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Optimizing Electrical System Performance at PTKP Coal Mining Company: Navigating Operational Challenges, Capitalizing on Load Growth, and Preparing for Future Energy Needs

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ABSTRACT: PTKP Coal Mining Company, a prominent player in the Indonesian coal mining industry, faces operational challenges in optimizing its power generation capacity following the termination of a contract with the national electricity company in 2020. This study employs a mixed-methods approach, combining qualitative insights from interviews with key stakeholders and quantitative data analysis using the Analytic Hierarchy Process (AHP), to provide a comprehensive and structured framework for project prioritization and resource allocation. The qualitative results reveal a multifaceted approach to addressing the company's operational challenges, focusing on improving asset utilization, reassessing operational strategies, optimizing operational flexibility, and adapting to load changes. The AHP analysis offers a robust decision-making framework, considering multiple criteria such as economic feasibility, strategic alignment, regulatory compliance, technical feasibility, and environmental impact. The prioritization of projects showcases the strategic significance of each initiative, with Project E emerging as the top priority, followed by Project G, and Projects B, H, and M forming the middle tier. This structured approach enables PTKP Coal Mining Company to navigate complex challenges, remain agile in changing market conditions, and effectively leverage its assets and capabilities to achieve its objectives and drive long-term success. The study highlights the strengths of the AHP methodology in guiding strategic planning and resource distribution while shaping decision-making processes across the organization. However, the research also acknowledges limitations, such as the reliance on a small sample size, the focus on a single company, and the emphasis on the prioritization phase. Future research directions are proposed to address these limitations and further enhance the understanding and effectiveness of structured decision-making approaches in the energy sector and beyond, ultimately contributing to the alignment of corporate strategies with broader societal goals and sustainable development.

KEYWORDS: Analytical hierarchy process, Decision Analysis, Power generation optimization, Project prioritization, Resource allocation.

INTRODUCTION

PCMC is a coal mining company based in East Kalimantan, Indonesia. The operational excellence of PCMC is fundamentally supported by its advanced electricity supply system, which is vital for continuous coal production. By investing strategically in an in-house power generation facility, the company has taken a significant step towards achieving energy independence. Its comprehensive power grid, which includes lines of high, medium, and low voltage, not only fuels the mining activities but also powers various operational infrastructures. This sophisticated electrical system demonstrates PCMC's commitment to operational effectiveness and ecological sustainability, ensuring a steady supply of power while aiming to reduce its environmental impact.

In 2018, PCMC entered into an important agreement with Indonesia's national electricity company to supply extra electricity. This collaboration demonstrated PCMC's ability to produce up to 48 MW of power, highlighting its role in supporting the national electricity need. Although the agreement ended in December 2020, the experience has solidified PCMC's role as a flexible and adaptive participant in the energy sector, capable of meeting both its internal and external energy requirements.

The company's approach to Resource Management and Sustainability, particularly through the lens of the Natural Resource Management Theory and the Sustainable Development Goals (SDGs), supports its commitment to sustainable mining practices. Studies by Asadikia et al., (2021), Cammarano et al., (2022), and Hudaefi, (2020) provide insights into PCMC's strategies for managing resources efficiently and sustainably. The company's efforts are aimed at promoting affordable energy, responsible

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consumption and production, and climate action, aligning with global sustainability trends and demonstrating a commitment to environmental stewardship and sustainable development.

Furthermore, PCMC's focus on Electricity Generation and Supply within its mining operations through captive power generation shows its proactive approach to ensuring a reliable electricity supply. This focus is part of the company's strategy to enhance operational efficiency and address the challenges of industry growth.

The main objective of this research is to examine PCMC's power management strategies, identifying challenges that affect the efficiency of its electrical systems. The study will assess current low electricity demand conditions and look into potential projects that could boost PCMC's electricity usage, aiming for a more reliable and efficient power supply system. It will also project future electricity demand growth, providing strategic insights for operational adjustments in PCMC's power plants to meet expected electricity needs effectively. This research intends to offer PCMC strategies that address current electricity management challenges while preparing it for future industry developments, emphasizing its commitment to operational excellence and sustainability.

THEORITICAL FOUNDATION

Resource Based View Theory

The Resource-Based View (RBV) is a pivotal theory in strategic management that emphasizes the importance of a firm's internal resources as the foundation for gaining and sustaining competitive advantage (Freeman et al., 2021; McGahan, 2021). Unlike traditional perspectives that focus on market position and competitive dynamics, RBV argues that the unique, inherent resources and capabilities of an organization are key to its success. These resources, which may be tangible or intangible, must possess qualities of being valuable, rare, inimitable, and non-substitutable to effectively differentiate a firm from its competitors and drive sustainable competitive advantage. This framework encourages firms to look inward, identifying and leveraging their distinctive assets and competencies to excel in the marketplace (Sukaatmadja et al., 2021).

Despite the RBV's significant contributions to strategic management, it is not without its criticisms. Some argue that the theory might overly concentrate on internal resources at the expense of recognizing the critical role of external market forces and industry dynamics (Kraus et al., 2022). Identifying which resources truly provide a competitive edge and understanding how to utilize them effectively remains a challenge. However, the RBV continues to serve as a fundamental approach in strategic planning, aiding firms in recognizing and nurturing their unique capabilities and resources. For companies looking to secure a lasting competitive position, the RBV offers a strategic lens through which to assess and develop their internal strengths, fostering innovation, skill development, and a culture that supports long-term success. In this light, the RBV not only guides firms in strategic decision-making but also in adapting to and capitalizing on changing market conditions and opportunities.

MCDM

Multiple Criteria Decision Making (MCDM) offers significant flexibility, making it applicable to a wide range of decision-making scenarios across diverse industries such as finance, healthcare, project management, and public policy (Gyani et al., 2022; Mardani et al., 2015). This adaptability allows decision-makers to incorporate both quantitative and qualitative criteria, ensuring that all relevant aspects of a decision are considered. Additionally, MCDM enhances transparency and accountability in the decision-making process by providing a structured and clear methodology to evaluate different options. This transparency is crucial for stakeholders to understand how decisions are made and to ensure that all viewpoints are considered (Asadabadi et al., 2019; Emovon & Oghenenyerovwho, 2020).

MCDM encompasses several methods, each suited for different kinds of decision-making environments. The Analytic Hierarchy Process (AHP) and the Analytic Network Process (ANP) are popular for their ability to handle complex decision-making processes by breaking them down into a hierarchy of simpler problems . The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) and Elimination and Choice Expressing Reality (ELECTRE) are effective for situations where decision criteria are conflicting, allowing for a detailed comparison of options against an ideal or anti-ideal solution. Additionally, Goal Programming is used for decisions that require achieving specific goals as closely as possible, making it ideal for resource allocation issues (Taherdoost & Madanchian, 2023). Each of these methods provides a unique framework to tackle the intricate challenges of multi-criteria decision-making, catering to the specific needs and constraints of different decision-making contexts.

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Method	Key Features	Typical Applications
AHP (Analytic Hierarchy Process)	Breaks complex decisions into a hierarchy of simpler problems, using pairwise comparison.	Strategic planning, resource allocation, prioritization of projects.
ANP (Analytic Network Process)	Similar to AHP, but allows for interdependencies among decision elements and feedback loops.	Complex decision-making with interconnected factors, like policy development and strategic decisions.
TOPSIS (Technique for Order Preference by Similarity to Ideal Solution)	Compares options against an ideal and anti-ideal point, considering the distance from both.	Supplier selection, job selection, and other scenarios where a best and worst condition can be defined.
ELECTRE (Elimination and Choice Expressing Reality)	Focuses on outranking methods where alternatives are compared pairwise to determine which is better with respect to multiple criteria.	Environmental impact assessments, choosing the best technology, and other areas with conflicting criteria.
Goal Programming	Aims to achieve specific goals by minimizing the deviation from these goals in the solution.	Resource allocation, budgeting, and scheduling where specific targets must be met.

The AHP is ideally suited for the study on PTKP Coal Mining Company's power management strategies due to its capability to systematically dissect complex decision-making into a manageable hierarchy of sub-problems. This method excels in structuring multi-faceted issues such as evaluating current electricity demands, potential enhancement projects, and future growth projections, into distinct, quantifiable criteria. AHP's strength lies in its ability to integrate expert judgments through pairwise comparisons, allowing the incorporation of insights from various stakeholders like engineers and operational managers. This facilitates a balanced evaluation of different strategies, emphasizing operational excellence and sustainability. Thus, AHP aids PTKP in making informed, strategic decisions that not only address immediate challenges in power management but also align with the company's long-term goals, ensuring a reliable and efficient power supply system.

METHODOLOGY

Data Collection

In the context of addressing the operational challenges at PTKP Coal Mining Company, the data collection aspect of this research is crucial for bridging the gap between current load demands and generation capacities. By employing a mixed-methods approach, the study harnesses both qualitative and quantitative data collection techniques to garner a holistic understanding of the operational issues (Jaskari & Syrjälä, 2023). Qualitative insights are obtained through semi-structured interviews with key members of the PTKP Coal Mining Company management team, shedding light on the nuanced operational challenges and potential areas for improvement. These qualitative insights are complemented by quantitative data, including historical load data and information from the power plant's internal reports. This balanced approach not only enables a thorough investigation of PTKP Coal Mining Company's operational status but also underpins strategic decision-making for project prioritization, ensuring that the solutions proposed are grounded in comprehensive empirical evidence and deep operational insights (Åkerblad et al., 2021; Jones, 2022; Timans et al., 2019).

The incorporation of the Analytic Hierarchy Process (AHP) into the quantitative phase of the study introduces a structured, multi-criteria decision-making framework that is instrumental in prioritizing solutions to PTKP Coal Mining Company's operational challenges (Ikram et al., 2020; Sequeira et al., 2021). AHP facilitates the breakdown of the complex problem of load and generation gap into manageable sub-problems, assessed through a hierarchy that includes the main objective, criteria, and sub-criteria relevant to PTKP Coal Mining Company's operational needs. This hierarchical structure enables the research to systematically evaluate the importance of various factors—ranging from technical feasibility to environmental impact—and their contribution to the overarching goal of optimizing operational strategy (Agarwal et al., 2022; Lyu et al., 2019) By conducting pairwise comparisons among these factors and calculating their relative weightings, the research identifies the most suitable strategic alternatives for addressing the load and generation gap. This methodological rigor ensures that the decision-making process is both transparent and objective, allowing

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PTKP Coal Mining Company to formulate and implement a strategic operational strategy that is not only evidence-based but also aligned with the company's long-term objectives and capacity for future growth.

Data Analysis

The research methodology employed in this study incorporates a sophisticated blend of qualitative and quantitative analyses to address the multifaceted operational challenges encountered by PTKP Coal Mining Company. On the qualitative front, the analysis is deeply rooted in thematic analysis of semi-structured interviews conducted with key stakeholders within the organization. This approach meticulously sifts through the narratives provided by participants to distill essential themes and insights, revealing the nuanced complexities of PTKP Coal Mining Company's operational environment. Through the identification and examination of recurring patterns, the qualitative analysis uncovers the underlying factors contributing to operational inefficiencies, as well as the potential for strategic improvements. This rich, narrative-driven exploration offers a detailed understanding of internal and external perspectives, shedding light on the strengths, weaknesses, opportunities, and challenges that shape the operational dynamics at PTKP Coal Mining Company. The process not only captures the subjective experiences and perceptions of those at the heart of the organization but also contextualizes the quantitative findings, providing a holistic view of the operational landscape.

In contrast, the quantitative dimension of the study leverages the Analytic Hierarchy Process (AHP) to systematically prioritize operational challenges and assess potential solutions. AHP serves as a robust multi-criteria decision-making tool that quantifies the subjective judgments of experts, transforming them into a structured framework of weighted criteria and alternatives. Through pairwise comparisons and subsequent aggregation of weights, AHP facilitates an objective evaluation of strategic options, culminating in a clear prioritization based on their effectiveness in bridging the load and generation gap at PTKP Coal Mining Company. This methodical approach ensures that decision-making is grounded in a transparent and replicable analysis, allowing for strategic choices that are not only justified but also tailored to PTKP Coal Mining Company's specific operational goals and constraints. By integrating qualitative insights with the quantitative rigor of AHP, the research crafts a comprehensive strategy that aligns with PTKP Coal Mining Company's long-term objectives, ensuring that the proposed operational strategies are both feasible and impactful in addressing the company's challenges.

Validity and Reliability

In the intricate process of evaluating operational challenges at PTKP Coal Mining Company, ensuring the validity and reliability of the qualitative insights and the Analytic Hierarchy Process (AHP) analysis is crucial for the integrity of the research outcomes. For the qualitative component, validity is achieved through rigorous methods such as triangulation and participant validation, which cross-verify data from multiple sources and confirm findings with participants, respectively. This approach ensures that the qualitative analysis accurately reflects the complex realities and perceptions of those involved in PTKP Coal Mining Company's operations. Reliability, on the other hand, is maintained by adopting a consistent and transparent approach in data collection and analysis, including a detailed documentation process. This systematic methodology allows for the replication of the study and ensures that the qualitative findings are consistent and free from bias, thereby reinforcing the credibility of the insights derived from the interviews and observations.

In parallel, the validity of the AHP analysis hinges on the accurate representation of PTKP Coal Mining Company's decision-making context, ensured by engaging stakeholders in the development of the AHP model and maintaining consistency in pairwise comparisons. The calculation of a consistency ratio (CR) assesses the rationality of participants' judgments, with a CR below 0.1 indicating a desirable level of consistency. The reliability of the AHP outcomes is tested through repetition with different participant groups and sensitivity analysis, examining the stability of results under varying criteria weights. This meticulous attention to validity and reliability in both qualitative and AHP analyses not only bolsters the trustworthiness of the research findings but also underpins the development of robust, evidence-based strategies for addressing PTKP Coal Mining Company's operational challenges. By intertwining these rigorous analytical approaches, the study provides a comprehensive and reliable foundation for strategic decision-making, facilitating the identification and implementation of effective solutions tailored to PTKP Coal Mining Company's unique operational context.

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RESULTS

Qualitative Result

The qualitative results from the interviews with participants at PTKP Coal Mining Company illuminate a multifaceted approach to addressing the company's operational challenges and strategic directions. These insights are organized into themes that span vision and strategy for excess generation capacity, historical development and expansion strategies, current operation and maintenance strategies, identification of strengths and weaknesses, recognition of opportunities, acknowledgment of threats, and project evaluation and management methodologies.

Table 1. Qualitative Results

Theme	P1	P2	P3	P4	P5
Vision and Strategy for Excess Generation Capacity	Improving utilization and developing a regional strategy.	Reassessment of operational strategies post-PLN contract termination.	Optimization of operational flexibility and strategic management of shutdown periods.	Strategic management for managing load growth and optimizing generating units.	Prioritizing projects and adapting operational strategies to enhance utility of existing assets.
Historical Development and Expansion Strategies	Significant expansions highlighted by upgrading operations; faced challenges including contractor issues.	Evolution from a modest capacity to a complex network, indicating critical decisions for increasing demand.	Highlighted effective operation of units with a specific mention of Unit 2 at 18 megawatts.	Acknowledged the gap in current load generation after PLN withdrawal, indicating a need for strategic adjustment.	Implied historical consideration for project prioritization and operational strategy adaptation.
Current Operation and Maintenance Strategy	Focus on cost-saving in maintenance for optimizing costs and ensuring efficient operations.	Asset optimization and strategic shift in power generation strategies to increase efficiency and reduce costs.	Balancing cost and safety in asset preservation and maintenance, highlighting standby readiness.	Technical initiatives for asset optimization post-PLN contract adjustment.	Operational strategy optimization post-excess power contract termination, focusing on surplus capacity.
Strengths	Comprehensive capacity with robust manpower and a stable, reliable fuel source.	Acknowledged the historical evolution as a testament to the company's adaptive strength and decision-making capabilities.	Effective unit operation and strategic response to load changes showcase operational strengths.	The challenge of underutilized power post-PLN withdrawal reflects the strength in available capacity for optimization.	Strategic foresight in managing load growth and optimizing power generation units as a strength.
Weaknesses	Aging infrastructure and need for technology upgrades identified as	The journey from modest beginnings to complex operations hints at overcoming past weaknesses.	Cost and safety balance in asset utilization point to areas of potential improvement in efficiency.	Operational challenges and the need for strategic adjustments underscore	The focus on project prioritization and operational strategy adaptation indicates a response to inherent weaknesses.

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	opportunities for improvement.			existing weaknesses.	
Opportunities	Expansion possibilities and potential for efficiency improvement in power generation.	Exploring alternative power generation options and cost reduction strategies as opportunities.	Capacity and demand management for additional power resources offer growth opportunities.	Future load projections and strategic planning for electricity demands highlight operational opportunities.	Forecasting and strategic load forecasting for identifying growth and efficiency opportunities.
Threats	External reliance and regulatory compliance challenges.	The need to navigate through regulatory and environmental challenges for sustainable development.	N/A	Concerns about regulatory changes impacting operations highlight external threats.	Regulatory landscape navigation with PLN emphasizes strategic and compliance-related threats.
Project Evaluation and Management	AHP implementation for structured decision-making; SOPs underscored for project management.	Comprehensive project assessment with economic, technical, and environmental criteria.	Comprehensive project assessment; financial and technical analysis critical for decision-making.	Economic feasibility, project prioritization, and the focus on financial metrics for strategic alignment.	Project prioritization and operational strategy focusing on optimizing standby generating units.

Based on the interviews with participants at PTKP Coal Mining Company, the company takes a multifaceted approach to address its operational challenges and strategic directions. The insights reveal themes spanning vision and strategy for excess generation capacity, historical development and expansion strategies, current operation and maintenance strategies, identification of strengths and weaknesses, recognition of opportunities, acknowledgment of threats, and project evaluation and management methodologies. The company aims to improve asset utilization and develop regional strategies, reassess operational strategies post-contract termination, optimize operational flexibility, and adapt to load changes to enhance the utility of existing assets. With a history of significant expansions, PTKP Coal Mining Company has evolved from modest beginnings to a complex network, showcasing its adaptive decision-making capabilities. The current focus is on cost-saving in maintenance, asset optimization, and strategic shifts in power generation to enhance efficiency and reduce costs, while balancing cost and safety in asset preservation. PTKP Coal Mining Company's strengths include comprehensive capacity, stable resources, and adaptive capabilities, while weaknesses relate to aging infrastructure and the need for technological upgrades. Opportunities lie in expansion possibilities, efficiency improvements, and alternative power generation options, though the company faces threats from external reliance and regulatory compliance challenges. The project evaluation and management approach involves structured decision-making tools and comprehensive assessments considering economic, technical, and environmental criteria.

Quantitative Result

Following the interviews, the AHP is suggested to optimize PTKP Coal Mining Company's power generation capacity post-2020 PLN contract termination. AHP systematically prioritizes factors like asset optimization, load management, regulations, and environmental impact to guide strategic decisions aligning with PTKP Coal Mining Company's long-term vision and operational efficiency.

Identification of Criteria and Sub -Criteria

Based on interview insights, initial AHP criteria and sub-criteria for enhancing electricity generation are presented in Table 2. To ensure strategic alignment, an average score threshold of 4.5 is set, with higher scores indicating greater importance. Sub-criteria such

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as Operational and Maintenance Costs, Technical Expertise, and Potential for Pollution were removed from further analysis due to their lower scores, as they were deemed insufficiently aligned with the organization's objectives or not viable enough for consideration.

Table 2. Development of AHP Criteria and Sub Criteria

Criteria & Sub Criteria	P1	P2	P3	P4	P5	Ave
1. Economic feasibility						
- Initial investment	5	5	5	5	5	5
- Operational and Maintenance costs	5	5	5	5	1	4,2
- Expected return on investment	5	5	5	5	5	5
2. Technical feasibility						
- Availability of equipment and technology	5	5	5	3	5	4,6
- Technical expertise	3	3	3	5	3	3,4
- Compatibility with existing systems	5	5	5	5	5	5
3. Environmental impact						
- Potential for pollution	5	3	5	3	5	4,2
- Impact on local Community & ecosystems	5	3	5	5	5	4,6
- Compliance with environmental regulations	5	5	5	3	5	4,6
4. Regulatory compliance						
- Compliance with mining & electricity generation regulations	5	5	5	5	5	5
- Compliance with worker safety regulations	5	5	5	5	5	5
5. Strategic alignment						
- Alignment with company mission and vision	5	5	5	5	5	5
- Alignment with strategic priorities	5	5	5	5	5	5

Decision Alternative Formulation

To determine the most urgent or beneficial projects for amplifying PTKP Coal Mining Company's electricity demand, an initial evaluation of eight potential projects was conducted (see Table 3). This evaluation process aims to prioritize projects that align with the organization's goals and offer the greatest value in terms of enhancing electricity generation capacity. Through a pairwise comparison process, projects were evaluated based on their alignment with the organization's strategic goals. A cutoff average score of 4 was set as the threshold for further consideration. As a result, six projects remained. These projects demonstrate the strongest potential to contribute to PTKP Coal Mining Company's objectives and will be the focus of subsequent analysis and decision-making.

Table 3. Decision Alternatives

Project Name	Description	P1	P2	P3	P4	P5	Av
Project A	Expand existing fuel terminal facilities by significantly increasing fuel tank capacity to meet rising demands. Take advantage of proximity to sea for more efficient refueling directly from tanker ships	5	5	3	5	5	4,6
Project B	Construct 11kV electrical network to replace current use of generator sets and transition workshop to main grid power for enhanced efficiency and sustainability.	5	5	3	5	5	4,6

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Project C	Construct additional sewage treatment plants to bolster waste management capabilities and ensure environmental compliance for the company's expanding mining operations.	5	5	3	5	5	4,6
Project D	Establish 20kV electrical line to power Inul Mega Workshop and offices, replacing diesel generators with grid connection for improved efficiency and reduced emissions	3	5	3	5	5	4,2
Project E	Establish new coal crushing facility closer to mining sites powered by 11kV line to reduce fuel usage from transportation and eliminate diesel generators	5	5	5	5	5	
Project F	Transition diesel-powered pumps used in mining to electric pumps powered by nearest electrical line for greater efficiency, cost savings and reduced emissions	5	5	3	5	5	4,6
Project G	Supply excess electrical power from the company's underutilized generating units to state electricity company PT PLN to optimize generation capacity.	5	5	5	5	5	5
Project H	Expand existing workshop and upgrade power supply by directly connecting to nearby 11kV grid to support increased workload and operations	5	5	5	5	5	5
Project I	Replace diesel generator sets currently powering workshop with 20kV transmission line from nearest substation for more reliable, efficient electricity source	5	5	5	5	5	5

The final AHP model, shown in Figure 1, presents a structured decision-making framework that evaluates multiple criteria and sub-criteria across the six shortlisted projects (Project A to Project I). The main criteria considered are Economic Feasibility, Technical Feasibility, Environmental Impact, Regulatory Compliance, and Strategic Alignment. Each criterion is further divided into sub-criteria that focus on specific elements crucial for project evaluation. This hierarchical structure allows for a comprehensive and systematic assessment of the projects, ensuring that all relevant factors are taken into account when determining the most suitable project(s) for enhancing PTKP Coal Mining Company's electricity generation capacity.

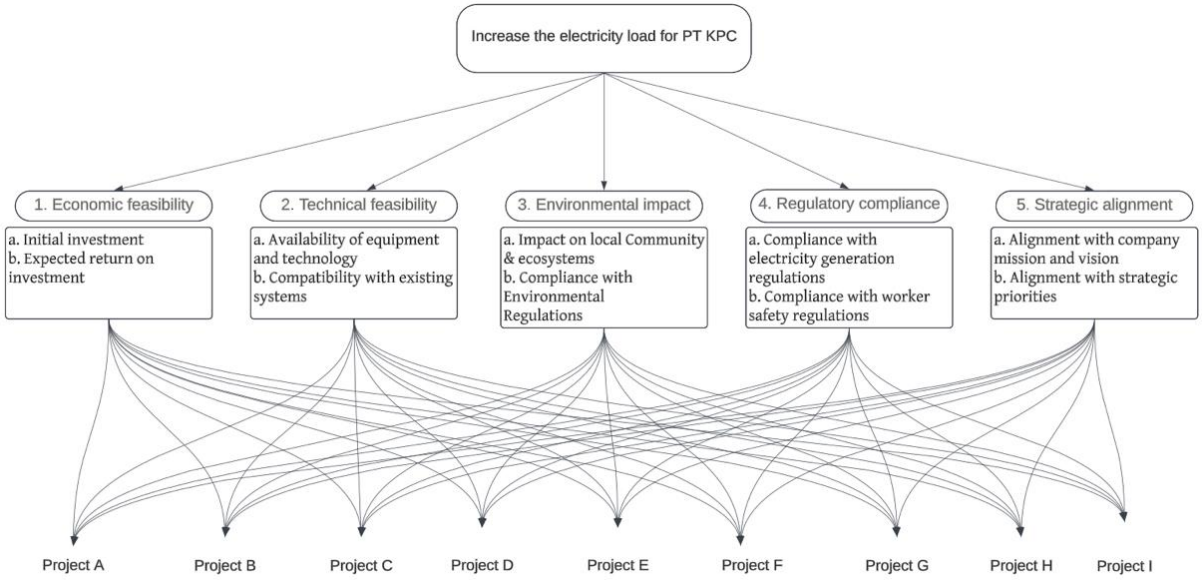

Figure 1. AHP Model

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Decision Hierarchy Result

The decision hierarchy presented in Table 5 offers a structured framework for evaluating the factors involved in the decision to "Increase the Electricity Load." At Level 1, Economic Feasibility emerges as the top priority, with a weight of 32.4%. This highlights the importance of financial aspects in the decision-making process. Within Economic Feasibility, Expected Return on Investment (23.4%) takes precedence over Initial Investment (9.0%). PTKP Coal Mining Company should prioritize projects not only by their feasibility and initial cost but also by their potential to deliver sustainable, long-term financial benefits, such as capacity upgrades, demand-side management, or diversification into renewable energy sources that could offer a higher return for the electricity system.

Strategic Alignment follows closely with a weight of 23.2%, emphasizing the need for the electricity load increase to align with the company's overall direction. Alignment with Strategic Priorities (15.2%) is given more importance than Alignment with Company Mission and Vision (8.10%). This underscores the necessity for all projects and operational adjustments to be closely aligned with the strategic goals of the company.

Regulatory Compliance (15.8%) and Technical Feasibility (14.4%) also play significant roles in the decision-making process. Within Regulatory Compliance, Compliance with Worker Safety Regulations (10.00%) is given more weight than Compliance with Electricity Generation Regulations (5.80%). It implies a proactive approach to risk assessment, the creation of safe work environments, and the implementation of rigorous safety protocols. In terms of Technical Feasibility, Compatibility with Existing Systems (10.0%) is prioritized over the Availability of Equipment and Technology (4.40%). It indicates that any new equipment or technology should not only be the latest or most efficient but must also seamlessly integrate with PTKP Coal Mining Company’s existing electrical infrastructure.

Lastly, Environmental Impact, with a weight of 14.2%, is also taken into consideration. Compliance with Environmental Regulations (8.50%) is given more importance than the Impact on Local Community and Ecosystem (5.70%). This element of the hierarchy acknowledges the criticality of aligning any operational changes or expansions with existing environmental laws and policies. It represents a commitment to upholding high standards of environmental stewardship and ensuring that PTKP Coal Mining Company's efforts to increase the electricity load are within the framework of regulatory compliance. This not only minimizes the risk of legal repercussions but also reflects the company's dedication to responsible environmental practices.

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Table 4. Decision Hierarchy

Decision Hierarchy												
Level 0	**Level 1**	**Level 2**	**Glb Prio.**	**Project A**	**Project B**	**Project C**	**Project D**	**Project E**	**Project F**	**Project G**	**Project H**	**Project I**
Increase the Electricity Load	Economic Feasibility 0.324	Initial investment 0.278	9.0%	0.153	0.112	0.136	0.048	0.137	0.058	0.133	0.121	0.103
		Expected return on investment 0.722	23.4%	0.070	0.089	0.045	0.063	0.236	0.124	0.180	0.094	0.099
	Technical Feasibility 0.144	Availability of equipment and technology 0.306	4.4%	0.119	0.115	0.130	0.112	0.089	0.072	0.143	0.102	0.119
		Compatibility with existing systems 0.694	10.0%	0.083	0.137	0.102	0.109	0.148	0.076	0.093	0.120	0.131
	Environmental Impact 0.142	Impact on local community and ecosystem 0.399	5.7%	0.109	0.110	0.091	0.105	0.097	0.085	0.223	0.090	0.089
		Compliance with Environmental Regulations 0.601	8.5%	0.120	0.111	0.155	0.098	0.109	0.085	0.150	0.079	0.093
	Regulatory Compliance 0.158	Compliance with electricity generation regula 0.368	5.8%	0.073	0.118	0.101	0.103	0.121	0.108	0.140	0.119	0.116

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Decision Hierarchy												
Level 0	**Level 1**	**Level 2**	**Glb Prio.**	**Project A**	**Project B**	**Project C**	**Project D**	**Project E**	**Project F**	**Project G**	**Project H**	**Project I**
		Compliance with worker safety regulations 0.632	10.0%	0.101	0.100	0.097	0.085	0.121	0.115	0.136	0.126	0.119
	Strategic Alignment 0.232	Alignment with company mission and vision 0.348	8.1%	0.052	0.114	0.057	0.112	0.324	0.089	0.073	0.073	0.105
		Alignment with strategic priorities 0.652	15.2%	0.053	0.112	0.050	0.113	0.308	0.113	0.052	0.099	0.101
			1.0	**8.7%**	**10.8%**	**8.5%**	**9.0%**	**19.3%**	**9.9%**	**13.1%**	**10.2%**	**10.6%**

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Comparison of Alternatives

Figure 2 illustrates the prioritization of potential projects within an organization. "Project E" leads with 19.3%, indicating its critical role and the need for significant resources. "Project G" follows at 13.1%, while "Project B," "Project H," and "Project M" form the middle tier with priorities between 10.2% to 10.8%. "Project D" and "Project F" show comparable prioritization at 9.0% and 9.9%, respectively. "Project A" and "Project C" have the lowest prioritization at 8.7% and 8.5%. These percentages reflect each project's importance and urgency, guiding the organization's strategic direction and resource allocation decisions.

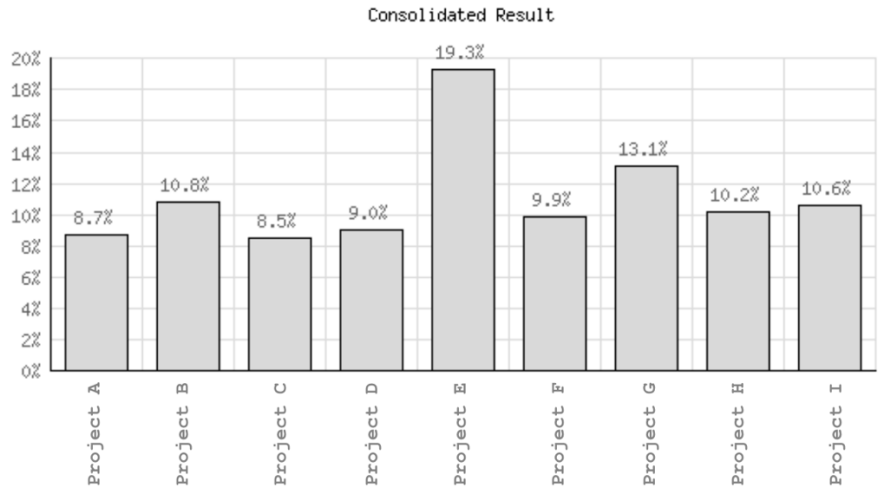

Figure 2. Consolidated Result

Project A

PTKP Coal Mining Company is at a critical juncture with Project A, aimed at increasing the company's electricity load. The decision-making process hinges on several factors, each weighed by its impact on the project's success. The most significant consideration is Economic Feasibility, underscored by the need for careful management of the Initial Investment (15.3%) and evaluating the Expected Return on Investment (7.0%). These elements are vital for assessing the financial viability and profitability of the project. Another important factor is Environmental Impact, particularly Compliance with Environmental Regulations (12.0%) and the Impact on the Local Community and Ecosystem (10.9%). PTKP Coal Mining Company needs to prioritize environmental stewardship to ensure the project's sustainability and adherence to regulations.

Technical Feasibility also plays a crucial role, including the Availability of Equipment and Technology (11.9%) and Compatibility with Existing Systems (8.3%). It is essential for the new infrastructure to integrate seamlessly with existing operations to ensure smooth implementation. Furthermore, Regulatory Compliance is essential, focusing on Compliance with Worker Safety Regulations (10.1%) and Compliance with Electricity Generation Regulations (7.3%). Adherence to these regulations is crucial for the lawful and safe execution of the project. Lastly, Strategic Alignment with the company's mission and vision and its strategic priorities are weighted 5.2% and 5.3%, respectively.

Project B

For Project B, the most heavily weighted factor is the Compatibility with Existing Systems, which holds the highest importance at 13.7%. This aspect underscores the necessity of ensuring that new infrastructure fits seamlessly with the existing setup to minimize disruptions and facilitate successful implementation. Following closely, the Regulatory Compliance related to Electricity Generation Regulations is significant at 11.8%. This highlights the importance of adhering to all relevant standards and regulations to ensure legal compliance and safe operation of the project. Technical Feasibility, particularly the Availability of Equipment and Technology, is also critical, accounting for 11.5% of the decision-making process. This ensures that all necessary resources and technologies are available to support the project's objectives effectively.

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IJCSRR @ 2024
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Environmental concerns are similarly emphasized, with Compliance with Environmental Regulations slightly edging out the Impact on the Local Community and Ecosystem, at 11.1% and 11.0% respectively. These considerations stress the importance of minimizing environmental impacts and maintaining legal and ethical standards. The Financial Aspects of the project, while crucial, are slightly less weighted in this analysis. The Initial Investment and Expected Return on Investment are considered at 11.2% and 8.9% respectively, underscoring the importance of assessing capital requirements and ensuring a viable financial return. Lastly, Compliance with Worker Safety Regulations, with a weighting of 10%, emphasizes the necessity of safeguarding workforce well-being and safety, underscoring its importance for the project's success.

Project C

In Project C, leading the considerations is Compliance with Environmental Regulations, assigned a high priority of 15.5%. This reflects the critical need to adhere to environmental laws and uphold standards that ensure the project's long-term viability and environmental integrity. Closely following is the Initial Investment, which is emphasized with a priority of 13.6%. This underscores the importance of efficiently managing the upfront capital to establish a solid financial foundation for the project. Technical Feasibility is another critical area, with the Availability of Equipment and Technology receiving a priority of 13%. This ensures that the necessary tools and technology are available to meet the project's technical demands.

The Compatibility with Existing Systems is also significant at 10.2%, highlighting the need for the project to integrate smoothly with existing company operations. Regulatory Compliance pertaining to Electricity Generation Regulations also holds considerable importance, with a priority of 10.1%. This is essential for ensuring that the project adheres to all relevant electrical standards and regulations. Compliance with Worker Safety Regulations, with a priority of 9.7%, underscores the commitment to maintaining a safe work environment. Environmental Impact through the Impact on Local Community and Ecosystem also plays a key role, with a priority of 9.1%. This factor is vital in minimizing adverse effects on the surrounding community and ecosystem. However, Strategic Alignment with the company's mission and vision (5.7%) and strategic priorities (5.0%) are less prioritized.

Project D

In Project D, the Strategic Alignment with the company's overall strategic priorities is the most emphasized, with a priority of 11.3%. This underscores the importance of ensuring that the project's objectives are well-integrated with the company's long-term goals. Similarly, Strategic Alignment with the Company Mission and Vision also holds a high priority, rated at 11.2%. This factor ensures that the project contributes positively towards fulfilling the company's broader mission and vision, reinforcing PTKP Coal Mining Company's competitive edge in the industry. Technical Feasibility also ranks highly in the decision hierarchy, particularly the Availability of Equipment and Technology, which is crucial at 11.2%. This priority reflects the necessity of having the right technology and equipment to successfully implement the project.

Close behind, the Compatibility with Existing Systems is valued at 10.9%, highlighting the need for the project to integrate seamlessly with the existing infrastructure to avoid disruptions. Environmental Impact considerations are significant as well, with the Impact on Local Community and Ecosystem prioritized at 10.5% and Compliance with Environmental Regulations at 9.8%. These priorities emphasize the need to mitigate negative impacts on the environment and comply with legal standards to ensure the project's sustainability. Regulatory Compliance is also critical, with Compliance with Electricity Generation Regulations rated at 10.3%. This indicates a strong necessity to meet all regulatory standards related to electricity generation. Compliance with Worker Safety Regulations, with a priority of 8.5%, stresses the importance of ensuring safety in the workplace. Lastly, in this project, the Financial aspects are less weighted with the Expected Return on Investment is considered at 6.3%, whereas the Initial Investment is given a lower priority at 4.8%.

Project E

In Project E, the highest priority is given to Strategic Alignment with the Company Mission and Vision, which stands at 32.4%. This priority ensures that Project E is deeply integrated with the company's core objectives, enhancing PTKP Coal Mining Company's position in the industry. Closely following is the Alignment with Strategic Priorities at 30.8%, which indicates the critical nature of ensuring that the project aligns with PTKP Coal Mining Company's long-term strategic goals, further reinforcing its competitive advantage.

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IJCSRR @ 2024
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On the financial aspect, the Expected Return on Investment is highly prioritized at 23.6%, illustrating the paramount importance of ensuring that Project E is financially viable and offers substantial returns, which is vital for justifying the investment. On the other hand, the Initial Investment only has an importance of 13.7%. In terms of Technical Feasibility, the Compatibility with Existing Systems is prioritized at 14.8%. This underscores the necessity for the project's infrastructure to integrate smoothly with the current systems, crucial for operational continuity and efficiency. The Availability of Equipment and Technology is also considered with a priority of 8.9%.

Regulatory Compliance is crucial, with both Compliance with Electricity Generation Regulations and Compliance with Worker Safety Regulations each allocated a priority of 12.1%. This dual focus highlights the need to adhere strictly to legal standards in both electricity generation and workplace safety. Environmental considerations are also significant, with Compliance with Environmental Regulations rated at 10.9%, emphasizing the importance of meeting environmental standards to avoid legal repercussions and reputational damage. The Impact on Local Community and Ecosystem holds a priority of 9.7%, reflecting the importance of minimizing adverse environmental impacts for the project's long-term sustainability and community relations.

Project F

In Project F, the highest priority is the Expected Return on Investment, which is emphasized with a priority of 12.4%. This underscores the importance of ensuring the project is financially viable and profitable, reflecting its critical role in the company's overall strategy. However, the initial investment is considered with a relatively lower emphasis compared to other factors, with a priority of 5.8%. Following this, the Compatibility with Existing Systems and Alignment with Strategic Priorities are also significant considerations, each given priorities of 11.3% and 7.6% respectively. These factors highlight the importance of the project integrating well with existing infrastructure and aligning closely with the company's long-term strategic objectives, aiding in enhancing PTKP Coal Mining Company's competitive edge in the market. Regulatory Compliance is another crucial aspect, with Compliance with Worker Safety Regulations rated at 11.5% and Compliance with Electricity Generation Regulations at 10.8%. These priorities indicate the essential nature of adhering to all relevant safety and regulatory standards to ensure legal and operational success.

Strategic Alignment with the Company Mission and Vision is also a key factor, rated at 8.9%. This ensures that the project contributes positively to fulfilling the company's broader goals and enhances its market position. Environmental considerations hold equal weight at 8.5% for both the Impact on Local Community and Ecosystem and Compliance with Environmental Regulations. These priorities reflect the importance of minimizing negative impacts on the environment and adhering to environmental laws to maintain sustainability and community relations.

Project G

In Project G, the Impact on the Local Community and Ecosystem holds the highest priority at 22.3%, signifying the utmost importance placed on social and environmental responsibilities. Following this, the Expected Return on Investment is prioritized at 18%, highlighting the critical importance of financial profitability. Compliance with Environmental Regulations is also highly regarded, with a priority of 15%, which underscores the necessity of adhering to environmental laws to avoid legal repercussions and maintain environmental integrity. Close in importance, the Availability of Equipment and Technology is given a priority of 14.3%. This reflects the need for advanced and appropriate technology to effectively implement the project, ensuring efficiency and modernization.

The priorities assigned to Regulatory Compliance aspects further illustrate their significance: Compliance with Electricity Generation Regulations at 14% and Compliance with Worker Safety Regulations at 13.6%. These emphasize the critical nature of adhering to industry standards and regulations, ensuring safe and compliant operational practices. The Initial Investment, with a priority of 13.3%, while substantial, focuses on the costs incurred at the outset, highlighting the financial considerations necessary to initiate the project effectively. In this project, compatibility with existing systems is only given a priority of 9.3%. Strategic alignment with the company's mission, vision, and strategic priorities is also less emphasized, with assigned priorities of 7.3% and 5.2%, respectively.

Project H

In Project H, leading the priority list is Compliance with Worker Safety Regulations, rated at 12.6%. This underscores the critical importance of ensuring a safe working environment. Closely following are the Initial Investment and Compatibility with Existing

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IJCSRR @ 2024
www.ijcsrr.org

Systems, each prioritized at 12.1% and 12% respectively. The Initial Investment highlights the upfront financial outlay required to establish the project, while Compatibility with Existing Systems ensures that the project can be seamlessly integrated into the existing operational framework, crucial for maintaining continuity and efficiency.

The Availability of Equipment and Technology, with a priority of 10.2%, reflects the importance of equipping the workshop with modern and effective tools and technology necessary for its operation, ensuring high standards of quality and performance. Strategic alignment, particularly Alignment with Strategic Priorities, holds a significant weight at 9.9%, stressing the importance of the workshop's role in fulfilling long-term business objectives and enhancing the company's strategic position. The Expected Return on Investment, with a priority of 9.4%, emphasizes the workshop's potential for profitability and its contribution to the company's financial health, highlighting its economic justification. The Impact on the Local Community and Ecosystem is given a priority of 9%, focusing on the workshop's social and environmental responsibilities, including considerations like minimizing noise, pollution, and enhancing local employment opportunities.

Compliance with Electricity Generation Regulations is prioritized at 11.9%, and Compliance with Environmental Regulations at 7.9%, both emphasizing the critical need to adhere to legal and operational standards to ensure sustainability and avoid legal repercussions. Lastly, Alignment with the Company's Mission and Vision is assigned a lower priority of 7.3%.

Project I

In Project I, the priority ranking is the project's Compatibility with Existing Electrical Systems, rated at 13.1%. This priority underscores the critical importance of ensuring that the new infrastructure integrates smoothly with the existing systems. Next, the Availability of Equipment and Technology holds a significant priority at 11.9%, emphasizing the need for up-to-date and efficient tools crucial for the installation and maintenance of the overhead line. Similarly, Compliance with Worker Safety Regulations is also prioritized at 11.9%, highlighting the focus on ensuring a safe working environment.

Compliance with Electricity Generation Regulation, with a priority of 11.6%, reflects the importance of adhering to legal standards specific to electricity generation, ensuring that the project meets all regulatory requirements and maintains high standards of operation. Strategic considerations are also prominent, with Alignment with the Company's Mission and Strategic Priorities given priorities of 10.5% and 10.1% respectively. These priorities ensure that the project not only aligns with PTKP Coal Mining Company's long-term goals but also enhances its strategic position within the industry.

The Initial Investment and Expected Return on Investment are prioritized at 10.3% and 9.9% respectively, highlighting the financial aspects of the project. Environmental concerns are carefully considered, with Compliance with Environmental Regulations receiving a priority of 9.3% and the Impact on the Local Community and Ecosystem each at 8.9%.

DISCUSSION

Figure 2 provides a structured visualization of project prioritization within an organization, highlighting the strategic significance and resource allocation for a range of projects. Project E, with the highest priority at 19.3%, underscores its crucial role within the company's strategic initiatives, necessitating significant investment and focus. Following closely, Project G holds a priority of 13.1%, marking it as important though less critical than Project E. The middle-tier projects, including Project B, H, and M, demonstrate moderate importance with priorities ranging between 10.2% to 10.8%, indicating a substantial but not critical need for immediate resources. Meanwhile, Projects D and F show comparable importance at around 9%, and Projects A and C are deemed least critical with the lowest priorities of 8.7% and 8.5%, respectively.

This prioritization not only directs the strategic planning and resource distribution but also shapes decision-making processes across the organization (Graham & Englund, 2004). By categorizing projects based on their urgency and importance, the organization can better allocate financial and human resources, ensuring that critical projects like Project E receive the attention necessary for successful implementation (Gray & Larson, 2011). Furthermore, this structured prioritization aids in aligning each project with the organization's broader objectives, thereby optimizing outcomes and enhancing the efficiency of project execution (Dvir, 2004). The prioritization effectively acts as a guide, assisting stakeholders in understanding which projects are vital for immediate focus and which can be scheduled for later consideration, streamlining the overall strategic efforts of the organization (Wysocki, 2019).

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IJCSRR @ 2024
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The prioritization of projects within an organization has significant strategic implications that shape the company's direction and resource allocation. The structured prioritization directly influences the strategic direction of the organization, focusing on areas deemed most critical for immediate resource allocation and execution (Graham & Englund, 2004). By identifying and prioritizing projects like Project E, which holds the highest priority at 19.3%, the organization underscores its commitment to initiatives that align with its strategic goals and drive long-term success (Kerzner & Saladis, 2009). Furthermore, the prioritization framework guides how resources, both financial and human, are allocated to optimize organizational outcomes and ensure the success of high-priority projects (Gray & Larson, 2011). This strategic approach to resource allocation enables the organization to effectively leverage its assets and capabilities to achieve its objectives (Dvir, 2004).

The decision-making process for project prioritization involves evaluating each project based on multiple criteria, including economic feasibility, technical requirements, regulatory compliance, and strategic alignment (Meredith et al., 2017). By considering these factors, the organization can make informed decisions that balance short-term needs with long-term strategic objectives (Serrador & Turner, 2015). Each project's weighting reflects its alignment with the organization's broader objectives and immediate needs, ensuring that the most critical initiatives receive the necessary attention and resources (PMI, 2017). This comprehensive approach to decision-making enables the organization to navigate complex challenges and opportunities, while remaining agile and responsive to changing market conditions (Wysocki, 2019). By prioritizing projects based on a thorough evaluation of key criteria, the organization can effectively allocate resources and drive strategic initiatives that contribute to its overall success.

CONCLUSION

In conclusion, the AHP analysis of PTKP Coal Mining Company's power generation capacity optimization post-2020 PLN contract termination, supported by qualitative insights from interviews with key stakeholders, provides a comprehensive and structured approach to project prioritization and resource allocation. By considering multiple criteria such as economic feasibility, strategic alignment, regulatory compliance, technical feasibility, and environmental impact, and evaluating each project's alignment with the company's strategic objectives, the AHP model offers a robust framework for informed decision-making. The prioritization of projects showcases the strategic significance of each initiative, with Project E emerging as the top priority, followed by Project G, and Projects B, H, and M forming the middle tier. This structured prioritization not only guides strategic planning and resource distribution but also shapes decision-making processes across the organization, ultimately contributing to PTKP Coal Mining Company's overall success and strategic growth in the future. The strength of this approach lies in its ability to enable the company to navigate complex challenges and opportunities, remain agile and responsive to changing market conditions, and effectively leverage its assets and capabilities to achieve its objectives and drive long-term success.

LIMITATION AND FUTURE RESEARCH

While the AHP analysis, supported by qualitative insights, provides a comprehensive and structured approach to project prioritization and resource allocation for PTKP Coal Mining Company, it is essential to acknowledge the limitations of the study and identify areas for future research. These limitations include the reliance on a relatively small sample size of participants for the qualitative interviews, the focus on a single company which may limit the generalizability of the findings, and the emphasis on the prioritization phase rather than the implementation of projects. Future research could address these limitations by expanding the sample size and scope of the study, exploring the application of the AHP methodology in different contexts, delving deeper into the implementation phase of prioritized projects, integrating additional decision-making tools such as scenario planning or sensitivity analysis, and incorporating sustainability criteria into the AHP model. By pursuing these research directions, future studies can further enhance the understanding and effectiveness of structured decision-making approaches in the energy sector and beyond, helping companies like PTKP Coal Mining Company to align their strategies with broader societal goals and contribute to a more sustainable future.

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