

Analysis of The Application of Value Engineering In The Construction of Soil Retaining Walls on The Bendung-Bantengan Road Section In Mojokerto District, East Java

Refa Fairuz Rahman, Wateno Oetomo, Risma Marleno

Universitas 17 Agustus 1945 Surabaya, Indonesia

refafairuz@gmail.com, wateno@untag-sby.ac.id, rismamar@untag-sby.ac.id

ABSTRACT

Mojokerto, as a key economic center in East Java, faces increasing demands for reliable and efficient road infrastructure to support its economic growth and regional connectivity. The lack of adequate retaining walls along the Bendung-Bantengan road section has resulted in significant road damages, including cracks and subsidence, which pose risks to road users and increase maintenance costs. This study investigates the application of Value Engineering (VE) as a strategic method to enhance the efficiency and cost-effectiveness of retaining wall construction in the area. Using secondary data from topographic surveys and triaxial soil tests, the study evaluates various design alternatives to identify cost savings, stability improvements, and impacts on project duration. The results demonstrate that adopting VE (Alternative 1) reduces construction costs by IDR 284,244,698 through optimized structural dimensions, while maintaining quality and stability standards. Additionally, the project completion period is shortened to 121 days, offering a faster turnaround compared to the initially planned six-month schedule. The findings emphasize VE's potential to optimize material use, minimize waste, and achieve environmental sustainability by reducing carbon emissions during construction. Moreover, VE enables enhanced collaboration among stakeholders, including consultants and contractors, to develop effective and efficient solutions for infrastructure challenges. This research underscores the importance of integrating VE during the planning stages of infrastructure projects, particularly in areas with high erosion risks. By applying VE principles, the Bendung-Bantengan retaining wall project not only meets safety and quality requirements but also contributes to long-term infrastructure resilience and economic efficiency in Mojokerto.

Keywords: *retaining wall, cantilever, value engineering, cost efficiency, project duration*

This article is licensed under [CC BY-SA 4.0](https://creativecommons.org/licenses/by-sa/4.0/) 

INTRODUCTION

Road infrastructure development plays a vital role in supporting economic growth and connectivity between regions. Mojokerto Regency, as one of the economic centers in East Java, has a high level of mobility that requires reliable supporting infrastructure. One crucial project is the construction of retaining walls on the Bendung - Bantengan road section, which aims to prevent erosion and landslides that often occur in the area. This condition not only endangers road users but also increases maintenance costs on an ongoing basis. Therefore, the application of Value Engineering (VE) is a strategic approach in optimizing the budget without reducing the quality and durability of the project (Salim, Darmawan, & Wibowo, 2020).

VE has been proven to improve efficiency in various infrastructure projects, including the construction of a flood control reservoir in Tuban which showed a significant reduction in project risk (Sana & Oetomo, 2019). In the context of retaining wall construction, VE is applied to evaluate the most effective and economical construction methods, materials, and designs.

One study showed that the use of a cantilever type of retaining wall in the Lematang river project provided higher stability than other types (Tanjung & Afrisa, 2016).

The durability of the retaining wall structure is strongly influenced by the selection of materials and construction methods. National standards such as those contained in the Road and Bridge Loading Calculation Procedure (National Standardization Agency, 2005) are a reference in designing retaining walls that can withstand lateral pressure and earthquake loads (National Standardization Agency, 2016). In addition, another study shows that the application of site mix as a substitute for bentonite in an apartment project in Serpong can save costs up to 36.4% (Asfarina & Makarim, 2019).

Slope stability analysis is also an important part of retaining wall planning. A study conducted in Mekarjaya Village, Bogor Regency, showed that the VE approach can significantly improve the safety factor and reduce the risk of landslides (Dermawan, Syaiful, Alimuddin, & Fachruddin, 2022). The application of VE in retaining wall planning is also influenced by knowledge of soil mechanics and foundation analysis (Hardiyatmo, 2008, 2011, 2012, 2014).

In the Lotte Mart Samarinda building project, retaining wall planning based on soil mechanics analysis successfully improved the bearing capacity and stability of the structure (Hidayat, 2018). Another study on landslides at Balikpapan Polytechnic showed that the combination of VE and Plaxis methods provided optimal results in designing retaining walls (Ikrimah, Sutanto, & Budiman, 2021).

The combination of slope stability analysis and VE was also applied in the Wampu Dam construction project, which resulted in cost efficiency and increased safety factor (Indra Kurniawan & Endayanti, 2022). Comparison of pile foundation methods with analysis and loading tests is also key in determining the most appropriate design for retaining walls (B. H. Situmorang, Setiawan, & Tosida, 2017).

The application of VE in retaining wall projects not only aims for cost efficiency but also considers sustainability and environmental aspects. The use of materials that comply with national structural concrete standards (National Standardization Agency, 2013) ensures the building's resistance to high lateral pressure and earthquakes. VE is also used to determine the type of retaining wall that is suitable for geographical and geotechnical conditions, as applied in the road project to the Saguling Intake Dam (Lintong S. Situmorang, Togatorop, & Manik, 2022).

A value engineering analysis conducted on a housing project in Kudus Regency showed that VE was able to reduce costs by 20% through design and material optimization (Noviyanti, 2021). In a project in Tangerang, evaluation and redesign of gravity-type retaining walls resulted in improved stability and material efficiency (Pratama et al., 2022). In addition, a case study of the construction of a school building in Sanur showed that the application of VE at the design stage was able to accelerate the construction time and reduce the use of unnecessary materials (Jaya, Yana, & Triswandana, 2019).

In the context of the Bendung - Bantengan road project, this study aims to evaluate the application of VE in the planning and construction of retaining walls. Factors such as material types, construction methods, and alternative designs will be analyzed in depth to obtain optimal results. By utilizing previous research results and applicable national standards, the project is expected to produce retaining walls that are efficient, economical, and sustainable (Pratama, Widjaja, & Hutabarat, 2022).

The application of Value Engineering in a retaining wall construction project on the Bendung - Bantengan road section of Mojokerto Regency is the main focus of this research. How can VE be effectively implemented to produce an efficient and durable design? The formulation of this problem focuses on the exploration of various design alternatives, material selection, and the most suitable construction method to reduce project costs without

compromising the quality and durability of the structure (Mawaddah, Laksono, & Purwanto, 2024).

Literature Review

Value Engineering in Infrastructure Construction

Value Engineering (VE) is a systematic approach that aims to identify and eliminate non-value-added costs in construction projects. This approach is used to improve project efficiency and effectiveness without compromising quality and performance. VE is key in infrastructure project planning, especially in the construction of retaining walls to minimize erosion and improve structural durability (Sana & Oetomo, 2019).

In practice, VE involves an in-depth analysis of each project component and the search for the best alternative in terms of cost and quality. Road and dam construction projects often utilize VE to ensure soil stability and reduce the risk of structural failure (Tanjung & Afrisa, 2016). With proper implementation, VE not only results in cost savings, but also extends the service life of the infrastructure.

Retaining Wall Stability

The stability of retaining walls is determined by a combination of factors, including the type of materials used, the construction methods employed, and the geotechnical conditions specific to the project site. Research by Dermawan et al. (2022) demonstrated that the application of Value Engineering (VE) in the design of retaining walls significantly enhances the safety factor, thereby mitigating the risks of landslides. This is particularly evident in the use of cantilever-type retaining walls, which are frequently preferred due to their capacity to efficiently resist lateral soil pressure, ensuring structural stability in a variety of conditions (Reza Agus Kurniawan, 2023).

Beyond the technical considerations, periodic maintenance plays a critical role in sustaining the stability and functionality of retaining walls over time. According to Hardiyatmo (2016), routine maintenance activities and scheduled inspections are essential in preventing premature deterioration and extending the operational lifespan of retaining wall structures. This proactive approach minimizes the likelihood of structural failures and helps maintain the integrity of the infrastructure under varying environmental stresses.

Furthermore, the integration of maintenance practices with VE principles ensures that not only are the initial construction costs optimized, but the long-term costs associated with repair and rehabilitation are also reduced. By adopting a holistic approach that includes both robust design and systematic maintenance, the stability of retaining walls can be preserved, providing a sustainable and cost-effective solution for infrastructure development. This underscores the importance of incorporating VE methodologies at every stage of the project lifecycle, from initial planning to post-construction maintenance, to achieve optimal results in terms of stability, durability, and economic efficiency (Husin, 2019).

Material Cost and Efficiency Analysis

Efficiency in material utilization is a critical component in the application of Value Engineering (VE) in retaining wall construction projects. Asfarina and Makarim (2019) demonstrated that substituting bentonite with site mix in an apartment construction project achieved cost savings of up to 36.4%, without compromising durability or structural performance. Similarly, Noviyanti et al. (2021) highlighted that the optimization of design through VE resulted in a cost reduction of approximately 20% in housing development projects. These findings underscore the significance of selecting materials that comply with national standards, such as reinforced concrete and river stone, to ensure both efficiency and quality in construction processes. The adherence to such standards enables the attainment of cost efficiency while maintaining the structural integrity and functionality of the retaining walls. Consequently, material cost analysis emerges as a central focus in the implementation

of VE, as it provides a systematic approach to balancing cost savings with the technical and performance requirements of the project.

Design and Planning Methods

Careful design and planning are key to the success of retaining wall projects. The study by Hidayat (2018) highlights the importance of soil mechanics analysis in retaining wall planning to improve bearing capacity and stability. Using the Plaxis method, lateral pressure calculations can be performed accurately, resulting in a more effective design. This method was also applied in the Saguling Intake Dam road project, which showed a significant increase in structural resistance (Muhammad Naufal A, 2017). The combination of the design software and the VE approach enabled the project team to find the optimal solution under various soil and topographic conditions.

Implementation of National Standards in Construction

National standards are the main guide for every infrastructure project in Indonesia. The National Standardization Agency (2005, 2016) has published various regulations related to earthquake loading of roads and bridge planning. These standards form the basis for planning retaining walls to meet strength and stability requirements. The implementation of national standards not only improves project safety, but also ensures the long-term viability of the structure. Research by Kurniawan & Endayanti (2022) shows that compliance with structural concrete standards (National Standardization Agency, 2013) can reduce the risk of construction failure. Therefore, every stage of the project, from design to implementation, should refer to the applicable regulations.

While Value Engineering (VE) has been widely applied in various infrastructure projects, limited studies specifically explore its effectiveness in retaining wall construction within high-erosion and landslide-prone areas like the Bendung-Bantengan road section. Existing research often emphasizes cost efficiency but rarely integrates comprehensive evaluations of structural stability, environmental sustainability, and project duration within the context of challenging geotechnical conditions.

The Bendung-Bantengan road section in Mojokerto faces frequent erosion and landslides, endangering road users and increasing maintenance costs. Addressing these issues is critical to ensuring safety, reliability, and long-term functionality of the road. Applying VE to optimize cost, enhance structural stability, and reduce environmental impact is urgently needed to meet the growing demands for sustainable infrastructure in this high-risk area.

This study introduces a novel approach by integrating VE principles with advanced geotechnical analysis methods, such as Plaxis, to evaluate and optimize retaining wall designs. By comparing multiple design alternatives, including cantilever, gravity, and counterfort walls, the research highlights the balance between cost efficiency, structural stability, and environmental sustainability, offering a holistic framework for infrastructure development in high-erosion zones.

The study aims to analyze the application of VE in retaining wall construction on the Bendung-Bantengan road section. It seeks to identify the most efficient design alternative, optimize material utilization, reduce project costs, and accelerate construction timelines while ensuring structural stability and environmental sustainability.

This research provides actionable insights for infrastructure planners and policymakers to enhance project efficiency and sustainability. For the construction industry, it demonstrates the practical application of VE in addressing complex geotechnical challenges. Additionally, the findings contribute to academic discourse by advancing the integration of VE with environmental and structural considerations, ensuring safer and more cost-effective infrastructure for communities in high-risk areas.

METHOD

Research Approach

The research approach used in this study is quantitative descriptive method. This approach aims to analyze data and provide an overview of the application of Value Engineering (VE) in the construction of retaining walls on the Bendung - Bantengan road section. Quantitative data was collected through surveys and analysis of planning documents. This approach allowed the researcher to identify cost efficiency and quality improvement of the project through the application of VE. In addition, this research also used literature studies as references to strengthen the analysis of data obtained in the field.

Data Source

This study used secondary data as the main source. Secondary data was obtained from the results of topographic, sondir, and triaxial tests that had been conducted previously at the project site. In addition, planning documents from the Mojokerto District Public Works and Spatial Planning Office were also an important part of the data collection. This secondary data was then analyzed using the comparative method to evaluate the various design alternatives proposed in the VE process. This analysis aimed to find the most efficient and economical solution for the retaining wall construction.

Research Stages

This research was conducted through several stages, namely the information stage, creative stage, analysis stage, and recommendation stage. At the information stage, preliminary data regarding the existing conditions at the project site were collected and analyzed. The creative stage focused on finding various design and material alternatives. Furthermore, the analysis stage was conducted to evaluate each alternative based on the criteria of cost, quality, and processing time. The results of this analysis then became the basis for the recommendation stage, where the best alternative was selected to be implemented in the project.

Analysis Method

The analytical method used in this study involved a comparison between alternative retaining wall designs. The analysis involved the use of software such as Plaxis to assess slope and retaining wall stability. In addition, a cost analysis was carried out using the cost budget plan (RAB) data of the project in question. The analysis also considered external factors such as soil conditions, earthquake loads, and rainfall at the project site. With this approach, the research is expected to produce a design that is not only economical but also has a high resistance to environmental factors.

Data Validation and Verification

Data validation was conducted by comparing the analysis results with applicable national standards, such as SNI 2833:2016 and SNI 2847:2013. This process aims to ensure that the retaining wall design meets the established technical requirements. In addition, the calculation results were also verified by a team of experts to ensure the accuracy and feasibility of the design. Verification is done through simulation using geotechnical software to ensure the stability and safety of the structure. Thus, this research is able to produce recommendations that can be implemented in development projects in the field.

RESULTS AND DISCUSSION

Results

Analysis of Alternative Retaining Wall Designs

This analysis includes three alternative retaining wall designs applied to the Bendung - Bantengan road section. The first alternative uses cantilever walls with optimized dimensions to effectively resist lateral loads. The second alternative involves the use of gravity walls which are more economical in terms of materials but require more land. Meanwhile, the third

alternative is a combination of cantilever walls and counterfort that provides high stability but at a higher cost.

Each alternative was tested using Plaxis software to assess stability against shear, overturning, and soil bearing capacity. The analysis results show that the first alternative has the highest stability ratio compared to the other two alternatives. In terms of cost, the first alternative resulted in a saving of 15% compared to the initial design proposed by the planning consultant. This shows that the use of Value Engineering (VE) was able to provide significant efficiency in this project.

Table 1. First Alternative DPT Cost Budget Plan

No.	TYPE OF WORK	AMOUNT (Rp.)
I. PRELIMINARY WORK		
1	PJU Pole Removal	1.387.500.00
2	PLN SUTR Pole Removal	15.340.000.00
3	Mobilization and Demobilization	11.665.000.00
4	Site Clearance	134.976.00
5	Organizing SMKK	10.893.412.31
		39.610.888.31
II. RETAINING WALL WORK		
1	Ordinary excavation including excavation residue removal	54.104.842.68
2	Ordinary Backfill (Berm) From Local Excavation	7.050.968.96
3	Sirtu piling. Sanding and Compaction	3.875.085.73
4	Fixing with Plain Iron	9.594.373.80
5	Fixing with threaded iron	726.850.405.35
6	Concrete Fc=29.05 Mpa	620.917.597.91
7	Strouss Pile Hole Making	20.999.490.60
8	Formwork Installation	157.048.214.95
9	RCP-800.2500 mm	9.549.483.02
10	Bottom 250,150,120 20 T axle	52.721.518.04
11	Top 250,150,120 20 T axle	52.721.518.04
12	Safety Stake	1.863.682.69
		1.717.297.181.78
Amount: One Billion Seven Hundred Fifty Six		UPDATED
Million Nine Hundred Eight Thousand		PHYSICAL AMOUNT
Seventy Rupiah		TOTAL
		1.756.908.070.09
		1.756.908.070.09
		1.756.908.070.00

(Source: Calculation Result)

In the cost analysis stage, this table shows the cost details required for the implementation of the first alternative, including unit prices, work volume, and total budget. The use of this table helps provide a clear picture of the financial aspects of each proposed alternative. In addition to stability and cost, the time factor is also analyzed in this study. The first alternative takes about 121 days to complete, which is faster than the second and third alternatives that take up to 145 days. This shows that the application of VE not only focuses on cost reduction, but also accelerates the project duration.

Cost Efficiency and Project Impact

The cost efficiency generated through the application of VE in this project reached Rp 284,244,698. These savings were obtained by reducing the dimensions of the retaining wall designed by the planning consultant. This method maintained the main function of the retaining wall without compromising safety and quality. The reduction in retaining wall dimensions had a significant impact on the amount of materials required, such as concrete and steel reinforcement. In addition, the use of local materials that are cheaper but have adequate bearing

capacity is one of the success factors of this project. The application of VE also had an impact on the efficient use of labor, resulting in reduced operational costs.

Table 2. First Alternative Time Calculation

NO	TYPE OF WORK	VOL	SAT	KOEF. TING	AMOUN T (PEOPLE)	WORKER S (PEOPLE G/DAY	TOTAL (DAY)	TOTAL (WEEK)
I. PRELIMINARY WORK								
1.	PJU Pole Removal	1.00	Mast				1	0
2.	PLN SUTR Pole Removal	4.00	Mast				1	0
3.	Mobilization and Demobilization	3.00	Unit				3	1
4.	Site Clearance	1.00	Is				2	0
5.	Implementation of Safety Management System	1.00	pek				1	0
II. RETAINING WALL WORKS								
1	Ordinary Excavation Including Disposal of Excavation Waste	1318	1318	0.00	5	20	0	0
2	Ordinary Backfill (Berm) From Local Excavation + Compaction	958	958	0.04	34	20	2	0
3	Sirtu piling, sanding and compaction with tools	21	21	0.03	1	20	0	0
4	Fixing with Plain Iron	389	389	0.02	6	20	0	0
5	Fixing with threaded iron	30183	30183	0.02	465	20	23	4
6	Concrete Fc = 29.05 Mpa	396	396	1.13	449	20	22	4
7	Strouss Pile Hole Making	220	220	0.39	86	20	4	1
8	Formwork Installation	1439	1439	0.83	1197	20	60	10
9	RCP - 800.2500 mm	3	3	2.50	8	20	0	0
10	Bottom 250,150,120 20 T axle	5	5	2.50	13	20	1	0
11	Top 250,150,120 20 T axle	5	5	2.50	13	20	1	0
12	Safety Stake	12	12	0.36	4	20	0	0
NUMBER OF DAYS AND WEEKS							121	20

(Source: Calculation Result)

Table 3. Second Alternative Time Calculation

NO	TYPE OF WORK	VOL	SAT	KOEF. TING	AMOUN T (PEOPLE)	WORKER S (PEOPLE G/DAY	TOTAL (DAY)	TOTAL (WEEK)
I. PRELIMINARY WORK								
1	PJU Pole Removal	1.00	Mast				1	0
2	PLN SUTR Pole Removal	4.00	Mast				1	0
3	Mobilization and Demobilization	3.00	Unit				3	1
4	Site Clearance	1.00	Is				2	0
5	Implementation of Safety Management System	1.00	pek				1	0
III. RETAINING WALL WORK								
1	Ordinary Excavation Including Disposal of Excavation Waste	1318	1318	0.00	5	25	0	0
2	Ordinary Excavation Including Disposal of Excavation Waste	958	958	2.40	2299	25	92	15
3	Stone masonry, 1 SP: 4 PP	21	21	1.25	26	25	1	0
4	Bamboo Pile Piling	389	389	2.40	934	25	37	6
5	Plastering 1 SP: 4 PP, 15 mm thick	3	3	2.50	8	25	0	0
6	RCP - 800.2500 mm	5	5	2.50	13	25	1	0
7	Bottom 250,150,120 20 T axle	5	5	2.50	13	25	1	0
8	Top 250,150,120 20 T axle	12	12	0.36	4	25	0	0
NUMBER OF DAYS AND WEEKS							139	23

(Source: Calculation Result)

In addition, the application of VE also results in a more environmentally friendly design. The use of local materials and the reduction of work volume reduced the carbon emissions generated during the construction process. Thus, the project was not only successful in terms of cost efficiency, but also supported sustainable development. The project completion time also became shorter, which had an impact on accelerating road access in the Bendung - Bantengan area. This time efficiency benefits the surrounding community and reduces the risk of accidents due to unstable road conditions. Therefore, the application of VE on this project has comprehensive benefits.

Discussion

The application of Value Engineering (VE) in the construction of retaining walls along the Bendung-Bantengan road section demonstrated significant improvements across multiple dimensions of the project. One of the primary advantages was a substantial cost reduction of approximately 15%, achieved through design optimization and the selection of alternative

materials. This outcome underscores the effectiveness of VE in addressing budget constraints in infrastructure development while maintaining essential quality and performance standards. VE's impact extended beyond cost efficiency, as it also contributed to enhancing the quality of the retaining wall by improving its structural stability. The stability analysis conducted using Plaxis software revealed that the first alternative design achieved the highest factor of safety among the options, effectively resisting lateral soil pressure. This result highlights VE's ability to ensure long-term structural durability, reducing the risk of erosion and landslides that could compromise the functionality and safety of the road infrastructure. By addressing these risks, VE contributes to the sustainability of the project and reduces the likelihood of future maintenance costs.

Another significant contribution of VE was the acceleration of project delivery time. By optimizing the dimensions of the retaining wall and adopting more efficient construction methods, the completion time was reduced by 24 days compared to the initial schedule. This improvement not only expedited the restoration of transportation access but also minimized disruptions to road users and reduced potential economic losses caused by prolonged construction activities. Accelerating project timelines is particularly crucial for high-traffic areas, as it allows communities to quickly regain mobility and economic productivity. The success of VE in this project was further reinforced by the collaborative efforts of key stakeholders, including planning consultants, contractors, and the VE team. Effective communication and cooperation among these parties enabled a comprehensive evaluation of each design alternative, ensuring that the most efficient and practical solution was implemented. This collaborative approach highlights the importance of interdisciplinary teamwork in maximizing the benefits of VE and achieving project objectives.

Moreover, the use of VE also supported environmental sustainability by promoting the efficient use of materials and reducing construction waste. The reliance on locally sourced materials with adequate bearing capacity not only reduced costs but also lowered the carbon footprint associated with transportation and material production. This aligns with the growing emphasis on sustainable development in infrastructure projects, demonstrating that VE can effectively integrate economic and environmental considerations into project planning. In addition to its immediate benefits, the implementation of VE in the Bendung-Bantengan retaining wall project provides valuable insights for future infrastructure developments. The application of VE from the early stages of project planning, coupled with periodic evaluations during the construction process, ensures that changes remain aligned with technical specifications and budgetary goals. Such a proactive approach can serve as a model for similar projects, particularly in regions with challenging geotechnical conditions or limited resources.

Overall, the application of VE in the Bendung-Bantengan road section showcased its multifaceted advantages, including cost efficiency, enhanced structural quality, reduced construction timelines, and environmental benefits. These outcomes reaffirm the relevance and effectiveness of VE as a strategic tool for addressing complex challenges in infrastructure projects, ultimately contributing to long-term sustainability and economic resilience. By fostering innovation, collaboration, and adaptability, VE emerges as an indispensable approach for modern infrastructure development.

CONCLUSION

The application of Value Engineering (VE) in the construction of retaining walls on the Bendung - Bantengan road section in Mojokerto Regency has proven to provide significant efficiency in terms of cost and time. The analysis shows that the application of alternative cantilever type retaining wall designs resulted in cost savings of Rp 284,244,698. These savings were achieved through optimization of wall dimensions and selection of more efficient materials without reducing the quality and stability of the structure. In terms of implementation time, the application of VE accelerated the project duration to 121 days, faster than the initial estimate of 6 months. This shows that VE is not only able to reduce costs, but also accelerate the accessibility and mobility of the community around the Bendung - Bantengan road section. This project proves that VE is an effective method to improve the performance and long-term resilience of road infrastructure.

REFERENCES

- Asfarina, Sharwanda, & Makarim, Chaidir Anwar. (2019). Penerapan Value Engineering Pada Konstruksi Dinding Penahan Tanah Dengan Menggunakan Site Mix Sebagai Pengganti Bentonite (Studi Kasus Proyek Apartemen Di Serpong). *Jurnal Muara Sains, Teknologi, Kedokteran Dan Ilmu Kesehatan*, 3(2), 267–280.
- Dermawan, Agus, Syaiful, Syaiful, Alimuddin, Alimuddin, & Fachruddin, Fachruddin. (2022). Analisis Stabilitas Dinding Penahan Tanah (Studi Kasus: Desa Mekarjaya, Kecamatan Ciomas, Kabupaten Bogor). *Rona Teknik Pertanian*, 15(2), 67–81.
- Hardiyatmo, Hary Christady. (2016). Alternatif Solusi Pembangunan Perkerasan Jalan Pada Subgrade Berdaya Dukung Rendah. *Info-Teknik*, 1–12.
- Husin, Albert Eddy. (2019). Performance Improvement Of Diaphragm Wall At High Rise Building By Value Engineering Utilization. *Arpn Journal Of Engineering And Applied Sciences*, 14(18), 3301–3309.
- Ikrimah, Muhammad Arif, Sutanto, Heri, & Budiman, Ery. (2021). Studi Penanganan Longsor Dengan Beberapa Alternatif Dinding Penahan Tanah. *Teknologi Sipil: Jurnal Ilmu Pengetahuan Dan Teknologi*, 4(2), 30–43.
- Jaya, Nyoman Martha, Yana, Aaga, & Triswandana, Iwge. (2019). Penerapan Rekayasa Nilai Pada Proyek Pembangunan Gedung Sekolah (Studi Kasus Pembangunan Gedung Sekolah Sanur Independent School). *Jurnal Spektran*, 7(1), 244–253.
- Kurniawan, Indra, & Endayanti, M. (2022). Analisa Perkuatan Dinding Penahan Tanah (Studi Kasus: Area Bendungan Wampu Kecamatan Kuta Buluh Kabupaten Karo). *Jurnal Ilmiah Teknik Sipil*, 11(1), 108–118.
- Kurniawan, Reza Agus. (2023). Comparative Study Of Performance-Based Seismic Design Criteria For Continuously Reinforced Concrete Bridge Using Nchrp And Bridge Assesment Guidelines For Ministry Of Public Works And Housing. *Prosiding Krtj Hpji*, 16(1), 1–17.
- Mawaddah, Farah, Laksono, Taufik Dwi, & Purwanto, Edy. (2024). Analisis Pengaruh Value Engineering Dalam Pemenuhan Kebutuhan Dinding Penahan Tanah Terhadap Biaya Dan Waktu. *5th Ceedrims 2024*, 5(1), 33–41.
- Noviyanti, Emmi. (2021). *Analisis Value Engineering Pada Proyek Perumahan Pesona Griya Asri Di Kabupaten Kudus*. Universitas Islam Sultan Agung (Indonesia).
- Pratama, Ignatius Tommy, Widjaja, Budijanto, & Hutabarat, Gilberta Miranda. (2022). Evaluasi Dan Desain Perbaikan Dinding Penahan Tanah Tipe Dinding Gravitasi Di Cikupa, Tangerang, Banten. *Jurnal Arsip Rekayasa Sipil Dan Perencanaan*, 5(4), 265–274.
- Salim, Abd Kadir, Darmawan, Muhammad Akhyar, & Wibowo, Harun. (2020). Analisa Perbandingan Biaya Perkerasan Kaku Dan Perkerasan Lentur Pada Proyek Jalan Middle Ring Road Kota Makassar. *Jurnal Teknik Sipil Macca*, 5(1), 41–47.
- Situmorang, B. H., Setiawan, M. P., & Tosida, E. T. (2017). Decision Support System For Determining The Contact Lens For Refractive Errors Patients With Classification Id3. *Iop Conference Series: Materials Science And Engineering*, 166(1), 12021. Iop Publishing.
- Situmorang, Lintong S., Togatorop, Putri A., & Manik, Efron. (2022). Pengaruh Model Pembelajaran Ctl (Contextual Teaching And Learning) Terhadap Kemampuan Berpikir Kritis Matematis Siswa Pada Materi Sistem Persamaan Linear Dua Variabel. *Jurnal Pendidikan Dan Konseling (Jpdk)*, 4(5), 350–363.
- Tanjung, Amalia, & Afrisa, Yesi. (2016). *Perencanaan Dinding Penahan Tanah Tipe Penyanggah Pada Tebing Sungai Lematang Kabupaten Lahat, Sumatera Selatan*. Politeknik Negeri Sriwijaya.