw water is 500 l/s with a project value of Rp. 188.799.932.000,-. Based on the analysis of technical values, by reducing the width of the dam, we obtained several performance optimizations. Among them are the dam spanning 125 peaks, flow rate of 17.90 m³/second/meter, raw water requirement of 600 liters/second and the project value of Rp. 183.229.730.000,- With a slight cost efficiency of the project value of about 2.95%, a more optimal dam function and performance were obtained.

1. Introduction
The Kamijoro Dam in Bantul district was built to solve problems on the Kamijoro river and downstream the Kamijoro Intake. With the Kamijoro Dam building, it provides protection against the Kamijoro Intake and irrigation canals. Another function is to raise the water level of the river so that it can supply irrigation water and meet raw water [1]. The Kamijoro Dam is very useful to support increased agricultural production, especially to strengthen food self-sufficiency and supply of raw water [2]. The authors redesigned the Kamijoro dam. Based on observations, there is a dam potential to increase its capacity and function by first redesigning the initial planning. In order to redesign the Kamijoro dam, value engineering analysis was applied. The value engineering results are compared with the initial design to obtain a better, more effective and efficient dam design. The way to compare it is to use the evaluation matrix method.
Figure 1. The Location of Kamijoro Dam

2. Research Method
Value engineering is an evaluation method that analyzes the technique and value of a project or product that involves owners, planners and experienced experts in their fields. With a systematic and creative approach that aims to produce the lowest possible quality and cost [3].

2.1. Information Stage
This stage is the initial stage of Value Engineering study which aims to obtain a comprehensive understanding of the system, structure, or parts of the study [4].

2.2. Creative Stage
Value Engineering creative stage is the stage to produce various kinds of alternatives that can fulfill or carry out the main function. At this stage ideas are developed in order to multiply the alternatives that will be selected by brainstorming [4].

2.3. Analysis Phase
This stage of Value Engineering aims to evaluate the alternatives produced in the negative stage. The results of this evaluation are used to determine useful alternatives for further studies that will provide the greatest potential for cost savings [4].

2.4. Recommendation Stage
The recommendation stage is the final stage which aims to provide written recommendations from the alternatives selected with consideration of the previous analysis [4].

2.5. Development Stage
The value engineering objective development stage is to prepare final written recommendations for the chosen alternatives. The possibilities for implementation, including consideration of the technical and economic factors for which these alternatives have been completely developed to enable implementation [4].
3. Results and Discussion
The steps taken are to modify several dam elements [5], including:
1. The height of water flow over the dam is analyzed using various dam width plans in order to obtain a larger inundation volume. The preliminary plan is presented in Figure 2.
2. Perform calculations to re-plan the structure in order to know the quality and benefits obtained after value engineering.

![Figure 2. Preliminary Plan of 161m wide dam](image)

3.1. Analyzed using various dam width plans
To get more optimal dam performance and meet technical requirements, a visualization of the HEC-RAS (Hydrologic Engineering System-River Analysis System) modeling design is required. Visualization of the dam design using HEC-RAS can be seen in Figure 3 [5].

![Figure 3. Visualization of the Kali Progo Intake Location Kamijoro 5 Km upstream and 2 Km downstream.](image)

The next step in the HEC-RAS calculation is to assume the value of the water surface at the initial channel (in this case the downstream section). Another option that can be used if the effect of the water level remains relatively far downstream can be approached by calculating the normal depth by entering the mean riverbed slope value by trial method [6]. Then by using the energy equation above, the water level profile for all sections in the channel can be found [7].
1. Condition of alternative plan A is a dam with a width of 175 m
2. The condition of alternative plan B is a dam with a width of 153 m
3. The condition of alternative plan C is a dam with a width of 125 m

The next step in the HEC-RAS calculation is to assume the value of the water surface at the initial channel (in this case the downstream section) [8]. Another option that can be used if the effect of the water level remains relatively far downstream can be approached by calculating the normal depth by entering the value of the base mean slope [9]. Flood water level rise in Q100 in alternative A for dam width B = 175 and Alternative B dam width B = 153 m is 12 cm. While alternative C for the width of the dam B = 125 m, the flood water will increase to 40 cm. By conducting a comparative study of
water level rise for various dam heights, it can be understood that alternatives A, B, and C have a smaller increase in impact.

Analysis of the specific discharge per unit width gives the following results:
A. The specific discharge at width B = 175 m is $q = \frac{2.000}{175} = 11.429 \text{ m}^3/\text{s}/\text{m}$.1.
B. The specific discharge at width B = 153 m is $q = \frac{2.000}{175} = 13.171 \text{ m}^3/\text{s}/\text{m}$.
C. The specific discharge at width B = 125 m is $q = \frac{2.000}{175} = 16.00 \text{ m}^3/\text{s}/\text{m}$.

3.2. Value Engineering Evaluation

The following is a comparison of the technical specification data between the initial planning and the results of the Kamijoro Dam redesign as presented in Table 1.

| Tabel 1. The Specification before and after Value Engineering Application |
|-------------------------------|-------------------------------|
| Elements                     | Initial plan                  | Alternative Design          |
| Dam Span                     | 161 m                         | 125 m                       |
| Dam Heght.                   | 2.4 m                         | 2.8 m                       |
| Discharge Flow.              | 13.171 m³/dt/m1.              | 16.000 m³/dt/m1.            |
| Dam Body Volume.             | 35642.24 m³                   | 34590.68 m³                 |
| Budget                       | Rp. 188.799.932.000,00        | Rp. 183.229.730.000,00      |

From the data above, value engineering evaluation is carried out to determine the best alternative planning to implement [10]. This evaluation is carried out using the evaluation matrix method, namely by comparing the cumulative assessment of several considerations. This method should be done by distributing questionnaires to several respondents consisting of experts who are competent in their fields, which include calculating the weight of the criteria, testing data consistency, and calculating the weight of the function [11]. However, due to limited time and resources, these values are assumed by the author according to the purpose of the dam. The planning alternative with the highest value is considered the best alternative. The categories compared between the initial design and the alternative design are presented in Table 2.

| Table 2. The categories to compare the advantages of VE |
|---------------------------------------------|-------------|
| No. 1 Raw water and irrigation facilities |
| No. 2 Field laboratory facilities, recreation and other activities |
| No. 3 Land acquisition |
| No. 4 Raw water and irrigation facilities |
| No. 5 Field laboratory facilities, recreation and other activities |
| No. 6 Land acquisition |

To be able to conduct an assessment using the evaluation matrix method, it is necessary to give weight to each category of assessment. After weighting the proposed alternatives, a matrix for the assessment is made, as presented in Table 3[12]. Based on the evaluation using the evaluation matrix method, the total matrix value of the dam initial design was 382. Meanwhile, the total matrix value of the proposed design alternatives was 432. The proposed design alternative has a larger total matrix value, so it can be selected as a better design alternative.
Table 3. The Evaluation Matrix Report

| No | Category                        | Weight | Alternatives Design | Predicate value |
|----|---------------------------------|--------|---------------------|-----------------|
|    |                                 | (%)    | Initial Predicate Value | Proposed Predicate Value |
| 1  | Dam Function                    |        |                     |                  |
|    | a. Raw water and irrigation facilities | 18    | 3                  | 54              | 4                | 72 | 4 = Baik |
|    | b. Water conservation           | 19    | 4                  | 76              | 5                | 95 | 3 = Cukup |
|    | c. Laboratory facilities, field, recreation and other activities | 18    | 4                  | 72              | 5                | 90 | 2 = Kurang |
| 2  | Project Value                   | 20    | 4                  | 80              | 5                | 100 |       |
| 3  | Social Impact                   |        |                     |                  |
|    | a. Land acquisition             | 10    | 4                  | 40              | 3                | 30 |       |
|    | b. Flood Risk in Downstream Areas | 15    | 4                  | 60              | 3                | 45 |       |
|    | Total                           | 100   | 382                | 432             |                  |

4. Conclusion

a. Value engineering application can be done at any time throughout the project time, from the initial planning process to the end of the project implementation.

b. Based on the engineering value analysis, namely by reducing the width of the dam, there are several optimization of the dam rehabilitation performance, namely:
   a. Dam flow discharge = 17.90 m^3 / sec / meter
   b. Raw water needs 600 litters / second
   c. It has an educational park area and a SPAM centre of around 53000 square meters and is equipped with open spaces as a tourism centre.

c. With a little cost efficiency from the value of the project, which is around 2.95%, a more optimal reservoir function and performance were obtained. text of your paper should be formatted as follows:

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