



OPERATIONS STRATEGY IN ENERGY INVESTMENT PRIORITIZATION: AN ADAPTED AHP-BASED DECISION FRAMEWORK

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Abstract

Introduction: Prioritizing investment projects in power-generation companies is a strategic operations decision because capital allocation shapes asset reliability, service continuity, organizational resilience, and energy-transition capability. This study develops a transparent managerial framework that integrates financial, technical, strategic, risk, and sustainability considerations in project selection at PT PLN Nusantara Power.

Methods: An exploratory sequential mixed-methods case study combined internal document analysis, executive contextualization, criterion assessments by Board members, and evaluations of 50 project proposals by Vice Presidents. Criterion weights were derived through an adapted Analytical Hierarchy Process, while project priorities were synthesized using a weighted additive approach.

Results: The resulting structure placed financial considerations slightly ahead of strategic, risk, sustainability, and technical considerations, indicating a balanced decision logic rather than financial dominance. Major inspections, system restoration, and maintenance projects ranked prominently, highlighting the strategic role of sustaining capital in protecting operating capability. Project priority was also not simply determined by project size.

Discussion: The framework connects operations strategy with project portfolio governance by making trade-offs more visible, documenting managerial reasoning, and distinguishing technical feasibility from strategic prioritization. It offers a practical basis for more consistent capital-allocation decisions, while its context-specific design and limited expert sample require cautious application and further validation.

Keywords: operations strategy; project portfolio management; energy investment; project prioritization; sustainability.

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A. INTRODUCTION

The energy transition is frequently presented as a technological challenge. For power-generation companies, however, it is equally an operations-management, capital-allocation, and organizational-governance challenge. Decisions concerning which investment projects receive funding determine not only the technologies that will be developed, but also the reliability of existing assets, the continuity of electricity supply, the organization's exposure to operational risk, and its capacity to respond to future market, regulatory, and environmental changes. Power-generation investments are generally capital intensive, require long development and asset life cycles, involve multiple stakeholders, and create consequences that may persist for decades. Poor investment choices can lock an organization into inefficient technologies, inflexible contractual arrangements, or operating configurations that are increasingly inconsistent with changing business and sustainability requirements. Project selection should therefore be treated as a strategic managerial process rather than as a narrow assessment of individual technical or financial feasibility.

From an operations-management perspective, investment-project prioritization determines how scarce capital is allocated among competing requirements for asset maintenance, capacity preservation, process improvement, technology renewal, risk mitigation, and operational transformation. These decisions shape the capabilities that an organization will maintain, strengthen, or replace over time. In asset-intensive businesses, investment allocation is closely connected to operations strategy because the selected portfolio influences equipment availability, production continuity, maintenance effectiveness, process flexibility, and the organization's ability to manage disruption (Slack & Lewis, 2020). An investment decision may therefore create substantial value even when it does not directly generate additional revenue. Major inspections, equipment restoration, and component replacement can preserve productive capacity, prevent unplanned outages, and reduce the operational consequences of failure. Operations strategy consequently requires managers to balance growth projects with sustaining investments that protect existing operating capabilities.

Strategic fit is especially important because resource allocation, operational capability, technological development, and strategic planning must reinforce one another if investment decisions are to improve organizational performance. Handiwibowo et al. (2020) identify resource-allocation, manufacturing, organizing, learning, and strategic-planning capabilities as dimensions of technological innovation capability, with strategic-planning and other market-oriented capabilities contributing to new-product-development performance. Although their empirical context differs from power generation, the underlying implication is relevant: investment prioritization is not merely the distribution of funds, but a mechanism through which an organization strengthens the capabilities required to compete, adapt, and transform.

The same issue is central to project portfolio management. Portfolio decisions determine which combination of projects receives limited financial, human, and organizational resources, consistent with the portfolio-governance emphasis in contemporary project-management standards (Project Management Institute, 2021). A sound portfolio is not necessarily composed of projects with the highest stand-alone returns. It should collectively support corporate strategy, preserve operational continuity, balance risk exposure, and create long-term value (Archer & Ghasemzadeh, 1999; Kester et al., 2011). Portfolio efficiency depends on the quality of project-level information and on the organization's ability to translate that information into coherent

cross-project decisions (Martinsuo & Lehtonen, 2007). This challenge is particularly visible in the power-generation industry, where investment budgets must be distributed among major maintenance, reliability improvement, capacity expansion, technology replacement, supporting infrastructure, environmental compliance, and decarbonization initiatives. Each category has a different benefit profile, urgency, and time horizon. No single financial indicator or budget measure can therefore represent a project's overall organizational value.

PT PLN Nusantara Power operates within this complex environment. As a power-generation company within the PT PLN (Persero) group, it manages a substantial portfolio of generation assets and undertakes activities related to plant ownership, operations and maintenance, business development, and investment. The company must preserve generation reliability while supporting Indonesia's energy-transition agenda and the 2060 Net Zero Emissions target. Its operating and business units submit diverse proposals, including major inspections, maintenance programs, equipment additions and replacements, system restoration, efficiency improvements, and strategic infrastructure. These proposals vary in technology, budget size, operational urgency, expected benefits, risk exposure, and contribution to long-term corporate objectives. A common and transparent evaluation framework is needed to compare heterogeneous projects without ignoring their different operational roles.

The investment-selection process presents several managerial challenges. First, evaluation may be fragmented across financial, technical, strategic, environmental, and operational considerations. Each organizational function can assess a proposal from its own professional perspective without producing an integrated representation of project value. Second, several criteria depend on expert judgment. Expert assessment is indispensable in complex settings, but the reasoning behind such judgments may not be translated into explicit and traceable weights. Third, strategic alignment, operational risk, sustainability, and reliability benefits are more difficult to quantify than conventional financial indicators. Projects with highly visible monetary values or large budgets may therefore attract disproportionate attention, while sustaining projects with less visible but substantial operational benefits can be undervalued.

This concern is especially relevant to the distinction between growth-oriented and sustaining investments. Expansion, renewable-energy development, and new technology are commonly associated with growth and transformation. Maintenance and reliability projects, however, preserve the productive capacity that makes transformation possible. A company experiencing frequent outages, declining asset availability, or unresolved equipment risks may have limited financial and operational capacity to undertake future growth. Sustaining investments should not be treated merely as routine technical expenditure. They form part of the strategic capital portfolio because they protect service continuity, reduce operational disruption, and extend the economic usefulness of existing assets. A prioritization system that favors novelty, project size, or visible revenue generation may overlook these contributions.

Operational continuity also depends on human capability. The loss of experienced personnel can disrupt work processes, increase replacement and training costs, and weaken the capacity to execute maintenance and investment programs. In a high-risk mining-contractor setting, Veronica and Handiwibowo (2026) found that career growth and a supportive physical work environment strengthened employee engagement and reduced turnover intention. The study does not directly address project prioritization, but it reinforces a relevant operational principle: capital investment in equipment and

infrastructure must be supported by organizational conditions that retain and develop the people responsible for operating those assets.

The challenge becomes more complex when financial discipline must be balanced with decarbonization and sustainability. Projects contributing to emissions reduction, environmental compliance, community acceptance, or access to green financing may not always offer the most attractive short-term returns. Conversely, financially attractive projects may not provide the strongest contribution to resilience, strategic capability, or transition readiness. Sustainability should therefore be incorporated into investment governance before capital is allocated rather than treated only as a reporting issue after approval (Eccles et al., 2014; Friede et al., 2015). Research on green operations also emphasizes that environmental objectives must be embedded in operating practices and organizational decision processes rather than handled as isolated initiatives (Purwanto & Ellitan, 2025). The managerial problem is not to choose between finance and sustainability, but to assess both alongside reliability, strategic alignment, technical feasibility, and risk.

A transparent evaluation process additionally supports governance and organizational learning. When criteria, weights, assumptions, and rationales are not documented, managers may find it difficult to determine whether changing priorities reflect new evidence, strategic shifts, or individual preference. The absence of a decision trail also limits post-investment review because actual outcomes cannot be compared with the assumptions used at selection. This issue is related to absorptive capacity, or the ability to acquire, assimilate, and apply knowledge. Handiwibowo (2025) highlights the role of knowledge absorption in organizational recovery and performance development. A documented multicriteria process may support this capability by preserving decision evidence and enabling managers to compare expected and realized benefits. Project prioritization can consequently evolve from a periodic scoring exercise into a mechanism of managerial control and learning.

Multi-Criteria Decision Making offers an analytical foundation for decisions involving competing objectives and heterogeneous information, including sustainability-oriented decision systems (Thanh Quang et al., 2025). The Analytical Hierarchy Process is widely used because it decomposes complex decisions into criteria, translates judgments into relative weights, and produces results that can be communicated to decision makers (Saaty, 1980; Forman & Gass, 2001; Vaidya & Kumar, 2006). Energy-sector studies have applied AHP to technology choice, source prioritization, plant location, and sustainable investment decisions (Çoban, 2020; Ruiz et al., 2020; Hernández-Torres et al., 2025). In the present study, however, AHP is positioned as a managerial decision-support instrument rather than the substantive focus. The central issue is how strategic and operational priorities can be converted into a transparent portfolio-selection process.

Three connected gaps motivate the study. First, much of the energy-related AHP literature focuses on choosing technologies, sources, or locations. Less attention has been given to heterogeneous internal portfolios containing maintenance, overhaul, replacement, restoration, procurement, and transformation projects. Such portfolios combine growth and sustaining capital, which serve different operational functions. Second, existing models often emphasize a limited combination of financial, technical, or environmental factors. Fewer studies integrate financial feasibility, technical readiness, strategic alignment, risk, and sustainability while interpreting their implications for operational continuity and portfolio governance. Third, limited

evidence shows how executive preferences in a state-owned Indonesian power-generation company can be translated into transparent weights and consistently applied to a large set of real proposals. The unresolved issue is therefore not only which criteria matter, but whether a practical multicriteria process can generate a decision trail and a ranking meaningfully different from a simple budget-size heuristic.

Accordingly, this study asks: How can financial, technical, strategic, risk, and sustainability considerations be integrated into a transparent investment-project prioritization system that supports corporate strategy and operational continuity? The objectives are to: (1) identify and operationalize the principal criteria for investment-project selection; (2) construct an integrated decision structure representing the five dimensions; (3) derive criterion-priority weights from executive assessments; and (4) apply the model to 50 real project proposals and examine whether the rankings merely reproduce a budget-size heuristic.

The study makes three contributions. First, it extends operations-management and project-portfolio discussion by framing capital prioritization as an operations-strategy decision and by highlighting the strategic value of sustaining projects that preserve reliability and service continuity. Second, it documents an adapted AHP-SAW procedure for processing a large number of alternatives while explicitly distinguishing the method from classical pairwise-comparison AHP. Third, it provides a managerial workflow for formalizing evaluation weights, separating minimum technical feasibility from strategic prioritization, strengthening the traceability of capital-allocation decisions, and linking project ranking with portfolio constraints. These contributions are deliberately bounded: the study develops a context-specific decision baseline rather than a universal set of energy-investment weights.

B. LITERATURE REVIEW

B.1 Operations Strategy And Sustaining Capital

Operations strategy concerns the pattern of decisions through which operating resources and capabilities support organizational direction (Slack & Lewis, 2020). In asset-intensive organizations, capital allocation is one of these decisions because the investment portfolio determines which assets will be maintained, replaced, expanded, or transformed. The operational consequences are cumulative. Deferring a maintenance intervention may release capital in the short term but increase the probability of forced outage, secondary damage, or higher future expenditure. Conversely, allocating excessive resources to sustaining projects without a coherent transition plan can delay modernization. Operations strategy must therefore balance current reliability with future capability.

The distinction between growth capital and sustaining capital is useful for project prioritization. Growth capital expands capacity, enters new markets, or introduces new technology. Sustaining capital protects the ability of existing assets and processes to deliver expected service. In power generation, sustaining projects include major inspections, component replacement, system restoration, safety improvement, and compliance-related work. Their value is often protective rather than directly revenue-generating. A portfolio framework should therefore recognize avoided disruption, preserved availability, risk reduction, and capability retention as legitimate forms of value.

Green operations adds another layer to this balance. Environmental performance increasingly affects operating legitimacy, financing access, resource efficiency, and

regulatory exposure. Purwanto and Ellitan (2025) show that green operations practices require organizational integration and evidence-based implementation. In energy investment, sustainability should therefore be treated as an operating and strategic criterion, not as a post-approval reporting label. The operational question is whether a project improves the organization's ability to deliver reliable service while reducing environmental and social exposure over the asset life cycle.

B.2 Project Portfolio Management And Decision Governance

Project portfolio management shifts the unit of analysis from the success of a single project to the collective contribution of a project set. Archer and Ghasemzadeh (1999) emphasize an integrated process for screening, evaluation, and selection, while Kester et al. (2011) describe portfolio decisions as organizational processes combining data, negotiation, and strategic interpretation. The central problem is not simply to identify good projects, but to select a combination that fits strategy and resource constraints.

Portfolio governance is strengthened when criteria and rationales are explicit. Transparent criteria reduce the risk that proposals are compared through inconsistent logic, while documented weights make trade-offs visible. Such documentation does not eliminate managerial judgment. It gives judgment a traceable structure and allows later review. This matters because portfolio decisions are made under uncertainty, and the organization should be able to learn whether the assumptions used at selection were realistic.

A ranking is only one element of portfolio governance. Final selection must also consider budget ceilings, outage windows, project dependencies, labor availability, procurement capacity, mandatory compliance, and concentration risk. A project with a lower score may be indispensable because it enables another project or responds to a non-negotiable requirement. Accordingly, a multicriteria score should support deliberation and optimization rather than mechanically replace managerial accountability.

B.3 MCDM, Adapted AHP, and Weighted Additive Ranking

MCDM methods compare alternatives across criteria that differ in measurement unit and managerial meaning. AHP is attractive because it structures criteria and derives relative priorities from judgments (Saaty, 1980). Classical AHP asks decision makers to compare each pair of elements using a ratio scale. The resulting matrix is used to estimate a priority vector, and the Consistency Ratio is examined to assess the coherence of judgments (Saaty & Vargas, 2012). Group judgments are commonly aggregated through the geometric mean because it preserves reciprocal properties (Aczel & Saaty, 1983; Ossadnik et al., 2016).

The method also has limitations. The number of comparisons grows rapidly with the number of elements, outcomes depend on hierarchy design and expert quality, and rank reversal may occur when alternatives change (Forman & Gass, 2001; Vaidya & Kumar, 2006). A direct pairwise comparison among 50 alternatives would impose an unrealistic response burden. Applied studies therefore frequently combine AHP-derived weights with direct ratings and weighted addition. In an AHP-SAW arrangement, AHP establishes criterion weights, while Simple Additive Weighting synthesizes alternatives measured on a common rating scale (Kabir et al., 2014).

Methodological adaptation must be disclosed. In the present data, Board members rated each criterion independently on a 1-9 scale. The mean scores were converted into

ratios, $a_{ij} = x_i/x_j$. A reciprocal matrix generated from one score vector is perfectly transitive by construction; $CR = 0$ is therefore an algebraic property rather than evidence that respondents completed coherent pairwise comparisons. Lukinskiy et al. (2025) similarly emphasize careful interpretation of consistency in modified AHP procedures. The method is described here as adapted AHP-SAW to avoid overstating its equivalence to classical AHP.

B.4 Evaluation Criteria And Analytical Framework

Five dimensions form the model: financial, technical, strategic, risk, and sustainability. The subcriteria serve as conceptual anchors rather than independently weighted elements. Table 1 summarizes the dimensions and clarifies their operations-management role. This distinction is important because a high score should represent evidence about the aggregate dimension, while the absence of independent subcriterion weights limits diagnostic detail.

Table 1. Evaluation criteria, conceptual anchors, and managerial roles

Criterion	Conceptual anchors	Managerial role
Financial	NPV, IRR, payback period, DSCR, sensitivity to cost and revenue assumptions	Capital discipline, value protection, and affordability
Technical	Technology readiness, safety, capacity, efficiency, fuel readiness, partner capability, schedule, grid compatibility	Minimum operational feasibility and implementation readiness
Strategic	Alignment with RUPTL and RJPP, reliability contribution, capability development, competitive position	Fit with operations strategy and long-term corporate direction
Risk	Regulatory, construction, financial, offtake, environmental-social, supply-chain, and geopolitical exposure	Operational resilience and control of deviation across the project life cycle
Sustainability	Emissions reduction, environmental impact, social acceptance, ESG alignment, green-financing potential	Long-term operating legitimacy, transition readiness, and access to sustainable finance

Source: Developed from the thesis literature review and organizational context.

Financial criteria assess economic feasibility and the organization's capacity to use capital responsibly, drawing on established capital-budgeting logic (Brealey et al., 2019). Technical criteria assess whether a project can be executed safely and compatibly with the generation system, including technology readiness and implementation maturity emphasized in energy-investment assessment (International Energy Agency, 2023). Strategic criteria connect projects to corporate and sector direction. Risk criteria consider the probability and consequences of deviation, while sustainability criteria address environmental, social, governance, and financing implications. The dimensions are complementary. A financially attractive project can still be operationally fragile, and a strategically desirable project can fail when technical or social risks are unmanaged.

The analytical framework follows a sequence from contextualization to weighting and ranking. Internal documents and executive input establish the decision context. Board ratings define criterion importance, Vice Presidents assess projects, and weighted addition produces a priority order. The output is interpreted as a portfolio decision baseline. It is not treated as a final automatic funding list because subsequent portfolio constraints and executive judgment remain necessary.

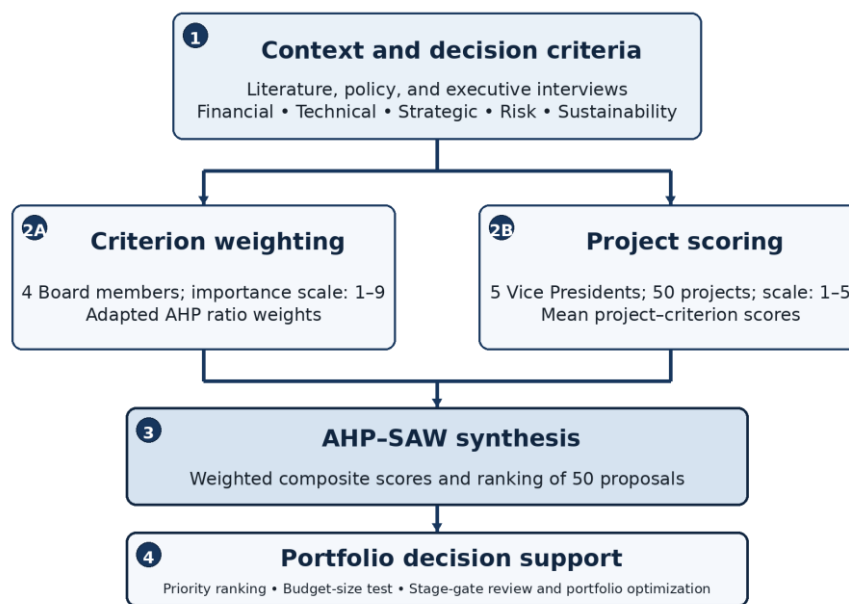


Figure 1. Framework for developing and testing the project-prioritization model

C. RESEARCH METHOD

C.1 Research Design And Organizational Context

The study used an exploratory sequential organizational case-study design following a building-integration logic (Creswell & Creswell, 2018; Creswell & Plano Clark, 2017). The exploratory component contextualized criteria through internal document review and semi-structured executive input, using the thematic-analysis principles described by Braun and Clarke (2006) and Nowell et al. (2017). The subsequent quantitative component derived criterion weights and project rankings. Because the thesis did not report a full set of qualitative codes, themes, and verbatim quotations, this article does not present the qualitative component as an independent body of findings. It is used only to explain how literature-derived dimensions were adapted to the organizational context. This reporting choice improves methodological precision and avoids claiming qualitative evidence that is not fully documented.

The study was conducted at PT PLN Nusantara Power during 2026 over approximately six months. The unit of analysis was the investment-project prioritization decision. Secondary sources included internal policy, planning, and budget documents. The alternatives were 50 real proposals submitted by 13 work units and included major inspections, maintenance, system restoration, component replacement, and equipment procurement. Project and work-unit names are reported as available in the source thesis to preserve traceability, but the analysis is not intended to evaluate the performance of individual units.

C.2 Respondents and Data Collection

Respondents were selected purposively because the study required organizational authority and direct knowledge of project evaluation (Etikan et al., 2016). Four Board members rated the importance of the five main criteria. Five Vice Presidents from operations and maintenance, primary energy, and contract-management functions assessed the 50 alternatives. The role division matched the decision hierarchy: Board

members represented corporate preferences, while Vice Presidents had closer knowledge of project feasibility and operational implications.

The exploratory protocol covered strategic context, investment-selection challenges, financial feasibility, technical readiness, RUPTL and RJPP alignment, risk, sustainability, and trade-offs. Document review and executive input were used to confirm the relevance and operational meaning of the five dimensions. The instrument was reviewed by three experts in project management, energy-investment evaluation, and MCDM. The thesis proposed Aiken’s V, but item-level coefficients were not reported in the results. The present article therefore reports expert review without claiming an unsupported validity coefficient.

Participation was voluntary and based on informed consent. Respondent identities were protected, results were reported in aggregate form, and organizational permission was obtained. The source thesis also described respondent confirmation and document checking as credibility procedures, consistent with member-checking and trustworthiness principles (Birt et al., 2016; Lincoln & Guba, 1985). The researcher’s structural position in the company was recognized as a possible source of positionality bias. Cross-functional participation and transparent calculation worksheets were used to reduce the dominance of a single perspective.

Table 2. Respondent groups and analytical roles

Respondent group	Number	Role	Use of data
Board of Directors	4	Rated the importance of the five main criteria on a 1-9 scale	Criterion-weight derivation
Vice Presidents	5	Rated 50 projects against five criteria on a 1-5 scale	Project-score synthesis and ranking

Source: Primary research data, 2026.

C.3 Measurement and Adapted AHP Weight Derivation

The Board used a 1-9 importance scale, where higher values represented greater perceived importance. Each Vice President assessed every project against each criterion on a five-point feasibility/contribution scale: 1 = very low, 2 = low, 3 = moderate, 4 = high, and 5 = very high. The five main criteria were supported by the conceptual anchors shown in Table 1. Project-specific behavioral anchors were not documented in the thesis, so the ratings should be interpreted as structured expert judgments rather than fully standardized measurements. This limitation is addressed in the implementation recommendations.

C.4 Project-ranking synthesis and additional analysis

Vice-President ratings were averaged for each project-criterion combination. A Spearman rank correlation tested whether the ranking merely reproduced a tendency to prioritize larger projects. Budget data were complete for 49 of the 50 proposals. The null hypothesis stated that project budget and priority score had no monotonic relationship. Mean scores were also calculated by proposing work unit as a descriptive portfolio diagnostic. Because the number of proposals per unit ranged from one to ten, unit averages were interpreted cautiously and not as performance measures.

No sensitivity analysis was available in the source data. Given the small differences among criterion weights and the clustered project scores, robustness under alternative weight scenarios remains an unresolved issue. The article therefore treats the ranking as

a reviewable baseline and explicitly includes sensitivity analysis among the required steps for future implementation.

D. RESULTS

D.1 Decision Structure And Criterion Weights

The empirical model used two decision levels. The first consisted of the five main criteria weighted by the Board. The second consisted of 50 project alternatives assessed by Vice Presidents. Conceptual subcriteria such as NPV, payback period, DSCR, technology readiness, strategic-plan alignment, regulatory risk, and emissions reduction clarified the meaning of the five dimensions but did not receive independent weights. The results should therefore be interpreted as aggregate-dimension priorities rather than detailed indicator priorities.

Mean importance ratings were 8.50 for financial criteria; 8.00 each for strategic, risk, and sustainability criteria; and 7.50 for technical criteria. The resulting weights were 0.2125, 0.2000, 0.2000, 0.2000, and 0.1875 respectively. The spread between the highest and lowest weights was only 0.025, or 2.5 percentage points. The structure is therefore relatively balanced, with a modest financial advantage rather than absolute financial dominance.

Table 3. Criterion-importance ratings and adapted AHP weights

Criterion	Mean score	Weight	Percentage	Rank
Financial	8.50	0.2125	21.25%	1
Strategic	8.00	0.2000	20.00%	2=
Risk	8.00	0.2000	20.00%	2=
Sustainability	8.00	0.2000	20.00%	2=
Technical	7.50	0.1875	18.75%	5

Source: Processed from Board-level importance ratings, 2026.

The exact equality of the strategic, risk, and sustainability weights followed directly from identical mean ratings. It can represent a substantive preference for balance, limited resolution of the importance scale, or both. Direct pairwise comparison would be required to determine whether respondents differentiate more finely when evaluating explicit trade-offs.

D.2 Consistency Result And Methodological Interpretation

Table 4. Summary Of Consistency Calculations

Parameter	Value	Interpretation
Maximum eigenvalue (lambda_max)	5.00	Equal to matrix order
Consistency Index (CI)	0.00	$CI = (\lambda_{max} - n)/(n - 1)$
Random Index (n = 5)	1.12	Saaty standard value
Consistency Ratio (CR)	0.00	Formally below 0.10; structurally generated

Source: Adapted AHP calculation worksheet, 2026.

CR = 0.00 formally meets the conventional threshold, but it cannot be interpreted as evidence that the four Board members produced perfectly coherent pairwise judgments. The ratio transformation creates perfect transitivity automatically. The relevant quality considerations are therefore criterion relevance, respondent expertise, transparency of transformation, and the robustness of rankings under changing weights.

D.3 Project Scores And Ranking Pattern

Applying the weights to 50 alternatives produced composite scores from 3.275 to 4.112, with a mean of 3.736. The relatively narrow range suggests that most proposals had already passed initial organizational screening and were considered broadly feasible. The model nevertheless produced sufficient differentiation to establish a priority order.

The highest-ranked project was the 2027 GTG 1.2 Major Inspection, with a score of 4.112. Major inspections, gas-system restoration, critical-material procurement, and component replacement occupied many of the leading positions. The pattern indicates that projects associated with availability, failure prevention, and operational-risk reduction were recognized as strategically important. Placement in the lower group does not mean that a project was infeasible; it indicates lower relative priority within the evaluated set.

Table 5. Selected Projects With The Highest And Lowest Priority

Rank	Project	Score	Group
1	2027 GTG 1.2 Major Inspection	4.112	Highest
2	2028 GT 1.3 New Hotpart Major Inspection	3.995	Highest
3	Gas System Restoration	3.995	Highest
4	2027 Procurement of MS-DS CNG Gresik-Bawean	3.958	Highest
5	2028 GTG 1.3 Hotpart Major Inspection Refurbishment	3.955	Highest
6	2029 GT 1.2 New Hotpart Combustion Inspection	3.955	Highest
7	Retubing of HRSG 1.3 HP Evaporator	3.955	Highest
8	Serious Overhaul Maintenance for 19 Existing Arun Engines	3.953	Highest
9	Procurement of HGPP and Non-HGPP Materials for GT 2.2	3.917	Highest
10	Phase II Replacement of HRSG GT 2.2 Tubes at Belawan CCGT	3.915	Highest
46	12K-Hour TBM for Engine #1, Suppa Diesel Power Plant	3.475	Lowest
47	12K-Hour TBM for Engine #5, Suppa Diesel Power Plant	3.475	Lowest
48	Procurement of SWSP Block 1 Pump and Motor	3.473	Lowest
49	Major Overhaul of IHI Pielstick 14 PC 5V 400	3.473	Lowest
50	Procurement of New TM2500+ Engine Only for Maleo Gas Turbine Plant	3.275	Lowest

Source: Processed from the project-assessment worksheet, 2026. The full ranking is retained in the company working documentation.

D.4 Relationship With Budget Size And Variation Across Units

For the 49 projects with complete budget data, the Spearman correlation between budget and composite score was $\rho = 0.136$ with $p = 0.351$. The relationship was positive, weak, and statistically nonsignificant. Larger projects did not systematically receive higher priority. The finding shows that the model generated a ranking distinct from ordering proposals by nominal budget, although it does not prove that all forms of judgment bias were eliminated.

Mean scores varied across work units. UPMK had the highest mean at 3.862, followed by UJAR at 3.834 and UPMT at 3.820. UPBK had the lowest mean at 3.475. Higher averages were associated with a relatively large presence of major inspection and comprehensive maintenance proposals. Because the number of projects differed substantially by unit, the averages are better interpreted as a portfolio diagnostic than as a comparison of unit performance.

Table 6. Mean priority scores by proposing work unit

Work unit	Number of projects	Mean score
UPMK	7	3.862
UJAR	2	3.834
UPMT	8	3.820
UPSG	4	3.819
SGRK	4	3.776
UPBW	10	3.718
UCRT	1	3.680
UPKS	2	3.671
UPPR	2	3.658
UPMH	1	3.638
UPGT	3	3.543
UPTR	3	3.501
UPBK	2	3.475

Source: Processed from project and work-unit data, 2026. Unequal project counts require cautious interpretation.

D.5 Discussion

D.5.1 Balanced Financial Primacy As An Operations-Strategy Pattern

The weight structure presents what may be called balanced financial primacy. Financial criteria ranked first, but the advantage over strategy, risk, and sustainability was only 1.25 percentage points. The result rejects two extreme interpretations. The portfolio was not driven solely by financial metrics, yet it did not abandon economic discipline in favor of an undifferentiated sustainability narrative. For a state-owned power generator, this balance is managerially rational. The company must account for capital use, maintain service reliability, respond to policy mandates, and prepare for the energy transition.

From an operations-strategy perspective, financial feasibility protects the resource base needed to sustain operations. Projects that create excessive financial strain can reduce future maintenance and transformation capacity. At the same time, project value cannot be reduced to NPV or payback because avoided outages, preserved capability, risk control, and regulatory readiness may be only partially monetized at the front end. The nearly flat weights indicate that financial discipline operates as one central requirement among several rather than as an overriding objective.

The finding is consistent with the broader argument that energy-transition decisions require integration of financial and long-horizon value (Yuan et al., 2024; Hernandez-Torres et al., 2025). It also supports the EKSIS journal's management orientation: the core issue is how managers govern trade-offs, not how an engineering formula produces a single technically optimal answer.

D.5.2 Sustaining Capital, Reliability, And Operational Continuity

The prominence of major inspections, restoration, overhaul, and critical component work is the most important operations-management finding. These projects do not necessarily expand installed capacity or create a new revenue stream. Their value lies in preserving asset availability, reducing the probability of failure, and maintaining the productive capability of the generation system. The ranking therefore recognizes sustaining capital as a strategic investment category rather than treating maintenance as routine expenditure.

This interpretation adds nuance to conventional portfolio discussions that frequently emphasize innovation, expansion, or new technology. In power generation, operational transformation depends on a reliable existing system. When current assets are unstable, management faces unplanned outage costs, reduced service capability, emergency procurement, and less financial space for transition investment. Sustaining projects can therefore create an enabling platform for later decarbonization and growth.

The evidence should nevertheless be interpreted carefully. The study does not estimate causal effects on availability, outage frequency, production cost, or maintenance performance. It shows only that projects with strong perceived contributions across the five dimensions received high priority. A stronger operations-management test would link initial project scores to realized indicators such as equivalent availability factor, forced-outage rate, maintenance cost variance, schedule compliance, and avoided production loss.

D.5.3 Technical Feasibility As A Gate Rather Than A Low-Value Criterion

Technical criteria received the lowest weight, which could be misread as evidence that technical quality is less important. A more plausible interpretation is stage-gate logic. Engineering and operating functions generally screen basic technology readiness, safety, compatibility, and resource availability before a proposal reaches corporate prioritization. Once alternatives have passed this minimum level, technical feasibility becomes a condition of entry rather than the main axis of differentiation.

Separating gates from ranking criteria prevents compensatory errors. Without a gate, an infeasible project could obtain a high total score because of exceptional strategic or sustainability benefits. A sound decision architecture should first classify technical and compliance readiness as pass, revision required, or fail. Multicriteria scoring should follow only after minimum requirements are satisfied. The empirical 18.75% weight should therefore not be applied as permission to trade away safety or feasibility.

This distinction between feasibility and differentiation is a conceptual contribution to portfolio governance. Criteria can be critical without requiring the highest ranking weight. Their role in the decision process matters as much as their numerical weight.

D.5.4 Strategy, Risk, Sustainability, And Operational Resilience

Strategic, risk, and sustainability criteria received identical weights. Substantively, the pattern can be interpreted as three connected dimensions of operational resilience. Strategy determines the direction in which the organization intends to move. Risk evaluates the possibility of deviation from that direction. Sustainability assesses whether the direction can be maintained environmentally, socially, and through acceptable governance.

The energy transition makes these dimensions difficult to separate. A project aligned with corporate plans can still fail when regulatory, construction, supply-chain, or social risks are unmanaged. A low-risk project can create future transition exposure when it locks the organization into high-emission assets. Sustainability is therefore not only an environmental concern; it influences financing access, stakeholder acceptance, operating legitimacy, and strategic flexibility (Yucel & Yucel, 2024).

The equality of the three weights may also reflect instrument limitations. All received the same mean rating of 8.00, and an independent importance scale may encourage central or socially desirable responses. Direct pairwise comparison and post-

assessment interviews would help determine whether the equality represents genuine balance or limited rating resolution.

D.5.5 Beyond Budget Size: Contribution And Limits Of The Additional Test

The nonsignificant budget correlation is useful because many MCDM applications stop after producing rankings. By testing the relationship with project size, the study examines whether the model yields information different from an immediately visible heuristic. The result indicates that nominal budget did not determine the priority order. Smaller projects could rank highly when their operational, strategic, risk, or sustainability contributions were strong.

The test should not be overstated. A weak correlation does not prove that the model improves decision quality, removes bias, or selects the projects with the highest realized benefits. It only shows that the score is not a direct replica of budget size. Other influences may remain, including proposing-unit advocacy, project urgency, rater familiarity, and the way project narratives were prepared. Future validation should compare model-assisted decisions with unaided panel decisions and examine decision time, interrater agreement, rationale quality, and realized outcomes.

The practical value of the model lies in requiring each proposal to explain its contribution across multiple dimensions. This requirement can reduce size salience and improve comparability, provided that rating rubrics and supporting evidence are sufficiently clear.

D.5.6 Work-Unit Variation As A Portfolio Diagnostic

Differences in mean scores across work units should not be interpreted as a league table. Units submitted different numbers and types of projects, and some averages were based on one or two proposals. The results are more useful as a diagnostic of portfolio composition and proposal articulation.

Central management can examine whether lower-scoring proposals have weaker evidence of strategic contribution, risk reduction, or sustainability, or whether their asset context simply produces different investment needs. Units can also review whether they express operational consequences clearly. A proposal for a small component may be strategically important when deferral creates a large outage risk, but that value must be documented rather than assumed.

Routine use of the model should therefore include rater calibration and evidence guidelines. Otherwise, scores may reflect the ability of a unit to write a persuasive business case rather than the underlying value of the project.

D.5.7 Decision Architecture For Managerial Implementation

A lasting implementation requires more than a spreadsheet. The first stage should standardize project business cases. Every proposal should identify expected benefits, costs, the consequence of deferral, dependencies, operational constraints, and evidence for each criterion. Standardization reduces information asymmetry between proposing units and the evaluation panel.

The second stage should apply technical and compliance gates covering safety, regulatory requirements, technology readiness, system compatibility, fuel or resource availability, procurement readiness, and schedule maturity. Projects requiring revision can return to the proposing unit rather than being permanently rejected.

The third stage is multicriteria assessment. The panel should include finance, engineering, operations, strategy, risk, sustainability, procurement, and relevant commercial functions. Members should submit independent ratings before discussion to reduce conformity pressure. Initial scores, post-deliberation scores, and reasons for changes should be retained as part of the audit trail.

The fourth stage is portfolio optimization. Ranking indicates relative attractiveness but does not identify the best combination under budget, labor, outage, procurement, and dependency constraints. A lower-ranked project may be a prerequisite for a higher-ranked one. The composite score should therefore serve as an input to scenario analysis or optimization rather than a mechanical rule that funds projects from the top until the budget is exhausted.

The fifth stage is controlled executive override. Executives may possess information that the instrument cannot capture, including regulatory change, emergencies, commercial negotiations, or government mandates. Override should remain possible but documented through the affected project, rationale, evidence, approving parties, and consequences for other projects.

The final stage is benefits-realization review. Actual cost, schedule, asset availability, risk reduction, emissions performance, and strategic benefits should be compared with the original business case. Repeated overestimation or underestimation can be used to revise rating rubrics and weights. Through this feedback loop, the model can become an organizational learning system rather than a one-time calculation.

D.5.8 Methodological Implications And Robustness Requirements

The study's methodological value lies partly in its transparency about adapted AHP. Converting importance ratings into ratios is easy to implement and reduces executive response burden, but it removes the diagnostic meaning of CR. Applied research should distinguish clearly between pairwise-judgment matrices and matrices derived from one rating vector. Using the AHP label without that distinction can create an unjustified impression of methodological rigor.

The narrow weight spread and clustered project scores make sensitivity analysis particularly important. A change of one or two percentage points could alter the order of closely ranked projects. Future analysis should test financially dominant, reliability dominant, and transition dominant scenarios, along with agreed weight intervals or Monte Carlo simulation, following current sensitivity-analysis practice in MCDM (Demir et al., 2024). Stable projects can be treated as robust priorities, while highly mobile projects require closer deliberation.

Interrater agreement should also be assessed. The present article reports averaged Vice-President ratings, but the available thesis narrative does not provide dispersion or agreement statistics. Future instruments should report the distribution of individual ratings, identify criteria with high disagreement, and use calibration exercises before formal scoring. Behavioral anchors and evidence requirements are more important than simply increasing the number of scale points.

Validation is needed at three levels. Content validity asks whether the criteria and evidence cover the important decision dimensions. Process validity assesses whether scoring is consistent, transparent, and free from domination. Predictive validity compares initial scores with realized benefits. A comprehensive framework will not improve management when it is used inconsistently, and a consistently applied model should still be revised when it fails to predict outcomes.

D.5.9 Theoretical And Managerial Contributions

The first contribution is to operations strategy. The study shows that capital prioritization determines which operating capabilities are preserved or transformed. The prominence of maintenance and restoration projects indicates that sustaining investment can carry strategic value comparable to expansion because it protects the reliability platform on which growth depends.

The second contribution is to project portfolio governance. Financial, strategic, risk, and sustainability considerations were nearly balanced, showing how multiple organizational mandates can be made explicitly comparable. The model does not eliminate managerial judgment; it structures judgment and creates a record that can be examined and improved.

The third contribution is the distinction between gate criteria and differentiation criteria. Technical feasibility can be indispensable without receiving the highest weight once infeasible proposals have been screened out. This distinction helps avoid the common error of equating numerical weight with absolute importance.

The fourth contribution is methodological candor. The study explains why the ratio-derived CR is structurally zero and why the procedure is more accurately described as adapted AHP-SAW. This qualification reduces overclaiming and provides a clearer foundation for future improvement.

Managerially, the model offers a practical baseline for recurrent budgeting, provided that it is combined with technical gates, standardized evidence, rater calibration, portfolio constraints, documented override, and post-investment learning.

E. CONCLUSION AND RECOMMENDATIONS

This study developed and applied an investment-project prioritization framework integrating financial, technical, strategic, risk, and sustainability dimensions at PT PLN Nusantara Power. Four Board members provided criterion-importance ratings, five Vice Presidents assessed 50 real proposals, and an adapted AHP-SAW procedure converted the assessments into a portfolio priority order.

The weights were relatively balanced: 21.25% for financial criteria, 20.00% each for strategy, risk, and sustainability, and 18.75% for technical criteria. Financial discipline remained central without becoming absolutely dominant. The ranking gave prominent positions to major inspections, restoration, and maintenance projects, highlighting the strategic role of sustaining capital in preserving asset reliability and operational continuity. Budget size was weakly and nonsignificantly related to priority, indicating that the model did not simply reproduce a project-size ordering.

The study supports an operations-strategy interpretation of investment prioritization. Capital allocation determines not only which projects are funded, but which operating capabilities are preserved, strengthened, or transformed. A transparent multicriteria process can make these trade-offs more visible and provide a foundation for decision governance and learning.

The findings are subject to several limitations. The expert sample was limited to four Board members and five Vice Presidents, which is appropriate for a small decision population but restricts statistical generalization. The exploratory qualitative component was used for contextualization, yet a full set of codes, themes, quotations, and integration evidence was not reported in the source thesis. The study therefore cannot claim independent qualitative findings.

The criterion matrix was derived from independent importance ratings, so $CR = 0$ was a mathematical consequence rather than evidence of judgment consistency. The model used only five aggregate dimensions and did not weight subcriteria independently. Project ratings were perceptual and lacked documented project-specific behavioral anchors. Interrater agreement and sensitivity analysis were not available. One project lacked complete budget data, and work-unit comparisons were based on unequal project counts. Finally, the model was not validated against realized cost, schedule, reliability, risk, or ESG outcomes.

Future research should collect direct pairwise comparisons for all criterion pairs, calculate individual CR values, and aggregate acceptable matrices through the geometric mean. Independent subcriterion weights should be developed to provide greater diagnostic precision. Sensitivity analysis should test ranking stability under alternative operations-strategy scenarios, and complementary methods such as TOPSIS can be used as a cross-method robustness check (Behzadian et al., 2012).

Future studies should report rating dispersion and interrater agreement, develop behavioral anchors supported by operational evidence, and compare scores with realized outcomes. Cross-company analysis could distinguish context-specific weights from more general criteria applicable to state-owned and asset-intensive energy enterprises.

For management, the model should be embedded in a stage-gate architecture. Technical feasibility and mandatory compliance should be screened first; multicriteria scoring should follow; portfolio optimization should account for capital and operational constraints; executive override should be documented; and benefits-realization review should feed actual outcomes into the next budgeting cycle. This arrangement preserves managerial judgment while making the process more transparent, consistent, and capable of learning.

REFERENCES

- Aczel, J., & Saaty, T. L. (1983). Procedures for synthesizing ratio judgements. *Journal of Mathematical Psychology*, 27(1), 93-102. [https://doi.org/10.1016/0022-2496\(83\)90028-7](https://doi.org/10.1016/0022-2496(83)90028-7)
- Archer, N. P., & Ghasemzadeh, F. (1999). An integrated framework for project portfolio selection. *International Journal of Project Management*, 17(4), 207-216. [https://doi.org/10.1016/S0263-7863\(98\)00032-5](https://doi.org/10.1016/S0263-7863(98)00032-5)
- Behzadian, M., Khanmohammadi Otaghsara, S., Yazdani, M., & Ignatius, J. (2012). A state-of-the-art survey of TOPSIS applications. *Expert Systems with Applications*, 39(17), 13051-13069. <https://doi.org/10.1016/j.eswa.2012.05.056>
- Birt, L., Scott, S., Cavers, D., Campbell, C., & Walter, F. (2016). Member checking: A tool to enhance trustworthiness or merely a nod to validation? *Qualitative Health Research*, 26(13), 1802-1811. <https://doi.org/10.1177/1049732316654870>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77-101. <https://doi.org/10.1191/1478088706qp063oa>

- Brealey, R. A., Myers, S. C., & Allen, F. (2019). *Principles of corporate finance* (13th ed.). McGraw-Hill Education.
- Coban, V. (2020). Solar energy plant project selection with AHP decision-making method based on hesitant fuzzy linguistic evaluation. *Complex & Intelligent Systems*, 6(3), 507-529. <https://doi.org/10.1007/s40747-020-00152-5>
- Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE.
- Creswell, J. W., & Plano Clark, V. L. (2017). *Designing and conducting mixed methods research* (3rd ed.). SAGE.
- Demir, G., Chatterjee, P., & Pamucar, D. (2024). Sensitivity analysis in multi-criteria decision making: A state-of-the-art research perspective using bibliometric analysis. *Expert Systems with Applications*, 237, 121660. <https://doi.org/10.1016/j.eswa.2023.121660>
- Eccles, R. G., Ioannou, I., & Serafeim, G. (2014). The impact of corporate sustainability on organizational processes and performance. *Management Science*, 60(11), 2835-2857. <https://doi.org/10.1287/mnsc.2014.1984>
- Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, 5(1), 1-4. <https://doi.org/10.11648/j.ajtas.20160501.11>
- Forman, E. H., & Gass, S. I. (2001). The analytic hierarchy process: An exposition. *Operations Research*, 49(4), 469-486. <https://doi.org/10.1287/opre.49.4.469.11231>
- Friede, G., Busch, T., & Bassen, A. (2015). ESG and financial performance: Aggregated evidence from more than 2,000 empirical studies. *Journal of Sustainable Finance & Investment*, 5(4), 210-233. <https://doi.org/10.1080/20430795.2015.1118917>
- Handiwibowo, G. A. (2025). Measurement of absorptive capacity implications in small and medium industries: Case in Ngingas small metal industry cluster. *JMD: Jurnal Riset Manajemen & Bisnis Dewantara*, 8(2), 53-60. <https://doi.org/10.26533/jmd.v8i2.1382>
- Handiwibowo, G. A., Nasution, A. H., Arumsari, Y. K., & Astuti, R. P. (2020). Strategic fit implication of technological innovation capabilities for SMEs with new product development. *Management Science Letters*, 10(12), 2875-2882. <https://doi.org/10.5267/j.msl.2020.4.020>
- Hernandez-Torres, J. A., Sanchez-Lozano, D., Sanchez-Herrera, R., Vera, D., & Torreglosa, J. P. (2025). Integrated multi-criteria decision-making approach for

power generation technology selection in sustainable energy systems. *Renewable Energy*, 243, 122481. <https://doi.org/10.1016/j.renene.2025.122481>

International Energy Agency. (2023). *World Energy Investment 2023*. IEA.

Kabir, G., Sadiq, R., & Tesfamariam, S. (2014). A review of multi-criteria decision-making methods for infrastructure management. *Structure and Infrastructure Engineering*, 10(9), 1176-1210. <https://doi.org/10.1080/15732479.2013.795978>

Kester, L., Griffin, A., Hultink, E. J., & Lauche, K. (2011). Exploring portfolio decision-making processes. *Journal of Product Innovation Management*, 28(5), 641-661. <https://doi.org/10.1111/j.1540-5885.2011.00832.x>

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. SAGE.

Lukinskiy, V., Lukinskiy, V., & Bazhina, D. (2025). Refining the analytic hierarchy process: A statistical and methodological exploration of expert judgments. *Alexandria Engineering Journal*, 125, 526-536. <https://doi.org/10.1016/j.aej.2025.04.022>

Martinsuo, M., & Lehtonen, P. (2007). Role of single-project management in achieving portfolio management efficiency. *International Journal of Project Management*, 25(1), 56-65. <https://doi.org/10.1016/j.ijproman.2006.04.002>

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic analysis: Striving to meet the trustworthiness criteria. *International Journal of Qualitative Methods*, 16, 1-13. <https://doi.org/10.1177/1609406917733847>

Ossadnik, W., Schinke, S., & Kaspar, R. H. (2016). Group aggregation techniques for analytic hierarchy process and analytic network process: A comparative analysis. *Group Decision and Negotiation*, 25(2), 421-457. <https://doi.org/10.1007/s10726-015-9448-4>

Project Management Institute. (2021). *A guide to the project management body of knowledge (PMBOK guide) and the standard for project management* (7th ed.). Project Management Institute.

Purwanto, M., & Ellitan, L. (2025). Adoption of green operation strategies and best practices in the era of Sustainable Development Goals: Study of public limited hospitals in Indonesia. *Eksis: Jurnal Riset Ekonomi dan Bisnis*, 19(2), 83-94. <https://doi.org/10.26533/eksis.v19i2.1330>

Ruiz, H. S., Sunarso, A., Ibrahim-Bathis, K., Murti, S. A., & Budiarto, I. (2020). GIS-AHP multi criteria decision analysis for the optimal location of solar energy plants at Indonesia. *Energy Reports*, 6, 3249-3263. <https://doi.org/10.1016/j.egyr.2020.11.198>

Saaty, T. L. (1980). *The analytic hierarchy process*. McGraw-Hill.

- Saaty, T. L., & Vargas, L. G. (2012). *Models, methods, concepts & applications of the analytic hierarchy process* (2nd ed.). Springer. <https://doi.org/10.1007/978-1-4614-3597-6>
- Slack, N., & Lewis, M. (2020). *Operations strategy* (6th ed.). Pearson.
- Thanh Quang, N., Ngoc Bach, N., Binh Nguyen, N., Quang Sang, L., Le Quyen, L., & Minh Phap, V. (2025). An overall assessment of multi-criteria decision support system framework in the context of sustainability. *Journal of Sustainable Development of Energy, Water and Environment Systems*, 13(4), 1-26. <https://doi.org/10.13044/j.sdewes.d13.0614>
- Veronica, R., & Handiwibowo, G. A. (2026). Career growth and work environment in reducing turnover intention: The mediating role of employee engagement. *Eksis: Jurnal Riset Ekonomi dan Bisnis*, 21(1), 15-32. <https://doi.org/10.26533/eksis.v21i1.1648>
- Vaidya, O. S., & Kumar, S. (2006). Analytic hierarchy process: An overview of applications. *European Journal of Operational Research*, 169(1), 1-29. <https://doi.org/10.1016/j.ejor.2004.04.028>
- Yuan, J., Wang, L., & Li, Y. (2024). Carbon emission reduction dynamic decision-making in the electricity supply chain with different carbon emission allowance principles. *Energy*, 312, 133563. <https://doi.org/10.1016/j.energy.2024.133563>
- Yucel, M., & Yucel, S. (2024). Environmental, social, and governance dynamics in the energy sector: Strategic approaches for sustainable development. *Energies*, 17(24), 6291. <https://doi.org/10.3390/en17246291>