

A Qualification-Based Analysis of Critical Success Factors Affecting Contractor Performance in Indonesia's Public Construction Tenders

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ABSTRACT

This study examines the Critical Success Factors (CSFs) influencing contractor performance in winning public construction tenders under Indonesia's Ministry of Public Works using a qualification-based comparative approach. A quantitative design was employed, with data collected from 597 contractors (161 small, 187 medium, and 249 large firms). Separate Structural Equation Modeling–Partial Least Squares (SEM-PLS) estimations were conducted for each contractor category, followed by a cross-group comparative analysis to identify scale-sensitive differences in CSF significance. The results reveal that Competitive Pricing and Equipment Resources consistently serve as significant determinants of tender success across all contractor classifications, confirming their universal importance within Indonesia's cost-driven and compliance-oriented procurement system. However, the influence of other CSFs varies by organizational scale. Small contractors are primarily influenced by Technology and Innovation and Regulatory Understanding; medium contractors by Company Qualification, Human Resources, and Document Quality; and large contractors by integrated resource management and regulatory risk control. This study is the first to apply a qualification-based comparative SEM-PLS framework, demonstrating that organizational scale moderates CSF relevance in public construction tendering. The findings challenge the prevailing one-size-fits-all perspective and provide scale-sensitive theoretical and practical implications for contractor strategy and public procurement policy in developing-country contexts.

Keywords-Critical Success Factors (CSFs); contractor performance; public construction tendering; Structural Equation Modeling–Partial Least Squares (SEM-PLS); contractor qualification

I. INTRODUCTION

The public construction tendering process plays a decisive role in determining not only project implementation outcomes but also the long-term competitiveness and sustainability of construction firms [1]. In practice, tender success is not solely

determined by technical capability, but by a complex interaction of pricing strategies, resource readiness, document quality, digital competence, and regulatory compliance [2]. In Indonesia, this complexity is amplified by the dominant role of the Ministry of Public Works as the largest public procuring entity, where large-scale infrastructure projects attract intense

competition from contractors across different qualification levels—small, medium, and large—each operating under distinct capacity constraints and strategic conditions [3].

Public procurement functions not only as an administrative mechanism but also as a strategic instrument that shapes market competition and contractor behavior through pricing rules, evaluation criteria, and compliance requirements [4, 5]. In public construction, tendering represents a multi-dimensional decision process in which contractors must integrate technical capability, pricing accuracy, documentation quality, and regulatory compliance to meet increasingly stringent procurement standards [6]. Unlike private contracting, public construction procurement operates under strict regulatory frameworks emphasizing transparency, accountability, and value for money. Consequently, contractor performance in public tenders depends not only on construction expertise but also on the ability to strategically manage organizational and procedural factors.

Extensive international research has identified Critical Success Factors (CSFs) as key determinants of success in construction projects and procurement processes [7]. Prior studies emphasize factors such as company qualification, equipment availability, human resources, cost competitiveness, and compliance with procurement regulations as essential drivers of contractor performance [3]. More recently, the increasing adoption of digital procurement systems and electronic tendering platforms has been shown to significantly influence efficiency, transparency, and competitiveness in public procurement [8]. However, most existing CSF studies are conducted in developed-country contexts and tend to adopt a generalized perspective, treating contractors as a homogeneous group and focusing primarily on project management outcomes rather than the specific decision-making mechanisms embedded within public procurement systems [3].

In Indonesia, public construction procurement is predominantly managed by the Ministry of Public Works and has undergone significant digital transformation through the mandatory SPSE platform supervised by LKPP [3, 9]. While these reforms enhance transparency and standardization, they simultaneously increase operational and compliance demands on contractors, particularly regarding pricing precision, documentation accuracy, and digital capability.

Empirical observations indicate that many contractors struggle to compete effectively in public tenders not because of inadequate construction capacity, but due to deficiencies in tender preparation, pricing strategies, equipment readiness, or procedural compliance. These challenges vary substantially across contractor qualification levels, reflecting differences in organizational scale, resource availability, and managerial maturity. However, existing procurement studies in Indonesia have largely focused on regulatory effectiveness and system implementation, with limited attention to how these institutional arrangements translate into differential performance outcomes among contractors.

The transition toward electronic procurement has been reinforced by national regulatory reforms, including Presidential Regulation No. 12 of 2021, which standardizes

procedures and strengthens accountability in public construction tenders [3, 10]. Although these reforms enhance governance, they also impose stricter procedural and digital requirements, leading to recurrent tender failures caused not by technical incapacity, but by pricing misalignment, documentation deficiencies, and regulatory non-compliance [11].

Despite the growing body of procurement-related research, limited attention has been given to how the relative importance of CSFs differs across contractor qualification categories. This gap is critical, as contractors of different scales operate under fundamentally different conditions. Small contractors often face financial and equipment constraints and therefore rely more heavily on digital capability and regulatory compliance to remain competitive [12]. However, few studies provide a systematic comparative perspective across qualification levels. Medium contractors typically operate in a transitional stage, where professional management systems, human resources, and document quality become decisive in meeting tender requirements. Large contractors, on the other hand, compete in complex, high-value projects that demand advanced technology adoption, integrated management systems, and rigorous regulatory risk control. Treating these heterogeneous contractor groups as analytically equivalent risks obscuring important scale-sensitive determinants of tender performance [5].

This study addresses these gaps by systematically examining the significance of CSFs in influencing contractor performance in public construction tenders managed by the Ministry of Public Works in Indonesia. A quantitative approach using Structural Equation Modeling–Partial Least Squares (SEM-PLS) is employed to capture complex relationships among multiple latent variables and to accommodate non-normal data distributions [13]. To move beyond conventional aggregated analysis, the study applies separate SEM-PLS estimations for small, medium, and large contractors, followed by a comparative structural analysis to identify cross-group differences in CSF significance.

The novelty of this study lies in its qualification-based comparative framework, which demonstrates that the determinants of tender success are not uniform but are strongly shaped by organizational scale. By revealing scale-sensitive patterns in the influence of pricing, equipment resources, technology adoption, document quality, human resources, and regulatory understanding, this study challenges the prevailing one-size-fits-all assumption commonly embedded in both academic models and public procurement evaluation practices. Consequently, the findings provide more precise theoretical insights into contractor performance in public tendering and offer practical, evidence-based guidance for contractors in formulating scale-appropriate bidding strategies, as well as for policymakers and procurement authorities in designing more differentiated and effective public procurement interventions in Indonesia. Unlike prior studies that treat contractors as homogeneous entities, this research introduces a structured qualification-based comparative model that empirically demonstrates how organizational scale moderates the significance of CSFs. This study therefore extends CSF theory

by introducing organizational scale as a structural moderator in procurement performance models.

II. METHODOLOGY

A. Research Design

This study employed a quantitative research design conducted between 2023 and 2024 to investigate the significance of CSFs on contractor performance in public construction tenders managed by the Ministry of Public Works in Indonesia. SEM-PLS was applied, which is particularly suitable for predictive and exploratory models with multiple latent variables and indicators [3, 13].

B. Population and Sample

The research population comprised contractors engaged in public procurement projects under the Ministry of Public Works in Indonesia. A purposive sampling method was applied to ensure adequate representation across different contractor qualification levels [14].

Data were collected from 597 respondents, including 161 small contractors, 187 medium contractors, and 249 large contractors. Respondents were drawn from various regions in Indonesia, representing western, central, and eastern zones, thus ensuring geographic diversity. The sample size of 597 respondents exceeds the minimum requirement for SEM-PLS analysis and provides sufficient statistical power for multi-group comparative modeling, particularly for analyzing differences across contractor qualification categories.

The demographic characteristics of the respondents reflect a broad cross-section of construction industry practitioners. They include company directors, commissioners, project managers, procurement officers, and engineers. Respondents also vary in terms of professional experience, ranging from less than 5 years to more than 20 years, and educational background, ranging from vocational degrees to postgraduate qualifications. This diversity strengthens the representativeness and generalizability of the findings within the Indonesian construction sector [3].

C. Variables and Measurement

A comprehensive literature review was conducted to identify the CSFs influencing contractor performance in public construction tenders. These variables were obtained from several related papers indexed by Scopus. The dependent variable (Y) is Contractor Performance in Tender, measured by indicators such as the frequency of winning bids, project value won, consistency across multiple years, and efficiency in the tendering process. Seven independent variables (X1–X7) were specified based on a comprehensive review of the literature and a contextual analysis of the Indonesian tendering environment. The definitions, indicators, and measurement items of all variables are summarized in Table I.

The digital-based cost optimization indicator (X4.4) captures the use of digital estimation tools, spreadsheet automation, and software-assisted unit price analysis commonly adopted by contractors to improve pricing accuracy. It does not assume advanced artificial intelligence deployment

but reflects practical digital cost optimization practices within the Indonesian procurement context.

To ensure analytical clarity and align with Indonesia's public procurement regulations, contractors in this study are classified into three categories based on their organizational scale and allowable project value. These categories—small, medium, and large contractors—reflect differences in financial capacity, resource availability, and project execution capability. The classification serves as a foundational basis for comparing the significance of CSFs across contractor groups in public construction tendering. The official criteria used in this study are presented in Table II.

D. Research Conceptual Framework

The conceptual framework, shown in Figure 1, illustrates the hypothesized relationships between the seven independent variables (X1–X7) and the dependent variable (Y).

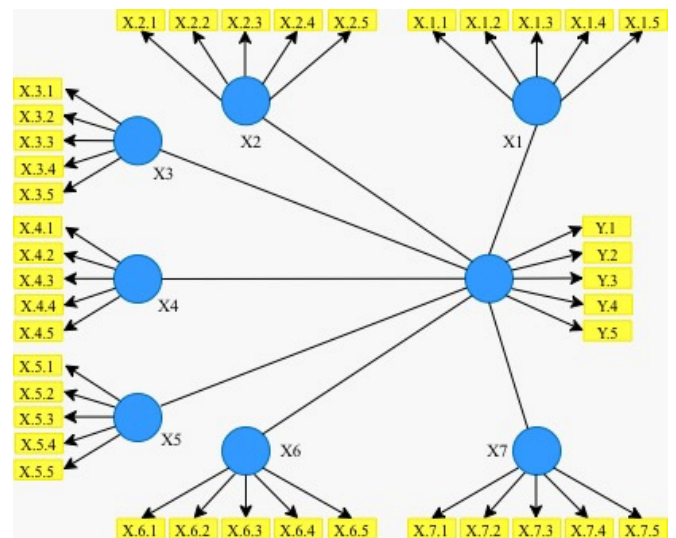


Fig. 1. Conceptual framework.

E. Research Operational Framework

The operational framework, shown in Figure 2, translates abstract constructs into measurable indicators. Each independent variable (X1–X7) was broken down into observable items, whereas the dependent variable (Y) was measured by performance outcomes in the tendering process.

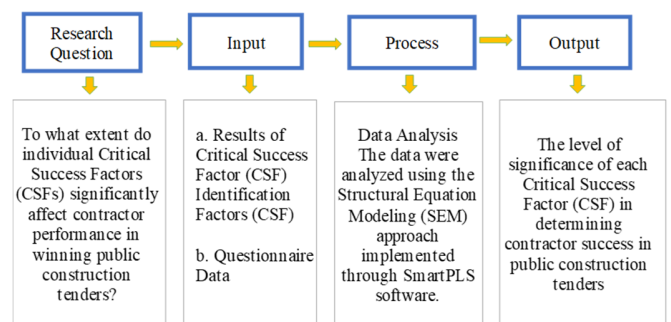


Fig. 2. Operational framework.

TABLE I. DEPENDENT AND INDEPENDENT VARIABLES WITH MEASUREMENT INDICATORS

Variables	Code	Indicators	Description / Measurement indicators	Ref.
(Y) Contractor Performance in Tender	Y.1	Winning rate	Ratio of winning bids to total bids submitted	[15]
	Y.2	Project acquisition	Number/value of projects won within a defined period	[3]
	Y.3	Success consistency	Trend of tender success over multiple years	[16]
	Y.4	Quality of awarded projects	Ability to win high value, complex, and strategic projects	[3]
	Y.5	Resource efficiency	Effective allocation of time, cost, workforce, and documents	[17]
(X1) Company Qualification	X1.1	Legal & licensing	Completeness of legal documents	[18]
	X1.2	Company experience	Past 4-year work experience portfolio	[19]
	X1.3	Remaining Work Capacity (RWC)	Valid remaining work capacity	[20]
	X1.4	Tax compliance	Valid Taxpayer Identification Number (TIN) status	[18]
	X1.5	Reputation	Good performance and project history	[3]
(X2) Equipment Resources	X2.1	Understanding of equipment requirements	Ability to understand equipment specifications	[21]
	X2.2	Equipment offering	Offering equipment that meets type, capacity, and minimum quantity	[22]
	X2.3	Documentation verification	Providing valid and verifiable equipment documentation	[18]
	X2.4	Equipment availability	Ensuring equipment is not committed to other projects	[16]
	X2.5	Third party cooperation	Collaboration with external suppliers for availability	[16]
(X3) Human Resources	X3.1	Managerial requirements	Understanding managerial personnel requirements	[18]
	X3.2	Qualification & experience	Education, position, and years of experience	[18]
	X3.3	Competency documentation	Curriculum vitae, certificates, education documents	[17]
	X3.4	Availability	Personnel not engaged in other projects	[18]
	X3.5	Unique personnel offering	Offering personnel different from other bidders	[18]
(X4) Technology and Innovation	X4.1	e-Tendering capability	Ability to use the National Electronic Procurement System e-tendering platform	[19]
	X4.2	Procurement information system compliance	Completing requirements in integrated procurement systems	[23]
	X4.3	Digital document preparation	Use of digital tools for faster document submission	[24]
	X4.4	Digital-based cost optimization	Use of digital tools, automated cost analysis software, or algorithm-based methods to improve pricing accuracy and bid competitiveness	[25]
	X4.5	Digital verification	Using technology to check document consistency	[9]
(X5) Document Quality	X5.1	Technical document completeness	Compliance with the Bid Data Sheet (BDS) and Qualification Data Sheet (QDS)	[17]
	X5.2	Safety documentation (SMKK)	SMKK compliance in Construction Safety Plan	[19]
	X5.3	Safety commitment	Safety commitment statement	[19]
	X5.4	Bid bond validity	Validity of bid security	[18]
	X5.5	Authenticity of bid security	Validity and authenticity of bid bonds	[26]
(X6) Competitive Pricing	X6.1	Base price knowledge	Understanding base cost components	[18]
	X6.2	Cost analysis accuracy	Accuracy of unit price analysis and bill of quantities	[17]
	X6.3	Competitive bid	Responsiveness and competitiveness of pricing	[27]
	X6.4	Financial capacity	Ability to finance bid-related costs	[27]
	X6.5	Overhead estimation	Proper indirect cost calculation	[17]
(X7) Regulatory Understanding	X7.1	Procurement regulation knowledge	Understanding Presidential Regulation No. 12 of 2021	[23]
	X7.2	Procedural compliance	Compliance with tender stages	[16]
	X7.3	Legal risk awareness	Awareness of sanctions and legal risks	[9]
	X7.4	Regulatory adaptation	Ability to adapt to digital procurement changes	[28]
	X7.5	Objection submission	Ability to file administrative objections	[26]

TABLE II. CONTRACTOR QUALIFICATION CLASSIFICATION IN INDONESIA

Category	Criteria
Small contractors	Allowed project value \leq IDR 15 billion
Medium contractors	Allowed project value > IDR 15 billion – IDR 50 billion
Large contractors	Allowed project value > IDR 50 billion

F. Data Collection

Data collection was conducted through a structured questionnaire, distributed both online and in person. A pilot study was carried out to test the clarity and reliability of the instrument, and adjustments were made based on feedback before full deployment [29]. Table III presents the population of contractors in Indonesia by enterprise scale (small, medium, and large), compiled from the latest available data published by the Central Bureau of Statistics (BPS). According to the latest

statistical records published by BPS, Indonesia has a total of 203,403 registered construction firms operating nationwide.

TABLE III. POPULATION OF CONTRACTORS IN INDONESIA BY ENTERPRISE SCALE

Contractor scale	Percentage (%)	Number of firms
Small contractors	82.40	167,605
Medium contractors	16.74	34,048
Large contractors	0.86	1,750
Total	100	203,403

According to [13], methodological literature recommends that the minimum sample size required in SEM-PLS should follow one of the following criteria: ten times the number of indicators associated with the most complex construct, or a minimum of 150–200 respondents for models with medium to high complexity.

G. Data Analysis

The data were analyzed using SEM-PLS implemented in SmartPLS software. PLS-SEM was selected over Covariance-Based SEM (CB-SEM) because the study emphasizes prediction and comparative analysis across contractor qualification groups rather than strict theory confirmation. Moreover, the model includes multiple latent constructs and indicators, increasing structural complexity. PLS-SEM is also more robust to non-normal data distributions and well-suited for multi-group analysis. These characteristics make SmartPLS an appropriate analytical approach for the qualification-based comparative framework adopted in this study [13]. Furthermore, separate estimations for each qualification category enable a structured comparative interpretation without imposing structural invariance assumptions. The analytical procedure comprised two main stages:

1. Measurement model (outer model) evaluation: Convergent validity was assessed through factor loadings (>0.70) and Average Variance Extracted ($AVE > 0.50$). Discriminant validity was tested using the Fornell–Larcker criterion and cross-loadings. Reliability was evaluated through Cronbach's Alpha (>0.70) and Composite Reliability ($CR > 0.70$) [30].
2. Structural model (inner model) evaluation: Collinearity was assessed through Variance Inflation Factor ($VIF < 5.0$). Predictive relevance was evaluated using R^2 values, which demonstrated substantial explanatory power across contractor categories (R^2 ranging from 0.729 to 0.790). Hypothesis testing was conducted using bootstrapping with 5,000 resamples. Path coefficients (β), t-statistics, and p-values were examined to determine the significance of each relationship [13, 31].

H. Ethical Considerations

Participation was voluntary, and respondents were assured of anonymity and confidentiality. Data collection followed ethical guidelines for social science research, ensuring no disclosure of sensitive personal information [32-35].

III. RESULTS AND DISCUSSION

A. Profile of Respondents

The respondent profile reflects balanced representation across contractor qualification levels and adequate diversity in professional experience and educational background, supporting the robustness of the SEM-PLS analysis. The details of respondent profiles are summarized in Table IV.

TABLE IV. PROFILE OF RESPONDENTS

No	Qualification	Amount of Data		Experience			Education			
		SUM	%	< 5 years	> 5 years	> 15 years	S1	S2	S3	Other
1	Small	161	26.97	98	54	9	110	26	0	25
2	Medium	187	31.32	110	65	12	138	30	1	18
3	Large	249	41.71	120	101	28	180	33	2	34
Total		597	100	328	220	49	428	89	3	77

S1 = Bachelor's, S2 = Master's, S3 = Doctoral.

These results demonstrate that the respondent data represent diverse experience and educational backgrounds across contractor categories in Indonesia.

B. Measurement Model Evaluation

Discriminant validity was assessed using the Fornell–Larcker criterion. As shown in Table V, the square root of AVE (\sqrt{AVE}) for each construct exceeds its inter-construct correlations, indicating adequate discriminant validity.

TABLE V. FORNELL–LARCKER CRITERION

Construct	\sqrt{AVE} (small)	\sqrt{AVE} (medium)	\sqrt{AVE} (large)
X1	0.838	0.782	0.815
X2	0.813	0.871	0.856
X3	0.822	0.847	0.839
X4	0.845	0.922	0.920
X5	0.827	0.907	0.942
X6	0.832	0.793	0.815
X7	0.892	0.830	0.860
Y	0.894	0.782	0.761

All constructs exceeded the recommended threshold of 0.70 for Cronbach's Alpha and Composite Reliability, confirming satisfactory internal consistency. Convergent validity was established through AVE values above 0.50, and discriminant validity was confirmed using the Fornell–Larcker criterion and cross-loading analysis.

As shown in Tables VI–VIII, all constructs exceed the minimum AVE threshold of 0.50, confirming adequate convergent validity. Cronbach's Alpha and Composite Reliability values also surpass 0.70, indicating satisfactory internal consistency across contractor categories.

C. Structural Model Results and Comparative Analysis

The inner model results are presented in Table IX. The structural model explains a substantial proportion of variance in contractor performance across all qualification categories. R^2 values ranging from 0.729 to 0.790 indicate substantial explanatory power. These results indicate that the selected CSFs collectively represent key determinants of tender success

in Indonesia's public construction procurement system. However, the relative importance of individual CSFs varies markedly across contractor categories, underscoring the need for a qualification-based analytical perspective. The path coefficients are presented in Table X.

TABLE VI. CONSTRUCT RELIABILITY AND VALIDITY – SMALL CONTRACTORS

	Cronbach's Alpha	Composite Reliability(rho_a)	Composite Reliability (rho_c)	AVE
X1	0.859	0.869	0.904	0.703
X2	0.830	0.841	0.886	0.661
X3	0.881	0.894	0.912	0.676
X4	0.900	0.901	0.926	0.714
X5	0.846	0.848	0.897	0.684
X6	0.777	0.783	0.871	0.692
X7	0.744	0.754	0.886	0.796
Y	0.874	0.877	0.922	0.799

TABLE VII. CONSTRUCT RELIABILITY AND VALIDITY – MEDIUM CONTRACTORS

	Cronbach's Alpha	Composite Reliability(rho_a)	Composite Reliability (rho_c)	AVE
X1	0.790	0.804	0.863	0.611
X2	0.894	0.901	0.926	0.758
X3	0.901	0.908	0.927	0.717
X4	0.824	0.827	0.919	0.850
X5	0.892	0.904	0.933	0.822
X6	0.851	0.854	0.894	0.629
X7	0.887	0.898	0.917	0.689
Y	0.788	0.789	0.863	0.612

TABLE VIII. CONSTRUCT RELIABILITY AND VALIDITY – LARGE CONTRACTORS

	Cronbach's Alpha	Composite Reliability(rho_a)	Composite Reliability (rho_c)	AVE
X1	0.873	0.881	0.908	0.664
X2	0.878	0.884	0.916	0.732
X3	0.895	0.904	0.922	0.704
X4	0.818	0.819	0.917	0.846
X5	0.874	0.879	0.940	0.888
X6	0.873	0.878	0.908	0.664
X7	0.769	0.797	0.850	0.740
Y	0.757	0.758	0.846	0.579

TABLE IX. INNER MODEL TEST (R-SQUARE) FOR SMALL, MEDIUM, AND LARGE CONTRACTORS

Level of contractors		R ²	R ² adjusted
Small	Y	0.790	0.781
Medium	Y	0.747	0.738
Large	Y	0.729	0.721

TABLE X. INNER MODEL TEST (PATH COEFFICIENTS)

	Y (small)	Y (medium)	Y (large)
X1	-0.048	0.207	0.085
X2	0.191	0.277	0.177
X3	-0.050	0.135	0.100
X4	0.275	0.089	0.114
X5	0.104	0.224	0.245
X6	0.248	0.504	0.591
X7	0.252	-0.037	0.206

The analysis results indicate that for small contractors, the most influential factor on performance is Technology and Innovation (X4 = 0.275), followed by Regulatory Understanding (X7 = 0.252) and Competitive Pricing (X6 = 0.248). For medium contractors, the dominant factor is Competitive Pricing (X6 = 0.504), followed by Equipment Resources (X2 = 0.277) and Document Quality (X5 = 0.224). Meanwhile, for large contractors, the most significant factor is Competitive Pricing (X6 = 0.591), followed by Document Quality (X5 = 0.245) and Regulatory Understanding (X7 = 0.206). Overall, the findings confirm that competitive pricing strategies consistently serve as the most critical determinant of contractor success in winning public construction tenders. The significance test results are presented in Tables XI–XIII.

TABLE XI. INNER MODEL TEST (SIGNIFICANCE T-STATISTICS) – SMALL CONTRACTORS

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	t-statistic ((O/STDEV))	p-value
X1 → Y	0.048	0.048	0.058	0.820	0.412
X2 → Y	0.191	0.191	0.055	3.464	0.001
X3 → Y	0.050	0.051	0.047	1.072	0.284
X4 → Y	0.275	0.281	0.089	3.091	0.002
X5 → Y	0.104	0.102	0.069	1.514	0.130
X6 → Y	0.248	0.242	0.074	3.346	0.001
X7 → Y	0.252	0.256	0.091	2.779	0.005

TABLE XII. INNER MODEL TEST (SIGNIFICANCE T-STATISTICS) – MEDIUM CONTRACTORS

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	t-statistic ((O/STDEV))	p-value
X1 → Y	0.207	0.212	0.044	4.660	0.000
X2 → Y	0.277	0.274	0.084	3.285	0.001
X3 → Y	0.135	0.129	0.067	2.029	0.043
X4 → Y	0.089	0.096	0.064	1.387	0.166
X5 → Y	0.224	0.224	0.045	5.005	0.000
X6 → Y	0.504	0.505	0.040	12.462	0.000
X7 → Y	0.037	0.031	0.088	0.424	0.672

TABLE XIII. INNER MODEL TEST (SIGNIFICANCE T-STATISTICS) – LARGE CONTRACTORS

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	t-statistic ((O/STDEV))	p-value
X1 → Y	0.085	0.093	0.070	1.213	0.226
X2 → Y	0.177	0.175	0.065	2.708	0.007
X3 → Y	0.100	0.096	0.062	1.618	0.106
X4 → Y	0.114	0.120	0.062	1.931	0.045
X5 → Y	0.245	0.245	0.040	6.164	0.000
X6 → Y	0.591	0.593	0.040	14.612	0.000
X7 → Y	0.206	0.205	0.037	5.649	0.000

For small contractors, Technology and Innovation, Regulatory Understanding, Equipment Resources, and Competitive Pricing emerge as significant determinants of tender performance. From a practical standpoint, this finding reflects the operational reality that small contractors frequently rely on digital capability, procedural compliance, and cost efficiency to compensate for limited financial and equipment

capacity. In real tender environments, they often lose bids not due to inadequate technical competence, but because of digital documentation inaccuracies, pricing misalignment, or procedural errors during electronic submission. The ability to navigate electronic procurement systems, prepare compliant digital documents, and align bid prices with regulatory constraints therefore becomes a critical survival mechanism within highly standardized and compliance-driven procurement systems. Accordingly, strengthening digital capability, regulatory literacy, and pricing accuracy is essential for small contractors to offset structural resource limitations. For procurement authorities, this underscores the importance of targeted digital capacity-building and compliance support initiatives tailored to small-scale firms.

For medium contractors, Company Qualification, Human Resources, Document Quality, Equipment Resources, and Competitive Pricing significantly influence tender performance. This pattern reflects their transitional position, requiring stronger organizational systems and professionalized tender management. Deficiencies in documentation accuracy, personnel compliance, or pricing strategy often undermine competitiveness despite adequate technical capability. Accordingly, medium contractors must prioritize structured qualification management, certified human resource development, and systematic documentation and pricing control to remain competitive in public tenders.

In operational tender settings, medium contractors frequently face disqualification not because of insufficient technical capacity, but due to fragmented internal coordination, inconsistent documentation control, or suboptimal pricing strategies. This suggests that organizational institutionalization—rather than technical strength alone—becomes decisive in sustaining competitiveness at this transitional scale. Policy-wise, this highlights the need for structured institutional capacity-building tailored to medium-scale firms.

For large contractors, the dominance of Competitive Pricing, Document Quality, Equipment Resources, Technology and Innovation, and Regulatory Understanding reflects the complexity of high-value public construction projects. Large contractors operate in environments where minor procedural errors, documentation inconsistencies, or regulatory non-compliance can result in substantial financial and reputational losses. Consequently, large contractors must prioritize integrated management systems, digital verification mechanisms, and proactive regulatory risk control to sustain competitiveness in complex public construction tenders.

In high-value infrastructure tenders, even minor procedural inconsistencies, documentation inaccuracies, or regulatory misinterpretations can generate substantial financial and reputational exposure. At this scale, procurement competition is fundamentally driven by governance quality, compliance precision, and integrated managerial control rather than technical capability alone. For regulators, this reinforces the importance of advanced compliance monitoring and digital verification mechanisms in large-scale procurement environments.

Model fit was assessed to evaluate structural adequacy across contractor categories. As shown in Table XIV, Standardized Root Mean Square Residual (SRMR) values below 0.08 and Normed Fit Index (NFI) values above 0.70 indicate acceptable model fit, supporting the robustness of the comparative framework.

TABLE XIV. INNER MODEL TEST VALUES (MODEL FIT)

Fit index	Saturated model			Estimated model		
	Small	Medium	Large	Small	Medium	Large
SRMR	0.072	0.064	0.057	0.072	0.064	0.057
d_ULS	2.411	2.187	1.429	2.411	2.187	1.429
d_G	1.302	1.189	0.782	1.302	1.189	0.782
Chi-square	1,168.006	1,171.586	1,124.456	1,168.006	1,171.586	1,124.456
NFI	0.712	0.733	0.759	0.712	0.733	0.759

d_ULS = squared Euclidean distance, d_G = geodesic distance.

The model fit indices confirm acceptable structural adequacy across contractor categories, with NFI values ranging from 0.712 to 0.759. These results support the robustness of the proposed comparative framework.

Hypothesis testing was conducted to determine whether exogenous variables significantly influence endogenous variables. An exogenous construct is considered statistically significant when the bootstrapped t-statistic exceeds the critical value of 1.96 at the 5% significance level. The results of significance testing are shown in Table XV.

TABLE XV. HYPOTHESIS TESTING SUMMARY

Hypothesis	Factor	Small contractors	Medium contractors	Large contractors
H1	Company Qualification	Rejected	Accepted	Rejected
H2	Equipment Resources	Accepted	Accepted	Accepted
H3	Human Resources	Rejected	Accepted	Rejected
H4	Technology and Innovation	Accepted	Rejected	Accepted
H5	Document Quality	Rejected	Accepted	Accepted
H6	Competitive Pricing	Accepted	Accepted	Accepted
H7	Regulatory Understanding	Accepted	Rejected	Accepted

The inner model results show that Competitive Pricing (H6) and Equipment Resources (H2) are consistently significant across all contractor classifications, confirming their role as universal determinants of success in public construction tendering. Practically, this reflects the strong emphasis of public procurement systems on cost efficiency and technical readiness, making accurate pricing and effective equipment management essential for contractors of all sizes.

For small contractors, tender performance is mainly influenced by Technology and Innovation, Regulatory Understanding, Equipment Resources, and Competitive Pricing, indicating that digital adoption, regulatory compliance, and operational efficiency help mitigate resource constraints. Medium contractors are primarily driven by Company

Qualification, Human Resources, Document Quality, Equipment Resources, and Competitive Pricing, highlighting the importance of organizational professionalism and accurate tender documentation. In contrast, large contractors are influenced by Equipment Resources, Technology and Innovation, Document Quality, and Regulatory Understanding, reflecting the need for advanced technologies, integrated management systems, and strong governance in managing complex, high-value projects.

The rejection of several hypotheses across contractor categories suggests that the strategic relevance of CSFs is context-dependent, as some factors lose discriminative power due to relatively homogeneous internal capacities within specific groups. These findings are consistent with prior studies emphasizing the importance of pricing and technical capacity in tender success [16], while also extending the literature by demonstrating that their relative importance is scale-dependent. Moreover, prior studies [12, 27] identified key tender success factors without differentiating contractor scale. The present study extends their findings by applying a qualification-based comparative SEM-PLS analysis, demonstrating that organizational scale moderates the significance of CSFs.

D. Strategic and Policy Implications in Public Procurement Practice

The findings highlight the need for contractors to align internal strategic priorities with qualification-specific evaluation mechanisms rather than adopting uniform bidding strategies. Small contractors should enhance digital capability and regulatory literacy; medium contractors should strengthen organizational systems and documentation management; and large contractors should emphasize integrated management and regulatory risk control.

Although the SEM-PLS analysis identifies statistically significant relationships, these findings must be interpreted within the institutional architecture of public procurement systems rather than as isolated numerical outputs. The consistent dominance of Competitive Pricing reflects the cost-oriented structure of public tender evaluation, where financial risk mitigation and budget optimization frequently outweigh technical differentiation.

The differentiated CSF patterns confirm that procurement competitiveness is structurally conditioned by organizational scale. Small contractors rely on digital adaptability and regulatory literacy; medium contractors depend on institutionalized management systems and documentation discipline; and large contractors require integrated governance and proactive regulatory risk control.

Strategically, uniform bidding approaches are inadequate. Qualification-sensitive strategies are therefore required across contractor categories. From a policy perspective, scale-sensitive procurement support mechanisms are essential to prevent structural disparities within the construction market.

E. Discussion in Relation to Previous Studies

Prior studies have identified key CSFs influencing contractor tender success, but they have largely treated contractors as a homogeneous group. The present study extends

this literature by demonstrating that organizational scale significantly moderates the relevance of CSFs. This qualification-based comparative SEM-PLS analysis provides new empirical evidence that challenges one-size-fits-all assumptions in construction procurement research and practice, thereby offering more nuanced and policy-relevant insights for improving competitiveness and efficiency in Indonesia's public construction procurement system. Although the study provides robust comparative evidence, it is limited to the Indonesian public procurement context, and cross-country validation would further strengthen the generalizability of the proposed framework.

IV. CONCLUSION

This study provides empirical evidence on how Critical Success Factors (CSFs) shape contractor performance in public construction tenders under the Ministry of Public Works in Indonesia through a qualification-based comparative Structural Equation Modeling–Partial Least Squares (SEM-PLS) approach. The findings demonstrate that the determinants of tender success are not uniform but vary systematically across contractor qualification levels, reflecting differences in organizational capacity, resource availability, and managerial complexity.

Competitive Pricing and Equipment Resources consistently emerge as universal determinants across contractor categories, confirming the cost-driven and compliance-oriented nature of public procurement systems. Beyond these common factors, distinct scale-sensitive patterns are observed. Small contractors depend primarily on digital capability and regulatory literacy; medium contractors are driven by structured qualification systems, professionalized human resources, and documentation control; and large contractors rely on integrated governance, advanced verification mechanisms, and regulatory risk management.

These findings should not be reduced to numerical path coefficients. Rather, they reveal how public procurement systems structurally reward managerial precision, pricing accuracy, digital readiness, documentation integrity, and regulatory compliance over purely technical differentiation. In real-world tender environments—both in Indonesia and internationally—contractor failure often stems from pricing misalignment, procedural non-compliance, or documentation deficiencies rather than inadequate engineering expertise.

By demonstrating that organizational scale fundamentally moderates CSF relevance, this research advances construction procurement theory beyond the prevailing one-size-fits-all perspective. Specifically, this study contributes by: (1) empirically validating scale-based heterogeneity in CSF significance, (2) introducing a structured qualification-based SEM-PLS comparative framework, and (3) providing differentiated strategic and policy guidance aligned with contractor qualification levels. The proposed qualification-based comparative framework may also serve as a reference model for other developing countries with similar cost-driven and compliance-oriented procurement systems.

DATA AVAILABILITY STATEMENT

The dataset generated and analyzed during the current study is available from the corresponding author upon reasonable request.

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