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# Risk Profiling in Public E-Procurement: Empirical Insights from Indonesia's Supreme Audit Institution (BPK RI)

✉[1,A,B,C,D,F]Aditya Pratama, [2,E,F]Bhakti Yudho Suprapto, [2,E,F]Chairul Razak
[1]The Audit Board of the Republic of Indonesia, Indonesia
[2]Universitas Sriwijaya, Indonesia

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**ABSTRACT**
*The rapid digitalization of government procurement introduces new accountability and risk management challenges for large-scale public infrastructure projects. To assess these systemic vulnerabilities, this study examines the e-purchasing catalog of Indonesia's Ministry of Public Works and Housing. Drawing on empirical data from 34 expert auditors of the Supreme Audit Institution (BPK RI) who conducted infrastructure audits in 2024, a risk-profiling framework was used to evaluate 41 risk factors across six procurement phases. The findings indicate that procurement preparation and contract implementation are the most vulnerable stages. Among the identified factors, 36 are classified as high risk, largely due to insufficient price negotiation mechanisms and weak quality-assurance protocols. The contribution of this research is the development of risk-profiling framework based on direct audit evidence, highlighting the need for specialized oversight in e-procurement systems to prevent systemic inefficiencies. To address these vulnerabilities, the study recommends the implementation of a vendor-experience profiling system, the adoption of alternative negotiation mechanisms supported by transparent transaction data, and the enforcement of rigorous vendor-database updates.*

*Keywords: Accountability, E-Procurement System, E-Purchasing, Public Infrastructure Projects, Risk Management, Risk-profiling Framework, Supreme Audit Institution.*

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✉Corresponding author :
Email: aditamaa13@gmail.com

## 1. INTRODUCTION

Electronic Procurement (e-procurement) has evolved in tandem with Industry 4.0, leveraging advances such as the Internet of Things, cloud computing, and artificial intelligence to automate end-to-end procurement workflows and enable seamless collaboration across organizational boundaries (Glas & Kleemann, 2016). Similar e-procurement risk frameworks have been successfully deployed in other regional blocs, such as COMESA member states, demonstrating transferable mitigation strategies for public-sector catalogs (Gilbert & Celestin, 2025).

In Indonesia, e-procurement is institutionalized through the e-purchasing catalog mechanism alongside Direct Procurement, Direct Selection, Fast Tender, and Tender under Presidential Regulation No. 12 of 2021 regarding Government Procurement of Goods/Services. By mandating fast, simple, transparent, and fully electronic transactions (Peraturan Lembaga Kebijakan Pengadaan Barang/ Jasa Pemerintah, 2021a), the e-catalog aims to curb corruption, nepotism, and inefficiency, addressing the well-documented shortcomings of manual procurement in efficiency, data security, communication, and transparency (Gunasekara et al., 2022).

Data from the Government Procurement Policy Agency (Table 1) illustrate the catalog's rapid uptake: contract volumes declined from 347,557 in 2019 (IDR69.2 trillion) to 228,807 in 2021 (IDR 49.7 trillion), while transaction values stabilized around IDR49-69 trillion (Lembaga Kebijakan Pengadaan Barang/ Jasa Pemerintah, 2021; Lembaga Kebijakan Pengadaan Barang/Jasa Pemerintah. 2022). By 2022, the e-catalog hosted 2.4 million products with IDR83.9 trillion in turnover, and by October 27, 2023, listings had expanded to 6.9 million products totaling IDR161.3 trillion (Arini, 2023). Notably, the Ministry of Public Works and Housing (PUPR) accounted for the highest e-catalog expenditure (Sari & Ika, 2024), underscoring its role as the pilot agency for Indonesia's digital procurement transformation.

Within PUPR's infrastructure portfolio, supported by a 2023 APBN allocation of IDR125.2 trillion (Kementrian Keuangan, 2023), the shift from traditional Tender toward e-purchasing has been particularly pronounced in road and housing projects. PUPR secured the top spot in the 2023 e-purchasing Awards for total transaction value, reaching IDR11.86 trillion by August 1, 2023 (PUPR, 2023). To accelerate catalog adoption, PUPR issued Circular Letter Number 09/SE/M/2023, which provides guidelines on applying the precautionary principle in e-purchasing.

Despite these gains, e-procurement in the construction sector faces significant barriers, including technological vulnerabilities, volatile material prices, frequent scope changes, and lapses in quality assurance (Gurgun et al., 2024; Vaidyanathan & Devaraj, 2008). The National Corruption Prevention Strategy (Stranas PK) and the Corruption Eradication Commission (KPK) have identified multiple fraud schemes, repeat purchases by project representatives, collusive vendor agreements, and last-minute price markups that have fueled 339 procurement-related corruption cases from 2004 to 2023, with a record 63 cases in 2023 alone (Rachman & Alamsyah, 2023; Ni'am & Rastika, 2024; KPK, 2024). Stranas PK further reported 65,947 contracts (IDR2.5 trillion) executed within 24 hours

Table 1. **Implementation of the E-Purchasing Catalog from 2019 to 2021 in Indonesia**

| Year | Contract Amount | Transaction Amount (IDR) |
|---|---|---|
| 2019 | 347.557 | 69.2 trillion |
| 2020 | 295.532 | 49.5 trillion |
| 2021 | 228.807 | 49.7 trillion |

Source: Processed Data

of product listing and 3,108 transactions (IDR328 billion) exhibiting pre-transaction price increases of ≥ 20%, often facilitated by a single supplier in 30% of cases (Yuantisya & Trianita, 2024).

President Joko Widodo has emphasized ongoing system evaluations to deter such malpractice, warning that non-compliance will be met with stringent legal action (Indraini, 2023). While Industry 4.0 offers opportunities to improve order accuracy, stakeholder coordination, and delivery reliability (Yevu et al., 2022), it also introduces novel risks concerning data ownership, transparency, and security (Glas & Kleemann, 2016). As Indonesia's Supreme Audit Institution, the Badan Pemeriksa Keuangan (BPK RI) audits all state financial operations from central and local governments to state-owned enterprises (SOEs) and public agencies under (Undang-undang (UU), 2006). By harnessing the independent assessments of 34 BPK auditors who audited the Ministry of PUPR in 2024, this study applies a Probability Impact Matrix (PIM) across six procurement phases to classify 41 risk factors and develop targeted mitigation strategies, thereby strengthening e-procurement governance and safeguarding Indonesia's public works investments.

This study contributes to the literature on public sector procurement and risk management in three key ways. First, it presents an empirically validated risk-profiling framework for government e-purchasing systems, shifting the analytical emphasis from theoretical vulnerabilities to observed compliance and operational risks. Second, by utilizing a unique dataset based on firsthand assessments from professionals within the Supreme Audit Institution, the research offers an authoritative perspective that is seldom represented in public administration scholarship. Third, the study bridges the gap between risk identification and systemic resolution by proposing actionable, policy-level mitigation strategies, including algorithmic vendor-experience profiling and transparent negotiation mechanisms. Although the analysis is rooted in Indonesia's infrastructure procurement context, these proposed controls provide a scalable model that can be adapted internationally to enhance accountability in digital public procurement.

## 2. LITERATURE REVIEW AND HYPOTHESIS

### Risk and Its Implications

Risk represents an event imbued with uncertainty, capable of producing both positive and negative outcomes; it is a function of the likelihood of occurrence and the magnitude of its impact (Project Management Institute, 2017). In construction projects, where information drives uncertainty, unidentified or poorly managed high-impact risks can threaten project objectives. Accordingly, systematic risk identification within a structured Risk Management process is essential to preempt undesirable outcomes.

### Risk Management Framework

According to Project Management Institute (2017), Risk Management comprises seven sequential stages (Figure 1), from Identification through to Monitoring and Control. In the IT services domain, structured risk registers and stakeholder collaboration models have been shown to enhance negotiation transparency and control, underscoring the value of standardized risk-management practices in e-procurement (Harju et al., 2024). This study follows three core stages:

a. Risk Identification: Cataloging potential threats across project phases;
b. Qualitative Analysis: Assessing each risk's probability and impact via a Probability Impact Matrix;
c. Risk Response: Formulating strategies to mitigate, transfer, accept, or exploit identified risks.

### Government Procurement in Indonesia

Government Procurement of Goods/ Services, known locally as PBJ, is defined by Presidential Regulation No. 12 of

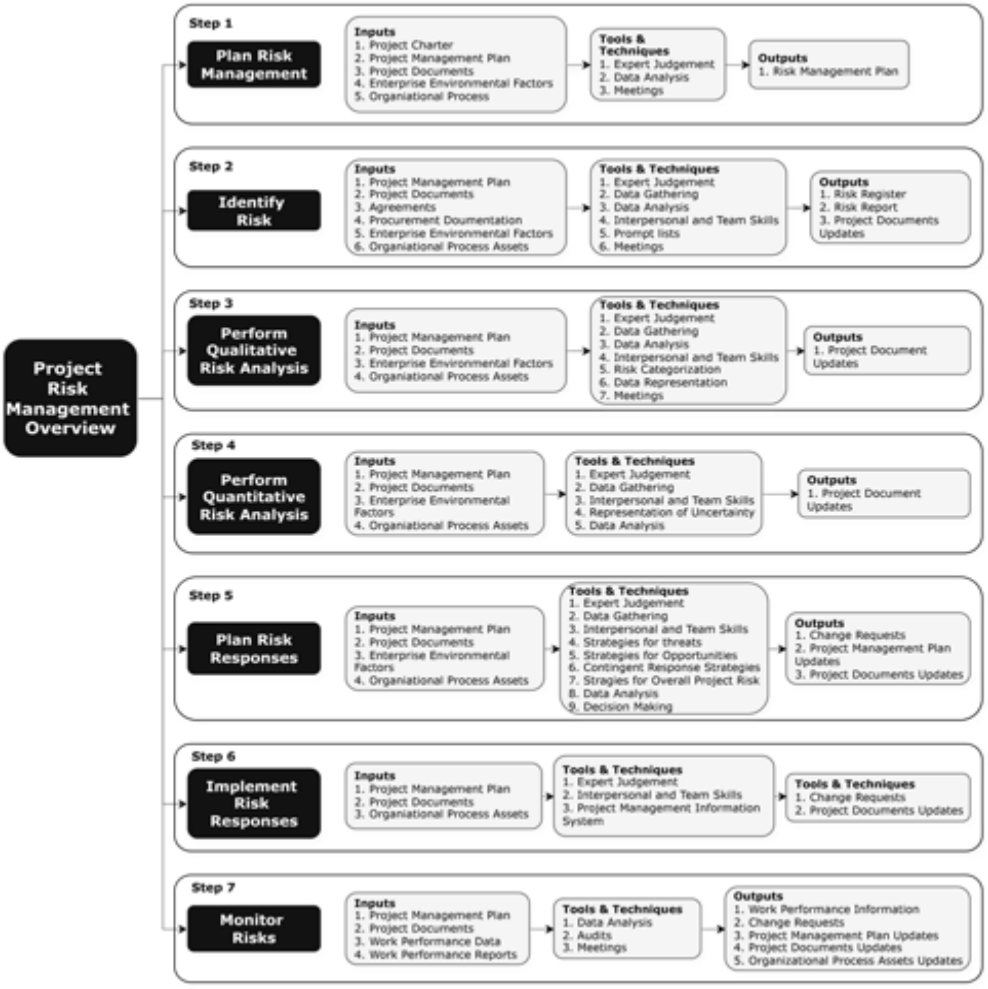
2021 about Government Procurement of Goods/Services as the end-to-end process, funded by APBN/APBD, that spans need identification through handover of deliverables. PBJ unfolds in six distinct stages (Figure 2):

a. Procurement Planning: Needs analysis, method selection, scheduling, and budgeting by PA/KPA.
b. Procurement Preparation: Post-approval of RKA-K/L by DPR/DPRD.
c. Selection Preparation: Documentation and request submission by the Project Owner's Representative to UKPBJ.
d. Selection: Evaluation by the Selection Working Group/Procurement Officer.
e. Contract Implementation: Execution per contractual and regulatory provisions.
f. Handover of Work Results: Formal acceptance of deliverables by the Contracting Officer

**E-Procurement via Electronic Catalog in Indonesia**

Indonesia's e-procurement model is operationalized through the e-purchasing catalog (Peraturan Presiden (Perpres), 2021), an electronic system listing product details, TKDN, SNI compliance, pricing, and provider credentials (Lembaga Kebijakan Pengadaan Barang/Jasa Pemerintah, 2020). Three e-catalog procurement methods are prescribed under the Government Procurement Policy Agency Regulation No. 9 of 2021 Concerning Online Stores and Electronic Catalogs in Government Procurement of Goods and Services:

Figure 1. **Summary of the Stages of Risk Management**




Source: Project Management Institute, 2017

a. Price Negotiation: Conducted on the unit price of the product by considering the quantity of products procured, shipping costs, installation costs, or product availability (Keputusan Kepala LKPP, 2022)
b. Mini Competition: Conducted with 2 (two) or more E-catalog providers that have the same product or a product with similar specifications required by the Project Owner's Representative to get the best price (Peraturan Presiden (Perpres), 2021).
c. Competitive Catalog: Closed E-catalog that contains data and information offered by qualified Providers within the scope of construction work in the form of essential construction components and basic prices within certain price limits, which are then completed automatically through an application system developed by the LKPP (Lembaga Kebijakan Pengadaan Barang/Jasa Pemerintah, 2020).

To date, Price Negotiation remains the predominant approach, with limited adoption of Mini Competition and no recorded instances of Competitive Catalog utilization.

## 3. METHODS

This study employs a quantitative descriptive methodology to systematically evaluate procurement vulnerabilities. By using a structured survey instrument, the research quantifies field auditors' empirical experiences to construct a mathematically grounded Probability-Impact Matrix (PIM) of e-purchasing risks.

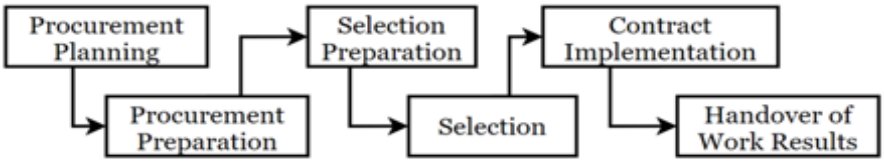
The population for this study comprises expert auditors from BPK RI specifically assigned to audit the Ministry of PUPR for the fiscal year 2024. The total number of auditors meeting this criterion during the study period was 64. Purposive sampling was utilized to establish strict inclusion criteria. Respondents were required to have direct, firsthand experience conducting infrastructure and procurement audits within the PUPR environment in 2024. This criterion ensures that risk assessments are not based on theoretical vulnerabilities but on actual compliance failures and operational realities observed in the field.

To determine a statistically robust sample size from this highly specialized population, the study applied Cochran's formula with a finite population correction. Given the constrained expert pool (N = 64), a 90% confidence level (Z = 1.645) and a 10% margin of error (e = 0.1) were established. Assuming maximum variability (p = 0.5, q = 0.5), the initial sample calculation yielded 67.65. Applying the correction for a finite population resulted in a required minimum sample size of 33.13, rounded to 34 respondents. Therefore, the selection of 34 auditors represents a statistically validated, highly representative sample, capturing over 50% of the total expert population and ensuring the findings possess significant empirical weight without risking statistical distortion.

The analytical process was conducted in three sequential phases:

a. Instrument Validation: Data were collected using a closed-ended questionnaire assessing 41 identified risk factors across six procurement stages. Respondents rated both the Probability of occurrence and the Impact of each risk on a 5-point Likert scale (1 = Very Low/Almost Never, 5 = Very High/Very Frequent). Before risk

Figure 2. **Stages of Procurement through Providers**




Source: Lembaga Kebijakan Pengadaan Barang/Jasa Pemerintah, 2021

calculation, the instrument's reliability was tested using Cronbach's Alpha. The overall reliability score across the 41 variables was 0.88, confirming strong internal consistency for the dataset.

b. Risk Quantification: The core analysis utilized the Probability-Impact Matrix (PIM) framework. For each of the 41 risk factors, the mean Probability score was multiplied by the mean Impact score, yielding a standardized Risk Index (Severity Index) for each variable.
c. Risk Profiling and Classification: The resulting Risk Index values were mapped onto a predefined matrix to categorize the vulnerabilities into distinct tiers (Low, Medium, and High Risk). This classification enabled the ranking of systemic vulnerabilities within the e-purchasing catalog, enabling targeted development of the nine proposed mitigation strategies focused on the highest-tier risks.

The research flowchart is shown in Figure 3.

**Stage 1: Risk Identification and Classification of E-Purchasing Catalog**

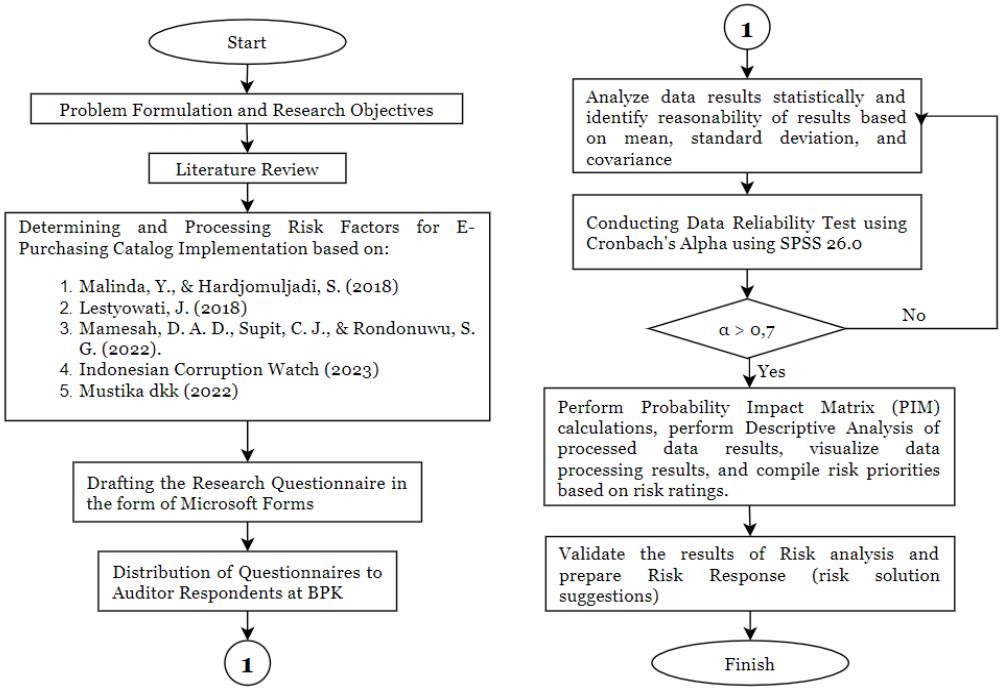
Risk classification involves categorizing potential events by their nature and effect on construction projects (Flanagan & Fredericks, 1993). Classification is aligned with Indonesia's six procurement stages. Drawing on seven foundational studies (Table 2), we identified 41 relevant risk factors labeled X1.1 through X6.6, where the first digit denotes the procurement stage and the second indicates the variable sequence (Table 5).

**Stage 2: Risk Assessment and Matrix Analysis**

A structured questionnaire is distributed to capture auditor judgments regarding risk probability and impact, operationalized through the following methodological steps:

a. Respondent Selection: Applying Cochran's formula (Cochran, 1963) and adjusting for a finite population (N = 64 active PUPR auditors in BPK's Auditorat IV.A based on Audit Task Letter), we determined a sample size of 34 respondents.

Figure 3. **Research Flowchart**




Source: Processed Data

b. Reliability Testing: Questionnaire consistency was assessed via Cronbach's Alpha (α), with a threshold of 0.70 indicating acceptable reliability (Taber, 2018). Analyses were conducted in SPSS 26.0 using the formula
c. PIM Construction: Respondents rated each risk's probability and impact on five-point scales (Table 3 and Table 4). The Severity Index for each factor was calculated as the mathematical product of its Probability Score and Impact Score and subsequently plotted on the PIM (Figure 4).

a) Chance or Frequency of Risk Occurring (Probability): The probability of a risk occurring assesses how often and/or likely an identified risk is. The frequency classification is divided into five classifications according to Table 3
b) Impact if the risk occurs (Impact): Risk impact assesses the impact on achieving the initial plan if the risk occurs. Risk classification is divided into five classifications (Table 4).

Table 2. **Related Publications**

| Journal | Research Title | Publication Year | Author |
|---|---|---|---|
| 1 | Dominant Constraint Factors of E-Catalog Use in the Procurement Process of Road Construction Projects with SPSS & RII Methods | 2019 | Malinda & Hardjomuljadi (2019) |
| 2 | Analysis of E-Purchasing Problems in the Procurement of Goods and Services of the Work Unit | 2018 | Lestyowati (2018) |
| 3 | Risk Analysis and Mitigation of the Implementation of Construction Services Viewed from the Procurement Side of Service Users in South Minahasa Regency | 2022 | Mamesah et al. (2022) |
| 4 | Mapping the Potential for Fraud in the E-Purchasing Method of the Goods/Services Procurement Process in Indonesia | 2023 | Rachman & Alamsyah (2023) |
| 5 | Risk Assessment of the Use of Construction Catalogs in the Road Maintenance Sector with Factor Analysis | 2022 | Mustika et al. (2021) |
| 6 | Using probability impact matrix (PIM) in analyzing risk factors affecting the success of oil and gas construction projects in Yemen | 2020 | Kassem et al. (2020) |
| 7 | Investigation into the Causes of Delays and Cost Overruns in Uganda's Public Sector Construction Projects | 2013 | Alinaitwe et al. (2013) |

Source: Processed Data

Table 3. **Frequency/Likelihood of Risk Scale**

| Scale | Frequency/Likelihood | Description |
|---|---|---|
| 1 | Very Rarely Occurs | Likelihood of Occurrence ≤ 10% |
| 2 | Rarely Occurs | Likelihood of Occurrence Between 11% - 30% |
| 3 | Normal | Likelihood of Occurrence Between 31% - 50% |
| 4 | Occurs Frequently | Likelihood of Occurrence Between 51% - 70% |
| 5 | Very Often Occurs | Likelihood of Occurrence > 70% |

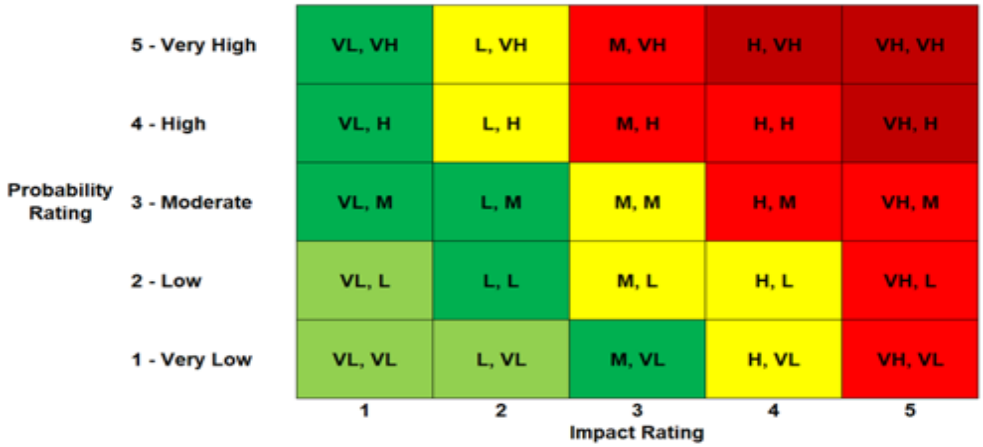
Source: Project Management Institute, 2017

Table 4. **Risk Impact Scale**

| Scale | Impact | Description |
|---|---|---|
| 1 | Very Small | Strongly does not affect the achievement of the plan |
| 2 | Small | Less influence on the achievement of the plan |
| 3 | Medium | Moderately affects the achievement of the plan |
| 4 | Large | Affects the achievement of the plan |
| 5 | Very Large | Strongly influence the achievement of the plan |

Source: Processed Data

Figure 4. **Probability Impact Matrix**




Source: Kassem et al., 2020

c) From these calculations, the categories of frequency and impact can be determined. After that, the risk value analysis process can be carried out. The risk score will be plotted in the PIM, as shown in Figure 4.

d. Risk Prioritization and Visualization: The overall PIM data will be presented in visuals, making it easier to analyze further. Tools for data visualization include scatter plots, which display all data in a single graph. Determining risk priority involves ranking the overall risk obtained into two types: risk rating for all identified variables and risk stage rating.

**Stage 3: Risk Response**

We organized risk responses in two phases:

A. Grouping Risk Response: It was clustered the nine highest-priority risks into two themes, Price Negotiation Methods and Quality Assurance, based on inter-risk correlations.

B. Risk Response Validation: Drawing on six action classifications (Ghaeb et al., 2023) and interviews with BPK auditors (> 20 years' experience), we refined mitigation measures:

a. Avoiding: Eliminating risk sources by adjusting project scope.
b. Accepting: Acknowledging risks with minimal response when the impact is tolerable.
c. Mitigating and Reducing: Decreasing the likelihood or impact of risk through targeted controls (e.g., specialized training).
d. Transferring: Shifting responsibility to third parties through contractual arrangements.
e. Sharing: Co-managing risk with partners who possess the requisite capabilities.
f. Removing: Eradicating the root causes to entirely eliminate the risk.

This structured methodology ensures systematic identification, rigorous analysis, and validated responses tailored to Indonesia's e-purchasing catalog context.

## 4. RESULTS AND DISCUSSION

### Respondents Demographic

Table 5 summarizes the characteristics of the 34 auditors who participated in the survey. The majority were male (68%) and aged 29-43 years (68%). Nearly all respondents (76%) had over 10 years of service at BPK. Half of the sample held a master's degree (S2), while the remainder possessed a bachelor's degree (S1/D4). The highly experienced and well-qualified cohort provides a robust foundation for reliable risk assessments.

### Identified E-Purchasing Catalog Risks

A comprehensive review of the literature, including academic journals and institutional guidelines regarding public procurement and e-purchasing catalog vulnerabilities, led to the identification of 41 specific risk factors. For systematic analysis, these risks were categorized into six sequential stages of the goods and services procurement process: Procurement Planning, Procurement Preparation, Selection Preparation, Procurement Implementation, Contract Implementation, and Handover of Work Results. The complete taxonomy of the 41 identified risk factors, along with their corresponding literature sources, is provided in Appendix 1.

### Reliability Analysis

Cronbach's Alpha values for each procurement stage (Table 6) all exceed the 0.70 threshold, indicating strong internal consistency across the 41 risk items (Taber, 2018). The overall α of 0.88 confirms that our survey instrument reliably captures auditors' perceptions.

Table 5. **Demographic Information**

| Respondents' Characteristics | Frequency | % |
|---|---|---|
| Gender | | |
| Male | 23 | 68 |
| Female | 11 | 32 |
| Age | | |
| 19 to 28 years old | 3 | 9 |
| Over 28 to 43 years old | 23 | 68 |
| More than 43 years old | 8 | 24 |
| Position | | |
| Auditor - First Expert | 16 | 47 |
| Auditor - Junior Expert | 17 | 50 |
| Auditor - Associate Expert | 1 | 3 |
| Period of Service at BPK | | |
| 1 to 5 years | 4 | 12 |
| More than 5 to 10 years | 3 | 9 |
| More than 10 to 15 years | 12 | 35 |
| More than 15 to 20 years | 14 | 41 |
| More than 25 years | 1 | 3 |
| Latest Education | | |
| S1/D4 - bachelor's degree | 17 | 50 |
| S2 - master's degree | 17 | 50 |

Source: Processed Data

Table 6. **Reliability Analysis Test Results with Cronbach's Alpha**

| No. | Risk Factor Stages | Variables | α | Standardized α |
|---|---|---|---|---|
| 1 | Procurement Planning | 5 | 0.839 | 0.839 |
| 2 | Procurement Preparation | 6 | 0.886 | 0.89 |
| 3 | Selection Preparation | 5 | 0.881 | 0.883 |
| 4 | Selection | 13 | 0.915 | 0.916 |
| 5 | Contract Implementation | 6 | 0.864 | 0.872 |
| 6 | Handover of Work Results | 6 | 0.87 | 0.869 |
| | Total | 41 | 0.88 | 0.88 |

Source: Processed Data

Table 7. **PIM Analysis Results at Stage 1: Procurement Planning**

| Variable | Probability Score | Impact Score | PIM | Classification Probability | Classification Impact | Risk Matrix | Rank |
|---|---|---|---|---|---|---|---|
| X1.1 | 2,88 | 2,97 | 8,55 | M | M | M | 1 |
| X1.2 | 2,79 | 3,00 | 8,37 | M | H | H | 2 |
| X1.3 | 2,38 | 2,76 | 6,57 | M | M | M | 4 |
| X1.4 | 2,29 | 2,85 | 6,53 | M | M | M | 5 |
| X1.5 | 2,65 | 3,12 | 8,27 | M | H | H | 3 |
| Average | 2,60 | 2,94 | 7,66 | | | | |

Source: Processed Data

**Results of Statistical Data Analysis**

Standard deviations (SD), and coefficient of variation (CV) for all 41 risks, is provided in Appendix 2. Mean scores cluster around 3.0 on the 1-5 scale, and CVs generally range from 10% to 30%, indicating consistent perceptions among the auditors.

**Probability-Impact Matrix (PIM) Analysis**

The probability and impact scores for each risk factor were plotted on a 5×5 PIM (Figure 4) and computed the PIM summaries for each stage (Tables 7-14).

a. Stage 1 (Procurement Planning): All five risks fall within the medium-medium quadrant, with X1.2 (Planning Document Mismatch) and X1.5 (Weak Legal Framework) also classified as medium-high but remain tolerable overall (Table 7).
b. Stage 2 (Procurement Preparation): All six factors occupy the high-high quadrant, with X2.2 (HPR Price Risk) as the highest concern (PIM = 13.50) (Table 8).
c. Stage 3 (Selection Preparation): A mix of medium and high classifications; X3.2 (Insufficient Catalog Display) emerges as the highest risk (PIM = 10.40) (Table 9).
d. Stage 4 (Selection): Price negotiation issues dominate, with X4.8 (Collusion Risk) topping the list (PIM = 14.10), followed by X4.9 and X4.10 (Table 10).
e. Stage 5 (Contract Implementation): Specification and price-analysis mismatches (X5.3, X5.4) both score highest (PIM = 13.70), highlighting field-to-catalog divergences (Table 11).
f. Stage 6 (Handover): Quality shortfalls (X6.5) and follow-up failures (X6.6) register the highest impact, placing them in the high-high quadrant (Table 12).

**Overall Stage Rankings**

Aggregating stage averages (Table 13) confirms Procurement Preparation (PIM = 11.62) and Contract Implementation (PIM = 11.45) as the most critical phases.

Table 8. **PIM Analysis Results at Stage 2: Procurement Preparation**

| Variable | Probability Score | Impact Score | PIM | Classification Probability | Classification Impact | Risk Matrix | Rank |
|---|---|---|---|---|---|---|---|
| X2.1 | 3,24 | 3,03 | 9,82 | H | H | H | 6 |
| X2.2 | 3,65 | 3,71 | 13,5 | H | H | H | 1 |
| X2.3 | 3,5 | 3,56 | 12,5 | H | H | H | 2 |
| X2.4 | 3,03 | 3,53 | 10,7 | H | H | H | 5 |
| X2.5 | 3,44 | 3,53 | 12,1 | H | H | H | 3 |
| X2.6 | 3,24 | 3,44 | 11,2 | H | H | H | 4 |
| Average | 3,35 | 3,47 | 11,64 | | | | |

Source: Processed Data

Table 9. **PIM Analysis Results at Stage 3: Selection Preparation**

| Variable | Probability Score | Impact Score | PIM | Classification Probability | Classification Impact | Risk Matrix | Rank |
|---|---|---|---|---|---|---|---|
| X3.1 | 2.56 | 3.12 | 7.99 | M | H | H | 4 |
| X3.2 | 3.12 | 3.32 | 10.4 | H | H | H | 1 |
| X3.3 | 3 | 3.06 | 9.18 | H | H | H | 2 |
| X3.4 | 2.76 | 2.85 | 7.87 | M | M | M | 5 |
| X3.5 | 2.68 | 3.38 | 9.06 | M | H | H | 3 |
| Average | 2.82 | 3.15 | 8.89 | | | | |

Source: Processed Data

Table 10. **PIM Analysis Results at Stage 4: Selection**

| Variable | Probability Score | Impact Score | PIM | Classification Probability | Classification Impact | Risk Matrix | Rank |
|---|---|---|---|---|---|---|---|
| X4.1 | 2.91 | 3.38 | 9.84 | M | H | H | 6 |
| X4.2 | 2.97 | 3.12 | 9.27 | M | H | H | 7 |
| X4.3 | 3.03 | 3 | 9.09 | H | H | H | 9 |
| X4.4 | 3.24 | 3.53 | 11.4 | H | H | H | 4 |
| X4.5 | 3.26 | 3.12 | 10.2 | H | H | H | 5 |
| X4.6 | 3.03 | 2.97 | 9 | H | M | H | 11 |
| X4.7 | 2.85 | 3.24 | 9.23 | M | H | H | 8 |
| X4.8 | 3.68 | 3.82 | 14.1 | H | H | H | 1 |
| X4.9 | 3.59 | 3.74 | 13.4 | H | H | H | 2 |
| X4.10 | 3.5 | 3.62 | 12.7 | H | H | H | 3 |
| X4.11 | 2.88 | 3.15 | 9.07 | M | H | H | 10 |
| X4.12 | 2.88 | 3 | 8.64 | M | H | H | 12 |
| X4.13 | 2.82 | 2.85 | 8.04 | M | M | M | 13 |
| Average | 3.13 | 3.27 | 10.30 | | | | |

Source: Processed Data

Table 11. **PIM Analysis Results on Stage 5: Contract Implementation**

| Variable | Probability Score | Impact Score | PIM | Classification Probability | Classification Impact | Risk Matrix | Rank |
|---|---|---|---|---|---|---|---|
| X5.1 | 2.97 | 3.29 | 9.77 | M | H | H | 5 |
| X5.2 | 3.06 | 3.29 | 10.1 | H | H | H | 4 |
| X5.3 | 3.71 | 3.68 | 13.7 | H | H | H | 2 |
| X5.4 | 3.62 | 3.79 | 13.7 | H | H | H | 1 |
| X5.5 | 3.15 | 2.97 | 9.36 | H | M | H | 6 |
| X5.6 | 3.38 | 3.65 | 12.3 | H | H | H | 3 |
| Average | 3.32 | 3.45 | 11.49 | | | | |

Source: Processed Data

Table 12. **PIM Analysis Results on Stage 6: Handover of Work Results**

| Variable | Probability Score | Impact Score | PIM | Classification Probability | Classification Impact | Risk Matrix | Rank |
|---|---|---|---|---|---|---|---|
| X6.1 | 2.85 | 3.41 | 9.72 | M | H | H | 5 |
| X6.2 | 2.53 | 3.26 | 8.25 | M | H | H | 6 |
| X6.3 | 3.29 | 3.47 | 11.4 | H | H | H | 3 |
| X6.4 | 2.79 | 3.5 | 9.77 | M | H | H | 4 |
| X6.5 | 3.21 | 3.85 | 12.4 | H | H | H | 1 |
| X6.6 | 3.38 | 3.47 | 11.7 | H | H | H | 2 |
| Average | 3.01 | 3.49 | 10.54 | | | | |

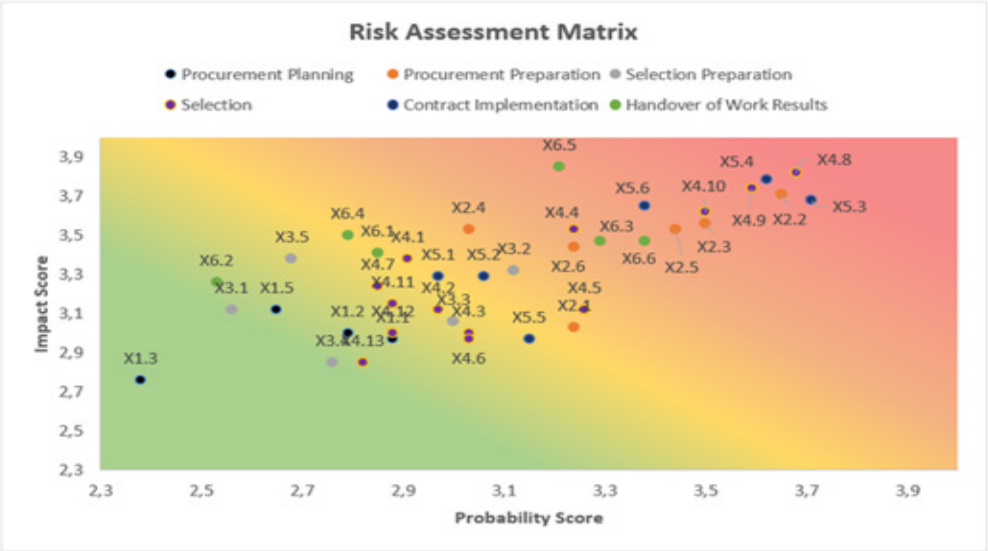
Source: Processed Data

Table 13. **Summary of PIM Scores by Stage**

| Rank | Stages | Probability Score | Impact Score | PIM | Classification Probability | Classification Impact | Risk Matrix |
|---|---|---|---|---|---|---|---|
| 1 | Procure-ment Preparation | 3.35 | 3.47 | 11.62 | H | H | H |
| 2 | Contract Implemen-tation | 3.32 | 3.45 | 11.45 | H | H | H |
| 3 | Handover of Work Results | 3.01 | 3.49 | 10.5 | H | H | H |
| 4 | Selection | 3.13 | 3.27 | 10.24 | H | H | H |
| 5 | Selection Preparation | 2.82 | 3.146 | 8.87 | M | H | H |
| 6 | Procure-ment Plan-ning | 2.6 | 2.94 | 7.64 | M | M | M |

Source: Processed Data

Figure 5. **Risk Assessment Matrix on All Risk Factor Variables**




Source: Processed Data

Table 14. **Top 10 Risks by PIM**

| Rank | Variable | Stages | Probability Score | Impact Score | PIM |
|---|---|---|---|---|---|
| 1 | X4.8 | Selection | 3.68 | 3.82 | 14.06 |
| 2 | X5.4 | Contract Implementation | 3.62 | 3.79 | 13.72 |
| 3 | X5.3 | Contract Implementation | 3.71 | 3.68 | 13.65 |
| 4 | X2.2 | Procurement Preparation | 3.65 | 3.71 | 13.54 |
| 5 | X4.9 | Selection | 3.59 | 3.74 | 13.43 |
| 6 | X4.10 | Selection | 3.50 | 3.62 | 12.67 |
| 7 | X2.3 | Procurement Preparation | 3.50 | 3.56 | 12.46 |
| 8 | X6.5 | Handover of Work Results | 3.21 | 3.85 | 12.36 |
| 9 | X5.6 | Contract Implementation | 3.38 | 3.65 | 12.34 |
| 10 | X2.5 | Procurement Preparation | 3.44 | 3.53 | 12.14 |

Source: Processed Data

**Risk Visualization**

Figure 5 illustrates the distribution of risk values based on the impact value called the Risk Assessment Matrix. In the figure, all the orange-colored variables, namely the procurement preparation stage, are in the upper right part of the graph, and the contract implementation, marked in light blue, is partly in that area. Meanwhile, the ash-colored selection preparation stage tends to have a smaller risk value at the bottom left.

**Top-Ranking Risks**

Table 14 lists the ten highest-scoring risks across all stages, led by X4.8 (Collusion) and X5.4 (Specification Differences).

**Risk Grouping and Response Themes**

We clustered the top ten risks into two response themes:

a. Price Negotiation Methods (Table 15): factors X4.8, X2.2, X4.9, and X4.10 highlight the need for structured negotiation protocols.

b. Quality Assurance (Table 16): factors X5.4, X5.3, X2.3, X6.5, and X5.6 underscore specification and method alignment.

**Validation of Risk Responses**

Table 17 presents nine validated mitigation strategies, sourced from Rachman & Alamsyah (2023) and senior auditor interviews, and mapped to our two themes and overall risk. These results provide a comprehensive, data-driven basis for developing targeted interventions within Indonesia's e-purchasing catalog system.

## DISCUSSION

### Addressing Price Negotiation Risks

The latest technological developments allow the entire transaction implementation to be monitored and recorded in the database. One recommendation for addressing negotiation-related problems is the publication of e-purchasing transaction data. LKPP must immediately publish e-purchasing transaction data on each Ministry/Agency/Local Government (Rachman & Alamsyah, 2023). European case studies demonstrate that public publication of bid-level transaction data

Table 15. **Group of Risk Factors Related to Price Negotiation Method**

| Rank | Var | Risk Summary | Underlying Causes |
|---|---|---|---|
| 1 | X4.8 | Price Fixing: Collusion between Construction Service Providers and Project Owner's Representative | Unit prices are set unilaterally by the Project Owner's Representative without independent oversight. |
| 4 | X2.2 | HPR Misalignment: Highest Retail Price not derived from genuine negotiation | E-Catalog prices are preset as HPR, bypassing any formal negotiation process. |
| 5 | X4.9 | Inadequate Negotiation: E-Purchasing catalog implementation proceeds without sufficient bargaining | Negotiation protocols are weak or absent during the e-purchasing process. |
| 6 | X4.10 | Disincentivized Negotiation: Price discussions are skipped due to lack of incentives | No structured incentives or regulatory requirements to prompt active price negotiations. |

Source: Processed Data

Table 16. **Quality Assurance Risk Factors**

| Rank | Var | Risk Summary | Underlying Causes |
|---|---|---|---|
| 2 | X5.4 | Specification Discrepancy: Divergence between catalog-listed and actual field specifications | E-Catalog entries omit or generalize critical item specifications required on site. |
| 3 | X5.3 | Analysis Mismatch: Unit Price Analysis and Technical Analysis components differ from field practices | E-Catalog's price breakdown and technical analysis templates are not aligned with real-world methods. |
| 7 | X2.3 | Generic TORs: Technical Specifications/Terms of Reference are overly broad or non-prescriptive | E-Catalog framework does not enforce detailed TORs as a procurement prerequisite. |
| 8 | X6.5 | Quality Shortfall: Failure to achieve planned work quality | E-Purchasing catalog lacks defined quality benchmarks and acceptance criteria in planning documents. |
| 9 | X5.6 | Method Inaccuracy: Inappropriate construction methods applied during implementation | E-Catalog does not specify or validate the intended work methods within TOR or contract documents. |

Source: Processed Data

significantly reduces collusion by enabling real-time heat-map analysis of price variances (Paraskeva & Tsoulfas, 2025).

In addition, monitoring the verification process and inclusion of a product in the electronic catalog to avoid collusion (Rachman & Alamsyah, 2023). Interviews findings support this solution, as there is indeed potential for collaboration between the PPK and the selected Service Provider. Transparency must be a priority, and all efforts toward transparency, such as public channels, are implementable solutions.

E-purchasing catalog transactions rely on negotiation mechanisms to ensure that the task can still be carried out efficiently. However, negotiation mechanisms are subjective, making it difficult to establish standards for evaluating negotiations. Regulations related to negotiation methods must require measurable outputs, such as binding working papers for PPK on the negotiation procedures regulated or carried out in accordance with the regulations.

Table 17. **Summary of Risk Response Results**

| No | Response Group | Risk Response | Explanation | Source |
|---|---|---|---|---|
| 1 | Price Negotiation | Sharing | Publish detailed e-catalog transaction data to enhance transparency. | Rachman & Alamsyah (2023) |
| 2 | Price Negotiation | Sharing | Create a public monitoring portal for tracking product listings and changes in the e-catalog. | Rachman & Alamsyah (2023), Interview |
| 3 | Price Negotiations | Mitigating & Reducing | Enforce mandated price-negotiation protocols in accordance with regulatory provisions. | Interview |
| 4 | Price Negotiations | Mitigating & Reducing | Introduce alternative procurement methods, Mini-Competition and Competitive Catalog, to promote competitive pricing. | Interview |
| 5 | Price Negotiations | Removing | Restrict direct communication between Project Owner's Representatives and service providers via a fully recorded system. | Rachman & Alamsyah (2023) |
| 6 | Quality Assurance | Mitigating & Reducing | Establish a conformity-assessment mechanism to verify that delivered goods/services match e-catalog specifications. | Rachman & Alamsyah (2023) |
| 7 | Quality Assurance | Removing | Adjust e-catalog specifications and price components in response to field validation findings. | Interview |
| 8 | Quality Assurance | Mitigating & Reducing | Implement scheduled updates to the vendor database, ensuring distributor and vendor information remains current. | Interview |
| 9 | Overall | Mitigating & Reducing | Develop and deploy a comprehensive system for recording and verifying service-provider experience profiles. | Interview |

Source: Processed Data

Based on the interview results, the implementation of Mini-Competitions is one of the solutions to consider as an alternative to e-purchasing catalogs tailored to the project's scale. However, it is important to note that the criteria for evaluating the winners of the mini-competition must be clearly defined and fair, taking into account various parameters beyond the lowest price, such as specifications, the service provider's experience, and other factors. The government must focus on developing adequate tools to support the evaluation mechanism, as formulating rules without such tools will complicate the implementation and enforcement of regulations. Tools such as an online mini-competition with publicly accessible parameters and predetermined coefficient factors could be one method to implement.

Communication between the PPK and the service provider is crucial in the selection process, as it determines the success of the project implementation. However, if not properly monitored and supervised, this can become a potential issue. The LKPP must ensure that communication between the PP/PPK and the service provider is recorded in the system to minimize the potential for bribery (Rachman & Alamsyah, 2023). In financial services procurement, rigorous post-implementation quality audits, linked to service-level agreements, have proven effective at aligning delivered outputs with specifications (Harju et al., 2024).

**Mitigating Quality Assurance Risks**

The implementation of work utilizing e-purchasing catalogs is conducted without a tender process, which certainly poses a risk, as supplier selection is not based on competitive specifications. This means that the quality of the work requires greater scrutiny, and there must be an evaluation mechanism regulated by regulations to ensure that the output complies with the specifications. The Indonesian Procurement Agency (LKPP) must ensure that the verification process for project completion is complemented by a mechanism to check the conformity of the goods/services delivered with the specifications in the electronic catalog (Rachman & Alamsyah, 2023).

The e-catalog has practical advantages; PPKs can easily compile work items for a work package using the items available in the e-catalog. However, construction projects sometimes have specific specifications that result in certain components not being available in the e-catalog. This limits the PPK's ability to include such work items. Based on interviews, the method that can be implemented is within the e-catalog application. There is an "other" menu option that allows PPK to input or edit the listed work items by slightly modifying their technical components to align with field conditions, thereby making the price estimates in the e-catalog more in line with real-world conditions.

The implementation of e-purchasing catalogs will heavily depend on the completeness of the data stored in the e-catalog (e-catalog database). The database includes the types of materials or work items, as well as the unit prices for labor and goods. Based on interviews, there is a need for special efforts or additional measures related to updating data collection or information. For example, collecting data on major vendors in each city for key construction-related work items, such as major producers of cement, coarse aggregate, fine aggregate, reinforcing bars, and so on. This could also serve as a solution for the basis for determining prices at risk of being HET (Highest Retail Price), making the HPS (Owner's Estimate) more representative.

**Integrated Risk-Response Framework**

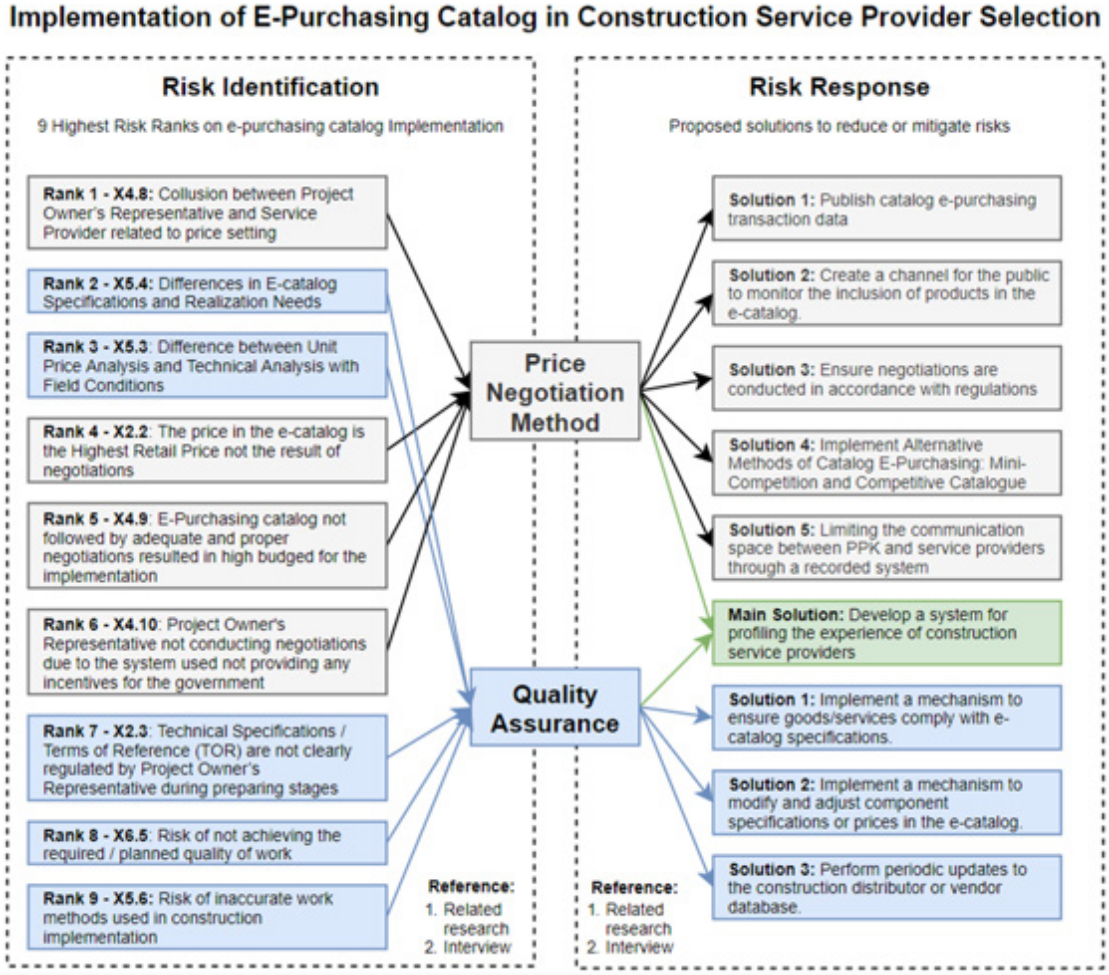
Issues related to negotiation mechanisms and the quality of results ultimately depend on the experience of the construction service provider, the party responsible for implementing and realizing these aspects. This underscores the importance of assessing the service provider's profile. Based on interview results, one key aspect

of a construction service provider is documenting their experience profile. This becomes even more important because the selection of service providers through e-purchasing catalogs and the negotiation process are based on the principle of trust between the employer/PPK and the service provider.

The delivery of construction services primarily depends on the principle of trustworthiness and within a limited timeframe. The principle of trust is easy to implement at the personal level or on a small scale, but it becomes much more difficult at a larger scale, such as in government, so a method is needed to assess or quantify that trust. Negotiations will be very difficult if the PPK does not know the company's track record, as it is hard to build trust between the PPK and the service provider. High trust can facilitate the selection of service providers in an effective, efficient, and quality-maintaining manner.

The expert provided several important notes for implementing the assessment of service provider portfolios, such as the necessity to maintain a complete and centralized record of the track record or portfolio of construction service providers, particularly regarding projects they have undertaken, including both government and private sector projects. Furthermore, parameters that must be evaluated from the track record to form the basis for the selection of service providers, such as the number of projects and project classifications previously undertaken,

Figure 6. **Chart of Risk Identification to Risk Response on E-Purchasing Catalog**




Source: Processed Data

innovation records from previous projects, and the satisfaction level of the PPK or employer on previously completed projects. The level of satisfaction can be measured and assessed, for example, using standardized grades, and the presence of special notes or comments on the strengths and weaknesses of the service provider in previous projects, thereby facilitating the PPK in conducting the selection process and understanding the criteria for service providers. Additionally, to implement portfolio assessment, there must be an institution responsible for recording the service provider's track record. This institution should be authorized to assess independently, outside the control of certain parties, to ensure objectivity. In some cases, for example, service providers with little experience or special notes must be marked and given additional attention, such as higher/more intensive supervision or assignments only on simpler work packages with more flexible deadlines. A summary of the overall research on the implementation of catalog e-purchasing in the selection of construction service providers is shown in Figure 6.

## 5. CONCLUSION

This study finds that while the digitalization of public procurement through e-purchasing catalogs is intended to improve operational efficiency, it systematically shifts critical vulnerabilities to the procurement preparation and contract implementation phases, particularly affecting the integrity of price negotiation and quality assurance. The empirical evidence indicates that addressing these systemic risks requires both theoretical and practical shifts from traditional procedural oversight to data-driven, transparent controls, such as integrated vendor-experience profiling and algorithmically supported alternative negotiation mechanisms. As this research is grounded in the ex-post perspective of supreme auditors specializing in construction services, future studies should examine the ex-ante perspectives of regulatory bodies, policymakers, and private contractors to develop a comprehensive, multi-stakeholder risk taxonomy. Additionally, further empirical research is recommended to assess the practical implementation and effectiveness of the proposed quality assurance frameworks and alternative negotiation models across various government e-procurement sectors.

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Appendix 1. **Identified Risk Results**

| Variable | Risk | Probability | | | Impact | | |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | CV (%) | Mean | SD | CV (%) |
| X1.1 | Risk of regional strategic plan mismatch with expected results | 2.88 | 0.8 | 28% | 2.97 | 0.9 | 31% |
| X1.2 | Risk of mismatch of planning needs (Documents needed during procurement planning (DED documents, tenders, etc.) | 2.79 | 0.9 | 32% | 3 | 0.9 | 29% |
| X1.3 | Risk of changes in goods and services procurement regulations related to the method for selecting Construction Service Providers with e-purchasing catalogs | 2.38 | 0.6 | 27% | 2.76 | 0.8 | 30% |
| X1.4 | Risk that there is no budget or special allocation related to the implementation of construction work with e-purchasing catalogs | 2.29 | 0.8 | 34% | 2.85 | 0.9 | 33% |
| X1.5 | The risk of not having a strong governing law underlying the implementation of the catalog e-purchasing policy | 2.65 | 0.9 | 33% | 3.12 | 0.9 | 30% |
| X2.1 | The risk that the work items needed in the implementation of the work are not or are not yet available in the E-Catalog (completeness of item types) | 3.24 | 0.9 | 28% | 3.03 | 0.7 | 22% |
| X2.2 | The risk that the price listed in the e-catalog is not the price that has been negotiated but the Highest Retail Price (HPR) for the Government so that it causes the Owner's Estimate (OE) value to be too high or low | 3.65 | 0.9 | 25% | 3.71 | 0.8 | 22% |
| X2.3 | The risk that the process of preparing technical specifications / Terms of Reference (TOR) for tender/selection documents by the Project Owner's Representative is not clear enough (too general/loose) | 3.5 | 0.8 | 22% | 3.56 | 0.7 | 18% |
| X2.4 | The risk that the construction planning design prepared does not follow the planned scope of work | 3.03 | 0.8 | 26% | 3.53 | 0.8 | 22% |
| X2.5 | The risk that the preparation of Construction Service Provider selection documents (DED, Technical Specifications, etc.) by the Project Owner's Representative is unclear/ biased | 3.44 | 0.8 | 22% | 3.53 | 0.6 | 16% |
| X2.6 | Risk of unavailability / incomplete design drawings / DED (Detail Engineering Design) used in the implementation of work | 3.24 | 0.7 | 21% | 3.44 | 0.8 | 22% |
| X3.1 | Lack of clarity/lack of understanding of the catalog contract | 2.56 | 0.7 | 29% | 3.12 | 0.8 | 27% |

| Variable | Risk | Probability | | | Impact | | |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | CV (%) | Mean | SD | CV (%) |
| X3.2 | Applications for the implementation of e-catalog have not been able to fully display the information needed by users. | 3.12 | 0.8 | 24% | 3.32 | 0.8 | 24% |
| X3.3 | Government agencies always want the original procurement documents. | 3 | 0.9 | 30% | 3.06 | 0.7 | 24% |
| X3.4 | The e-catalog system is not practical and user-friendly. | 2.76 | 0.8 | 30% | 2.85 | 0.7 | 24% |
| X3.5 | Security of application systems and documents from virus or hacker attacks. | 2.68 | 0.8 | 31% | 3.38 | 1 | 29% |
| X4.1 | Risk of lack of legal control systems that can be used to report or address Construction Service Provider selection fraud in the electronic scope | 2.91 | 0.9 | 29% | 3.38 | 0.7 | 22% |
| X4.2 | Risk of miscommunication between Project Owner's Representative and Construction Service Provider due to lack of personal interaction with people involved in procurement, such as where clarification is needed | 2.97 | 0.8 | 27% | 3.12 | 0.8 | 27% |
| X4.3 | Risk of a small number of Construction Service Providers in the e-catalog being able to carry out catalog e-purchasing due to various causes such as human resource needs in the IT field, lack of knowledge/information, etc. | 3.03 | 0.9 | 28% | 3 | 0.6 | 20% |
| X4.4 | The risk of not conducting Construction Service Provider performance assessments causes the selected service provider to not necessarily have the ability to complete the work as expected/planned | 3.24 | 0.8 | 25% | 3.53 | 0.6 | 17% |
| X4.5 | Risk of lack of involvement of small business groups that can participate in the catalog e-purchasing process because they have not met the requirements to be registered as Construction Service Providers in the e-catalog | 3.26 | 0.8 | 25% | 3.12 | 0.7 | 23% |
| X4.6 | Risk of unprepared culture of Construction Service Provider companies and the government in the implementation of e-purchasing catalogs | 3.03 | 0.7 | 23% | 2.97 | 0.6 | 21% |
| X4.7 | Risk of difficulty in determining the legality of a document included in electronic e-procurement at the selection stage | 2.85 | 0.8 | 28% | 3.24 | 0.8 | 25% |
| X4.8 | Risk of collusion between construction service providers and Project Owner's Representative who compile e-catalogs related to price setting because Project Owner's Representative determines the unit price | 3.68 | 0.8 | 21% | 3.82 | 0.8 | 21% |

| Variable | Risk | Probability | | | Impact | | |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | CV (%) | Mean | SD | CV (%) |
| X4.9 | The risk of a high budget for the implementation of the work package due to the implementation of the E-Purchasing catalog is not followed by proper and adequate price negotiations in the catalog management controller | 3.59 | 0.8 | 23% | 3.74 | 0.8 | 21% |
| X4.10 | The risk of not carrying out the price negotiation or bargaining process by the Project Owner's Representative to the Construction Service Provider due to the system used is not profitable / not providing incentives to the Project Owner's Representative. | 3.5 | 0.8 | 22% | 3.62 | 0.8 | 21% |
| X4.11 | Risk of failure in the implementation of selection or determination of the selected Construction Service Provider | 2.88 | 0.8 | 28% | 3.15 | 0.8 | 27% |
| X4.12 | Risk of incomplete or unfulfilled administrative document requirements for selecting a Construction Service Provider | 2.88 | 0.8 | 26% | 3 | 0.8 | 26% |
| X4.13 | Risk of Construction Service Provider not understanding the E-Purchasing Catalog method | 2.82 | 0.9 | 32% | 2.85 | 0.8 | 29% |
| X5.1 | Risk of incompatibility of contract clauses with the draft contract | 2.97 | 0.9 | 31% | 3.29 | 0.8 | 25% |
| X5.2 | Risk of contract price fluctuations and maintenance costs that have not been considered when listing prices in the E-Catalog | 3.06 | 0.8 | 25% | 3.29 | 0.9 | 26% |
| X5.3 | Risk that the components forming the price of the Unit Price Analysis and Technical Analysis Work items have implementation components that are different from the work methods in the field | 3.71 | 0.6 | 17% | 3.68 | 0.7 | 20% |
| X5.4 | Risk that there are differences in the specifications of work items planned in the e-catalog and those needed in the field | 3.62 | 0.5 | 15% | 3.79 | 0.7 | 18% |
| X5.5 | The risk of unavailability of the involvement of human resources in Construction Service Providers who are sufficiently trained to be able to carry out work with the catalog e-purchasing method | 3.15 | 0.7 | 22% | 2.97 | 0.8 | 28% |
| X5.6 | Risk of inaccurate work methods used in construction implementation | 3.38 | 0.7 | 20% | 3.65 | 0.7 | 19% |
| X6.1 | Risk of follow-up on the implementation of work that has failed or the Construction Service Provider cannot complete the work | 2.85 | 0.6 | 21% | 3.41 | 0.7 | 19% |

| Variable | Risk | Probability | | | Impact | | |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | CV (%) | Mean | SD | CV (%) |
| X6.2 | Risk of not implementing retention or maintenance guarantees in the selection of Construction Service Provider with the catalog e-purchasing method | 2.53 | 0.7 | 28% | 3.26 | 0.7 | 20% |
| X6.3 | Risk of many findings made by the External Auditor | 3.29 | 0.8 | 23% | 3.47 | 0.7 | 19% |
| X6.4 | Risk of legal issues arising in the selection of Construction Service Provider | 2.79 | 0.9 | 32% | 3.5 | 0.8 | 22% |
| X6.5 | Risk of not achieving the required/planned quality of work | 3.21 | 0.8 | 26% | 3.85 | 0.7 | 17% |
| X6.6 | Risk of delays in construction implementation according to the planned schedule, especially due to limited/short implementation time | 3.38 | 0.8 | 24% | 3.47 | 0.7 | 19% |

Appendix 2. **Statistical Summary of Risk Variables**

| Variable | Risk | Probability | | | Impact | | |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | CV (%) | Mean | SD | CV (%) |
| X1.1 | Risk of regional strategic plan mismatch with expected results | 2.88 | 0.8 | 28% | 2.97 | 0.9 | 31% |
| X1.2 | Risk of mismatch of planning needs (Documents needed during procurement planning (DED documents, tenders, etc.) | 2.79 | 0.9 | 32% | 3 | 0.9 | 29% |
| X1.3 | Risk of changes in goods and services procurement regulations related to the method for selecting Construction Service Providers with e-purchasing catalogs | 2.38 | 0.6 | 27% | 2.76 | 0.8 | 30% |
| X1.4 | Risk that there is no budget or special allocation related to the implementation of construction work with e-purchasing catalogs | 2.29 | 0.8 | 34% | 2.85 | 0.9 | 33% |
| X1.5 | The risk of not having a strong governing law underlying the implementation of the catalog e-purchasing policy | 2.65 | 0.9 | 33% | 3.12 | 0.9 | 30% |
| X2.1 | The risk that the work items needed in the implementation of the work are not or are not yet available in the E-Catalog (completeness of item types) | 3.24 | 0.9 | 28% | 3.03 | 0.7 | 22% |
| X2.2 | The risk that the price listed in the e-catalog is not the price that has been negotiated but the Highest Retail Price (HPR) for the Government so that it causes the Owner's Estimate (OE) value to be too high or low | 3.65 | 0.9 | 25% | 3.71 | 0.8 | 22% |
| X2.3 | The risk that the process of preparing technical specifications / Terms of Reference (TOR) for tender/selection documents by the Project Owner's Representative is not clear enough (too general/loose) | 3.5 | 0.8 | 22% | 3.56 | 0.7 | 18% |
| X2.4 | The risk that the construction planning design prepared does not follow the planned scope of work | 3.03 | 0.8 | 26% | 3.53 | 0.8 | 22% |
| X2.5 | The risk that the preparation of Construction Service Provider selection documents (DED, Technical Specifications, etc.) by the Project Owner's Representative is unclear/biased | 3.44 | 0.8 | 22% | 3.53 | 0.6 | 16% |
| X2.6 | Risk of unavailability / incomplete design drawings / DED (Detail Engineering Design) used in the implementation of work | 3.24 | 0.7 | 21% | 3.44 | 0.8 | 22% |
| X3.1 | Lack of clarity/lack of understanding of the catalog contract | 2.56 | 0.7 | 29% | 3.12 | 0.8 | 27% |

| Variable | Risk | Probability | | | Impact | | |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | CV (%) | Mean | SD | CV (%) |
| X3.2 | Applications for the implementation of e-catalog have not been able to fully display the information needed by users. | 3.12 | 0.8 | 24% | 3.32 | 0.8 | 24% |
| X3.3 | Government agencies always want the original procurement documents. | 3 | 0.9 | 30% | 3.06 | 0.7 | 24% |
| X3.4 | The e-catalog system is not practical and user-friendly. | 2.76 | 0.8 | 30% | 2.85 | 0.7 | 24% |
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| X4.1 | Risk of lack of legal control systems that can be used to report or address Construction Service Provider selection fraud in the electronic scope | 2.91 | 0.9 | 29% | 3.38 | 0.7 | 22% |
| X4.2 | Risk of miscommunication between Project Owner's Representative and Construction Service Provider due to lack of personal interaction with people involved in procurement, such as where clarification is needed | 2.97 | 0.8 | 27% | 3.12 | 0.8 | 27% |
| X4.3 | Risk of a small number of Construction Service Providers in the e-catalog being able to carry out catalog e-purchasing due to various causes such as human resource needs in the IT field, lack of knowledge/information, etc. | 3.03 | 0.9 | 28% | 3 | 0.6 | 20% |
| X4.4 | The risk of not conducting Construction Service Provider performance assessments causes the selected service provider to not necessarily have the ability to complete the work as expected/planned | 3.24 | 0.8 | 25% | 3.53 | 0.6 | 17% |
| X4.5 | Risk of lack of involvement of small business groups that can participate in the catalog e-purchasing process because they have not met the requirements to be registered as Construction Service Providers in the e-catalog | 3.26 | 0.8 | 25% | 3.12 | 0.7 | 23% |
| X4.6 | Risk of unprepared culture of Construction Service Provider companies and the government in the implementation of e-purchasing catalogs | 3.03 | 0.7 | 23% | 2.97 | 0.6 | 21% |
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| Variable | Risk | Probability | | | Impact | | |
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| | | Mean | SD | CV (%) | Mean | SD | CV (%) |
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| X4.12 | Risk of incomplete or unfulfilled administrative document requirements for selecting a Construction Service Provider | 2.88 | 0.8 | 26% | 3 | 0.8 | 26% |
| X4.13 | Risk of Construction Service Provider not understanding the E-Purchasing Catalog method | 2.82 | 0.9 | 32% | 2.85 | 0.8 | 29% |
| X5.1 | Risk of incompatibility of contract clauses with the draft contract | 2.97 | 0.9 | 31% | 3.29 | 0.8 | 25% |
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| X5.4 | Risk that there are differences in the specifications of work items planned in the e-catalog and those needed in the field | 3.62 | 0.5 | 15% | 3.79 | 0.7 | 18% |
| X5.5 | The risk of unavailability of the involvement of human resources in Construction Service Providers who are sufficiently trained to be able to carry out work with the catalog e-purchasing method | 3.15 | 0.7 | 22% | 2.97 | 0.8 | 28% |
| X5.6 | Risk of inaccurate work methods used in construction implementation | 3.38 | 0.7 | 20% | 3.65 | 0.7 | 19% |
| X6.1 | Risk of follow-up on the implementation of work that has failed or the Construction Service Provider cannot complete the work | 2.85 | 0.6 | 21% | 3.41 | 0.7 | 19% |

| Variable | Risk | Probability | | | Impact | | |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | CV (%) | Mean | SD | CV (%) |
| X6.2 | Risk of not implementing retention or maintenance guarantees in the selection of Construction Service Provider with the catalog e-purchasing method | 2.53 | 0.7 | 28% | 3.26 | 0.7 | 20% |
| X6.3 | Risk of many findings made by the External Auditor | 3.29 | 0.8 | 23% | 3.47 | 0.7 | 19% |
| X6.4 | Risk of legal issues arising in the selection of Construction Service Provider | 2.79 | 0.9 | 32% | 3.5 | 0.8 | 22% |
| X6.5 | Risk of not achieving the required/planned quality of work | 3.21 | 0.8 | 26% | 3.85 | 0.7 | 17% |
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Source: Data Processed