ustainable Civil Building Management and Engineering Journal Vol: 1, No 3, 2024, Page: 1-11

Value Engineering Analysis on Building Structure (Case Study: Java Steam Power Plant 9&10 2x1000 MW Suralaya Project)

Reza Andhika Putra*, Setiono, Fajar Sri Handayani

Sebelas Maret University

DOI:
https://doi.org/10.47134/scbmej.v1i3.2835
*Correspondence: Setiono
Email:
andhikareza_2210@student.uns.ac.id

Received: 11-06-2024
Accepted: 14-06-2024
Published: 17-06-2024

Abstract: Cost is an important element in the success of a project because problems with project implementation costs can hinder the achievement of the project. Problems in project implementation related to costs can be overcome by carrying out value engineering analysis. The concept of value engineering is a systematic effort to analyze existing problems and aims to achieve the desired functions or types of work with efficient costs and optimal results. The value engineering carried out in the case study analyzed by the author is a change in the implementation of concrete work from conventional methods to precast methods to obtain cost efficiency. The method used is a data collection method and analysis method according to the value engineering analysis stages. The results of the value engineering analysis obtained by the author through creative ideas in the form of changing conventional concrete work to precast concrete are savings in work costs on building structural components in the form of slabs. The cost savings obtained were Rp695,905,059.00 or 2.21%.

Keywords: Cost, Precast Concrete, Value Engineering

Introduction

The increasing need for national electricity supply is the beginning of the government's plan to build infrastructure related to the addition of national electricity supply in the form of PLTU (Steam Power Plant). In addition, the construction of new PLTU is also carried out to overcome possible problems that arise such as the performance of plants that are considered inappropriate and must be replaced (Alkalis, 2021). Suralaya Village in Cilegon City, Banten Province, was chosen as one of the locations for the construction of a PLTU in Java Island called PLTU Jawa Unit 9&10. This is due to the results of feasibility studies that have been carried out previously, including the availability of a large enough plain land that is less suitable for agriculture, sufficient sea depth for ships to dock, the surrounding population that is not too dense so as to facilitate land acquisition, and so on(Hutauruk et al., 2021).

Construction projects are one of the complex things because they require careful calculation and analysis as well as certain considerations that will produce buildings that are up to standard, economical, and aesthetic (Gulo et al., 2022). The implementation of a construction project can run well when it has good resources, including labor, costs, work methods, machinery or equipment, and materials used (Fitriyana et al., 2019). In the implementation of construction projects, management science is also needed so that existing resources can be managed properly so as to produce good performance, integration and harmony between resources, accuracy, accuracy and high accuracy, and have work security and safety (Wibowo et al., 2020). By definition according to Soeharto (1999), construction project management is the process of planning, organizing, leading, and controlling the activities of organizational members and other resources so as to achieve predetermined organizational goals (Dimyati et al., 2014). The implementation of construction management requires resources that are experts in their respective fields which include Planning, Organizing, Actuating, and Controlling or commonly called POAC systematically and measurably (Albar, R.F., 2023). A construction project is said to be successful if it can manage and utilize available resources with maximum results and can find the right solution if unwanted problems arise (Tama et al., 2020). One of the problems that often arise in the implementation of construction projects is the problem of cost management(Rudiyantoa et al., 2023).

This PLTU construction project is the same as other infrastructure projects that are greatly affected by costs. Cost is the main component and its existence is vital for the running of the project because any cost shortfall will hinder the progress of the project (Wulandari et al., 2022). In every project implementation, there are ways to prevent cost shortages, namely by making cost savings. One method of saving costs on a project is with Value Engineering (VE) Analysis(Syahputra et al., 2019).

According to Rani, H. A., (2022), Value Engineering is a systematic and structured concept in conducting analysis to achieve the best value in construction projects. Value Engineering is carried out to reduce/save project costs incurred without reducing the quality and performance produced, and still pay attention to the appropriate duration. In the implementation of Value Engineering analysis, there are terms cost breakdown and pareto distribution law that must be analyzed first. Cost breakdown is a presentation of cost details used to describe the cost distribution of each work item in a project (Musliha et al., 2021). Pareto distribution law is a law that must be analyzed to determine which work components are worth doing Value Engineering(Darmawan & Yuwono, n.d.).

Concrete is a mixture of Portland cement or other hydraulic cement, fine aggregate, coarse aggregate, and water, with or without additives (SNI 2847, 2019). Reinforced concrete is a combination of concrete and steel tulans that have high strength and elasticity. Some components of building structures that use reinforced concrete materials are beams, columns, slabs, and so on. Beams are the main structural components that resist bending and shear, and columns are structural components that are vertically mounted and used to bear moments, shear, and torsion (SNI 2847, 2019). Concrete slabs are structural elements that receive live and dead loads on the floor which are transmitted to beams and columns to the lower structure (Mozes et al., 2017).

Precast concrete is a concrete element or component without or with reinforcement that is pre-molded before being installed in such a way that it becomes a building (Santoso et al., 2020). According to Triwiyono, A. (2005), precast concrete is usually composed of components that are prepared elsewhere and then lifted, transported and installed in the final position to be joined with other components to form a complete building (Sufyana et al., 2023).

This research uses a case study of the Flue Gas Desulfurization and Electrostatic Precipitator Control and Electrical Building of the Java 9&10 2x1000 MW Suralaya PLTU Project. The FECB building is a building used to control and control the mixing of gas emissions from coal combustion with CaCO3 and control the ash from the combustion process (Nugraha & Muflikhun, 2023).

Methodology

This research applies the discipline of construction management with the Value Engineering Job Plan study. This study is used to obtain cost efficiency from a project by coming up with new creative ideas. The methods used in this research are data collection methods and analysis methods based on Value Engineering analysis procedures (Devi & Putu, 2020).

This research was conducted at the Java 9&10 Coal Fired Steam Power Plant (PLTU) Development Project, Jalan Yos Sudarso No.42, Pulomerak District, Cilegon City, Banten Province. The Java 9&10 Suralaya PLTU was built on an area of 67.9 hectares (Purnomo & Haryono, 2020).

Figure 1. Project Sites as Research Case Studies.

Value Engineering Job Plan is the analysis method used in this research. Analysis using Value Engineering (VE) consists of 5 stages (Rani, H.A., 2022), namely (Prabasiwi, Sukirno, et al., 2020):

1. Information stage, is the initial stage of the Value Engineering (VE) analysis carried out to collect data and information needed in the Value Engineering (VE) analysis. The data and information in question include project identity, cost breakdown model, and pareto distribution law.
2. Creative stage, is a stage that brings up creative ideas or alternatives that are considered to be able to do Value Engineering (VE) analysis based on data and information that has been previously available.
3. Analysis stage, is the stage to analyze the alternatives that arise with the appropriate formulation. The results of the analysis of several existing alternatives can be selected based on the order of the most efficient cost.

4. Development stage, is a preparatory stage for making recommendations/reporting which begins with making a concept to compare existing conditions with alternative conditions.
5. Recommendation/reporting stage, is the final stage of the Value Engineering (VE) analysis. This stage is in the form of a written presentation in the form of a final or oral report of the selected alternative and presents considerations in accordance with the results of the analysis(Sagaf, 2020) .

Result and Discussion

Information Stage

The Java Steam Power Plant 9&10 Suralaya construction project, especially in the FECB building which functions to control the mixing of coal combustion gas emissions with CaCO3 and control the ash from the combustion process, consists of 4 floors and 1 rooftop(Prabasiwi, Murniasih, et al., 2020). The construction of this FECB building spent a budget of Rp31,491,848,963.00. The following are the results of the Pareto distribution law analysis presented in Table 1.

Table 1: Pareto distribution analysis results of FECB structure of Java 9&10 Suralaya PLTU Project

No	Type of Work	Cost (Rp)	Cost Percentage (%)	Cumulative Percentage (%)
1	Foundation Work	1.764.539.116	5,60	5,60
2	PIT & Duct Bank Work	978.931.193	3,11	8,71
3	Beam Work	11.098.878.667	35,24	43,96
4	Column Work	9.777.000.211	31,05	75,00
5	Slab Work	6.092.030.575	19,34	94,35
6	Staircase 1 Work	1.154.408.595	3,67	98,01
7	Staircase 2 Work	585.581.739	1,86	99,87
8	Canopy Work	26.669.992	0,08	99,96
9	Embedded Steel	13.808.875	0,04	100,00
	Total	**31.491.848.963**	100,00	

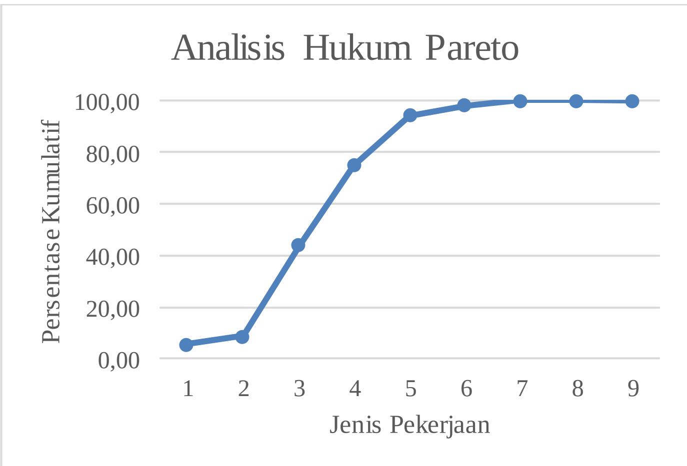

Figure 2. Pareto distribution analysis graph of FECB building structure of Java 9&10 Suralaya PLTU Project

Based on the results of the analysis using Pareto's Law, three jobs with the highest percentage of costs were obtained, namely Beam Work (35.24%), Column Work (31.05%), and Plate Work (19.34%). However, in this research, the object of research using Value Engineering Analysis is only on plate work because the dimensions of the columns and beams are so large that it is difficult to do with precast concrete methods(Yudisaputro et al., 2021).

Creative Stage

At this stage, there is an idea to save the cost of implementing the work, namely changing the work from conventional concrete to precast concrete. This is because the slab work, which has a cost percentage of 19.34%, has the potential to be carried out using the precast concrete method(Lukmana & Helmy, 2020).

Analysis Stage

This analysis stage is carried out to analyze and evaluate alternative ideas obtained at the creative stage(Prasetyo, Oktaufik, & Himawan, 2019). The results of this analysis stage are used to determine alternative ideas that can be a solution(Prasetyo, Oktaufik, & ..., 2019). The analysis carried out on existing alternative ideas is to calculate the estimated cost of existing and alternative work. The following is an estimate of the cost of existing work made based on the guidelines for analyzing the Unit Price of Work listed in the PUPR Ministerial Regulation No.8 of 2023 with the Basic Unit Price obtained from the Banten Governor Regulation No.39 of 2021 concerning Standard Unit Prices for Goods / Services of the Banten Provincial Government for the 2022 Budget Year with a 5% price increase. The following are the estimated cost of existing slab work presented in Table 2(Cahyaningsih et al., 2019).

Table 2: Estimated cost of existing slab work (conventional concrete)

No	Type of Work	Unit	Volume	Unit Price	Total Price
1	Lean Concrete FC' 15 MPa	m^3	59,08	Rp1.602.315	Rp94.664.790
2	Formwork	m^2	4523,48	Rp563.042	Rp2.546.907.865
3	Concrete fc' 30 Mpa	m^3	964,81	Rp1.804.849	Rp1.741.336.557
4	Grouting 450 kg/cm2	m^3	0,23	Rp14.289.615	Rp3.286.611
5	Reinforcement Bar D10	kg	33931,23	Rp16.661	Rp565.323.142
6	Reinforcement Bar D13	kg	49826,45	Rp13.713	Rp683.288.315
7	Removal of Reinforcement Bar	kg	70636,85	Rp6.187	Rp437.053.854
8	Concrete Curing	m^2	4556,74	Rp4.426	Rp20.169.441
	Total				**Rp6.092.030.574**

Based on the results of the Unit Price Analysis of Work referring to the Regulation of the Minister of PUPR No.8 of 2023 with the Basic Unit Price referring to Banten Governor Regulation No.39 of 2021 for Fiscal Year 2022 with a 5% price increase, the total cost of existing slab work is Rp6,092,030,574.00(Jason et al., 2019).

After obtaining the cost of existing slab work (conventional concrete), the calculation of the cost of alternative slab work (precast concrete) can be submitted as follows. The following are the estimated cost of alternative slab work presented in Table 3(Triani et al., 2024).

Table 3: Estimated cost of alternative slab work (precast concrete)

No	Type of Work	Unit	Volume	Unit Price	Total Price
1	Formwork	m2	4523,48	Rp485.430	Rp2.195.832.059
2	Concrete	m3	964,81	Rp1.744.177	Rp1.682.799.460
3	Reinforcement Bar D10	kg	33931,23	Rp16.661	Rp565.323.142
4	Reinforcement Bar D13	kg	49826,45	Rp13.713	Rp683.288.315
5	Erection	buah	74,00	Rp1.150.558	Rp85.141.294
6	Precast Slab Mobilization	ea	1,00	Rp60.000.000	Rp60.000.000
7	Concrete Curing	m2	4556,74	Rp27.156	Rp123.741.246
		Total			**Rp5.396.125.515**

Function Analysis is carried out to classify the functions that exist in a work item. The results of the classification can be used to determine the comparison between the cost and the value of the benefits obtained. The following are the analysis of slab work function presented in Table 4(Komarudin et al., 2023).

Table 4: Analysis of Slab Work Function

No	Description	Verb	Noun	*Cost* (Rp)	*Worth* (Rp)
1	Lean Concrete fc' 15 MPa	Preventing	Infiltration	94.664.790	-
2	Formwork	Giving	Shape	2.546.907.865	2.195.832.059
3	Concrete fc' 30 MPa	Holding	Press	1.741.336.557	1.682.799.460
4	Grouting 450 kg/cm2	Repairing	Broken	3.286.611	-
5	Reinforcement Bar D10	Holding	Pull	565.323.142	565.323.142
6	Reinforcement Bar D13	Holding	Pull	683.288.315	683.288.315
7	Removal of Reinforcement Bar	Lifting	Shape	437.053.854	-
8	Concrete Curing	Maintaining	Result	20.169.442	123.741.246
9	Erection	Installing	Shape	-	85.141.294
10	Precast Slab Mobilization	Carrying	Shape	-	60.000.000
	Total			**6.092.030.575**	**5.396.125.515**
	Ratio Cost/Worth				**1,1290**

Description:

a. Cost value obtained from existing costs.

b. Worth value obtained from alternative costs.

c. Cost/Worth ratio > 1 indicates cost savings

Development Stage

Based on the results of the analysis, the author recommends changing concrete work from conventional methods to precast methods, especially in slab work due to lower implementation costs(Muslihudin et al., 2022). The following is an estimate of the total cost of alternative slabs when using precast concrete work on slab components presented in Table 5.

Table 5: Estimated cost of structural works after the change of conventional slab to precast slab

No	Type of Work	Total Cost
1	Foundation Work	Rp1.764.539.116
2	PIT & Duct Bank Work	Rp978.931.193
3	Beam Work	Rp11.098.878.667
4	Column Work	Rp9.777.000.211
5	Slab Work	Rp5.396.125.515
6	Staircase 1 Work	Rp1.154.408.595
7	Staircase 2 Work	Rp585.581.739
8	Canopy Work	Rp26.669.992
9	Embedded Steel	Rp13.808.875
	Total	**Rp30.795.943.904**

Recommendation Stage

The recommendation stage of the Value Engineering Analysis study is described as follows(Muslim-Muslim et al., 2024):

1. Existing Conditions
   The cost of work for the Flue Gas Desulfurization & Electrostatic Precipitator Control and Electrical Building (FECB) Structure is IDR 31,491,848,963.00.
2. Alternative Conditions
   Based on the results of the Value Engineering analysis that has been carried out, the alternative design that has been analyzed is to change from conventional concrete work to precast concrete on the slab work. The alternative resulted in savings of Rp695,905,059.00 or 2.21% of the existing cost. The following is a detailed comparison of existing and alternative work costs (after Value Engineering analysis).

Table 6. Recapitulation of the comparison of the final results of existing and alternative costs

No	Type of Work	Total Existing Price	Total Alternative Price	Price Difference Ratio (%)
1	Foundation Work	Rp1.764.539.116	Rp1.764.539.116	0,00
2	PIT & Duct Bank Work	Rp978.931.193	Rp978.931.193	0,00
3	Beam Work	Rp11.098.878.667	Rp11.098.878.667	0,00
4	Column Work	Rp9.777.000.211	Rp9.777.000.211	0,00
5	Slab Work	Rp6.092.030.575	Rp5.396.125.515	11,42
6	Staircase 1 Work	Rp1.154.408.595	Rp1.154.408.595	0,00
7	Staircase 2 Work	Rp585.581.739	Rp585.581.739	0,00
8	Canopy Work	Rp26.669.992	Rp26.669.992	0,00

9	Embedded Steel	Rp13.808.875	Rp13.808.875	0,00
	JUMLAH	**Rp31.491.848.963**	**Rp30.795.943.904**	**2,21**

Conclusion

Based on the Value Engineering analysis conducted on the Java 9&10 Coal Fired Steam Power Plant 2x1000 MW Suralaya Construction Project, especially the Flue Gas Desulfurization & Electrostatic Precipitator Control and Electrical Building (FECB) Structure, the following conclusions can be drawn:

1. The types of work carried out cost efficiency using Value Engineering Analysis are column, beam, and plate work. However, the author only examines Value Engineering Analysis on plate work because the dimensions of the columns and beams are too large and less possible to implement with precast concrete.
2. The cost comparison before and after the Value Engineering Analysis is the cost before (existing) of Rp31,491,848,963.00 and the cost after (alternative) of Rp30,795,943,904.00.
3. The results of the Value Engineering analysis resulted in cost savings for structural work of Rp695,905,059.00 or 2.21% of the cost of existing work obtained from changing the use of conventional concrete slabs to precast concrete slabs.

References

Albar, R. F. (2023). Evaluasi Kinerja Manajemen Konstruksi Proyek Pembangunan Kantor Dinas Kesehatan. Jurnal Konstruksi Institut Teknologi Garut, 21(2). https://doi.org/10.33364/konstruksi/v.21-2.1409.

Alkalis, G. (2021, September 28). PLTU Jawa 9 dan 10 Pembangkit Ramah Lingkungan Perkuat Kelistrikan Jamali. Ruang Energi. Diakses pada 8 September 2023, dari https://www.ruangenergi.com/pltu-jawa-9-dan-10-pembangkit-ramah-lingkungan-perkuat-kelistrikan-jamali/.

Badan Standarisasi Nasional. (2019). Persyaratan Beton Struktural Untuk Bangunan Gedung (SNI No. 2847-2019).

Cahyaningsih, S., Wulan, D. R., & Sembiring, T. (2019). Water quality assessment around a coal-fired power plant in southern coast of Java, Indonesia. Regional Studies in Marine …. https://www.sciencedirect.com/science/article/pii/S2352485518302159

Darmawan, N., & Yuwono, T. (n.d.). The Effect of Jakarta Bay Reclamation on the Performance of the Steam Turbine of Muara Tawar Power Plant, Indonesia. Researchgate.Net. https://www.researchgate.net/profile/Triyogi-Yuwono/publication/335579643_Effect_of_Increasing_Sea_Water_Temperature_on_Performance_of_Steam_Turbine_of_Muara_Tawar_Power_Plant/links/5e768b744585157b9a5130fb/Effect-of-Increasing-Sea-Water-Temperature-on-Performance-of-Steam-Turbine-of-Muara-Tawar-Power-Plant.pdf

Devi, O., & Putu, D. K. (2020). Improving Overhaul Process on Steam Power Plants using Lean Thinking and LCA. IOP Conference Series: Earth and …. https://doi.org/10.1088/1755-1315/448/1/012043

Dimyati, H., & Nurjaman, K. (2004). Manajemen Proyek. Bandung: Pustaka Setia. Vol.12 (2), ISBN: 978-979-076-438-5.

Fitriyana, T. (2019). Analisis Manajemen Konstruksi Pembangunan Gedung POLRESTA Pontianak Dengan Perhitungan SNI dan Analisa Software Microsoft Project 2016. Jurnal Teknik Kelautan, PWK, Sipil, dan Tambang Universitas Tanjungpura, 6(3). https://dx.doi.org/10.26418/jelast.v6i3.38844.

Gulo, D. P. J. (2022). Analisa Manajemen Konstruksi Proyek Pembangunan Gedung Koperasi Astra Internasional Jakarta Pusat. Jurnal Ilmiah Teknik Sipil Universitas Darma Agung Medan, 11(1). http://dx.doi.org/10.46930/tekniksipil.v11i1.1720.

Hendrianto, G. K. (2018). Analisis Value Engineering untuk Efisiensi Biaya (Studi Kasus: Proyek Apartemen Yukata Suites Alam Sutera Tangerang). Matriks Teknik Sipil, 6(4). https://doi.org/10.20961/mateksi.v6i4.36538.

Hutauruk, B. C., Martono, D. N., & ... (2021). Risk and Impact Control of PM2. 5 and SO2 Exposure of Power Plant to Communities (A Case Study in the Steam Power Plant Babelan Bekasi). Jurnal Kesehatan …. https://pdfs.semanticscholar.org/15fb/f30055fc20a578ccb6c39c6bc28df7dbeb9e.pdf

Jason, A., Asih, A. M. S., & Yuniarto, H. A. (2019). Analysis of coal allocation on steam power plants and the effect of multi-suppliers, demand and time variations on coal's safety stock. IOP Conference Series …. https://doi.org/10.1088/1757-899X/673/1/012074

Komarudin, K., Abrianto, H. H., Multi, A., & ... (2023). Performance analysis of extraction condensing turbine-unit 1 at Pltu X, Bekasi, West Java. International Journal of …. https://greenpub.org/IJAM/article/view/217

Lukmana, A. H., & Helmy, M. F. (2020). A Techno-Economic Analysis of Geothermal Energy in West Java. … of LPPM UPN …. http://proceeding.researchsynergypress.com/index.php/ess/article/view/130

Mozes, M. S. (2017). Kuat Lentur Panel Lantai Pracetak Beton Ringan Menggunakan Agregat Kasar Pumice. Laporan Tugas Akhir, Yogyakarta.

Musliha, S. S. A. (2021). Analisis Value Engineering pada Struktur Bangunan dengan Metode Analytical Process (AHP) (Studi Kasus: Proyek Supporting Unit DPRD Kota Salatiga). Matriks Teknik Sipil, 9(1). https://doi.org/10.20961/mateksi.v9i1.51241.

Muslihudin, M., Adawiyah, W. R., Hendarto, E., & ... (2022). Environmental constraints in building process a sustainable geothermal power plant on the slopes of slamet mount, central java, indonesia. catalog.lib.kyushu-u.ac.jp. https://catalog.lib.kyushu-u.ac.jp/ja/recordID/4793669/?repository=yes

Muslim-Muslim, M., Wulandari, S. Y., Maslukah, L., & ... (2024). Radiological impact of the operation of two Steam Power Plants on the activity levels of 232Th, 226Ra and 40K in the sediments at Semarang and Cirebon, Indonesia. researchsquare.com. https://www.researchsquare.com/article/rs-4480254/latest

Nugraha, A. D., & Muflikhun, M. A. (2023). Failure in power plant system related to mitigations and economic analysis; A study case from steam power plant in Suralaya, Indonesia. Results in Engineering. https://www.sciencedirect.com/science/article/pii/S2590123023001317

Prabasiwi, D. S., Murniasih, S., & ... (2020). Transfer factor as indicator of heavy metal content in plants around adipala steam power plant. Journal of Physics …. https://doi.org/10.1088/1742-6596/1436/1/012133

Prabasiwi, D. S., Sukirno, S., & Murniasih, S. (2020). Assessment of heavy metals pollution and risks around Tuban steam power plant using neutron activation analysis. AIP Conference Proceedings. https://doi.org/10.1063/5.0000931/14209714/030005_1_online

Prasetyo, B. T., Oktaufik, M. A. M., & ... (2019). Testing of Early Stage of BPPT-3MW Condensing Type Small Scale Geothermal Power Plant–Kamojang-Indonesia. Journal of Physics …. https://doi.org/10.1088/1742-6596/1376/1/012014

Prasetyo, B. T., Oktaufik, M. A. M., & Himawan, S. (2019). Design, construction and preliminary test operation of bppt-3mw condensing turbine geothermal power plant. catalog.lib.kyushu-u.ac.jp. https://catalog.lib.kyushu-u.ac.jp/ja/recordID/2321012/?repository=yes

Purnomo, D. S., & Haryono, T. (2020). Derating Prediction Due to Scaling at Kamojang Geothermal Turbine Using Nozzle Blocking Ratio Calculation. … in Energy and Electric Power (ICT …. https://ieeexplore.ieee.org/abstract/document/9249825/

Rani, H. A. (2022). Konsep Value Engineering Dalam Manajemen Proyek Konstruksi. Yogyakarta: Deepublish Publisher.

Rosyid, H. A. (2021). Exergy analysis of renewable energy power plant with organic rankine cycle for regions outside Java Island. IOP Conference Series: Earth and Environmental …. https://doi.org/10.1088/1755-1315/700/1/012027

Rudiyantoa, B., Wicaksonob, A., & ... (2023). Evaluation and Optimization Based on Exergy in Kamojang Geothermal Power Plant Unit 3. International Journal on …. https://www.researchgate.net/profile/Bayu-Rudiyanto/publication/377389018_Evaluation_and_Optimization_Based_on_Exergy_in_Kamojang_Geothermal_Power_Plant_Unit_3/links/662b088435243041534b8f44/Evaluation-and-Optimization-Based-on-Exergy-in-Kamojang-Geothermal-Power-Plant-Unit-3.pdf

Sagaf, M. (2020). Predicting Boiler Efficiency Deterioration using Energy Balance Method: Case Study in 660 Mw Power Plant Jepara, Central Java, Indonesia. Journal of Thermal Engineering. https://dergipark.org.tr/en/pub/thermal/article/821052

Santoso, V. Y. (2020). Penerapan Value Engineering pada Struktur Bangunan Gedung (Studi Kasus: Proyek Gedung Kantor Dinas Pemadam Kebakaran Kota Surakarta). Matriks Teknik Sipil, 8(2). https://doi.org/10.20961/mateksi.v8i2.44175.

Sufyana, C. M., Akbar, F. T., & Srigutomo, W. (2023). … and simulation of a single-flash geothermal power plant involving non-condensable gas: a case study of Kamojang geothermal field in Garut, West Java …. Geothermal Energy. https://doi.org/10.1186/s40517-023-00249-3

Syahputra, R., Nugroho, A. W., & ... (2019). Dynamic Performance of Synchronous Generator in Steam Power Plant. International …. https://pdfs.semanticscholar.org/7f02/af6e85832a8fc1bfd65aab884ccf83511ef2.pdf

Tama, A. K. (2020). Analisis Kinerja Manajemen Konstruksi Pada Proyek Gedung Digitasi Universitas Negeri Semarang. Jurnal Teknik Sipil Universitas Negeri Semarang.

Triani, M., Nurfanani, A., Aditya, I. A., & ... (2024). Mapping analysis of biomass potential on Java Island for supporting power plant: A review. E3S Web of …. https://www.e3s-conferences.org/articles/e3sconf/abs/2024/49/e3sconf_talenta2024_02012/e3sconf_talenta2024_02012.html

Triwiyono, A. (2005). Bahan Ajar Struktur Beton Pracetak. Yogyakarta: Jurusan Teknik Sipil Universitas Gadjah Mada.

Wibowo, P. (2020). Analisis Manajemen Konstruksi Pembangunan Gedung Rawat Inap Kelas III RSUD Waled Kabupaten Cirebon. Jurnal Konstruksi UNSWAGATI CIREBON, 9(2). https://dx.doi.org/10.33603/jki.v9i2.3928.

Wulandari, A. (2022). Analisis Value Engineering Dengan Penggantian Bahan Additive Campuran Semen pada Struktur Beton (Studi Kasus: Gedung Graha Bakti Budaya Proses Revitalisasi PKJ TIM Tahap II). Matriks Teknik Sipil, 10(4). https://doi.org/10.20961/mateksi.v10i4.61565.

Yudisaputro, H., Caesarendra, W., & ... (2021). A study on the performance and reliability effect of low-rank coal to the steam power plant. Journal of Physics …. https://doi.org/10.1088/1742-6596/1845/1/012053