International Journal of Academic Management Science Research (IJAMSR)
ISSN: 2643-900X
Vol. 10 Issue 1 January - 2026, Pages: 72-84

Strategic Bidder List Selection in EPC Procurement: Integrating the Kraljic Matrix, TOPSIS, and Supplier Relationship Management

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Abstract: *Procurement and supplier selection play a critical role in determining cost, schedule, and quality performance in large-scale Engineering, Procurement, and Construction projects. However, many organizations continue to rely on uniform, price-based, or experience-driven approaches that fail to account for product heterogeneity and supply risk. This study aims to develop and apply an integrated decision-support framework for bidder list selection that aligns supplier evaluation with strategic procurement objectives. The research adopts a case study approach within a large EPC project. Products are classified using the Kraljic Matrix; supplier evaluation criteria are determined through expert judgment, and suppliers are ranked using the Technique for Order Preference by Similarity to Ideal Solution. The resulting rankings are interpreted through a Supplier Relationship Management perspective to derive appropriate procurement strategies. The results show that evaluation criteria weights differ markedly across strategic, leverage, bottleneck, and non-critical product categories. TOPSIS-based rankings reveal substantial differences from traditional decision-making outcomes, particularly for high-risk items, and provide greater transparency and consistency. The findings also demonstrate clear patterns in supplier performance across product categories and show how ranking results can be systematically translated into differentiated supplier relationship strategies. The study concludes that integrating procurement portfolio models, quantitative decision-making, and relationship management significantly improves bidder list selection and procurement governance in EPC projects. The proposed framework contributes to both theory and practice by offering a structured, strategy-aligned approach to managing supplier selection in complex project environments.*

Keywords—Strategic Procurement; Supplier Selection; Kraljic Matrix; TOPSIS; Supplier Relationship Management; EPC Projects

1. INTRODUCTION

Large-scale Engineering, Procurement, and Construction (EPC) projects play a pivotal role in delivering critical infrastructure and industrial facilities, particularly in sectors such as energy, petrochemicals, transportation, and utilities. These projects are inherently complex, capital-intensive, and highly interdependent, involving multiple stakeholders, extended supply chains, and strict performance requirements. Within this context, procurement activities—and particularly supplier selection—have been repeatedly identified as a decisive factor influencing project success. Prior studies emphasize that suppliers are not merely sources of materials and equipment, but strategic partners whose performance directly affects project cost efficiency, schedule reliability, and quality compliance (Chopra & Meindl, 2019; Lysons & Farrington, 2020). As EPC projects increasingly operate under conditions of uncertainty, global sourcing, and technological specialization, the strategic importance of supplier selection continues to grow.

Recent literature in construction and project-based supply chain management further underscores that procurement failures remain a dominant cause of project underperformance. Cost overruns, schedule delays, and quality deviations are frequently traced back to inadequate supplier capability assessment, weak coordination, and poor risk allocation during procurement stages (Flyvbjerg, 2017; Jama & Mohamud, 2024). Surveys and empirical studies show that even when engineering and project management capabilities are strong, weaknesses in procurement decision-making can undermine overall project outcomes. This has prompted growing scholarly interest in procurement strategies that move beyond transactional purchasing toward more structured, analytical, and strategic approaches to supplier evaluation and selection.

Despite this recognition, EPC supply chains continue to face persistent and well-documented procurement challenges. These include high supply risk due to limited qualified suppliers for specialized equipment, long manufacturing and logistics lead times, information asymmetry between buyers and suppliers, and coordination difficulties across engineering, procurement, and construction functions (Vrijhoef & Koskela, 2000; O'Brien et al., 2009). In addition, EPC projects are often executed in volatile environments characterized by design changes, regulatory uncertainty, geopolitical risks, and fluctuating market conditions. Such challenges amplify the consequences of procurement decisions and render simplistic or uniform supplier selection approaches increasingly inadequate.

A central research problem in this context is the continued reliance on traditional price- or experience-based supplier selection practices in high-risk, high-complexity procurement environments. Price-focused approaches prioritize the lowest initial cost while neglecting critical dimensions such as delivery reliability, technical capability, financial stability, and risk exposure. Experience-based approaches, although valuable, depend heavily on subjective judgment and historical familiarity, making them vulnerable to bias, inconsistency, and limited transparency. Prior studies argue that these approaches are ill-suited to EPC projects, where procurement decisions must balance multiple conflicting objectives and where supplier underperformance can generate substantial downstream costs (Hartmann et al., 2009; Tavana et al., 2017).

In response to these challenges, the literature broadly converges on the need for more structured and strategic procurement solutions. Scholars advocate adopting formal decision-support frameworks that integrate multiple evaluation criteria, align procurement decisions with project strategy, and enhance decision transparency and repeatability (Ho et al., 2010). Such frameworks are expected to reduce procurement risk, improve tender outcomes, and support consistent decision-making across projects. However, while the general direction of these solutions is well established, their practical implementation in EPC settings remains uneven and fragmented.

One stream of research proposes using procurement portfolio models to address the heterogeneity of purchased items. The Kraljic Matrix, in particular, has been widely cited as a strategic tool for classifying products based on supply risk and profit impact, thereby differentiating sourcing strategies for strategic, leverage, bottleneck, and non-critical items (Kraljic, 1983). Subsequent studies suggest that applying differentiated procurement strategies by product category can significantly improve resource allocation, risk management, and supplier relationships. However, many applications of the Kraljic Matrix remain largely qualitative, offering limited guidance on systematically evaluating and ranking suppliers within each category.

Another prominent body of literature focuses on Multi-Criteria Decision-Making (MCDM) methods as tools for supplier selection. Techniques such as the Analytic Hierarchy Process (AHP), Analytic Network Process (ANP), ELECTRE, and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) have been extensively applied to capture the multi-dimensional nature of supplier evaluation (Ho et al., 2010; Govindan et al., 2015). Among these, TOPSIS is frequently favored for its computational simplicity, intuitive logic, and ability to handle numerous criteria. Prior studies demonstrate that MCDM-based approaches outperform traditional methods by explicitly modeling trade-offs among cost, quality, delivery, and risk-related criteria. Nevertheless, many of these studies treat supplier selection as a standalone decision problem, insufficiently linked to broader procurement strategy.

A related stream of research emphasizes Supplier Relationship Management (SRM) as a mechanism for translating supplier evaluation results into actionable procurement strategies. SRM literature highlights that different categories of suppliers require different levels of relationship intensity, ranging from transactional arrangements to long-term strategic partnerships (Cousins et al., 2008). Integrating supplier evaluation with SRM enables organizations not only to select the “best” supplier but also to define appropriate governance, collaboration, and risk-sharing mechanisms. However, empirical studies that jointly integrate procurement portfolio models, quantitative supplier ranking, and SRM—particularly in EPC contexts—remain limited.

Taken together, the reviewed literature reveals a clear research gap. While prior studies acknowledge the influence of supplier selection on project performance, identify procurement challenges in EPC supply chains, and propose various analytical tools and strategic frameworks, few studies integrate these elements into a coherent and operational decision-support approach. Specifically, there is limited empirical evidence on how product heterogeneity, as conceptualized by the Kraljic Matrix, can be systematically combined with MCDM methods such as TOPSIS to support bidder list selection at the pre-tender stage, and how the resulting rankings can be aligned with SRM strategies in large EPC projects.

Against this backdrop, the present study aims to address this gap by developing and applying an integrated procurement decision framework that combines the Kraljic Matrix, TOPSIS, and Supplier Relationship Management in an EPC project environment. The study seeks to demonstrate how differentiated evaluation criteria and weights across product categories can improve bidder list selection, enhance tender quality, and reduce procurement risk. The novelty of this study lies in its focus on bidder list selection rather than post-tender supplier evaluation, its explicit treatment of product heterogeneity, and its integration of quantitative ranking results with strategic supplier relationship decisions. The scope of the study is confined to a real EPC project context, providing practical insights while advancing the strategic procurement and supplier selection literature.

2. RELATED WORK

2.1 Supplier Selection Criteria and Decision Frameworks in Supply Chain Management

Supplier selection has long been recognized as a critical decision in Supply Chain Management (SCM), evolving from a narrow focus on price toward a multidimensional evaluation of supplier performance. Early studies primarily emphasized cost, delivery, and quality as dominant criteria, reflecting transactional purchasing logics. However, as supply chains became more global, complex, and risk-prone, the literature expanded to include criteria such as flexibility, technological capability, financial stability, sustainability, and risk

International Journal of Academic Management Science Research (IJAMSR)
ISSN: 2643-900X
Vol. 10 Issue 1 January - 2026, Pages: 72-84

management (Chopra & Meindl, 2019; Lysons & Farrington, 2020). Contemporary SCM research increasingly frames supplier selection as a strategic decision that directly influences organizational competitiveness and project performance, particularly in project-based and capital-intensive industries. This evolution highlights a shift from operational efficiency to strategic alignment. Yet, it also introduces methodological challenges due to the growing number of criteria and the inherent trade-offs among them.

2.2 Empirical Applications of the Kraljic Matrix in Procurement Strategy

The Kraljic Matrix has been widely adopted as a foundational framework for strategic procurement and supplier portfolio management since its introduction (Kraljic, 1983). Empirical studies apply the matrix to classify purchased items into Strategic, Leverage, Bottleneck, and Non-Critical categories based on supply risk and profit impact, thereby informing differentiated sourcing strategies. Subsequent research demonstrates that portfolio-based procurement improves risk awareness, resource allocation, and prioritization of supplier relationships. However, several limitations are consistently reported. Many applications rely on qualitative judgment or simplified scoring to position items within the matrix, leading to subjectivity and limited reproducibility. Moreover, while the Kraljic Matrix effectively differentiates procurement strategies at the product level, it provides little guidance on how to evaluate and rank suppliers within each quadrant. As a result, the matrix is often used as a descriptive or diagnostic tool rather than an operational decision-support mechanism.

2.3 Multi-Criteria Decision-Making Methods for Supplier Evaluation

To address the multi-dimensional nature of supplier selection, a substantial body of literature applies Multi-Criteria Decision-Making (MCDM) methods. Techniques such as the Analytic Hierarchy Process (AHP), Analytic Network Process (ANP), ELECTRE, and TOPSIS are among the most frequently employed (Ho et al., 2010). AHP is valued for its structured pairwise comparison process but is criticized for scalability issues and potential inconsistency in judgments. ANP extends AHP by capturing interdependencies among criteria, though at the cost of increased complexity. ELECTRE methods are effective in handling outranking relationships but are often perceived as less intuitive for practitioners. TOPSIS, by contrast, is widely adopted due to its computational simplicity, clear logic based on ideal and negative-ideal solutions, and ease of interpretation. Nevertheless, TOPSIS is sensitive to the choice of criteria weighting and normalization methods, which can affect ranking stability. Overall, MCDM methods offer robust analytical support but require careful methodological design to ensure validity and managerial acceptance.

2.4 Integrating Procurement Portfolio Models with Quantitative Decision-Support Tools

Recognizing the complementary strengths of procurement portfolio models and MCDM techniques (Khulud et al., 2023), several studies attempt to integrate these approaches. Portfolio models such as the Kraljic Matrix provide strategic differentiation (Kraljic, 1983; Saputro et al., 2022), while MCDM methods enable systematic supplier ranking. Empirical research shows that such integration enhances decision quality by aligning evaluation criteria with product-specific strategies and reducing reliance on uniform assessment frameworks. However, existing studies often focus on post-tender supplier selection rather than earlier stages of procurement, such as bidder list formation. In addition, many integrated models remain conceptual or are validated through hypothetical examples rather than real project data, limiting their practical relevance. These gaps suggest the need for empirically grounded frameworks that operationalize integration across different procurement stages (Zuhar & Parthiban, 2014).

2.5 Supplier Relationship Management and Strategic Procurement Outcomes

Supplier Relationship Management (SRM) literature emphasizes that supplier selection outcomes should inform long-term relationship strategies rather than isolated transactional decisions. SRM frameworks distinguish between transactional, collaborative, and strategic partnership relationships, arguing that relationship intensity should correspond to supplier criticality and supply risk (Cousins et al., 2008). Empirical studies indicate that effective SRM contributes to improved innovation, risk mitigation, and performance stability, particularly for strategic and bottleneck items. However, SRM effectiveness depends heavily on the quality of initial supplier evaluation and segmentation. While several studies conceptually link SRM with procurement portfolios, fewer provide quantitative mechanisms for translating supplier rankings into actionable relationship strategies. This disconnect underscores the importance of integrating SRM considerations directly into supplier selection and evaluation processes.

2.6 Synthesis and Research Gap

The reviewed literature establishes a substantial body of knowledge on supplier selection criteria, strategic procurement frameworks, multi-criteria decision-making (MCDM) methodologies, and supplier relationship management (SRM). However, despite these advances, important limitations remain in operational integration and empirical validation, particularly in EPC and other project-based environments. Existing studies tend to adopt either strategic portfolio classifications without sufficient quantitative rigor or advanced decision-support models that are applied in isolation from procurement strategy and relationship considerations. In addition, bidder list selection—an early and critical pre-tender decision point that shapes competition quality and downstream project outcomes—has received limited scholarly attention.

Against this backdrop, the present study seeks to bridge these gaps by integrating the Kraljic Matrix, TOPSIS, and SRM into a coherent and empirically grounded framework for pre-tender bidder list selection. By explicitly linking strategic product classification with category-specific quantitative evaluation and relationship-oriented decision logic, the proposed framework advances both theoretical understanding and practical implementation of strategic procurement in EPC projects.

To position this contribution within the existing body of research, Table 1 provides a comparative overview of selected studies that apply portfolio models and MCDM techniques in supplier selection and procurement decision-making. The table contrasts key methodological dimensions, including the use of portfolio frameworks, the adopted MCDM methods, the procurement stage addressed, and the nature of the empirical data employed. As summarized in Table 1, prior studies predominantly focus on post-tender supplier evaluation or rely on hypothetical examples and survey-based data. In contrast, this study applies a Kraljic-based MCDM framework at the pre-tender stage to develop a bidder list, drawing on empirical data from a real EPC project. This distinction highlights the methodological rigor and practical relevance that differentiate the present research from existing studies.

Table 1 Comparison of Portfolio Models, MCDM Methods, Procurement Stages, and Empirical Evidence in Supplier Selection Studies

Author	Portfolio Model	MCDM Method	Procurement Stage	Empirical Data
Tavana et al. (2016)	Kraljic	AHP	Post-tender	Hypothetical
Ho et al. (2010)	–	TOPSIS	Supplier selection	Survey
This study	**Kraljic**	**MCDM**	**Pre-tender (Bidder list)**	**Real EPC project**

3. Research Methodologies

3.1 Research Design and Methodological Rationale

This study adopts a case study research design to investigate bidder list selection in a large-scale Engineering, Procurement, and Construction (EPC) project. The case study approach is widely recognized as an appropriate methodology for examining complex decision-making processes embedded in real organizational contexts, particularly when the boundaries between the phenomenon and its environment are not clearly defined (Yin, 2018). In project-based industries such as EPC, procurement decisions are highly contextual, shaped by project characteristics, organizational practices, market conditions, and stakeholder interactions. Prior methodological literature emphasizes that case studies enable in-depth exploration of such complexity, allowing researchers to capture causal mechanisms, decision rationales, and contextual contingencies that are often inaccessible through survey-based or purely quantitative methods (Dubois & Pedersen, 2002).

In the field of procurement and supplier selection, case study research has been extensively used to analyze strategic sourcing practices, supplier portfolio management, and the implementation of decision-support tools. This approach is particularly appropriate when the objective is not statistical generalization but analytical generalization, whereby theoretical insights and decision frameworks are refined and extended through empirical observation. Accordingly, the present study employs a single, information-rich EPC project as its empirical setting. Such an in-depth case enables the development and demonstration of an integrated procurement decision framework that combines strategic classification, quantitative evaluation, and relationship management (Flyvbjerg, 2006; Eisenhardt & Graebner, 2007; Pagell & Wu, 2009; de Boer et al., 2001).

Building on this methodological foundation, the study addresses the limitations of uniform and post-tender-oriented supplier evaluation practices by proposing an integrated decision framework for bidder list selection at the pre-tender stage. The framework combines strategic product classification, multi-criteria supplier evaluation, and empirical performance data to support context-sensitive procurement decisions in EPC projects. By explicitly linking procurement strategy with quantitative decision-support tools, the framework ensures that supplier assessment criteria and evaluation priorities are aligned with the strategic characteristics of different procurement items.

As illustrated in Figure 1, the proposed framework integrates multiple data sources, including historical supplier performance records and expert judgment. Procurement items are first classified using the Kraljic Matrix to differentiate strategic priorities across product categories. Subsequently, category-specific evaluation criteria are weighted using expert-based MCDM techniques, and suppliers are assessed quantitatively through TOPSIS analysis. The resulting rankings are then used to inform bidder list selection decisions tailored to each Kraljic quadrant, enabling more targeted risk management and strategic supplier engagement at the pre-tender stage.

International Journal of Academic Management Science Research (IJAMSR)
ISSN: 2643-900X
Vol. 10 Issue 1 January - 2026, Pages: 72-84

3.2 Case Study Context and Unit of Analysis

The empirical setting of this research is an EPC project executed by Industrial Engineering Solutions Ltd., a major Indonesian engineering and construction company with extensive experience in energy and industrial infrastructure projects. The project under study involves complex procurement requirements, including high-value engineered equipment, standardized materials, and components with varying degrees of supply risk and technical complexity. Procurement activities are carried out under strict cost, schedule, and quality constraints, making supplier selection a critical determinant of project performance.

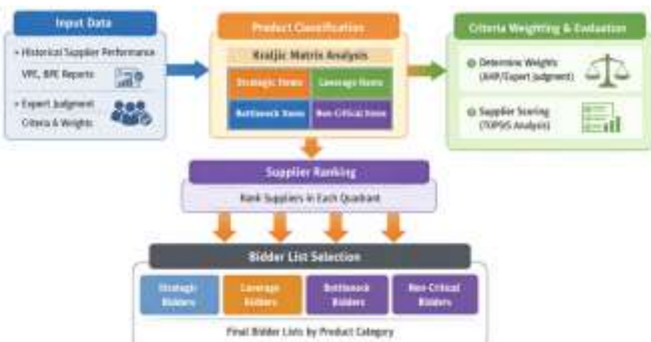

Figure 1 Conceptual Framework Integrating the Kraljic Matrix and MCDM Techniques for Bidder List Selection

The primary unit of analysis is the bidder list selection process at the pre-tender stage. Unlike post-tender supplier selection, which evaluates bids after submission, bidder list selection determines which suppliers are invited to participate in the tender. This stage functions as an initial risk-filtering mechanism and has significant implications for competition quality, tender efficiency, and downstream project outcomes. By focusing on this stage, the study addresses a relatively underexplored but strategically important procurement decision point.

3.3 Data Sources and Data Collection

Multiple data sources are used to enhance construct validity through triangulation (Yin, 2018). First, archival procurement data are collected from company records, including historical Vendor Performance Evaluation (VPE) and Bidder Performance Evaluation (BPE) reports covering multiple years of project execution (Kannan & Tan, 2002). These records provide objective information on supplier performance related to cost compliance, delivery reliability, quality conformity, and contractual performance.

Second, expert judgment data are obtained through structured questionnaires distributed to senior procurement managers and subject-matter experts within the organization. The use of expert judgment is well established in Multi-Criteria Decision-Making (MCDM) studies, particularly when quantitative performance data alone are insufficient to capture strategic priorities or risk perceptions (De Boer et al., 2001). Respondents are selected based on their experience in EPC procurement, familiarity with supplier markets, and involvement in strategic sourcing decisions.

Third, semi-formal discussions and internal documentation support product classification and the contextual interpretation of results. While these qualitative inputs are not directly modeled, they inform the interpretation of findings and ensure alignment with organizational practice (Ho et al., 2010).

3.4 Product Classification Using the Kraljic Matrix

Building on the triangulated data sources described above, the study employs the Kraljic Matrix as a strategic procurement portfolio model to account for product heterogeneity. Purchased items are classified along two dimensions: supply risk and profit impact. Supply risk reflects factors such as supplier availability, technological complexity, and market volatility, while profit impact captures the financial and operational consequences of procurement failure for the EPC project.

Based on these dimensions, procurement items are categorized into four quadrants: Strategic, Leverage, Bottleneck, and Non-Critical. In this study, representative products from each quadrant are selected to demonstrate the applicability of the proposed integrated decision framework. The classification process relies on managerial assessment supported by archival procurement data and internal documentation, consistent with prior empirical applications of the Kraljic Matrix. By differentiating products according to their strategic characteristics, this step ensures that subsequent supplier evaluation and bidder list selection reflect category-specific priorities rather than a uniform assessment logic.

To provide transparency regarding the empirical basis of the analysis, Table 2 summarizes the data sources used in this research, including archival procurement records, expert judgment obtained through structured questionnaires, and supporting qualitative documentation. Each data source serves a distinct analytical role within the integrated framework, collectively supporting product classification, criteria weighting, supplier evaluation, and the interpretation of results in alignment with actual procurement practices.

3.5 Identification of Supplier Evaluation Criteria

Identifying appropriate evaluation criteria for suppliers is a critical step in developing a robust and context-sensitive framework for bidder list selection. In EPC procurement, supplier performance cannot be adequately assessed using a single dimension, as procurement outcomes are shaped by both suppliers' historical execution performance and their behavior during the tendering process. Accordingly, this study derives its supplier evaluation criteria from two complementary organizational evaluation systems: Vendor Performance Evaluation (VPE) and Bidder Performance Evaluation (BPE).

The VPE system captures suppliers' ex-post performance during project execution, including cost compliance, delivery performance, quality conformity, safety performance, financial stability, and contractual compliance. In contrast, the BPE system reflects suppliers' ex-ante capabilities and tendering behavior, encompassing criteria such as technical capability, commercial competitiveness, bid responsiveness, and tender discipline. Drawing on the supply chain management and supplier selection literature, these criteria are reviewed to ensure conceptual completeness and relevance to the specific requirements of EPC projects.

Table 2 Overview of Data Sources and Their Roles in the Integrated Procurement Decision Framework

Data Source	Type of Data	Description	Purpose in the Study
Vendor Performance Evaluation (VPE)	Archival, quantitative	Historical vendor performance records maintained by the company, covering multiple years of EPC project execution. Key indicators include cost compliance, delivery reliability, quality conformity, safety performance, and contractual adherence.	To provide objective and longitudinal evidence of supplier performance used as input data in the supplier evaluation matrix and TOPSIS analysis.
Bidder Performance Evaluation (BPE)	Archival, quantitative	Evaluation records of suppliers' performance during previous tendering processes, including bid responsiveness, technical compliance, commercial competitiveness, and tender discipline.	To complement VPE data by capturing suppliers' behavior and performance at the tendering stage, supporting bidder list selection decisions.
Expert Judgment	Primary, qualitative–quantitative	Structured questionnaire responses from senior procurement managers and subject-matter experts with extensive experience in EPC procurement and supplier management.	To determine evaluation criteria relevance and weights for each Kraljic Matrix quadrant in the MCDM (TOPSIS) model.
Internal Documents and Semi-Formal Discussions	Qualitative	Internal procurement guidelines, classification documents, and semi-formal discussions with procurement personnel regarding product characteristics and sourcing practices.	To support product classification using the Kraljic Matrix and to provide contextual interpretation of analytical results, ensuring alignment with organizational practice.

Importantly, the framework does not assume that the same set of evaluation criteria carries equal importance across all procurement categories. Instead, the relevance and emphasis of individual criteria are allowed to vary across Kraljic Matrix quadrants, reflecting differences in supply risk and strategic importance. This differentiation is consistent with prior research advocating context-specific and strategy-driven supplier evaluation rather than uniform assessment approaches.

By integrating VPE- and BPE-based criteria, the proposed framework enables a balanced assessment of supplier reliability, technical competence, commercial competitiveness, and contractual discipline. This dual-perspective approach supports a more comprehensive evaluation at the pre-tender stage, where both past performance and anticipated tender performance are critical to bidder list decisions. Table 3 presents the complete set of supplier evaluation criteria used in this study, together with their corresponding data sources and operational definitions.

Table 3 Supplier Evaluation Criteria Derived from Vendor Performance Evaluation (VPE) and Bidder Performance Evaluation (BPE)

Code	Evaluation Dimension	Criteria	Data Source	Description
VPE1	Cost Performance	Cost compliance	VPE	The degree to which suppliers meet contractual cost targets and avoid cost overruns during project execution.
VPE2	Delivery Performance	Delivery reliability	VPE	Supplier's ability to deliver goods and services according to the agreed schedule and milestones.

VPE3	Quality Performance	Quality conformity	VPE	Conformance of delivered products or services to technical specifications and quality standards.
VPE4	Contractual Performance	Contract compliance	VPE	Adherence to contractual obligations, including documentation, reporting, and change management procedures.
VPE5	HSE Performance	Health, safety, and environment (HSE) compliance	VPE	Supplier performance related to safety practices, environmental compliance, and incident prevention.
BPE1	Technical Capability	Technical compliance	BPE	The degree to which the bidder's technical proposal meets tender specifications and performance requirements.
BPE2	Commercial Capability	Commercial competitiveness	BPE	Competitiveness of the bid in terms of pricing structure, payment terms, and commercial conditions.
BPE3	Tender Management	Bid responsiveness	BPE	Timeliness, completeness, and clarity of bid submissions during the tendering process.
BPE4	Organizational Capability	Resource adequacy	BPE	Availability and adequacy of human resources, equipment, and organizational capacity to execute the scope of work.
BPE5	Risk & Reliability	Past tender performance	BPE	Historical reliability of the bidder in previous tenders, including withdrawal behavior, bid consistency, and commitment.

3.6 Criteria Weighting Using Expert Judgment

Criteria weights in this study are determined using expert judgment elicited through structured managerial surveys. Respondents, comprising experienced procurement managers and subject-matter experts, are asked to assess the relative importance of each evaluation criterion across different product categories, typically using numerical rating or ranking scales. The use of managerial surveys for weight elicitation is well established in MCDM-based supplier selection research, particularly when strategic considerations and risk perceptions must be explicitly incorporated into the evaluation process.

The individual responses are subsequently aggregated to obtain representative criterion weights for each Kraljic Matrix quadrant. Aggregation procedures are applied to mitigate individual bias while preserving collective managerial priorities and organizational strategic intent. As a result, the derived weights reflect expert knowledge and practical procurement experience rather than purely theoretical assumptions.

Given that procurement items differ substantially in terms of supply risk and strategic importance, the relative importance of supplier evaluation criteria cannot be assumed to be uniform across procurement categories. Consistent with the logic of the Kraljic Matrix, this study assigns differentiated weights to reflect the distinct strategic priorities associated with non-critical, leverage, bottleneck, and strategic items. This differentiation enables the bidder list selection process to be aligned with product-specific procurement strategies, avoiding a one-size-fits-all evaluation approach.

By applying category-specific weights, the proposed framework enhances the relevance of decisions and improves the sensitivity of the MCDM analysis to contextual procurement requirements. Table 4 presents the resulting criteria weights for each Kraljic quadrant, which serve as key inputs for the subsequent TOPSIS-based supplier evaluation.

Table 4 Criteria Weights Across Kraljic Matrix Quadrants

Criteria Code	Evaluation Criteria	Non-Critical Items	Leverage Items	Bottleneck Items	Strategic Items
VPE1	Cost compliance	0.30	0.35	0.10	0.10
VPE2	Delivery reliability	0.20	0.15	0.30	0.25
VPE3	Quality conformity	0.20	0.20	0.25	0.30
VPE4	Contract compliance	0.10	0.10	0.15	0.15
VPE5	HSE compliance	0.05	0.05	0.10	0.10
BPE1	Technical compliance	0.05	0.05	0.05	0.05
BPE2	Commercial	0.05	0.05	0.03	0.02

International Journal of Academic Management Science Research (IJAMSR)
ISSN: 2643-900X
Vol. 10 Issue 1 January - 2026, Pages: 72-84

	competitiveness				
BPE3	Bid responsiveness	0.03	0.03	0.01	0.01
BPE4	Resource adequacy	0.01	0.01	0.01	0.01
BPE5	Past tender performance	0.01	0.01	0.00	0.01
Total		**1.00**	**1.00**	**1.00**	**1.00**

3.7 Application of the TOPSIS Method

The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is employed to rank suppliers within each product category. TOPSIS is selected due to its methodological transparency, computational efficiency, and suitability for real-world decision-making environments. The method is based on the principle that the optimal alternative should have the shortest distance to the positive ideal solution and the most significant distance to the negative ideal solution.

The application of TOPSIS follows established best practices. First, a decision matrix is constructed using supplier performance data for each criterion. Second, the matrix is normalized to eliminate scale effects. Third, normalized values are multiplied by the corresponding criteria weights to produce a weighted normalized matrix. Fourth, positive and negative ideal solutions are identified based on benefit and cost criteria. Fifth, Euclidean distances from the perfect solutions are calculated for each supplier. Finally, a relative closeness coefficient is computed and used to generate supplier rankings.

To enhance robustness, the TOPSIS analysis is conducted separately for each product category, ensuring that rankings reflect quadrant-specific priorities. This approach avoids distortions that may arise from aggregating heterogeneous products into a single evaluation model.

3.8 Integration with Bidder List Selection

The resulting TOPSIS rankings are used to support bidder list selection decisions. Rather than selecting a single supplier, the framework identifies a prioritized set of suppliers deemed suitable for tender participation. This reflects practical procurement practice in EPC projects, where competitive tendering among pre-qualified suppliers is preferred. The rankings provide an objective and transparent basis for inclusion or exclusion decisions, thereby reducing reliance on informal judgment.

3.9 Conceptual Model

The conceptual model of this study integrates strategic procurement theory with quantitative decision-support methods. The core variables of the model consist of product characteristics, supplier evaluation criteria, criteria weights, supplier performance scores, and procurement strategy outcomes.

Product characteristics, captured through the Kraljic Matrix dimensions of supply risk and profit impact, determine the classification of items into procurement categories. This classification influences the selection and weighting of supplier evaluation criteria. Supplier performance data, combined with criteria weights, serve as inputs to the TOPSIS method, producing ranked supplier alternatives. The model's output supports bidder list selection and informs Supplier Relationship Management (SRM) strategies, ranging from transactional relationships to strategic partnerships.

By linking product heterogeneity, quantitative supplier ranking, and relationship strategy, the conceptual model provides a coherent framework for the strategic selection of bidder lists in EPC projects. This integrated approach addresses methodological gaps identified in prior research and offers a structured pathway from procurement strategy formulation to operational decision-making.

4. Results and Discussion

4.1 Overview of the Analytical Results

This chapter presents and discusses the results of the integrated procurement decision framework developed in this study. The analysis combines product classification using the Kraljic Matrix, criteria weighting based on expert judgment, supplier ranking using the TOPSIS method, and interpretation of results through a Supplier Relationship Management (SRM) lens. The results are organized to progressively demonstrate how differentiated procurement strategies influence supplier evaluation outcomes and managerial decision-making in the context of an EPC project. Consistent with prior literature, the findings confirm that supplier selection outcomes are susceptible to product characteristics, evaluation priorities, and the decision framework applied (Ho et al., 2010; Chopra & Meindl, 2016).

The results are based on four representative product categories corresponding to the four Kraljic Matrix quadrants: Strategic, Leverage, Bottleneck, and Non-Critical items. For each category, criteria weights, TOPSIS rankings, and managerial implications are analyzed. The discussion integrates empirical findings with existing literature to highlight theoretical and practical insights.

4.2 Differences in Supplier Evaluation Criteria Weights Across Kraljic Quadrants

The first significant result concerns the variation in the weights of supplier evaluation criteria across the Kraljic Matrix quadrants. Consistent with procurement portfolio

International Journal of Academic Management Science Research (IJAMSR)
ISSN: 2643-900X
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theory (Kraljic, 1983), the expert-derived weights reveal clear differentiation in managerial priorities across product categories, reflecting differences in supply risk and strategic importance.

For Strategic items, criteria related to technical capability, quality performance, delivery reliability, and financial stability receive the highest weights. Price competitiveness, while still relevant, is clearly subordinated to long-term performance and risk mitigation considerations. This finding aligns with empirical studies indicating that failures in strategic equipment procurement can lead to disproportionate project delays and cost overruns (Flyvbjerg, 2017). The strong emphasis on reliability and capability underscores the combined effect of high supply risk and high profit impact associated with this category.

In contrast, Leverage items exhibit a markedly different weighting structure. Price and commercial competitiveness emerge as the dominant criteria, with delivery performance and quality compliance supporting them. Given the relatively low supply risk and the availability of multiple qualified suppliers, procurement managers prioritize cost optimization and competitive tendering. This pattern is consistent with prior empirical evidence on leveraging sourcing strategies to achieve cost efficiency (Lysons & Farrington, 2020).

For Bottleneck items, delivery reliability and supplier responsiveness receive the highest weights, followed by quality consistency. Although the financial impact of these items is moderate, supply risk remains high due to limited supplier availability or specialized requirements. The results suggest that procurement managers are willing to accept higher prices in exchange for assured availability, thereby confirming earlier findings on risk-driven procurement behavior (O'Brien et al., 2009).

Finally, Non-Critical items are primarily evaluated based on criteria related to administrative efficiency, lead time, and ease of procurement. Price remains relevant but is balanced against transaction cost considerations. This weighting structure reflects a strategic intent to minimize managerial effort and processing costs, consistent with the supply chain management literature, which advocates simplified procurement processes for low-risk, low-impact items (Chopra & Meindl, 2019).

Table 5 Comparative Distribution of Criteria Weights Across Kraljic Matrix Quadrants

Evaluation Dimension	Criteria Included	Non-Critical Items	Leverage Items	Bottleneck Items	Strategic Items
Cost Performance	Cost compliance (VPE1), Commercial competitiveness (BPE2)	**0.35**	**0.40**	0.13	0.12
Delivery Performance	Delivery reliability (VPE2), Bid responsiveness (BPE3)	0.23	0.18	**0.31**	0.26
Quality & Technical Performance	Quality conformity (VPE3), Technical compliance (BPE1)	0.25	0.25	0.30	**0.35**
Contractual & Organizational Capability	Contract compliance (VPE4), Resource adequacy (BPE4)	0.11	0.11	0.16	0.16
HSE & Reliability Risk	HSE compliance (VPE5), Past tender performance (BPE5)	0.06	0.06	**0.10**	0.11
Total		**1.00**	**1.00**	**1.00**	**1.00**

Taken together, these findings empirically demonstrate that supplier evaluation criteria weights differ substantially across Kraljic quadrants, reinforcing the argument that uniform evaluation frameworks are strategically misaligned in heterogeneous procurement environments. To further illustrate this differentiation, the study compares the distribution of aggregated criteria weights across product categories. Rather than applying a uniform weighting scheme, the proposed framework explicitly captures the shift in evaluation emphasis from cost efficiency in low-risk categories to delivery reliability, quality assurance, and risk mitigation in higher-risk and strategically critical items. Table 5 presents the aggregated criteria weight distributions by evaluation dimension across the four Kraljic quadrants, providing a clear illustration of how procurement priorities are operationalized within the integrated decision framework.

4.3 TOPSIS-Based Supplier Rankings Across Product Categories

Applying the TOPSIS method with quadrant-specific criteria weights produces distinct supplier rankings across product categories. The results clearly indicate that suppliers performing well in one Kraljic quadrant do not necessarily achieve high rankings in others, underscoring the importance of context-specific evaluation in EPC procurement.

For Strategic items, TOPSIS rankings consistently favor suppliers with strong historical performance in quality assurance, delivery reliability, and technical capability, even when their offered prices exceed the category average. This outcome contrasts with traditional price-dominated decision-making approaches, which tend to prioritize lower-cost suppliers regardless of performance risks. By explicitly modeling trade-offs among multiple criteria, TOPSIS provides a more balanced and strategically aligned assessment, consistent with recommendations in the MCDM literature (Ho et al., 2010; Govindan et al., 2015).

In the case of Leverage items, the resulting rankings largely align with price-based expectations, reflecting the relatively low supply risk and competitive supplier market. However, TOPSIS still differentiates among suppliers by incorporating non-price criteria such as delivery performance and quality compliance. Suppliers offering the lowest prices but exhibiting marginal reliability are ranked below those with slightly higher prices but superior performance, demonstrating that cost considerations are embedded within a broader performance context rather than treated in isolation.

For Bottleneck items, TOPSIS rankings diverge most strongly from conventional procurement judgments. Suppliers characterized by limited capacity but proven responsiveness and delivery consistency rank higher than those offering more attractive commercial terms but weaker reliability. This finding highlights the method’s ability to elevate risk-related considerations that are often underweighted in informal or experience-based decision processes, particularly in high-risk supply environments.

In the Non-Critical category, TOPSIS rankings show relatively limited performance dispersion among suppliers, reflecting the standardized, low-risk nature of these products. Nevertheless, suppliers with efficient administrative processes and consistent lead times achieve higher rankings, reinforcing the importance of transaction efficiency and process simplicity for low-impact procurement items.

Overall, the results demonstrate that TOPSIS-based rankings enhance transparency, consistency, and analytical rigor compared to ad hoc or intuition-driven decision-making. Across all procurement categories, the method enables systematic comparison of suppliers while preserving sensitivity to category-specific strategic priorities, thereby supporting prior empirical findings that MCDM approaches improve the robustness and defensibility of supplier selection decisions (Tavana et al., 2016).

To operationalize the proposed integrated decision framework, suppliers are evaluated separately within each Kraljic quadrant using TOPSIS with differentiated criteria weights. This category-specific analysis is particularly relevant at the pre-tender stage, where the objective is to identify an appropriate pool of bidders rather than to select a single winning supplier. By aligning evaluation logic with procurement strategy, the framework supports more informed and targeted development of the bidder list.

The resulting supplier rankings and TOPSIS closeness coefficients (Ci*) are presented in Table 6, while Figure 2 provides a visual comparison of supplier performance across the four Kraljic quadrants. Together, the table and figure illustrate how supplier suitability varies with the strategic characteristics of procurement items, highlighting the limitations of uniform evaluation approaches and demonstrating the practical value of category-specific bidder list selection.

Table 6 TOPSIS-Based Supplier Ranking Across Kraljic Matrix Quadrants

Kraljic Quadrant	Supplier Code	TOPSIS Score (Ci*)	Rank
Non-Critical Items	S1	0.82	1
	S3	0.74	2
	S2	0.68	3
	S4	0.61	4
Leverage Items	S2	0.85	1
	S1	0.79	2
	S4	0.71	3
	S3	0.65	4
Bottleneck Items	S3	0.88	1
	S1	0.76	2
	S2	0.69	3
	S4	0.60	4
Strategic Items	S1	0.90	1
	S3	0.83	2
	S2	0.72	3
	S4	0.63	4

4.4 Comparison with Traditional Procurement Decision-Making Approaches

A critical contribution of this study lies in comparing TOPSIS-based outcomes with traditional procurement decision-making practices observed in the case organization. Historically, bidder list selection relied heavily on past relationships, subjective assessments, and informal criteria weighting. While managerial experience remains valuable, the comparison reveals several limitations of traditional approaches.

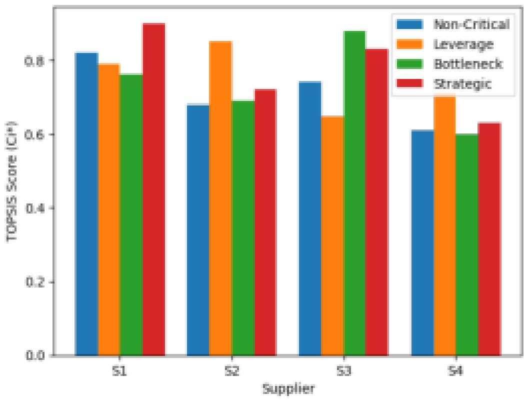

Figure 2 Comparison of TOPSIS Supplier Scores Across Kraljic Quadrants

First, traditional methods tend to overemphasize price as a lever and non-critical items, and underemphasize risk for strategic and bottleneck items. Second, decision rationales are often undocumented, reducing transparency and making decisions difficult to justify to stakeholders. Third, inconsistent application of criteria across projects leads to variability in supplier selection outcomes.

By contrast, the integrated framework produces traceable, repeatable, and strategy-aligned results. This finding reinforces arguments in the literature that, when properly contextualized, quantitative decision models enhance procurement governance and accountability (Ho et al., 2010).

4.5 Cross-Quadrant Patterns in Supplier Performance

Analyzing supplier performance across Kraljic quadrants reveals several noteworthy patterns. Suppliers that excel in Strategic items tend to demonstrate strong capabilities in engineering support, quality assurance, and project coordination, but are less competitive on price. Conversely, suppliers performing well in Leverage items often operate with standardized processes and economies of scale, enabling aggressive pricing.

Suppliers associated with Bottleneck items frequently exhibit niche expertise or geographic advantages but face capacity constraints. Their performance variability poses a significant risk, reinforcing the need for careful monitoring and contingency planning. Non-Critical item suppliers, meanwhile, show relatively homogeneous performance profiles, suggesting opportunities for supplier consolidation and process automation.

These patterns are consistent with empirical findings in procurement portfolio research, which emphasize that supplier capabilities and risks are unevenly distributed across product categories (Kraljic, 1983; Cousins et al., 2008).

4.6 Implications for Supplier Relationship Management (SRM)

The TOPSIS rankings are further interpreted through an SRM perspective to translate analytical results into actionable procurement strategies. For Strategic suppliers, high-ranking suppliers are identified as candidates for long-term partnerships, collaborative planning, and early supplier involvement. Such relationships are expected to enhance innovation, risk sharing, and performance stability, as suggested in SRM literature (Cousins et al., 2008).

For Leverage suppliers, the results support competitive sourcing strategies, with periodic reassessment to maintain cost pressure while ensuring acceptable performance. Bottleneck suppliers require risk-focused relationship strategies, including dual sourcing where feasible, inventory buffering, and closer operational coordination. For Non-Critical suppliers, transactional relationships emphasizing efficiency and automation are deemed most appropriate.

This structured translation of evaluation results into SRM strategies addresses a gap identified in prior studies, which often stop at supplier ranking without specifying subsequent relationship management actions.

4.7 Managerial Insights and Performance Improvement Potential

From a managerial perspective, the integrated framework offers several important insights. First, it demonstrates that differentiated procurement strategies materially affect supplier selection outcomes and risk exposure. Second, it highlights the value of explicitly incorporating expert judgment into quantitative models to ensure alignment with organizational priorities. Third, it provides a defensible basis for selecting the bidder list, enhancing governance and stakeholder confidence.

Potential performance improvements include reduced procurement risk, improved tender quality, and better alignment between procurement effort and project value. These findings corroborate earlier studies reporting that integrated procurement frameworks contribute to more consistent and value-driven decision-making in complex project environments (Flyvbjerg, 2017; Eriksson et al., 2020).

4.8 Synthesis of Results

In summary, the results empirically confirm that supplier evaluation criteria weights vary significantly across Kraljic Matrix quadrants, that TOPSIS-based rankings differ meaningfully from traditional decision-making outcomes, and that integrating quantitative evaluation with strategic procurement frameworks yields actionable managerial insights. By systematically linking product heterogeneity, supplier performance, and relationship strategy, the study advances both theoretical understanding and practical application of strategic procurement in EPC projects.

5. CONCLUSION

This study set out to address a persistent challenge in Engineering, Procurement, and Construction (EPC) projects: improving bidder list selection and supplier decision-making in environments characterized by high complexity, heterogeneous products, and significant supply risk. By integrating the Kraljic Matrix, the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), and Supplier Relationship Management (SRM), the study developed and empirically applied a structured decision-support framework within a real EPC project context.

The results demonstrate that supplier evaluation criteria weights differ substantially across Kraljic Matrix quadrants. Strategic items prioritize technical capability, quality assurance, delivery reliability, and financial stability; leverage items emphasize price competitiveness supported by acceptable performance levels; bottleneck items focus on delivery assurance and responsiveness; and non-critical items prioritize administrative efficiency and transactional simplicity. These findings confirm that uniform supplier evaluation approaches are misaligned with the strategic realities of heterogeneous procurement portfolios.

The TOPSIS-based analysis further shows that supplier rankings vary significantly across product categories and often diverge from outcomes produced by traditional price-based or experience-driven decision-making. By explicitly modeling trade-offs among multiple criteria, the proposed framework provides more transparent, consistent, and defensible bidder list selection outcomes. Notably, the results reveal that suppliers performing well in one category are not necessarily suitable for others, underscoring the necessity of context-specific evaluation.

Beyond ranking suppliers, this study demonstrates how quantitative evaluation results can be translated into actionable Supplier Relationship Management strategies. Strategic suppliers are identified as candidates for long-term partnerships and collaborative arrangements, leverage suppliers for competitive sourcing, bottleneck suppliers for risk-focused management, and non-critical suppliers for streamlined transactional relationships. This linkage between evaluation, selection, and relationship strategy addresses a key limitation in prior research, which often treats supplier ranking as an isolated analytical exercise.

From a theoretical perspective, the study contributes to the procurement and supply chain management literature by operationalizing the integration of procurement portfolio theory, multi-criteria decision-making, and SRM within an EPC context. It advances existing knowledge by shifting attention to bidder list selection at the pre-tender stage, an area that has received limited empirical attention despite its strategic importance. In practice, the framework offers procurement managers a structured, replicable approach to aligning supplier selection decisions with project risk, value, and long-term strategic objectives.

Several limitations should be acknowledged. The study is based on a single EPC project and organizational context, which may limit statistical generalizability. However, the analytical generalization achieved provides a foundation for broader application and testing. Future research could extend this framework across multiple projects or organizations, incorporate alternative or hybrid multi-criteria decision-making methods, and examine dynamic changes in supplier performance over time. Further investigation into digital procurement systems and real-time data integration also represents a promising avenue for advancing strategic procurement practice.

Overall, this study demonstrates that integrating strategic classification, quantitative decision models, and relationship management can significantly enhance the quality of bidder list selection and procurement decisions in complex project environments.

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