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Multi-Criteria AHP Approach for Selecting Office Facility Vendors

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ABSTRACT

Purpose – This study develops and validates a multi-criteria decision-making framework based on the Analytic Hierarchy Process (AHP) to support objective and transparent selection of office facility vendors. The framework aims to enhance procurement accountability and align vendor choice with organizational competency and compliance requirements.
Methodology/approach – A quantitative, descriptive-analytic approach was applied using a case study at PT. XYZ. Expert judgments were elicited from procurement and facility management professionals to construct pairwise comparison matrices across predefined criteria (experience, certification, business licensing, and professional association membership). Individual judgments were aggregated using the geometric mean method, criterion weights were derived from the principal eigenvector, and consistency of judgments was assessed via Saaty's consistency ratio. Sensitivity checks were performed to evaluate ranking robustness.
Findings – It Results show that vendor experience carries the greatest relative weight, followed by certification, business licensing, and association membership. All pairwise comparison matrices satisfied the consistency threshold (CR < 0.10). The AHP framework produced a clear, reproducible vendor ranking and reduced reliance on ad-hoc or subjective decision criteria.
Novelty/value – The paper contributes a validated, practical AHP model tailored for office facility procurement, addressing a documented gap in structured vendor assessment within the Indonesian corporate context. The framework is readily adaptable for organizations operating under high compliance and safety demands.

INTRODUCTION

The selection of competent office facility vendors is a strategic factor in ensuring operational continuity, cost efficiency, and compliance with health, safety, and environmental standards in the oil and gas sector. At PT. XYZ, the current vendor selection process remains heavily dominated by administrative verification of documents. As a result, technical capability, health, safety, and environment (HSE) performance, and sustainability considerations are often neglected. This gap is

evident in the company's PT XYZ, which revealed that several contractors passed administrative checks but failed to comply with HSE requirements in practice. Internal assessments further indicated that some vendors with complete documentation still required significant service improvement, while performance reviews highlighted inconsistent trends over a two-year period. These conditions expose the company to operational delays, increased costs, and elevated safety risks, underlining the urgent need for a more systematic, data-driven, and accountable vendor evaluation method.

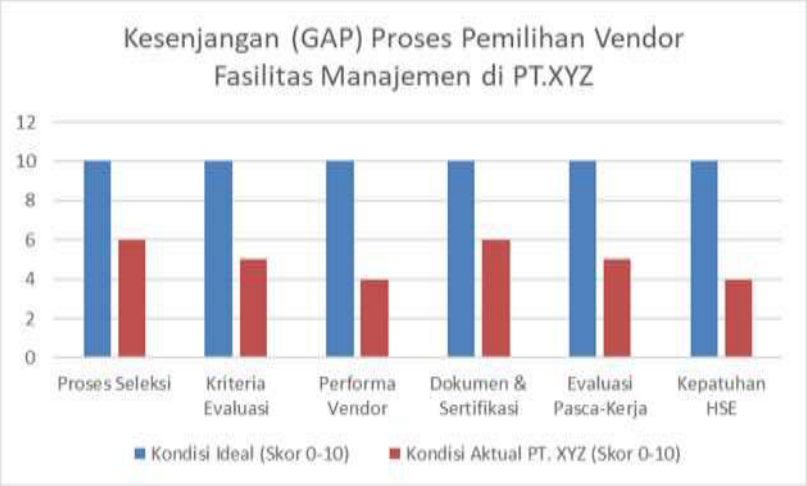

Figure 1 about here: Gap between the ideal multi-criteria vendor selection process and the current administrative practice at PT. XYZ.

Figure 1 illustrates the performance gap between the ideal multi-criteria vendor selection process and the current administrative practice at PT. XYZ. The blue bars represent the ideal conditions based on best-practice standards, while the red bars indicate the actual performance scores achieved by PT. XYZ on a scale of 0–10. The results show significant gaps across several critical areas, particularly in vendor evaluation criteria, post-project performance reviews, and HSE compliance, where the actual scores are far below the expected benchmarks.

Recent developments in supplier and vendor management show an increasing adoption of multi-criteria decision-making (MCDM) methods such as the Analytical Hierarchy Process (AHP), TOPSIS, and fuzzy-based models. These methods allow organizations to address multiple evaluation criteria simultaneously and have been proven effective in enhancing objectivity and transparency in procurement (Govindan et al., 2015) Most studies emphasize traditional dimensions such as cost, quality, and delivery (Saputri & Syafrina, 2023) whereas the global procurement landscape is moving toward integrating sustainability, safety, and regulatory legitimacy as critical factors (Abdel Aal, 2024). The trend indicates a growing need for more comprehensive vendor evaluation frameworks that reflect these emerging requirements.

From a theoretical perspective, prior research has mainly treated vendor evaluation as a function of economic and operational indicators, leaving gaps in incorporating HSE, environmental sustainability, and corporate governance dimensions. From a practical perspective, PT. XYZ continues to face issues where vendors pass administrative checks but underperform in technical execution and compliance, highlighting the limitations of current evaluation systems. The challenges call for a robust, structured approach that can reconcile technical, legal, and sustainability requirements into a unified evaluation model.

The background reveals that vendor selection at PT. XYZ suffers from gaps between administrative procedures and operational performance, reflecting broader shortcomings in existing evaluation models. A few researchers have focused on evaluating suppliers using criteria such as cost, quality, and delivery performance. Limited studies concerned on integrating safety (HSE), environmental sustainability, and legal compliance into vendor evaluation frameworks, particularly in high-risk

industries such as oil and gas. This research intends to develop a structured and quantitative vendor evaluation system using the Analytical Hierarchy Process (AHP) to address both theoretical and practical problems. The objectives of this research are: (1) to design an objective and structured vendor evaluation system for PT. XYZ, (2) to identify and assign weights to the most critical criteria in vendor selection, and (3) to apply AHP to evaluate and rank vendors, thereby strengthening transparency, accountability, and sustainability in procurement decisions.

The novelty of this study lies in the integration of technical experience, HSE certification, business legality, and professional association membership into a single decision-making framework. Unlike previous research that concentrated on cost or delivery performance, this study provides a more comprehensive evaluation model aligned with Good Corporate Governance (GCG) principles and the Sustainable Development Goals (SDGs), making it both theoretically significant and practically applicable to the energy sector.

LITERATURE REVIEW

Operational Management

Operational management is a branch of management science that focuses on the processes of planning, organizing, directing, and controlling company operations so that they run efficiently and effectively (Khairun Nisa et al., 2019) The main aspects of operational management include quality management, inventory control, location selection, capacity planning, and process design. The ultimate goal is to create added value for customers through the optimization of cost, time, and resources.

Digital Transformation in Operations

Digital transformation in operations signifies the integration of advanced digital technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), Big Data Analytics, and intelligent automation into operational workflows to enhance efficiency, flexibility, responsiveness, and real-time decision-making. A review by Supriadi & Mulyani (2024) highlights how digital transformation reshapes operational management through emerging technologies and outlines current trends and best practices in optimizing operational processes. In the industrial sector, Thomas & Adelusi (2024) explore how the convergence of IoT, AI, robotics, and big data analytics is fundamentally transforming manufacturing operations. Their findings demonstrate that digitization and intelligent automation significantly boost productivity, reduce costs, and empower organizations with capabilities for agile, data-driven decision-making in real time. Together, these studies provide robust, up-to-date evidence that digital transformation is reshaping operations management enabling organizations to operate smarter, more adaptively, and with enhanced operational excellence.

Business Legality

Vendor legality, including licenses and business permits, is a fundamental criterion for ensuring accountability, transparency, and alignment with regulatory frameworks. Literature on supply chain governance emphasizes that legality protects organizations from compliance risks, contractual disputes, and reputational damage (Manupati, 2020). International studies confirm that organizations increasingly incorporate legal compliance as part of their vendor selection frameworks, particularly in contexts where governance and sustainability are prioritized (Govindan, 2020).

Professional Association Membership

Membership in professional associations reflects a vendor's commitment to continuous improvement, industry best practices, and ethical standards. Studies show that association membership strengthens knowledge sharing, innovation, and adoption of sustainability practices across the supply chain (Zhang,

2021). In vendor selection, association membership serves as an indicator of credibility and alignment with sectoral benchmarks, which can reduce uncertainties in procurement decisions.

Multi-Criteria Decision-Making Approaches in Vendor Evaluation
Multi-criteria decision-making (MCDM) has been widely applied to address the complexity of vendor evaluation, allowing decision makers to integrate economic, environmental, social, and governance dimensions. Among these, the Analytical Hierarchy Process (AHP) is one of the most popular methods due to its simplicity, flexibility, and ability to handle both qualitative and quantitative factors (Govindan, 2020; Cheraghalipour, 2022). Recent works emphasize integrating sustainability and risk into AHP-based models to improve vendor evaluation (Abdel Aal, 2024; Cheraghalipour, 2022).

METHOD

Research Approach and Design
This study employed a quantitative, descriptive-analytic approach designed to construct a systematic framework for evaluating office facility vendors. The Analytic Hierarchy Process (AHP) was selected as the main methodological tool due to its robustness in handling multi-criteria problems, integrating subjective judgments with quantitative computation, and providing mathematical checks for consistency (Saaty, 2008). Unlike simple scoring systems, AHP enables decision-makers to evaluate both tangible and intangible aspects simultaneously. Its hierarchical structure also facilitates the decomposition of complex decision-making into manageable levels (Ho, 2010).

The research design consisted of three hierarchical levels:

a) Goal selecting the most competent vendor for office facility management.
b) Criteria experience, HSE certification, business legality, and professional association membership.
c) Alternatives three vendor candidates under evaluation at PT. XYZ.

This design allows for a structured comparison across multiple criteria, ensuring objectivity and transparency in the selection process.

Data Collection and Respondents
Primary data were obtained through structured pairwise comparison questionnaires distributed to eight experts purposively selected based on their expertise and direct involvement in vendor management. The panel consisted of procurement managers, HSE officers, and facility administrators, each possessing a minimum of five years of professional experience. The purposive sampling approach ensured that the selected experts had relevant domain knowledge and decision-making authority, thereby increasing the reliability of the collected judgments (Etikan, 2024). Expert-based evaluation is widely acknowledged as a valid method in multi-criteria decision-making studies, as it captures tacit knowledge and contextual insights that are not easily quantifiable (Hasan M. K., 2024).
Secondary data were drawn from organizational reports, vendor performance scorecards, and sustainability documentation, serving as a triangulation mechanism to validate expert judgments. The integration of expert-based data with documented performance records enhances methodological robustness and reduces bias associated with single-source reliance (Keshavarz-Ghorabaee M. Z., 2024). This dual-source approach aligns with best practices in AHP applications, where the combination of subjective assessments and objective records strengthens both construct validity and practical applicability. The methodological triangulation not only increases the credibility of the research but also ensures that the developed framework is sensitive to both theoretical rigor and practical realities of vendor evaluation in high-risk industries such as oil and gas.

Research Instrument and Pairwise Comparison

The primary research instrument was a structured pairwise comparison questionnaire designed according to (Saaty, 2008)fundamental 1–9 scale, where 1 represents equal importance and 9 denotes extreme importance of one criterion relative to another. The use of Saaty scale enables decision makers to articulate judgments on both tangible and intangible factors, providing a balance between cognitive simplicity and analytical rigor. Recent studies reaffirm that the 1–9 scale remains robust in capturing expert preferences and minimizing inconsistency when compared to alternative ratio or fuzzy-based scales (Alonso, 2023; Hasan M. K., 2024). Each respondent compared criteria in pairs, generating reciprocal matrices. For example, when criterion i was rated five times more important than criterion j, the corresponding comparison value was 5, while the reciprocal entry was 1/5. These reciprocal properties preserve logical coherence within the matrix.
Multiple expert judgments were aggregated using the geometric mean method, which is the standard practice in AHP group decision-making. The geometric mean is preferred because it preserves the reciprocal properties of the comparison matrix and reduces the influence of extreme values compared to arithmetic aggregation (Forman, 1998). Recent studies also support geometric mean aggregation as consistent with the theoretical foundations of ratio-scale comparisons (Keshavarz-Ghorabaee M. A., 2024). The questionnaire design incorporated clear definitions and practical examples of each criterion to ensure that respondents evaluated criteria with a shared understanding. Recent methodological reviews emphasize that well-designed instruments mitigate cognitive biases and improve the accuracy of pairwise judgments (Hasan M. K., 2024). The instrument was also pilot-tested with two non-sample experts to refine clarity and reduce ambiguity before full deployment.

Population and Sampling
The population of this study consisted of stakeholders directly engaged in vendor evaluation and procurement at PT. XYZ, an Indonesian energy-sector company operating under strict health, safety, and environmental (HSE) compliance requirements. This population included facility managers, procurement officers, and senior administrative staff who possessed both technical and regulatory expertise relevant to vendor assessment. From this population, a purposive sample of eight experts was selected, based on their professional experience (a minimum of five years in procurement or facility management) and active involvement in the company's vendor selection process.

Data Collection and Analysis
Data were collected through structured questionnaires aligned with the AHP framework. Respondents performed pairwise comparisons among four evaluation criteria: (1) experience, (2) certification, (3) business licensing, and (4) professional association membership. Each comparison used Saaty nine-point scale, where a score of 1 indicates equal importance and a score of 9 indicates extreme importance of one criterion over another. The aggregated group comparison matrix was derived using the geometric mean method. Normalized weights were then calculated through the principal eigenvector method, and a consistency ratio (CR) was computed to assess the logical coherence of the judgments, with CR values below 0.10 considered acceptable. A sensitivity analysis was also conducted to evaluate the stability of the final vendor ranking under varying criterion weights. All computations were performed using Microsoft Excel, utilizing built-in matrix and statistical functions. This methodological approach ensures that the resulting vendor selection framework is empirically validated, reliable, and adaptable to other organizational contexts requiring transparent and criteria-based procurement decisions.

RESULT
The AHP analysis produced weighted priorities for the four evaluation criteria used in vendor selection. Data from eight expert respondents were aggregated using the geometric mean method, and the resulting consensus matrix was processed to obtain normalized weights and consistency ratios. Table 1 presents the aggregated pairwise comparison matrix of the criteria. The diagonal entries are fixed at 1 because each criterion is equally important to itself, while reciprocal values are applied for opposite

comparisons to preserve logical symmetry. For example, if experience is judged twice as important as certification, the matrix entry is 2; the reciprocal entry is then 0.5.

Table 1. Aggregated Pairwise Comparison Matrix of Criteria

Criteria	Experience	Certification	Business Licensing	Association Membership
Experience	1	2	3	4
Certification	0.5	1	2	3
Business Licensing	0.33	0.5	1	2
Association Membership	0.25	0.33	0.5	1

Source: Processed primary data, 2025

As shown in Table 1, the expert panel established a clear prioritization gradient across the criteria. Experience is consistently rated higher than all others, followed by Certification, then Business Licensing, and finally Association Membership. This ordering reflects the belief that capability and compliance-related factors (experience and certifications) should dominate over formal requirements (licensing and membership), which is consistent with procurement risk management in high-hazard industries. The structure of the matrix is largely transitive—for example, if Experience > Certification and Certification > Business Licensing, then Experience > Business Licensing - yet not perfectly multiplicative ($2 \times 2 \neq 3$ exactly), which is typical of real expert judgments. This is why the Consistency Ratio (CR) is later tested (see Table 2) to ensure the reliability of the judgments. For readers, Table 1 can be interpreted as follows: larger numbers in the upper-right triangle show how many times the row criterion is judged more important than the column criterion; the lower-left triangle contains exact reciprocals. This design ensures that the matrix preserves internal logic before the derivation of normalized weights. The normalized weights for each criterion were derived from the aggregated pairwise comparison matrix shown in Table 1. The weights indicate the relative importance of each criterion in selecting a vendor. The consistency of the expert judgments was evaluated using the Consistency Ratio (CR) to ensure that the pairwise comparisons were logically sound.

Table 2. Criteria Weights and Consistency Ratio

Criteria	Weight	Rank
Experience	0.46	1
Certification	0.28	2
Business Licensing	0.17	3
Association Membership	0.09	4
Consistency Ratio (CR)	**0.046**	

Source: Processed primary data, 2025

As shown in Table 2, Experience is given the highest priority, reflecting the expert panel's consensus that prior performance and capability are the most critical factors in vendor selection. Certification is the second most important criterion, followed by Business Licensing and Association Membership, which carry lower weights. The CR value of 0.046 is well below the generally accepted threshold of 0.10, confirming that the expert judgments are consistent. A low CR indicates that the derived weights accurately reflect the logical preferences of the experts, providing a reliable basis for subsequent scoring and ranking of vendor alternatives. For readers, Table 2 can be interpreted as follows: the Weight column shows the normalized importance of each criterion, while the Rank column indicates the relative

order. The consistency check (CR) validates that these weights are based on coherent and rational judgments, which is crucial before applying the weights in further AHP computations.

Table 3. Final Vendor Ranking

Vendor	Weighted Score	Rank
Vendor A	0.392	1
Vendor B	0.351	2
Vendor C	0.257	3

Source: Processed primary data, 2025

The Table 3 presents the final vendor ranking based on the weighted criteria derived from the AHP analysis. Vendor A achieved the highest weighted score of 0.392, followed by Vendor B (0.351) and Vendor C (0.257). This ranking demonstrates the significant influence of the priority weights assigned to each criterion, particularly the dominance of Experience and Certification. Vendor A's superior score reflects consistent performance across these critical factors, aligning with prior research that emphasizes the importance of vendor track record and service reliability (Ho et al., 2010; Kannan et al., 2014).

Certification, weighted as the second most important criterion, further differentiates vendors based on adherence to quality and HSE standards, consistent with findings from Nguyen et al. (2018). Meanwhile, Business Licensing and Association Membership—included to ensure compliance—exerted relatively minor influence, serving more as baseline requirements than differentiating factors.

These results illustrate a strategic shift for organizations operating in high-risk, compliance-driven industries, where decision-makers prioritize non-price criteria to ensure long-term operational reliability and risk mitigation. The low Consistency Ratio (CR = 0.046) confirms the reliability of the expert judgments, supporting the robustness of the AHP methodology in producing coherent and defensible rankings. For interpretation, the Weighted Score column shows the aggregated scores calculated from the product of criterion weights and vendor performance scores, while the Rank column translates these results into clear ordinal positions. This model enhances transparency, reduces subjectivity, and provides a structured decision-making framework aligned with organizational strategic objectives.

DISCUSSION

The results of this study provide strong evidence that a structured, criteria-based vendor evaluation framework can SIGNIFICANTLY improve decision-making in high-risk, compliance-driven industries such as oil and gas. The AHP analysis revealed that Experience is the most influential criterion, followed by Certification, Business Licensing, and Association Membership. This ordering is consistent with the theoretical premise that operational capability and safety compliance are critical determinants of vendor reliability, as highlighted in the literature (Ho, 2010). The dominance of Experience indicates that vendors with proven track records are perceived as better equipped to manage complex projects, mitigate operational risks, and maintain consistent service quality. Certification and HSE compliance, while slightly less influential than Experience, remain crucial because they provide assurance that vendors adhere to international standards and regulatory requirements. These findings align with (Abdel-Baset, 2019)and (Alkahtani, 2020), who emphasize that safety and quality certifications serve as essential risk-reduction tools in procurement decisions. Business Legality and Professional Association Membership received lower weights but still contribute to the overall evaluation as baseline compliance measures. This suggests that, although legal and professional affiliations are necessary for

accountability and legitimacy, they do not strongly differentiate vendor performance when technical competence and HSE compliance are satisfied. This finding contrasts with studies in lower-risk industries, where legal compliance or cost considerations often dominate the decision-making process (Govindan, 2020; Manupati, 2020). The final vendor ranking (Table 3) demonstrates the practical application of the AHP framework. Vendor A's superior score of 0.392 reflects high performance across Experience and Certification criteria, indicating alignment between theoretical importance and actual vendor capability. Vendor B, with a score of 0.351, shows competitive performance but slightly weaker alignment with the prioritized criteria. Vendor C's lower score (0.257) highlights gaps in meeting critical performance and compliance requirements. These results suggest that applying weighted, multi-criteria evaluation can effectively differentiate vendors, reducing subjectivity inherent in traditional administrative checks. From a strategic perspective, this study confirms that organizations operating in high-risk sectors increasingly value qualitative, non-price criteria over traditional cost-based metrics. The structured weighting of criteria through AHP ensures that decisions reflect both operational priorities and regulatory imperatives, promoting long-term sustainability and risk mitigation. By incorporating Experience, HSE Certification, Business Legality, and Association Membership, the proposed framework aligns vendor evaluation with Good Corporate Governance (GCG) principles and Sustainable Development Goals (SDGs). This integration addresses gaps identified in both the theoretical and practical contexts of vendor evaluation at PT. XYZ. Moreover, the low Consistency Ratio (CR = 0.046) demonstrates that expert judgments were logically coherent and reliable. This supports the robustness of the AHP methodology in producing actionable insights from subjective expert assessments. The combination of empirical data with structured expert evaluation reduces cognitive bias, enhances transparency, and ensures that the derived rankings are defensible for organizational decision-making. In comparison with prior studies that emphasize cost, quality, or delivery as dominant criteria (Abdel-Baset, 2019), the present findings underscore a paradigm shift toward safety, compliance, and experience-based evaluation in high-risk operational settings. The research provides empirical evidence that a multi-criteria approach not only aligns with strategic objectives but also strengthens procurement accountability and operational continuity. In conclusion, the discussion of the results demonstrates that the proposed AHP-based vendor evaluation model:

1. Effectively prioritizes critical selection criteria relevant to high-risk industries.
2. Differentiates vendors based on operational capability, safety compliance, and regulatory legitimacy.
3. Reduces subjectivity in decision-making while aligning vendor selection with organizational strategy and governance standards.
4. Provides a practical, scalable, and transparent framework applicable to similar contexts beyond PT. XYZ.

This study contributes to the literature by integrating technical experience, HSE certification, legal compliance, and professional affiliation into a single, structured evaluation model. It provides a theoretically grounded and practically implementable approach that advances both the scholarship and practice of vendor management in high-hazard and compliance-sensitive sectors.

CONCLUSION

This study successfully developed and validated a multi-criteria decision-making framework using the Analytic Hierarchy Process (AHP) to enhance transparency, objectivity, and compliance in office facility vendor selection. The application of the framework to PT. XYZ revealed that Experience is the most critical factor influencing vendor performance, followed by Certification, Business Licensing, and Professional Association Membership. The low Consistency Ratio (CR = 0.046) confirms that expert judgments were coherent and reliable, supporting the robustness of the AHP methodology in structuring complex procurement decisions. The results demonstrate that organizations operating in high-compliance and high-risk sectors, such as the energy industry, prioritize qualitative, operational, and compliance-related attributes over purely cost-based criteria. Vendors with proven experience and strong adherence to HSE standards are more likely to deliver reliable and sustainable services, whereas legal compliance and professional association membership serve as baseline requirements that reinforce accountability and credibility. By providing a structured and replicable evaluation process, the proposed

AHP model reduces subjectivity, enhances decision-making transparency, and aligns vendor selection with corporate governance principles and long-term operational objectives. The framework also allows organizations to integrate technical, regulatory, and sustainability considerations into a unified assessment, bridging gaps in conventional administrative-focused evaluations. In conclusion, this research contributes both theoretically and practically by offering a comprehensive, empirically validated tool for vendor selection in high-risk industries. Future studies could expand this model by incorporating additional sustainability, social, or financial performance indicators, and by testing the framework in other sectors to evaluate its generalizability and adaptability.

Suggestion

Building on the findings of this study, future applications of the proposed AHP-based vendor evaluation framework could expand its scope to incorporate cost-related and performance-based indicators, in addition to the existing technical, compliance, and sustainability criteria. Integrating such dimensions would allow organizations to evaluate vendors not only on reliability and regulatory adherence but also on competitiveness and efficiency, providing a more holistic view of vendor capability. Organizations implementing this framework are encouraged to customize the criteria and weighting scheme to reflect their specific operational realities. For example, changes in regulatory requirements, industry standards, or strategic priorities may necessitate updating the relative importance of experience, certification, and other factors. Tailoring the model ensures that the evaluation process remains relevant, aligned with organizational objectives, and responsive to evolving risk environments. Further research should apply and test the framework in other high-risk or compliance-driven sectors, such as healthcare, construction, or chemical processing, to assess its generalizability and adaptability. Comparative studies could refine the weighting and scoring mechanisms, evaluate the impact of adding additional qualitative or quantitative criteria, and explore integration with other multi-criteria decision-making tools (e.g., TOPSIS, VIKOR, or fuzzy AHP). Such investigations would strengthen the practical applicability of the model and contribute to developing robust, scalable, and transparent vendor evaluation systems across diverse procurement environments. By adopting these recommendations, organizations can enhance procurement decision-making, promote long-term operational sustainability, and maintain alignment with corporate governance and risk management principles.

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