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Implementation of Value Engineering in Evaluating the Project Plan of Agrosari Water Supply Construction in Kutai Kartanegara

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Abstract— *This study aims to implement value engineering analisis to the project plan of Agrosari Drinking Water Supply System (SPAM) in Samboja District, Kutai Kartanegara Regency. This case study applies quantitative methods. Value engineering analysis is performed to analyze the budgetting of three works in the project; construction of water treatment plant, electrical mechanics, and reservoir construction. The value engineering model applied in this study is a job plan. Primary data were obtained through direct interviews with the project manager and other parties involved in the drinking water supply system development plan. Secondary data includes working drawings, budget plans, work plans, and requirements. Meanwhile, the value engineering analysis stage includes the stages of information, function analysis, creative, evaluation, and recommendations. The Agrosari clean water supply system (SPAM) construction project has a bid rate of IDR 29,697,700,000. Based on the results of the analysis, it can be concluded that the application of value engineering for the Agrosari drinking water supply system development project plan, Kutai Kartanegara, was able to generate significant cost savings in the aspects of the water treatment plant construction work, electrical mechanics, and reservoir construction. The value of savings for each job sequentially is 26% (IDR 1,100,000,000), 3.24% (IDR 132,000,000), and 48% (IDR 1,496,573.199). The results of this value engineering can be considered by the relevant project management, and should be applied before the project is implemented. The budget plan needs to be reviewed so that the financing of development projects is more effective and efficient. The selection of alternatives carried out in this study does not only refer to the lowest costs, but still maintains the quality of these alternatives. To reduce risks in selecting alternatives, calculations should be made regarding material preparation, work methods, and the expertise of construction workers.*

Keywords— *Value engineering, construction project, SPAM Argosari, drinking water.*

I. INTRODUCTION

Regional development is closely related to population growth and population density. The greater the population growth can show that the area has its own charm to live in. Growth in population which is getting bigger from time to time also has an impact on increasing the need for facilities and infrastructure in an area. One of the impacts that occur as a result of population growth is an increase in the amount of clean water use. This clean water will be used by humans to carry out daily production and consumption activities such as industrial activities, agriculture, animal husbandry, cooking, washing, bathing and so on (Wulandari, 2018).

The use of water resources that demands the best quality is consumption, where water must be hygienic and clean. The use of unhygienic water will have an adverse impact on health. According to Regulation of the Minister of Health Number 32 of 2007, good quality water is water that meets the physical quality requirements; odorless, colorless, tasteless, meets chemical quality, and does not contain microorganisms. On the other hand, water can also cause disaster if the quantity exceeds the normal threshold.

The provision of clean water needs in Indonesia cannot be separated from the government's role in building a drinking water supply system. This is explained through Government Regulation number 122 of 2015 concerning drinking water supply systems (SPAM). The regulation regulates the source of raw water, its processing, piping spam and its management. This regulation applies in all spheres of local government, including in the Kutai Kartanegara area, namely through Regional Regulation (Regent) number 28 of 2015 concerning the master plan for the drinking water supply system (RISPAM) through regional work units of the Housing and Settlement Area Services and business entities owned area, namely Perumda Tirta Mahaka. The two stakeholders were appointed as managers of the drinking water supply system in the Kutai Kartanegara Regency.

Kutai Kartanegara Regency is one of the second largest districts on the island of Borneo in general and in the Province of East Kalimantan in particular. Kutai Kartanegara Regency has an area of 27,263 km² and consists of 20 districts, 44 sub-districts and 193 villages. In 2020, the district's population will reach 734,485 people, with a population distribution of 28 people/km². Given the vast area and large population in Kutai Kartanegara district, the development program must be prepared in a fair and equitable manner to ensure that the needs of every resident are met with each activity sector, be it the transportation sector (land and water), education, health (medical personnel, medicine- medicine, sanitation and clean water), agriculture, fisheries, and plantations.

Currently, the Kutai Kartanegara district government has built 19 drinking water supply systems in several sub-district capitals and 19 branches of village processing units, as well as 67 other units in community-based rural areas (PAMSIMAS). With a population that continues to increase, the development of this drinking water supply system will continue to increase all the time. Another factor that has contributed to the importance of developing a clean water supply system is to meet the growing demand for consumption and sanitation, related to the development of the nation's capital city in East

Kalimantan, including in the Kutai Kartanegara region. Regions in the province of East Kalimantan are required to respond quickly to their regional development, in line with the currently ongoing development of the national capital.

For example, the construction of a clean water supply system in Samboja District and its surroundings is managed by the Housing and Settlement Area Office. One of the programs that will take place is the construction of the Agrosari SPAM, a clean water supply system that utilizes the Ambarawang weir as a source of raw water. This water supply system aims to support the Salok Api SPAM which is currently unable to meet the community's water needs in line with the increase in population in the area. In the 2020 fiscal year, the Department of Housing and Settlement Areas is making a technical plan for the construction of SPAM Agrosari with an expectation that the water production capacity will reach 50 liters per second. Meanwhile, the total engineer estimate value of this construction reaches IDR 29,000,000,000.

The construction of a clean water supply system requires high costs, so value engineering is needed to find the point of efficiency. Value engineering is a management technique using a systems approach to identifying non-essential functions and eliminating unnecessary costs. The goal is to get infrastructure functions that meet standards and requirements, but with a minimum total cost. The value engineering approach must, of course, maintain the safety, performance, reliability and quality aspects of the product/project (Sompie, 1993). The application of value engineering will provide great benefits for many parties in the long run. For the local government of Kutai Kartanegara, the results of the application of value engineering in the drinking water supply system development project will result in budget efficiencies, which in the future the results of these cost savings can be used for other infrastructure developments.

Previous studies have proven the importance of value engineering in planning development projects, especially large-scale development. To apply value engineering to the fullest, Nandito et al. (2020) explained that coordination between value engineering specialists, project owners, and planners is an important factor that must take place in an integrated manner. This is useful for in-depth and detailed research regarding the truth and accuracy of all shopping needs. so that value engineering efforts can be carried out properly and perfectly. Mesquita et al. (2019) evaluated the need for concrete column beams and steel columns in the Malang City MPU Purwa Museum development project. The value engineering approach shows that construction costs should be reduced by up to 10% if a more economical alternative is used, which in this case is steel. Simpurupura (2017) explained similar findings, that the application of value engineering can reduce the cost of building a five-story office building by 25.15%, namely by using a steel frame structure compared to a reinforced concrete frame structure. Soares (2018) applies value engineering to evaluate the construction of the Dinoyo City Mall, Malang City. The results of his research show that development should be able to reduce costs by up to 9.68%. The significance of cost savings through the implementation of value engineering was also reported by Diputera (2018) and Rozi et al. (2022).

This study aims to apply value engineering to the Agrosari Drinking Water Supply System (SPAM) development project plan in Samboja District, Kutai Kartanegara Regency. This application is intended to determine the best results from development efficiency without leaving the function and continuity of a drinking water supply system. For this reason, this research technically identifies which work items are the most efficient and effective, determines the best alternative that can replace the initial design of the selected work items, and calculates cost savings based on the application of value engineering. The results of this study will benefit the local government in saving the budget for the development of drinking water supply systems. In addition, the research results can also become important discourse for the planners of any construction project to apply value engineering before project implementation begins.

II. METHOD

This research is included in the type of case study, with the object being a project plan for the development of the Agrosari drinking water supply system (SPAM) in Samboja District, Kutai Kartanegara Regency, East Kalimantan. This drinking water supply system is planned to have a production capacity of 50 liters per second. Value engineering analysis is applied to the work aspects of intake, transmission pipelines, water treatment plants, mechanical and electrical, as well as distribution pipelines. Based on the type of data, this study uses a quantitative method to determine the gaps and efficiency of the planned construction material requirements. The value engineering model applied in this study is a job plan based on Dell'Isola's theory (1975).

Primary data was obtained through direct interviews with project managers and people involved to obtain comprehensive information regarding development projects. Secondary data includes working drawings, budget plans, work plans, and requirements. Meanwhile, the value engineering analysis stage includes the stages of information, function analysis, creative, evaluation, and recommendations.

The Agrosari clean water supply system (SPAM) construction project has a bid price of IDR 29,697,700,000. Furthermore, a preliminary analysis of the project plan has been carried out to determine the work items with the highest rank (in cost terms) to be reviewed using a value engineering approach. The work items are construction of a water treatment plant, electrical-mechanical work, and reservoir construction.

III. RESULT AND DISCUSSION

This study applies value engineering to three aspects of the work in the Argosari drinking water supply system construction project plan, Kutai Kartanegara, namely the construction of a water treatment plant, electrical mechanics, and reservoir construction. The value engineering model applied in this study is a job plan. The three work items were chosen because they have the highest ranking in terms of financing, with cost values as shown in Table 1. Furthermore, the value engineering analysis for each work item will be explained in separate sections.

TABLE I. Value of work items in the Argosari SPAM project with the highest ranking

No	Work Description	Total Cost (IDR)	Weight (%)	Cumulative Weight (%)
1	Water Treatment Plant	5.626.882.226,77	21,03	21,03
2	Electrical-Mechanical	4.490.765.000,00	16,78	37,82
3	Reservoir Construction	2.925.102.337,06	10,93	48,75
Total		13.042.749.563,83		

A. Water Treatment Plant

The water treatment plant construction work in the Agrosari SPAM development plan has the highest rank in terms of the amount of financing. The scope of the problem refers to alternative material planning, material quality and the function of the structure, namely to support the building load. The initial work plan will be reviewed to obtain the most efficient construction costs. Alternative replacement materials are obtained by brainstorming with several people involved in the field, including the project manager and project owner. Through a series of value engineering analysis processes, in the end a recapitulation of the analysis results is obtained as shown in Table 2. Water treatment plant construction work has the highest weight with a score of 1.00 and a savings value of 26% or IDR 1,100,000,000.

TABLE II. Results of the evaluation of the water treatment plant construction work

No	Weight	Subject Comparison	Initial Plan	Alternative 1	Alternative 2
		Total cost (IDR)	5.200.000.000,00	5.200.000.000,00	4.100.000.000,00
		Saving amount (IDR)	-	0	1.100.000.000
		Saving percentage	-	0%	26%
1	31.3%	Construction cost	3	2	1
2	33.2%	Quality and durability	3	2	1
3	7.0%	Aesthetics	1	1	1
4	14.5%	Time of operation	1	1	1
5	14.0%	Material ease of obtain	1	1	1
		Total	2.29	1.64	1.00
		Rank	3	2	1

B. Electrical Mechanics Jobs

The electrical mechanics work on the Agrosari SPAM development plan is planned to use a DWKE submersible intake pump, a VSD Cue 37 Kw intake pump panel, and the installation of a Q 47.36 l/s vertical multistage distribution pump. This work will be re-analyzed/replaced because it has a large enough cost. The criteria for selecting the material used are ensured that it meets the elements of the scope of the problem examined at the function analysis stage. Alternative replacement materials are obtained by brainstorming with the project manager and project owner. The unit price analysis calculations from electrical mechanics work are also reviewed to determine alternative materials at lower prices. The final results of the value engineering analysis on electrical mechanic work are shown in Table 3. Electrical mechanic work has a score of 1.00 and a saving value of 3.24% or IDR 132,000,000

TABLE III. Results of the evaluation of electrical-mechanical work

No	Weight	Subject Comparison	Initial Plan	Alternative 1	Alternative 2
		Total cost (IDR)	4.490.765.000	4.490.765.000	3.936.845.000
		Saving amount (IDR)	-	0	132.000.000
		Saving percentage	-	0%	3,24%
1	27.1%	Construction cost	3	2	1
2	30.3%	Quality and durability	2	2	1
3	13.8%	Aesthetics	1	1	1
4	13.6%	Time of operation	1	2	1
5	15.2%	Material ease of obtain	1	1	1
		Total	1.84	1.71	1.00
		Rank	3	2	1

C. Pekerjaan Pembangunan Reservoir

Reservoir development work on the Agrosari SPAM construction project plan is planned with sections using a 400 M3 glass fused steel reservoir. This initial plan was reviewed to evaluate the cost of procuring and installing a 400M3 glass fused steel reservoir because the cost was quite high. The criteria for selecting the material used must fulfill the elements of the scope of the problem examined at the function analysis stage. Alternative replacement materials are obtained by brainstorming with several people involved in the field. The parties invited to discuss in determining alternative replacements are the project manager and the project owner. This discussion will result in alternative decisions to substitute materials at a lower cost. The 400M3 glass fused steel reservoir is recommended to be replaced with a 400M3 tiger water solution reservoir. In addition, the initial specification which has a diameter of 11140 mm and a minimum height of 4370 mm is recommended to be replaced with a diameter of 11680 mm and a minimum height of 3560 mm. Reservoir construction work has the highest weight with a score of 1.00 and a saving value of 48% or IDR 1,496,573,199, -.

TABLE IV. Results of evaluation of reservoir construction work

No	Weight	Subject Comparison	Initial Plan	Alternative 1	Alternative 2
		Total cost (IDR)	2.925.102.337	2.925.102.337	1.428.529.137
		Saving amount (IDR)	-	0	1.496.573.199
		Saving percentage	-	0%	52%
1	31.3%	Construction cost	3	2	1
2	33.2%	Quality and durability	1	1	1
3	7.0%	Aesthetics	1	2	1
4	14.5%	Time of operation	1	1	1
5	14.0%	Material ease of obtain	3	1	1
		Total	2.29	1.64	1.00
		Rank	3	2	1

In general, the points of value engineering analysis results can be explained as follows:

1. In the water treatment plant construction work, installation of a treatment plant (complete package) with a capacity of 50 liters per second (initial price per unit IDR 5,200,000,000) is replaced with a treatment plant (complete package) with the same capacity, but with lower unit price; IDR 4,100,000,000. That is, the value of the savings achieved is IDR 1,100,000,000, or 26%.
2. In the electrical mechanics work, procurement and installation of the intake submersible pump DWKE.10.200.300.5.1D was replaced with a unit costing IDR 318,000,000 per unit. In addition, the VSD Cue 37 Kw intake pump panel was replaced with a 37 Kw Star Delta Soft Starter intake pump panel costing IDR 90,240,000. Finally, the vertical multistage distribution pump Q 47 l/s was replaced with a vertical multistage Q 50 l/s with a unit price of IDR 382,800,000. That is, the value of the savings achieved is IDR 132,000,000, or 3.24%.
3. In the reservoir construction work, a 400M3 glass fused steel reservoir with a price per unit of IDR 2,527,000,000 replaced with a 400M3 tiger water solution reservoir at a price per unit of IDR 1,030,426,800. That is, the value of the savings achieved is IDR 1,496,573,199, or 48%.

IV. CONCLUSION

Based on the results of the analysis, it can be concluded that the application of value engineering for the Agrosari drinking water supply system development project plan, Kutai Kartanegara, was able to generate significant cost savings in the aspects of the water treatment plant construction work, electrical mechanics, and reservoir construction. The value of savings for each job sequentially is 26% (IDR 1,100,000,000), 3.24% (IDR 132,000,000), and 48% (IDR 1,496,573,199). The results of this value engineering can be considered by the relevant project management, and should be applied before the project is implemented. The budget plan needs to be reviewed so that the financing of development projects is more effective and efficient. The selection of alternatives carried out in this study does not only refer to the lowest costs, but still maintains the quality of these alternatives. To reduce risks in selecting alternatives, calculations should be made regarding material preparation, work methods, and the expertise of construction workers.

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