

An Analytic Network Process (ANP) Approach to Refining the Hurdle Rate by Factoring in Project Risk Premium: A Case Study of Indonesia National Oil Company^{1, 2}

Nina Ratna Enggar Puspita

ABSTRACT

This study comprehensively analyzes the optimal hurdle rate, or the Minimum Attractive Rate of Return (MARR), for oil and gas investments in Indonesia's National Oil Company. By incorporating country-specific, industry, and project risk into the calculation of the Weighted Average Cost of Capital (WACC), the study outlines a risk-adjusted methodology to guide investment decisions. The Analytic Network Process (ANP) method and Monte Carlo Simulation employ the lognormal distribution to quantify and analyze risk variables, establishing a project-specific risk premium. The significance of the country risk premium is emphasized, highlighting its role in investment diversification, accurate valuations, strategic decision-making, and effective risk management. The calculated hurdle rate ranges from 10,91% to 15,42%. The study underscores the importance of thorough risk analysis in ensuring sound investment decisions in the global oil and gas industry. It concludes by emphasizing the risks of setting too low a hurdle rate, leading to excessive risk-taking, or too high a hurdle rate, which might preclude potentially profitable investments.

Keywords: Analytic Network Process, ANP, WACC, Hurdle Rate, MARR, Project Risk Premium, Monte Carlo Simulation, Investment Decision, Country Risk Premium

INTRODUCTION

Opportunities in Indonesia's Oil and Gas Sector

In 2022, the Indonesia oil and gas sector hit a commendable high point in terms of investment value. The target was approximately 17 billion U.S. dollars, marking a significant upsurge from previous years. The zenith of a five-year trend had seen steady increases year after year.

¹ How to cite this paper: Puspita, N.R.E. (2023). An Analytic Network Process (ANP) Approach to Refining the Hurdle Rate by Factoring in Project Risk Premium: A Case Study of Indonesia National Oil Company; *PM World Journal*, Vol. XII, Issue IX, September.

² This paper was originally prepared during a 6-month long Graduate-Level Competency Development/Capacity Building Program developed by PT Mitratata Citragraha and led by Dr. Paul D. Giammalvo to prepare candidates for AACSB CCP or other Certifications. <https://build-project-management-competency.com/our-faqs/>

The year 2022's target was a testament to the sustained growth and indicative of the sector's vitality and increasing appeal to investors. However, it's noteworthy that the record high remains untouched from 2014, when the investments peaked at a staggering 21,7 billion U.S. dollars, setting a benchmark for the industry's potential.

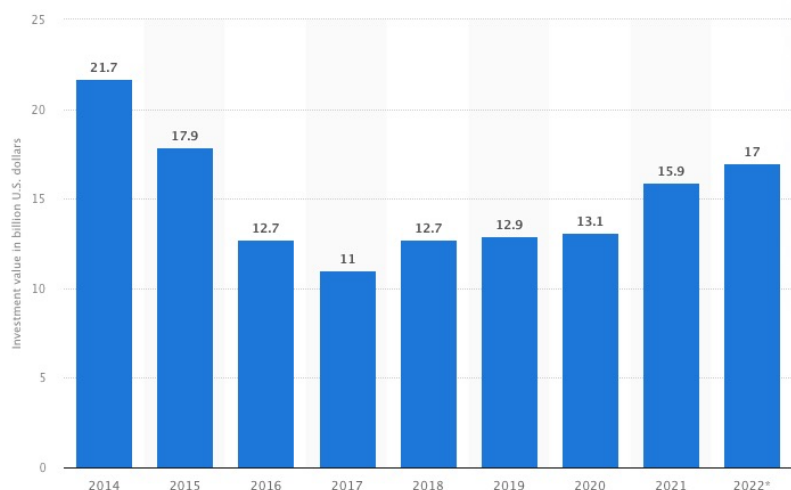


Figure 1 – Value of investments in the oil and gas sector in Indonesia from 2014 to 2022 (in billion U.S. dollars)³

Indonesia National Oil Company plays a pivotal role in the country's energy sector. "The company has allocated a budget of US\$ 5,71 billion, approximately Rp 86,64 trillion, for investment, marking a substantial increase of 44% compared to the investment realized in 2022."⁴ This move demonstrates the company's commitment to boosting its activities in the energy sector and marks a strategic shift in its approach. A significant portion of the investment is allocated towards drilling development wells, workovers, and well repairs, directly impacting oil and gas production enhancement in existing wells. "The company's plan includes drilling development wells and exploration wells, indicating an increase, and undertaking workovers and WIWS."⁵

Rising investment in Indonesia's downstream oil and gas sector is expected to boost production, aiming at thousands of barrels per day and a 5% increase in gas output from 2022. The company's contribution to national production is significant. The Ministry of Energy and Mineral Resources (2023) "projects these investments to reach \$10,77 billion

³ Statista. (2023). Value of investments in the oil and gas sector in Indonesia from 2014 to 2022. Retrieved from <https://www.statista.com/statistics/993188/indonesia-investment-in-oil-and-gas/#statisticContainer>

⁴ CNBC. (2023). Terungkap! Investasi Pertamina Melejit, Ternyata Buat ini. Retrieved from <https://www.cnbcindonesia.com/news/20230208110151-4-412048/terungkap-investasi-pertamina-melejit-ternyata-buat-ini>

⁵ CNBC. (2023). Pertamina Siap Jor-joran di 2023! Kucurkan Investasi Rp86 T. Retrieved from <https://www.cnbcindonesia.com/news/20230207194410-4-411908/pertamina-siap-jor-joran-di-2023-kucurkan-investasi-rp86-t>.

by 2024.”⁶ Showing Indonesia’s commitment to meet domestic energy needs and become a global contributor.

The decision to approve or reject an investment project is often a complex process involving carefully assessing numerous factors. One such critical factor is the hurdle rate, the minimum rate of return required for a company to proceed with a project.

This study aims to illustrate the importance of the hurdle rate in investment decisions, using the case of the National Oil Company and its current investment strategy. We aim to demonstrate how the hurdle rate is crucial in investment decisions, influencing which projects are approved and how resources are allocated. By understanding the significance of the hurdle rate, organizations can better navigate their strategic investment decisions, potentially leading to more effective use of resources and enhanced returns.

A Deep Dive into WACC and Hurdle Rate

National Oil Company has adopted a strategic approach to managing its investments across various sub-holdings. A vital component of this strategy is publishing the Weighted Average Cost of Capital (WACC) for each sub holdings. Given the globally observed median WACC of 8,31% and 10,2%⁷ as of August 24th, 2023, indicating the average rate of return the company is expected to pay to finance its assets. The author intends to conduct an assessment using the principles of several kinds of literature to calculate the company's WACC. This is to facilitate an evaluation of whether the company's current WACC for the investment decision-making process aligns appropriately with this global benchmark.

The comparison with the global WACC will enable the company to ascertain if its financial operations align with global standards, thereby assisting in strategic financial decision-making, which has significant implications for investment decisions.

⁶ Ministry of Energy and Mineral Resources. (2023). Retrieved from <https://www.esdm.go.id/id/berita-unit/direktorat-jenderal-minyak-dan-gas-bumi/proyek-hilir-migas-terus-berkembang-investasi-tahun-2024-diproyeksikan-us1077-miliar>

⁷ Oil & Gas Development Co (OTCPK: ODVCI) WACC. (2023) Retrieved from <https://www.gurufocus.com/term/wacc/ODVCI/>



Figure 2 – Global WACC Oil & Gas⁸

The published WACC forms the basis for setting the hurdle rate, a minimum acceptable rate of return on investment. This higher hurdle rate is chosen to ensure that the investments are not only covering their costs but are also generating a sufficient return.

When evaluating potential investments, companies use this hurdle rate to calculate vital economic indicators such as Net Present Value (NPV) and Internal Rate of Return (IRR). These calculations help the company assess potential investments' profitability and make informed decisions. However, it's important to note that this analysis does not cover shale gas with its unique operational and financial characteristics.

METHODOLOGY

A critical component of carrying out scientific research is the formulation of a methodology. A well-designed and structured process is instrumental in ensuring high-quality scientific research. An illustration of the developing method is shown in the graphic below:

⁸ Gurufocus. (2023). Oil & Gas Development Co (OTCPK: ODVCI) WACC. Retrieved from <https://www.gurufocus.com/term/wacc/ODVCI/>

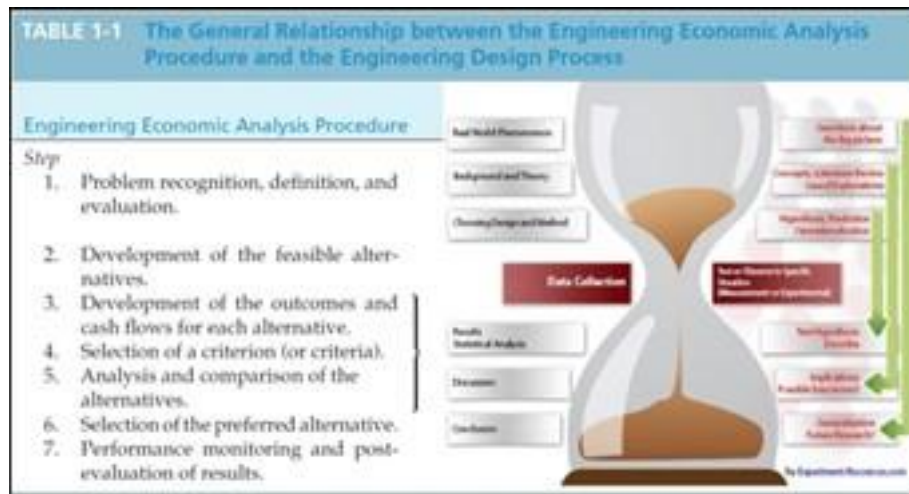


Figure 3 – Engineering Economic Analysis Procedure & Steps of the Scientific Process⁹

Every scientific method employed should incorporate four elements that require thorough elaboration ¹⁰:

1. **Problem recognition** is a clear description of the essential issues identified provided initially; this step is succeeded by the phase of Refining the Research Paper Question to break it down into more specific problems.
2. **Development of the Feasible Alternatives** is a process of confirmation where other scientists reproduce the experiment and evaluate its validity to explore various potential outcomes.
3. **Development of the Outcomes and Cash Flows for each alternative** offers an exact account of the techniques and instruments employed for data collection.
4. **Selection of a Criterion (or Criteria)** describes how the raw data is gathered and scrutinized.

Step 1 – Problem Recognition, Definition, and Evaluation

Investment decisions hinge on several factors, with the hurdle rate being a key determinant. The steady annual increase in oil and gas investments and Indonesia's vast reserves call for a well-suited project evaluation process. Analyzing the project with the proper assessment tools is essential to ensure tangible benefits for the nation. This study has the following objectives:

⁹ Shuttleworth, M. (2008). What is Research?. Retrieved from <https://explorable.com/what-is-research>

¹⁰ Sullivan, G. W., Wicks, M. E., & Koelling, C. P. (2023). Engineering Economy 17th Edition. Chapter 1 Introduction to Engineering Economy, pages 7-12.

1. To investigate whether a hurdle rate is appropriate for Indonesia National Oil Company to evaluate the economics of the projects, ensuring it is not too high or too low.
2. To identify the suitable methodology for calculating the hurdle rate for diverse oil and gas projects across all streams in Indonesia, factoring in the risks linked to the stream, type of investment, classification of stream, and country-specific risks.
3. To emphasize that country-specific risk is crucial when applied to the Hurdle Rate.

Step 2 - Development of the Feasible Alternatives

Determining the Hurdle Rate

The Weighted Average Cost of Capital (WACC) formula, combining the proportion of debt to equity and the cost of these sources of finance, plays a pivotal role in guiding investment decisions. If a project's expected return surpasses the calculated WACC, it will likely generate shareholder value, thus becoming a viable investment. Therefore, an accurate calculation of WACC ensures the selection of profitable investments and the optimal allocation of resources.

Sullivan (2023:346) WACC formula¹¹:

$$WACC = \lambda (1 - t) i_b + (1 - \lambda) ea \quad \text{(Equation 1)}$$

Here,

λ = fraction of a firm's pool of capital that is borrowed from lenders,

t = effective income tax rate as a decimal,

i_b = before-tax interest paid on borrowed capital,

ea = after-tax cost of equity capital.

Sullivan (2023:573) The cost of equity is calculated by using Capital Asset Pricing Model (CAPM) formula¹²:

$$RS - RF = \beta S (RM - RF) \quad \text{(Equation 2)}$$

RF = Risk-Free

βS = Beta Stock Risk

$(RM - RF)$ = Market Premium

¹¹ Sullivan, G. W., Wicks, M. E., & Koelling, C. P. (2023). Engineering Economy 17th Edition. Chapter 7 Depreciation and Income Taxes, page 346.

¹² Sullivan, G. W., Wicks, M. E., & Koelling, C. P. (2023). Engineering Economy 17th Edition. Chapter 13 The Capital Budgeting Process, page 573.

"In reality, every project should be evaluated based on the risk it adds to the company and its return. If the risks are roughly normal and there are no significant capital limitations, then WACC is an appropriate hurdle rate (i.e., the MARR). If the project is riskier than the current business, then an upward adjustment in the MARR might be appropriate."¹³

$$\text{Hurdle Rate} = \text{WACC} + \text{Identified Risk Premium}$$

(Equation 3)

Project Risk Category for Oil and Gas Investment in Indonesia¹⁴

Investing in the oil and gas sector brings a unique set of risks, each falling under different project risk categories. Understanding these categories is pivotal to navigating the intricate landscape of oil and gas investments effectively and safely.

Project Risk by Stream

The oil and gas industry is typically divided into three main sectors: upstream, midstream, and downstream. Here's a brief overview of each:

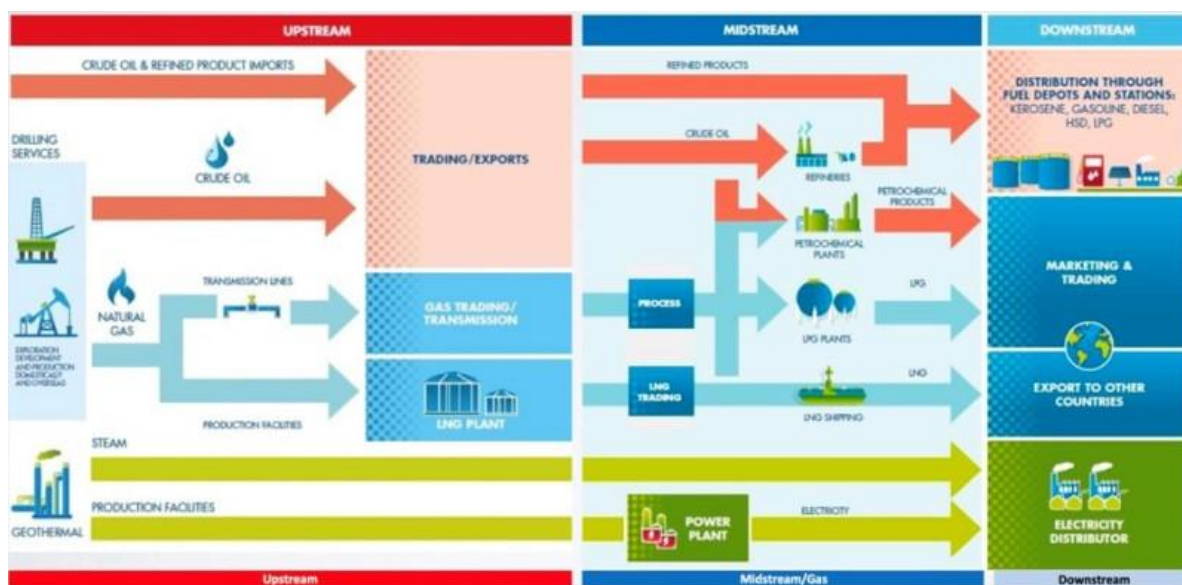


Figure 4 - Oil & Gas Main Sector¹⁵

¹³ Sullivan, G. W., Wicks, M. E., & Koelling, C. P. (2023). Engineering Economy 17th Edition. Chapter 13 The Capital Budgeting Process, page 576.

¹⁴ PT Pertamina (Persero). (2022). WACC per Sektor di Indonesia.

¹⁵ PT Pertamina (Persero). (2015). Pertamina Highlight. Retrieved from <https://pertamina.com/media/4f6bce59-35df-4964-94ef-9cf458f8db5c/Investor%20Presentation%20for%20Non-Deal%20Roadshow%20Nov2015.pdf>

- **Upstream**

The upstream sector is the industry segment dedicated to discovering and extracting oil and gas. It encompasses firms that identify possible underground or undersea reservoirs of crude oil and natural gas, initiate exploratory drilling, and eventually operate the wells that extract and transport these raw resources to the surface.

- **Midstream**

This sector involves transporting, storing, and wholesaling crude or refined petroleum products. Pipelines, tanker ships, trucks, and trains transport crude oil from production sites to refineries and deliver oil products to downstream distributors. Storage facilities balance the supply and demand of oil and gas. Processing plants are used to prepare oil and gas for downstream use. But midstream area is not covered in this analysis.

- **Downstream**

The downstream sector is the oil and gas industry segment that delivers various products to the consumer. These products include gasoline, gasoil, kerosene, jet fuel, diesel oil, lubricants, asphalt, liquified petroleum gas (LPG), & petrochemicals.

Project Risk by Type of Investment

The oil and gas industry type of investment is divided into upstream and downstream. Here's a brief overview of each:

Classification for Upstream

- **Organic Investment**

This refers to growth achieved through the expansion of existing operations or activities. In the upstream oil and gas sector, this could mean investing in more exploration and drilling activities in existing fields, improving technology and processes to increase efficiency and production, or training and developing existing staff.

- **Anorganic Investment**

This refers to growth achieved through mergers, acquisitions, or partnerships. In the upstream oil and gas sector context, this could mean acquiring other companies or assets, entering into partnerships or joint ventures with other companies, or purchasing rights to new oil and gas fields.

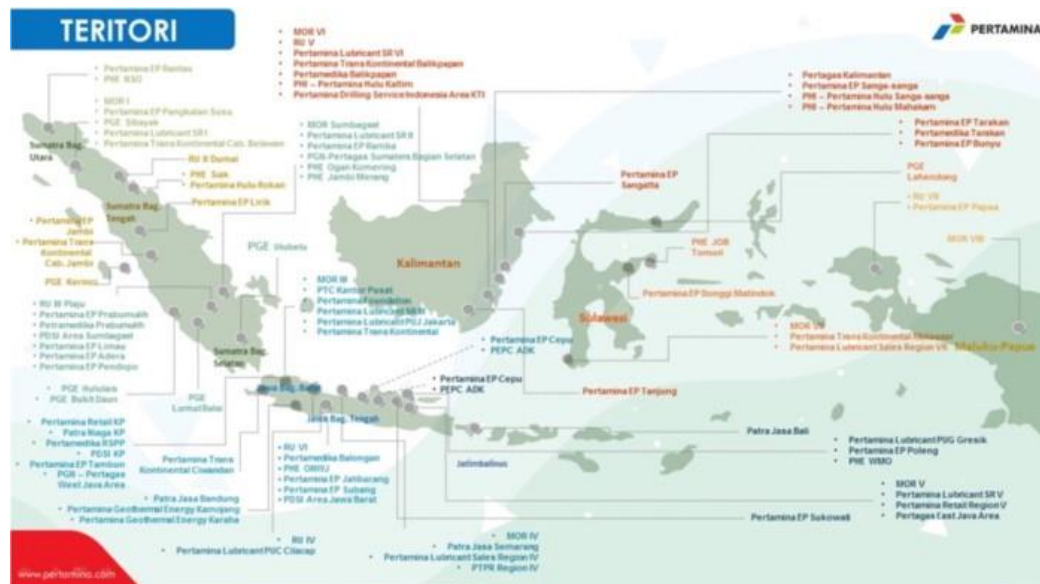


Figure 5 - Territory of Indonesia NOC ¹⁶

Classification for Downstream

The classification for Downstream is divided into Fuel Distribution and Refining & Petrochemical. Here's a brief overview of each:

Fuel Distribution

- **Full Equity**
 This refers to an investment where an investor or company purchases 100% ownership of a business or asset. The investor controls the business or asset, including all decision-making and profits.
- **Partnership**
 This refers to an investment where two or more parties contribute capital to a business or asset and share ownership. The partners share in the business or asset's decision-making, profits, and risks.

Refining & Petrochemical

- **Expansion**
 This refers to projects that increase the capacity of the refinery & petrochemical. This could involve adding new processing units to increase the volume of crude oil that can be processed or upgrading existing units to allow them to process more crude oil.

¹⁶ PT Pertamina (Persero). (2023). Pertamina Territory. Retrieved from <https://www.pertamina.com/id/teritori>

- **Non-Expansion**

This refers to projects that improve the refinery's efficiency, flexibility, or environmental performance but do not increase its overall processing capacity. This could involve replacing old equipment with more efficient models, modifying processing units to allow them to process different types of crude oil, or installing new technologies to reduce emissions.

Project Risk by Type of Project

The oil and gas industry type of project is divided into upstream and downstream. Here's a brief overview of each:

Upstream Sector

In the upstream sector of the oil and gas industry, the terms Exploration, Enhanced Oil Recovery (EOR), and Development refer to different stages and techniques used in extracting oil and gas. Here's a brief explanation of each:

- **Exploration**

This is the first stage in the upstream process. Exploration involves searching for new oil and natural gas deposits, typically using geological surveys and seismic data. Once potential deposits are identified, exploratory wells are drilled to test whether oil or gas is present sufficiently to make extraction economically viable.

- **Enhanced Oil Recovery (EOR)**

This is a set of techniques used to increase the amount of oil that can be extracted from an oil field. Traditional drilling methods can only extract a portion of the available oil, and EOR techniques are used to extract more. EOR is typically used in fields that have been in production for some time and where the easy-to-extract oil has already been recovered.

- **Development**

This stage comes after a successful exploration. Development involves drilling production wells and the construction of infrastructure necessary to extract, process, and transport the oil or gas. The goal of the development stage is to extract the oil or gas discovered during the exploration stage most efficiently and profitably possible.

Downstream Sector

In the context of downstream oil and gas projects, the terms "greenfield/grass root" and "brownfield/revamping" refer to the nature of the project site. The author assumes that this type of risk has an equal level of risk, leading them to combine those risks into a single cluster. Here's a brief explanation of each:

- **Greenfield / Grass Root**

A greenfield project might involve building a new plant or fuel terminal on a site not previously used for industrial purposes. The term Grass Root is often used interchangeably with "greenfield project."

- **Brownfield / Revamping**

This project might involve expanding the capacity of an existing plant or fuel terminal to produce different products. This project might involve the addition of new units, the replacement of old equipment, or modifications to existing units. These projects can be less costly than grass root projects, as they use existing infrastructure. However, they can also be complex, as they need to be carried out while minimizing disruption to ongoing operations.

Analytic Network Process (ANP)

"The Analytic Network Process (ANP) is a decision-making tool that considers interdependencies among decision elements."¹⁷ It is a more general form of the Analytic Hierarchy Process (AHP), a decision-making method that involves structuring a hierarchy among alternatives and criteria. ANP, however, allows for a more complex network structure where elements can influence each other non-hierarchically.

This method allows for more complex relationships between decision elements, including dependencies and feedback loops. It's a "non-linear" process where elements can influence each other in a non-hierarchical manner. "This makes ANP more flexible and capable of handling more complex decision problems than AHP."¹⁸

¹⁷ Saaty, T.L. and Vargas, L.G. (2013). Decision Making with the Analytic Network Process, page 2.
¹⁸ Saaty, T.L. and Vargas, L.G. (2013). Decision Making with the Analytic Network Process, page 76.

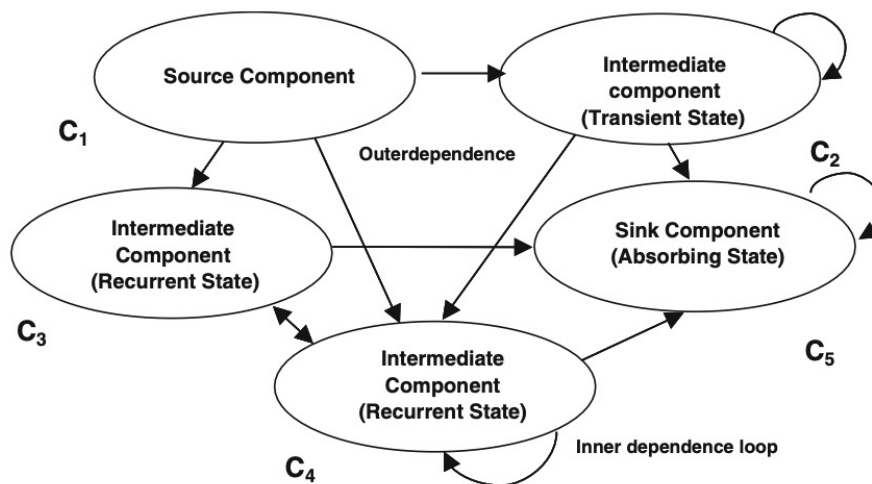


Figure 6 - Types of components in a network¹⁹

"In using the AHP or its generalization to feedback networks, the Analytic Network Process (ANP) to model a problem, one needs a hierarchic or a network structure to represent that problem, as well as pairwise comparisons to establish relations within the structure."²⁰

Intensity of Importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
2	Weak	
3	Moderate importance	Experience and judgment slightly favor one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgment strongly favor one activity over another
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favored very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation
Reciprocals of above	If activity i has one of the above nonzero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i	A reasonable assumption
Rationals	Ratios arising from the scale	If consistency were to be forced by obtaining n numerical values to span the matrix

Figure 7 – The fundamental scale of absolute numbers²¹

¹⁹ Saaty, T.L. and Vargas, L.G. (2013). Decision Making with the Analytic Network Process, page 9.

²⁰ Saaty, T.L. and Vargas, L.G. (2013). Decision Making with the Analytic Network Process, page 3.

²¹ Ibid

"Paired comparison judgments in the AHP/ANP are applied to pairs of homogeneous elements. In all the examples in this book, the judgments used to perform the comparisons are not purely the preferences of the authors but are frequently tantamount to expert judgments. They represent their best understanding of the influences involved from the different parties' points of view, as surmised from the literature, the parties' points of view expressed in the media and occasionally, when possible, by consulting the parties themselves."²²

The author will use the software SuperDecisions²³ for model building. SuperDecisions is a software application developed by Creative Decisions Foundation, which Dr. Saaty co-founded for decision-making based on the AHP and the ANP.

Step 3 - Development of the Outcomes

Calculating WACC (Weighted Average Cost of Capital)

"The WACC is the product of the fraction of total capital from each source and the cost of capital from that source, summed over all sources. To illustrate the concept, we will look at debt and equity sources and their respective costs. A company's WACC increases as the beta and rate of return on equity increase, as an increase in WACC denotes a decrease in valuation and an increase in risk."²⁴

Modeling Project Risk Premium

"The project's risk premium calculation method was divided into two steps: step one, the establishment of priorities for the different risk levels that the project can have, using the ANP model; and step two, quantifying the risk premium of each risk project."²⁵ An overview of the model is presented in Figure 8:

²² Saaty, T.L. and Vargas, L.G. (2013). Decision Making with the Analytic Network Process, page 2.

²³ SuperDecisions. (2023). Retrieved from <https://www.superdecisions.com>

²⁴ Sullivan, G. W., Wicks, M. E., & Koelling, C. P. (2023). Engineering Economy 17th Edition. Chapter 13 The Capital Budgeting Process, page 574.

²⁵ Rodas, J. M. C., Fernández J.C., Gómez J. M. N, Castanho R. A. (2019). Risk Premium Assessment for the Sustainable Valuation of Urban Development Land: Evidence from Spain, page 6. Retrieved from <https://www.mdpi.com/2071-1050/11/15/4191>

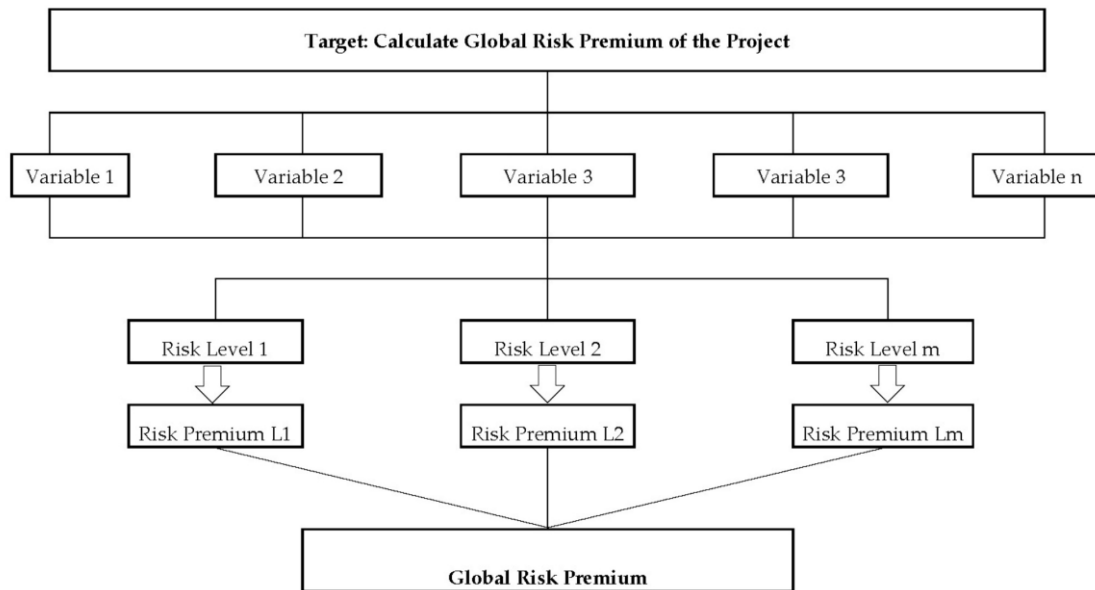


Figure 8 – Project Risk Premium Modeling²⁶

After the risk is quantified, the project risk premium can be determined. This can be done in various ways, but one common approach is to compare the risk of the project with the overall market risk (as represented by the market risk premium) and then adjust upwards or downwards based on a subjective assessment of how much greater the project's risk is compared to the market risk. This requires professional judgment.

By modifying the model and formula developed by Rodas, J. M. C., Fernández J.C., Gómez J. M. N, Castanho R. A. (2019), as follow²⁷

$$RP_s = \sum_{i=1}^5 ARP_i \cdot w_i$$

(Equation 4)

to define the Project Risk Premiums (PRP_i) for each project were obtained by applying the weight of each of them (w_i) and factoring to the Market Risk Premium by a study of IESE Business School from 2016 to 2023. PRP_i for each project was obtained by the following formula:

$$PRP_i = \text{Market Risk Premium} \times W_i$$

(Equation 5)

²⁶ Ibid

²⁷ Rodas, J. M. C., Fernández J.C., Gómez J. M. N, Castanho R. A. (2019). Risk Premium Assessment for the Sustainable Valuation of Urban Development Land: Evidence from Spain, page 10. Retrieved from <https://www.mdpi.com/2071-1050/11/15/4191>

Since the project risk premium varies for each project and the scope isn't about sustainability, this study does not calculate the global risk premium.

Developing Risk Matrix

The purpose is to determine the risk matrix based on the ANP method:

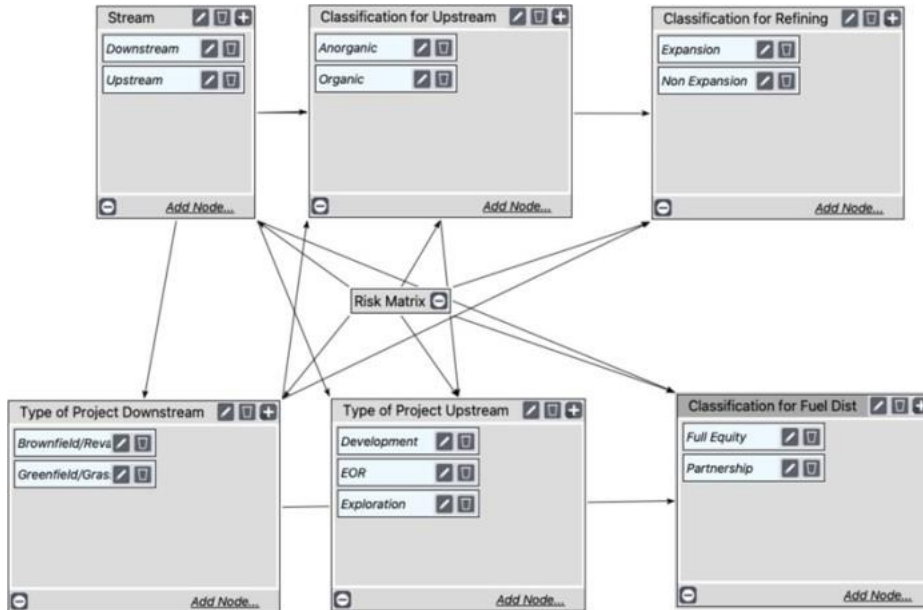


Figure 9 – Risk Matrix using ANP²⁸

For the implementation of the ANP, a panel of professionals was chosen, all of whom possess the required qualifications or specialized knowledge concerning project risk. In this particular context, a group of 8 experts has been selected, and the relevant data regarding them will be provided in the subsequent section.

Members	Degree	Expertise	Role
2	Master	Engineering Physics	Sub-ordinate
1	Bachelor	Civil Engineering	Peer
2	Master	Electrical Engineering	Senior Engineer
1	Master	Industrial Engineering	Lead Engineer
1	Bachelor	Electrical Engineering	Peer
1	Bachelor	Mechanical Engineering	Peer

Table 1 – Expert Group²⁹

²⁸ By Author
²⁹ By Author

Step 4 - Selection of a Criterion (or Criteria)

Consistency Ratio

The Consistency Ratio (CR) in ANP is a measure used to estimate how consistent the decisions or judgments are. When assigning priorities or making comparisons, some degree of inconsistency is expected. This inconsistency could be due to various factors such as cognitive bias, error in judgment, or the complexity of the decision problem itself.

In ANP, "the CR is calculated by dividing the Consistency Index (CI) by the Random Index (RI), which is a value obtained from a random matrix. Generally, a consistency ratio of 0,10 or less is considered acceptable, meaning the level of inconsistency is tolerable."³⁰ If the consistency ratio exceeds 0,10, it's advisable for the decision-maker to revisit and adjust their evaluations or comparisons to enhance consistency.

Factoring Project Risk Premium

The maximum market risk premium using the study of IESE Business School from 2016 to 2023. The data is as follows:

INDONESIA	2016	2017	2018	2019	2020	2021	2022	2023
Market Risk Premium	14,50%	11,40%	11,90%	13,00%	19,40%	9,00%	16,30%	11,40%

Table 2 - Market Risk Premium of Indonesia from 2016 to 2023 ^{31 32 33 34 35 36 37 38}

Monte Carlo Simulation is a "Computation intensive forecasting technique applied where statistical analysis is extremely cumbersome due to the complexity of a problem (such as queuing or waiting for line probabilities, or inventories involving millions of items). Used only where the Problem has a chance (random) component and is subject to unpredictable influences, it simulates (models) a situation based on current and past (historical) data. In the simulation process, it computes an equation (mathematical model)

³⁰ Wedley, W.C. (1993). Consistency Prediction for Incomplete AHP Matrices. Retrieved from <https://pdf.sciencedirectassets.com/271552/1-s2.0-S0895717700X01690/1-s2.0-089571779390183Y/>

³¹ Fernandez, P., Ortiz A., Acín, I. F. (2016). Market Risk Premium used in 71 countries in 2016: a survey with 6,932 answers. Retrieved from <https://ssrn.com/abstract=2776636>

³² Fernandez, P., Pershin, V., Acín, I. F. (2017). Discount Rate (Risk-Free Rate and Market Risk Premium) used for 41 countries in 2017: a survey. Retrieved from <https://ssrn.com/abstract=2954142>

³³ Fernandez, P., Pershin, V., Acín, I. F. (2018). Market Risk Premium and Risk-Free Rate used for 59 countries in 2018: a survey. Retrieved from <https://ssrn.com/abstract=3155709>

³⁴ Fernandez, P., Martínez, M., Acín, I. F. (2019). Market Risk Premium and Risk-Free Rate used for 69 countries in 2019: a survey. Retrieved from <https://ssrn.com/abstract=3358901>

³⁵ Fernandez, P., Apellaniz E., Acín, J. F. (2020). Market Risk Premium and Risk-Free Rate used for 81 countries in 2020: a survey. Retrieved from <https://ssrn.com/abstract=3560869>

³⁶ Fernandez, P., Bañuls, S., Acín, P. F. (2021). Market Risk Premium and Risk-Free Rate used for 88 countries in 2021. Retrieved from <https://ssrn.com/abstract=3861152>

Retrieved from <https://ssrn.com/abstract=3803990>

³⁸ Fernandez, P., García, D., Acín, J. F. (2023). Survey: Market Risk Premium and Risk-Free Rate used for 80 countries in 2023. Retrieved from <https://ssrn.com/abstract=4407839>

thousands or millions of times, injecting random numbers to come up with a range of possibilities or outcomes of possible actions. The larger the number of computations, the greater the probability (according to the law of large numbers) approximating the future events to provide the maximum amount of known data incorporated into the model."³⁹

It uses software @RISK 8.0 by LUMIVERO for **Monte Carlo Simulation** with 100.000 iteration tests to generate the Probability Distribution of Market Premium Risk. Based on GAO Cost Estimating and Assessment Guide, "by adopting a higher confidence level estimate (70 or 80 percent) can be used to make some provision for risks unknown at the time but likely to appear as the program progresses. Research has shown that budgeting each program in a portfolio at its 80th percentile can result in budgeting the portfolio above the 95th percentile. The total portfolio budget will be larger than needed to successfully execute the programs."⁴⁰

The distribution for this analysis uses a lognormal distribution that is favored in the financial industry, as it inherently assumes that "the randomly varying factors are the rates of return, rather than the absolute shifts in pricing"⁴¹, thereby making it a suitable model for financial analysis.

Utilizing lognormal distribution in the Monte Carlo simulation will adhere to the guidelines outlined in the NASA Cost Estimating Handbook "Sometimes the normal distribution can produce negative values that obviously do not make logical sense for describing cost. Furthermore, the normal distribution's inherent symmetric characteristic cannot characterize the common tendency for costs to go up rather than down over time. For these two reasons, the lognormal distribution, which cannot go below zero and is nonsymmetrical (e.g., can be right-skewed), is typically preferred over the normal distribution by many cost analysts."⁴²

³⁹ PTMC, & Giammalvo, P. D. (2021). 1.4.1.6 Unit 6- Managing Risk and Opportunity. Retrieved from <https://build-project-management-competency.com/1-4-1-6-unit-6/>. Page 41 of 70.

⁴⁰ The United States Government Accountability Office. (2020). GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs, page 173.

⁴¹ Bouchaud, J. and Potters, M. (2009). Theory of Financial Risk and Derivative Pricing : From Statistical Physics to Risk Management. Retrieved from https://www.researchgate.net/publication/248072283_Theory_of_Financial_Risk_and_Derivative_Pricing_From_Statistical_Physics_to_Risk_Management

⁴² NASA Cost Estimating Handbook. (2023). Retrieved from <https://www.nasa.gov/content/cost-estimating-handbook>

FINDINGS

Step 5 - Analysis and Comparison of the Alternatives

Calculated WACC

Equation 1 above is applied to calculate the WACC, along with the detailed assumptions regarding the WACC components listed below. Thus, the WACC calculation for the company is as follows:

Components	Calculated
Risk-Free (R_f)	6,248% ⁴³
Equity Risk Premium	9,23% ⁴⁴
β	0,98 ⁴⁵
CAPM (Equation 2)	15,29%
WACC	10,47%

Table 3 – Calculated WACC⁴⁶

The above calculation is based on the following assumptions:

1. Risk-Free (R_f) is based on Indonesia 10 Years of Government Bond⁴⁷
2. Equity Risk Premium is based on the 2023 Aswath Damodaran study on Equity Risk Premium (ERP): Determinant, Estimation and Implications for Indonesia ⁴⁸
3. Beta (β) based on the beta industry from Aswath Damodaran 2023 study for a non-public listed company (Oil & Gas Integrated)⁴⁹
4. A portion of debt and equity as indicated in the company's financial statement for the year ended in 2022.⁵⁰

As the author utilizes the Equity Risk Premium (ERP) from Damodaran's study, it is important to note, based on the literature, that this ERP already incorporates the country

⁴³ World Government Bonds. Indonesia 10 Years Bond – Historical Data. Retrieved from <http://www.worldgovernmentbonds.com/bond-historical-data/indonesia/10-years/#:~:text=The%20Indonesia%2010%20Years%20Government,%3A15%20GMT%2B0>

⁴⁴ Damodaran, A. (2023). Equity Risk Premiums (ERP): Determinants, Estimation, and Implications – The 2023 Edition. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4398884

⁴⁵ Damodaran, A. (2023). Betas by Sector (US). Retrieved from https://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/Betas.html

⁴⁶ By Author

⁴⁷ Milza, R., & Rahadi, R. (2023). Valuation of PT Pertamina (Persero) Post Restructuring. Asian Journal Of Research In Business And Management, 5(1), 158-173. Retrieved from <https://myjms.mohe.gov.my/index.php/airbm/article/view/21242>

⁴⁸ Ibid

⁴⁹ Liana, L. (2014). Using Analytical Hierarchy Process to Determine Appropriate Minimum Attractive Rate of Return for Oil and Gas Projects in Indonesia. Retrieved from <http://pmworldjournal.net/article/using-analytical-hierarchy-process-determine-appropriate-minimum-attractive-rate-return-oil-gas-projects-indonesia/>

⁵⁰ PT Pertamina (Persero). (2023). Consolidated Financial Statements 2022. Retrieved from <https://www.pertamina.com/Media/Upload//Pertamina%20Financial%20Report%202022.pdf>

risk of Indonesia. "The significance of using an ERP accomodating country risk cannot be understated. Countries vary regarding economic stability, political stability, regulatory environments, and market efficiency."⁵¹ Each of these factors, which is divided geographically, can contribute to the overall risk profile of an investment in a particular country.

Incorporating the country risk premium into the cost of capital calculation allows for a more accurate reflection of the returns expected by investors for investing in a given country. This leads to more precise investment decisions and valuations. The relevance of this consideration is further supported by the following research graph:

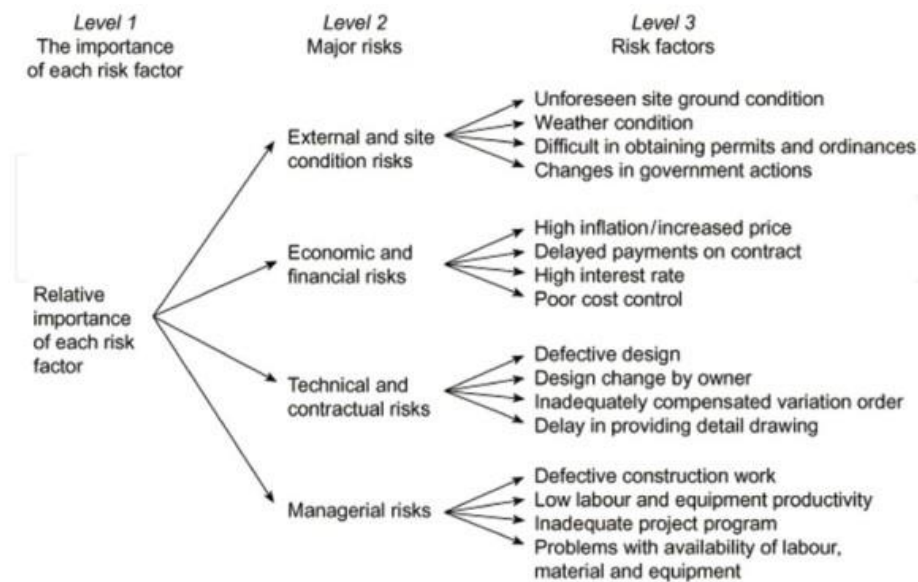


Figure 10 – Hierarchy of Risk in Indonesia⁵²

Since Indonesia NOC restructured the company by spin-off its business into 6 (six) sub-holdings to focus on each portfolio management and strategy to meet the challenge of decarbonization and maximize the potential valuation of the whole business. Below are results in WACC references for all sub-holdings and subsidiaries using the same assumption of ERP:

⁵¹ Damodaran, A. (2023). Data Update 4 for 2023: Country Risk. Retrieved from <https://pages.stern.nyu.edu/~adamodar/pdfiles/blog/DataUpdate4for2023.pdf>

⁵² Wibowo, M. A., Hatmoko, J. U. D., and Nurdiana, A. (2018). Risk Management in Indonesia Construction Project: A Case Study of a Toll Road Project. Retrieved from <https://www.intechopen.com/chapters/62555>

WACC	PHE	KPI	PPN	PPI	PGAS	PIS	PDV	TUGU	PAS	PTC	PJSA	IHC
Beta	0,58	0,60	0,65	1,29	1,18	0,75	0,28	-	1,53	0,73	0,81	0,63
Equity Risk Premium	9,23%	9,23%	9,23%	9,23%	9,23%	9,23%	9,23%	9,23%	9,23%	9,23%	9,23%	9,23%
Risk Free Rate	6,72%	6,72%	6,72%	6,72%	6,72%	6,72%	6,72%	6,72%	6,72%	6,72%	6,72%	6,72%
Cost of Equity	12,04%	12,27%	12,75%	18,64%	17,61%	13,67%	9,27%	6,72%	20,80%	13,42%	14,17%	12,57%
Dafault Spread	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%
Cost of Debt	10,90%	10,90%	10,90%	10,90%	6,54%	6,54%	10,90%	10,90%	10,90%	10,90%	10,90%	10,90%
Tax Rate	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%
Weight of Equity	89,44%	97,88%	87,82%	59,41%	52,68%	88,62%	100,00%	98,00%	53,77%	100,00%	80,54%	94,86%
Weight of Debt	10,56%	2,12%	12,18%	40,59%	47,32%	11,38%	0,00%	2,00%	46,23%	0,00%	19,46%	5,14%
WACC	11,63%	12,19%	12,20%	14,39%	11,60%	12,67%	9,27%	6,75%	14,96%	13,42%	13,00%	12,35%

Table 4 - WACC of All Sub-holdings and Subsidiaries⁵³

Risk Matrix using ANP Method

The analysis of the variables affecting investment risk was conducted utilizing the perspectives of the experts (Table 1). Each expert crafted their analysis and evaluations. The collective evaluation outcomes were then derived through the implementation of the geometric mean using the software SuperDecisions as follows:

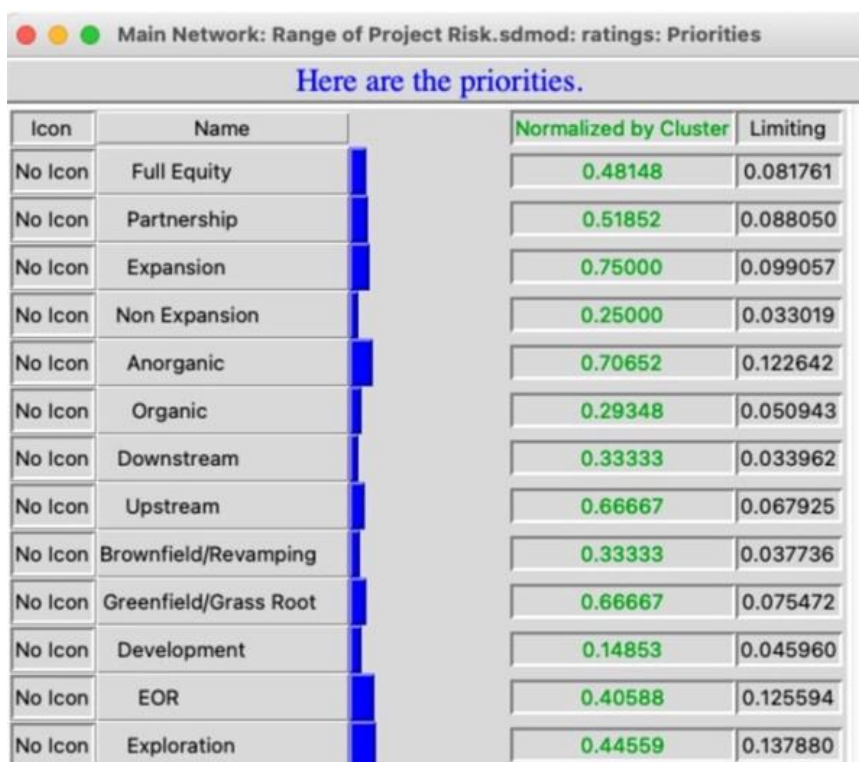


Figure 11 - Risk Matrix using ANP Method⁵⁴

⁵³ Milza, R., & Rahadi, R. (2023). Valuation of PT Pertamina (Persero) Post Restructuring. Asian Journal Of Research In Business And Management, 5(1), 158-173. Retrieved from <https://myjms.mohe.gov.my/index.php/ajrbm/article/view/21242>
⁵⁴ By Author

The result of all the Consistency Ratio is $< 0,1$. Therefore the output of the decision matrix's inconsistency for each weight is acceptable or manageable. Below is an example of one of the categories:

3. Results		
Normal	Hybrid	
Inconsistency: 0.05156		
Developme~		0.10852
EOR		0.34454
Explorati~		0.54693

Figure 12 – Consistency Ratio Result⁵⁵ (See Appendix 1)

Monte Carlo Simulation

The subsequent analysis applies Monte Carlo Simulation to recreate the data from Table 2. The simulation currently employs the Lognormal & Normal Distribution to see the difference between two distributions, for 100.000 iterations using the @RISK⁵⁶. The results of the overlaying distributions are presented as follows:

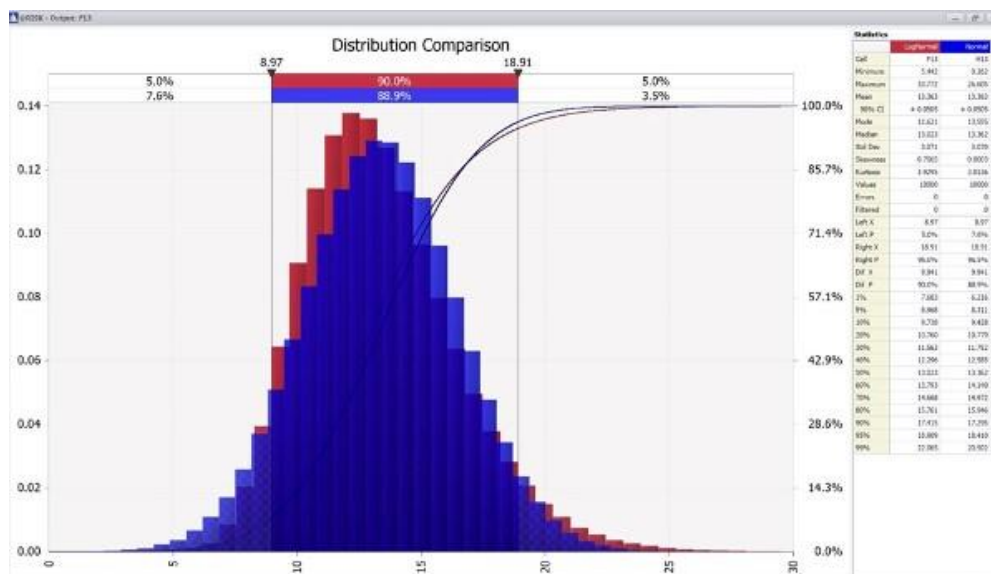


Figure 13 – Risk Output: NORMAL & LOGNORMAL Distribution Curve⁵⁷

By adopting a higher confidence level estimate⁵⁸, therefore the Market Risk Premium for factoring the project risk used **P80 - Lognormal Distribution: 15,761%**.

⁵⁵ By Author

⁵⁶ @RISK by LUMIVERO. (2023). Retrieved from <https://lumivero.com>

⁵⁷ By Author

⁵⁸ The United States Government Accountability Office. (2020). GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs, page 173.

Factoring Project Risk Premium

To calculate the Project Risk Premium, **Equation 5** above is applied, factoring along with the Market Risk Premium calculated before. Thus, each Project Risk Premium per category for the company is as follows:

Stream	Classification	Type of Project	Result	Remarks
Upstream	Organic	Exploration	1,37%	
Upstream	Organic	EOR	1,25%	
Upstream	Organic	Development	0,46%	LOWEST
Upstream	Anorganic	Greenfield	4,95%	HIGHEST
Upstream	Anorganic	Brownfield	2,47%	
Refining & Petrochemical				
Downstream	Grass Root		2,63%	HIGHEST
Downstream	Revamping	Expansion	1,31%	
Downstream	Revamping	Non Expansion	0,44%	LOWEST
Fuel Distribution				
Downstream	Full Equity	Greenfield	1,90%	
Downstream	Partnership	Greenfield	2,04%	HIGHEST
Downstream	Full Equity	Revamping	0,84%	LOWEST
Downstream	Partnership	Revamping	0,91%	

Table 5 – Project Risk Premium⁵⁹

⁵⁹ By Author

Step 6 - Selection of the Preferred Alternatives

The calculation of the hurdle rate for each oil and gas initiative in Indonesia can be performed by incorporating the project risk premium into the WACC, as depicted in **Equation 3** as follow:

Stream	Classification	Type of Project	Hurdle Rate	Remarks
Upstream	Organic	Exploration	11,84%	
Upstream	Organic	EOR	11,72%	
Upstream	Organic	Development	10,93%	
Upstream	Anorganic	Greenfield	15,42%	HIGHEST
Upstream	Anorganic	Brownfield	12,94%	
Refining & Petrochemical				
Downstream	Grass Root		13,10%	
Downstream	Revamping	Expansion	11,78%	
Downstream	Revamping	Non Expansion	10,91%	LOWEST
Fuel Distribution				
Downstream	Full Equity	Greenfield	12,37%	
Downstream	Partnership	Greenfield	12,51%	
Downstream	Full Equity	Revamping	11,31%	
Downstream	Partnership	Revamping	11,38%	

Table 6 – Calculated Hurdle Rate⁶⁰

Step 7 - Performance Monitoring and Post-Evaluation of Results

It becomes crucial to ensure that the risk premium calculation is comprehensive and reflects all possible risks. While this study has offered a fundamental groundwork, it may not encompass all potential risks, particularly those intrinsic to the company's unique business processes. Therefore, in addition to the risks identified in this study, it needs to scrutinize and incorporate those risks inherent to the company's own operational processes.

This ensures a more precise calculation of the risk premium, thereby leading to more accurate investment decisions and contributing to the overall efficacy of the company's operations.

⁶⁰ By Author

CONCLUSION

- 1. To investigate whether a hurdle rate is appropriate for Indonesia National Oil Company to evaluate the economics of the projects, ensuring it is not too high or too low.**

Benchmarking against the global WACC and reviewing literature enhances understanding for setting a company's investment hurdle rate. Recognizing & identify all potential risks is pivotal. An adequately set hurdle rate, reflecting all relevant risks, can determine profitable investments.

Too Low Hurdle Rate

Setting the hurdle rate too low can lead to several problems. “One is that it might encourage the initiation of projects that might not offer enough return to justify their risk. This could potentially result in projects that end up over budget or over time, leading to a misuse of resources and inefficiencies.”⁶¹

“**Optimism Bias:** When the hurdle rate is set too low, it might encourage an optimism bias. This is a cognitive bias that causes someone to believe that they are less likely to experience a negative event. Managers might become overly optimistic about the potential success of their projects, underestimating costs & overestimating benefits, leading to over and delayed projects.

Strategic Misrepresentation: A low hurdle rate could also encourage strategic misrepresentation, which is a deliberate distortion of information or narrative in the pursuit of personal or professional advantage. In the context of capital budgeting, if managers know the hurdle rate is low, they might overstate the potential return of a project or understate the costs to get approval, leading to a higher risk of project failure.”⁶²

Too High Hurdle Rate

While “a too high one can deter profitable projects. Setting the hurdle rate too high can introduce the risk that a business will pass on attractive investment opportunities.

⁶¹ Flyvbjerg, B. (2011). Over Budget, Over Time, Over and Over Again: Managing Major Projects. In Peter W. G. Morris, Jeffrey K. Pinto, and Jonas Söderlund, eds., *The Oxford Handbook of Project Management*, Oxford: Oxford University Press, pp. 321-344. Retrieved from https://www.academia.edu/3365343/Over_Budget_Over_Time_Over_and_Over_Again_Managing_Major_Projects

⁶² Ibid

This occurs because when the hurdle rate is set at a premium to the WACC, the company is only looking at projects that promise a higher than usual rate of return.”⁶³

This can be an issue because numerous potential projects could offer returns slightly below this high hurdle rate but are still above the WACC, implying these projects would add value to the company. By setting the hurdle rate too high, the company could inadvertently reject these worthwhile projects.⁶⁴

It's important to note that a high hurdle rate should not be used as a substitute for a clear strategy. Projects that align well with the company's strategic goals and promise a good return, even if slightly below a high hurdle rate, can still be valuable for the long-term growth and success of the company.

Hence, the hurdle rate should be balanced, high enough to account for risks and provide satisfactory returns, but not discouraging for worthy investments. This approach improves investment decisions and overall company performance.

The calculated range of hurdle rate in this study is **10,91% to 15,42%**⁶⁵.

2. To identify the suitable methodology for calculating the hurdle rate for diverse oil and gas projects across all streams in Indonesia, factoring in the risks linked to the stream, type of investment, classification of stream, and country-specific risks.

This study uses the ANP method and Monte Carlo Simulation to analyze variables affecting investment risk. Experts analyze and evaluate these variables individually, with collective outcomes derived through the geometric mean. The ANP method results in a risk matrix, and all Consistency Ratios are found to be less than 0,1, indicating acceptable inconsistency levels. The Monte Carlo Simulation, with 100.000 iterations, simulates data and results in a LOGNORMAL Distribution Curve. The Project Risk Premium (PRP) is calculated using these methods, and the hurdle rate for each oil and gas initiative is determined by incorporating the PRP into the WACC.

⁶³ Harms, T. W. (2018). Determining the Right Hurdle Rate: How Good is Good Enough?. Retrieved from <https://www.linkedin.com/pulse/determining-right-hurdle-rate-how-good-enough-travis-w-harms>

⁶⁴ Davies, R., Goedhart, M., and Koller, T. (2012). Avoiding a risk premium that unnecessarily kills your project. Retrieved from <https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/avoiding-a-risk-premium-that-unnecessarily-kills-your-project#/>

⁶⁵ By Author

3. To emphasize that country-specific risk is crucial when applied to the Hurdle Rate.

Damodaran's study has developed a methodology to include country risk in investment and valuation decisions. This process is vital because⁶⁶:

- **Risk Diversification:** Accounting for country risk helps companies to spread their investments across different risk levels tied to variables like political stability, economic climate, regulatory factors, and currency fluctuations.
- **Accurate Valuation:** By factoring in country risk, companies can better gauge the valuation of investments. This inclusion aids in setting practical return expectations and considering potential operational risks in specific countries.
- **Strategic Decision Making:** Comprehending country risk can guide strategic decisions. It might lead to entering a high-risk country with significant potential returns or avoiding an excessively risky country.
- **Risk Management:** Quantifying country risk allows for effective risk management. It can lead to mitigation strategies like obtaining political risk insurance or hedging currency risk.

This country risk assessment methodology, which involves calculating a country-specific risk premium, is highly regarded. It can be added to the cost of capital or used to adjust cash flows in a discounted cash flow valuation, offering a quantitative way to integrate country risk into investment decisions.

⁶⁶ Damodaran, A. (2022). Country Risk: Determinants, Measures and Implications - The 2022 Edition. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4161010

BIBLIOGRAPHY

No. Description

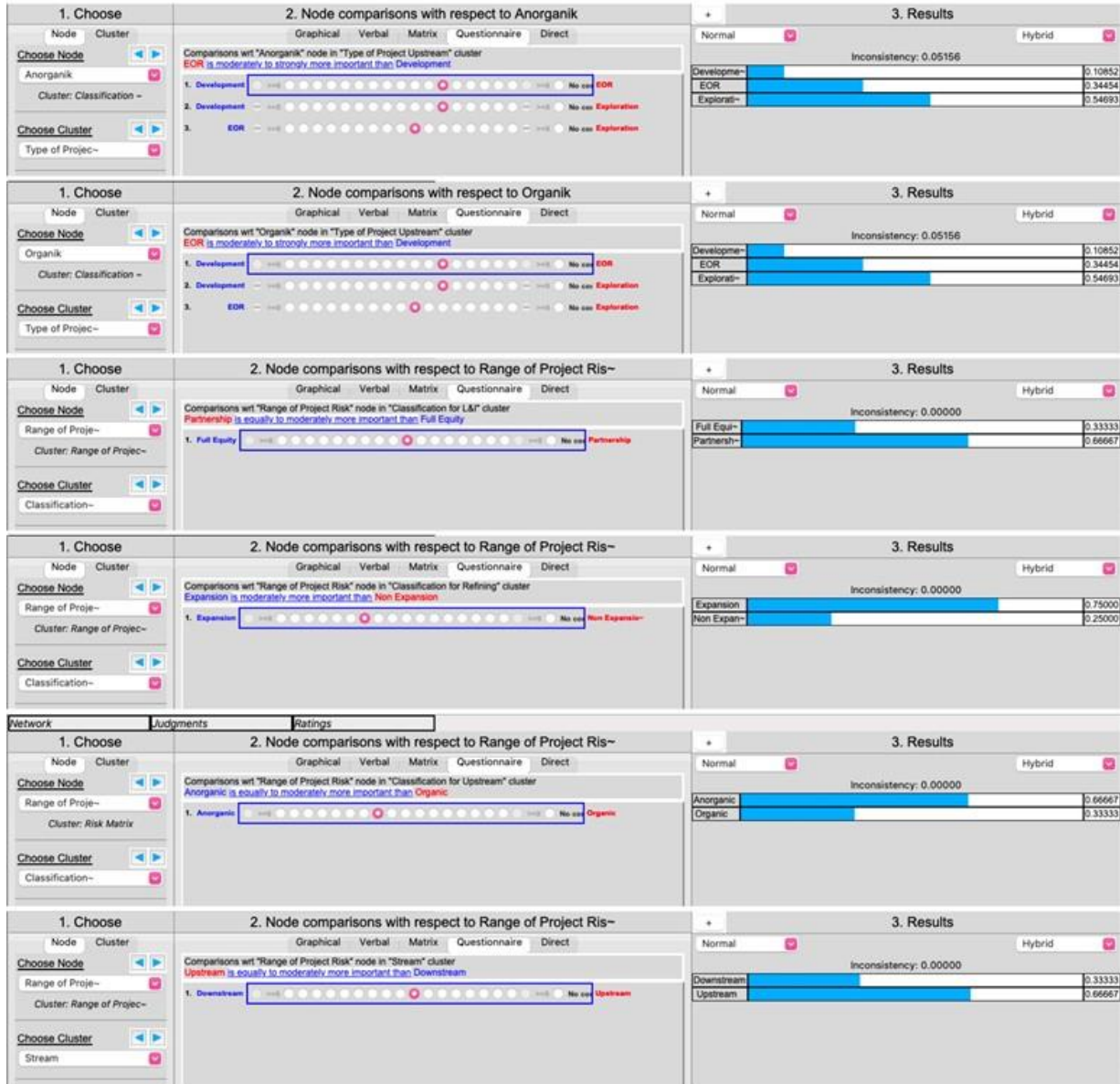
1. Statista. (2023). Value of investments in the oil and gas sector in Indonesia from 2014 to 2022. <https://www.statista.com/statistics/993188/indonesia-investment-in-oil-and-gas/#statisticContainer>
2. CNBC. (2023). Terungkap! Investasi Pertamina Melejit, Ternyata Buat ini. <https://www.cnbcindonesia.com/news/20230208110151-4-412048/terungkap-investasi-pertamina-melejit-ternyata-buat-ini>
3. CNBC. (2023). Pertamina Siap Jor-joran di 2023! Kucurkan Investasi Rp86 T. <https://www.cnbcindonesia.com/news/20230207194410-4-411908/pertamina-siap-jor-joran-di-2023-kucurkan-investasi-rp86-t>.
4. Ministry of Energy and Mineral Resources. (2023). <https://www.esdm.go.id/id/berita-unit/direktorat-jenderal-minyak-dan-gas-bumi/proyek-hilir-migas-terus-berkembang-investasi-tahun-2024-diproeksikan-us1077-miliar>
5. Gurufocus. (2023). Oil & Gas Development Co (OTCPK:ODVCI) WACC. <https://www.gurufocus.com/term/wacc/ODVCI/>
6. Shuttleworth, M. (2008). What is Research? <https://explorable.com/what-is-research>
7. Sullivan, G. W., Wicks, M. E., & Koelling, C. P. (2023). Engineering economy 17th Edition. Chapter 1 Introduction to Engineering Economy, page 7-12.
8. Sullivan, G. W., Wicks, M. E., & Koelling, C. P. (2023). Engineering Economy 17th Edition. Chapter 7 Depreciation and Income Taxes, page 346.
9. Sullivan, G. W., Wicks, M. E., & Koelling, C. P. (2023). Engineering Economy 17th Edition. Chapter 13 The Capital Budgeting Process, page 573.
10. Sullivan, G. W., Wicks, M. E., & Koelling, C. P. (2023). Engineering Economy 17th Edition. Chapter 13 The Capital Budgeting Process, page 576.
11. PT Pertamina (Persero). (2022). WACC per Sektor di Indonesia.
12. PT Pertamina (Persero). (2015). Pertamina Highlight. <https://pertamina.com/media/4f6bce59-35df-4964-94ef-9cf458f8db5c/Investor%20Presentation%20for%20Non-Deal%20Roadshow%20Nov2015.pdf>
13. PT Pertamina (Persero). (2023). Teritori Pertamina. <https://www.pertamina.com/id/teritori>
14. Saaty, T.L. and Vargas, L.G. (2013). Decision Making with the Analytic Network Process, page 2.
15. Saaty, T.L. and Vargas, L.G. (2013). Decision Making with the Analytic Network Process, page 76.
16. Saaty, T.L. and Vargas, L.G. (2013). Decision Making with the Analytic Network Process, page 9.
17. SuperDecisions. (2023). Retrieved from <https://www.superdecisions.com>
18. Saaty, T.L. and Vargas, L.G. (2013). Decision Making with the Analytic Network Process, page 3.

19. Sullivan, G. W., Wicks, M. E., & Koelling, C. P. (2023). *Engineering Economy* 17th Edition. Chapter 13 The Capital Budgeting Process, page 574.
20. Rodas, J. M. C., Fernández J.C., Gómez J. M. N, Castanho R. A. (2019). Risk Premium Assessment for the Sustainable Valuation of Urban Development Land: Evidence from Spain, page 6. <https://www.mdpi.com/2071-1050/11/15/4191>
21. Rodas, J. M. C., Fernández J.C., Gómez J. M. N, Castanho R. A. (2019). Risk Premium Assessment for the Sustainable Valuation of Urban Development Land: Evidence from Spain, page 10. <https://www.mdpi.com/2071-1050/11/15/4191>
22. Wedley, W.C. (1993). Consistency Prediction for Incomplete AHP Matrices. <https://pdf.sciencedirectassets.com/271552/1-s2.0-S0895717700X01690/1-s2.0-089571779390183Y/>
23. Fernandez, P., Ortiz A., Acín, I. F. (2016). Market Risk Premium used in 71 countries in 2016: a survey with 6,932 answers. <https://ssrn.com/abstract=2776636>
24. Fernandez, P., Pershin, V., Acín, I. F. (2017). Discount Rate (Risk-Free Rate and Market Risk Premium) used for 41 countries in 2017: a survey. <https://ssrn.com/abstract=2954142>
25. Fernandez, P., Pershin, V., Acín, I. F. (2018). Market Risk Premium and Risk-Free Rate used for 59 countries in 2018: a survey. <https://ssrn.com/abstract=3155709>
26. Fernandez, P., Martinez, M., Acín, I. F. (2019). Market Risk Premium and Risk-Free Rate used for 69 countries in 2019: a survey. <https://ssrn.com/abstract=3358901>
27. Fernandez, P., Apellaniz E., Acín, J. F. (2020). Market Risk Premium and Risk-Free Rate used for 81 countries in 2020: a survey. <https://ssrn.com/abstract=3560869>
28. Fernandez, P., Bañuls, S., Acín, P. F. (2021). Market Risk Premium and Risk-Free Rate used for 88 countries in 2021. <https://ssrn.com/abstract=3861152>
29. Fernandez, P., García, T., Acín, J. F. (2022). Market Risk Premium and Risk-Free Rate used for 81 countries in 2022: a survey. <https://ssrn.com/abstract=3803990>
30. Fernandez, P., García, D., Acín, J. F. (2023). Survey: Market Risk Premium and Risk-Free Rate used for 80 countries in 2023. <https://ssrn.com/abstract=4407839>
31. PTMC, & Giammalvo, P. D. (2021). 1.4.1.6 Unit 6- Managing Risk and Opportunity. <https://build-project-management-competency.com/1-4-1-6-unit-6/>. Page 41 of 70.
32. The United States Government Accountability Office. (2020). GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs, page 173.
33. Anderson, Timothy P. (2006). *The Trouble with Budgeting to the 80th Percentile,* Aerospace Corporation.
34. Bouchaud, J. and Potters, M. (2009). *Theory of Financial Risk and Derivative Pricing : From Statistical Physics to Risk Management.* https://www.researchgate.net/publication/248072283_Theory_of_Financial_Risk_and_Derivative_Pricing_From_Statistical_Physics_to_Risk_Management
35. NASA Cost Estimating Handbook. (2023). <https://www.nasa.gov/content/cost-estimating-handbook>
36. Bouchaud, J. and Potters, M. (2009). *Theory of Financial Risk and Derivative Pricing : From Statistical Physics to Risk Management.*

- https://www.researchgate.net/publication/248072283_Theory_of_Financial_Risk_and_Derivative_Pricing_From_Statistical_Physics_to_Risk_Management
37. World Government Bonds. Indonesia 10 Years Bond – Historical Data.
<http://www.worldgovernmentbonds.com/bond-historical-data/indonesia/10-years/#:~:text=The%20Indonesia%2010%20Years%20Government,%3A15%20GMT%2B0>
 38. Damodaran, A. (2023). Equity Risk Premiums (ERP): Determinants, Estimation, and Implications – The 2023 Edition.
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4398884
 39. Damodaran, A. (2023). Betas by Sector (US)
https://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/Betas.html
 40. Milza, R., & Rahadi, R. (2023). Valuation of PT Pertamina (Persero) Post Restructuring. Asian Journal Of Research In Business And Management, 5(1), 158-173. Retrieved from <https://myjms.mohe.gov.my/index.php/airbm/article/view/21242>
 41. @RISK by Lumivero. (2023). <https://lumivero.com>
 42. Liana, L. (2014). Using Analytical Hierarchy Process to Determine Appropriate Minimum Attractive Rate of Return for Oil and Gas Projects in Indonesia.
<http://pmworldjournal.net/article/using-analytical-hierarchy-process-determine-appropriate-minimum-attractive-rate-return-oil-gas-projects-indonesia/>
 43. PT Pertamina (Persero). (2023). Consolidated Financial Statements 2022.
<https://www.pertamina.com/Media/Upload//Pertamina%20Financial%20Report%202022.pdf>
 44. Damodaran, A. (2023). Data Update 4 for 2023: Country Risk.
<https://pages.stern.nyu.edu/~adamodar/pdffiles/blog/DataUpdate4for2023.pdf>
 45. Wibowo, M. A., Hatmoko, J. U. D., and Nurdiana, A. (2018). Risk Management in Indonesia Construction Project: A Case Study of a Toll Road Project.
<https://www.intechopen.com/chapters/62555>
 46. Flyvbjerg, B. (2011). Over Budget, Over Time, Over and Over Again: Managing Major Projects. In Peter W. G. Morris, Jeffrey K. Pinto, and Jonas Söderlund, eds., The Oxford Handbook of Project Management, Oxford: Oxford University Press, pp. 321-344.
https://www.academia.edu/3365343/Over_Budget_Over_Time_Over_and_Over_Again_Managing_Major_Projects
 47. Harms, T. W. (2018). Determining the Right Hurdle Rate: How Good is Good Enough?
<https://www.linkedin.com/pulse/determining-right-hurdle-rate-how-good-enough-travis-w-harms>
 48. Davies, R., Goedhart, M., and Koller, T. (2012). Avoiding a risk premium that unnecessarily kills your project. <https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/avoiding-a-risk-premium-that-unnecessarily-kills-your-project/>
 49. Damodaran, A. (2022). Country Risk: Determinants, Measures and Implications - The 2022 Edition. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4161010

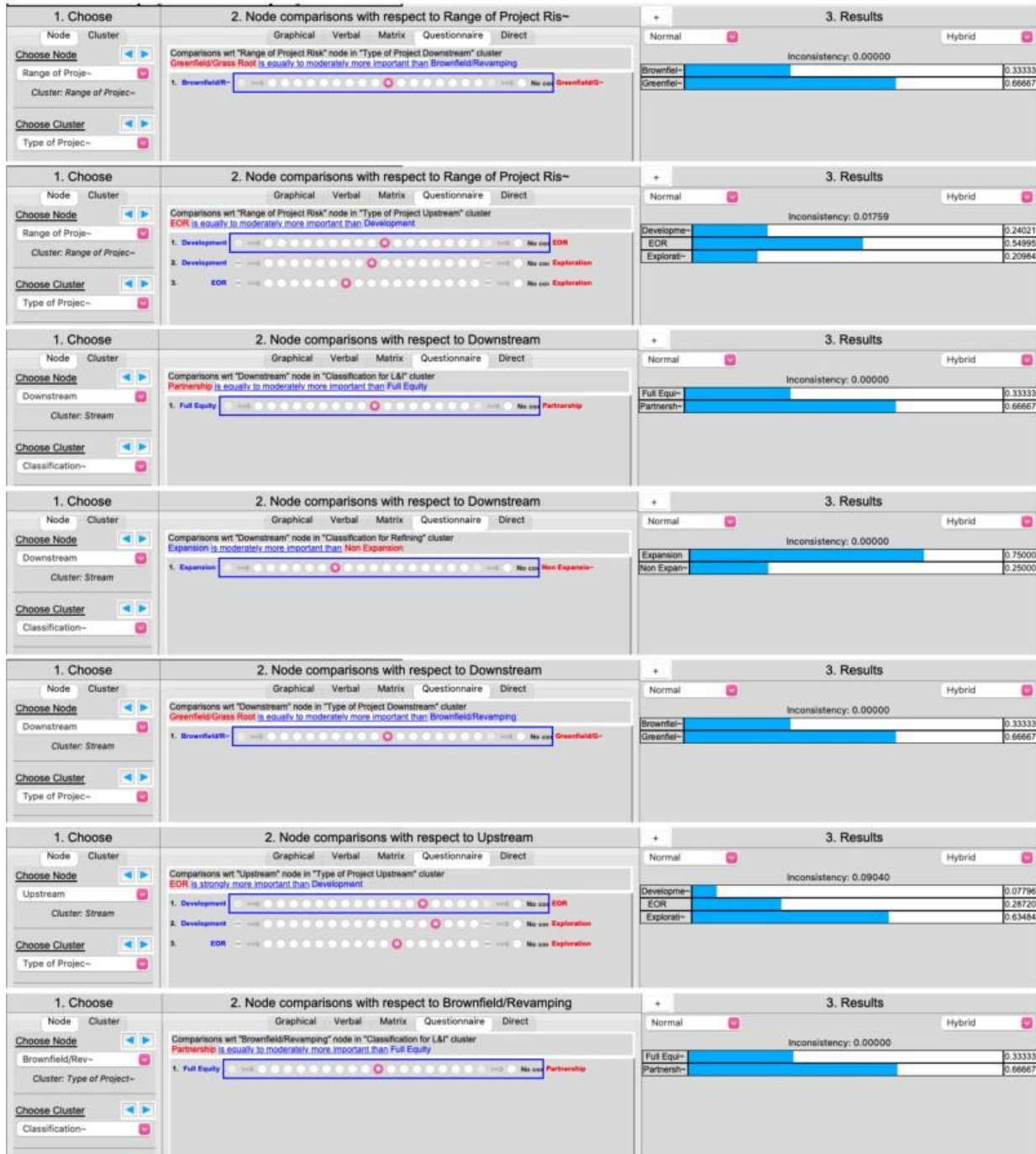
APPENDICES

APPENDIX 1 - Consistency Ratio Result per Categories⁶⁷



⁶⁷ By Author

APPENDIX 1 - Consistency Ratio Result per Categories⁶⁸ (continue)



⁶⁸ By Author

About the Author



Nina Ratna Enggar Puspita

Jakarta, Indonesia



Nina Ratna Enggar Puspita is an engineer with 8 (eight) years of professional experience in the oil and gas sectors. Currently, she works as a cost engineer at the Indonesia National Oil Company of Indonesia. During her career, she has an experience as a Cost Estimator, Procurement Staff, Construction Engineer, Monitoring & Budgeting Officer, and Inspector. She has been involved in several projects, including Fuel Terminal, Pipeline, Jetty Facilities, and Aviation Fuel Supply Facilities.

She holds a bachelor's degree in Industrial Engineering from Diponegoro University, a master's degree in Business Administration from Gadjah Mada University (UGM), and a certified engineer from Bandung Institute of Technology (ITB). She is attending a distance learning mentoring course under the tutorage of Dr. Paul D. Giammalvo, CDT, CCE, MScPM, MRICS, Senior Technical Advisor (Project Management), PT Mitratata Citragraha (PTMC/APMX), to attain Certified Cost Professional certification from AACE International.

Nina lives in Jakarta, Indonesia and can be contacted at ninaratnaep@gmail.com.