

## Performance Evaluation of a Construction Materials Testing Laboratory in the Implementation of ISO/IEC 17025:2017

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### ABSTRACT

Public construction materials laboratories play a vital role in safeguarding infrastructure quality and public safety. Although ISO/IEC 17025:2017 is widely adopted as a quality management system, its actual influence on strategic performance in government laboratories is not well understood. This study evaluates the implementation of ISO/IEC 17025:2017 at a provincial government testing laboratory in North Sumatra, Indonesia, by integrating it with the Balanced Scorecard (BSC) framework. A mixed-methods approach was used involving 60 participants 30 internal personnel and 30 external users through surveys, interviews, and direct observation. The BSC evaluation produced a performance score of 77.35%, categorized as satisfactory, with the strongest contribution from customer and financial perspectives. This study introduces an integrated evaluation framework tailored to public laboratories, bridging quality compliance with strategic governance. The results highlight the importance of aligning technical quality with institutional accountability, offering a practical pathway for improving performance and public trust in government testing services.

**Keywords:** ISO/IEC 17025:2017, balanced scorecard, performance evaluation, government laboratory, construction materials testing.

### INTRODUCTION

High-quality infrastructure development is one of the fundamental pillars in supporting economic growth and enhancing overall public welfare [1]. In North Sumatra Province, the rapid expansion and increasing demand for infrastructure have underscored the critical role of construction materials testing laboratories in ensuring the quality of public construction projects. As an internationally recognized standard, ISO/IEC 17025:2017 provides a comprehensive quality system framework that not only enhances testing accuracy but also improves service efficiency and overall customer satisfaction [2], [3], [4]. The implementation of this standard contributes to stronger quality control, more structured reporting, and documentation aligned with the principles of good governance [5], [6] As a technical service unit under the Public Works and Spatial Planning Agency (PUPR) of North Sumatra Province, the Construction Materials Testing Laboratory (UPTD Laboratorium Bahan Konstruksi) has adopted ISO/IEC 17025:2017 since 2023. However, the implementation process has encountered various challenges, particularly in human resource training, limitations in performance evaluation systems, and the lack of integration of performance indicators specifically tailored to the characteristics of construction materials testing laboratories [7].

Despite the growing importance of quality standards in laboratory management, most prior studies have predominantly focused on the administrative and technical aspects of standard implementation. In contrast, evaluative studies linking ISO standard adoption to strategic organizational performance—particularly within the public sector context—remain scarce [8]. This gap is particularly evident in the integration of performance measurement frameworks with quality management systems in government-owned laboratories.

Therefore, this study aims to develop a performance evaluation framework based on the Balanced Scorecard (BSC) to comprehensively assess the contribution of ISO/IEC 17025:2017 implementation and provide a robust foundation for designing improvement strategies to enhance the quality of services delivered by government-owned laboratories in a sustainable manner. This

research offers a novel contribution by integrating ISO/IEC 17025:2017 and the Balanced Scorecard in evaluating the performance of a public-sector construction materials testing laboratory—an approach that has not been extensively explored in the national literature.

### **ISO/IEC 17025:2017**

ISO/IEC 17025:2017 is an international standard that specifies the general requirements for the competence of testing and calibration laboratories [9]. This standard emphasizes the critical importance of testing method validation, measurement traceability, quality control, and the implementation of a well-documented management system. In the context of construction materials testing laboratories, the adoption of ISO/IEC 17025:2017 aims to ensure the reliability and accuracy of test results while enhancing stakeholders' confidence in the laboratory's integrity and quality assurance capabilities [10]. The implementation of this standard has become increasingly crucial for ensuring that testing outcomes meet the stringent demands of a rapidly evolving construction industry that requires exceptional levels of precision and reliability.

### **Balanced Scorecard**

As a comprehensive organizational performance evaluation tool, the Balanced Scorecard (BSC)—developed by Kaplan and Norton (1996)—provides a holistic managerial framework that transcends traditional financial metrics. The BSC evaluates organizational performance through four interconnected perspectives: financial, customer, internal processes, and learning and growth [11], [12]. This multidimensional approach is particularly relevant in the public sector, as it enables performance measurement not only in terms of operational outputs but also in terms of strategic alignment, long-term capability development, and the achievement of broader organizational objectives [13]. Unlike conventional performance measurement systems, the BSC evaluates both operational efficiency and the organization's capacity for sustainable growth and adaptability to future challenges.

Previous studies have demonstrated that the strategic integration of quality management systems with the Balanced Scorecard framework can significantly enhance organizational accountability, service delivery efficiency, and customer satisfaction levels [14], [15]. However, empirical research examining this integration specifically within the context of government-owned laboratories—particularly those in the early stages of ISO/IEC 17025:2017 implementation—remains notably scarce in the existing literature. This research gap is particularly pronounced in developing countries where public sector laboratories are increasingly adopting international quality standards to improve service delivery. Therefore, this study addresses this critical gap by investigating the potential application of the BSC framework for evaluating the performance of government-owned construction materials testing laboratories that have recently implemented ISO/IEC 17025:2017.

### **RESEARCH METHODS**

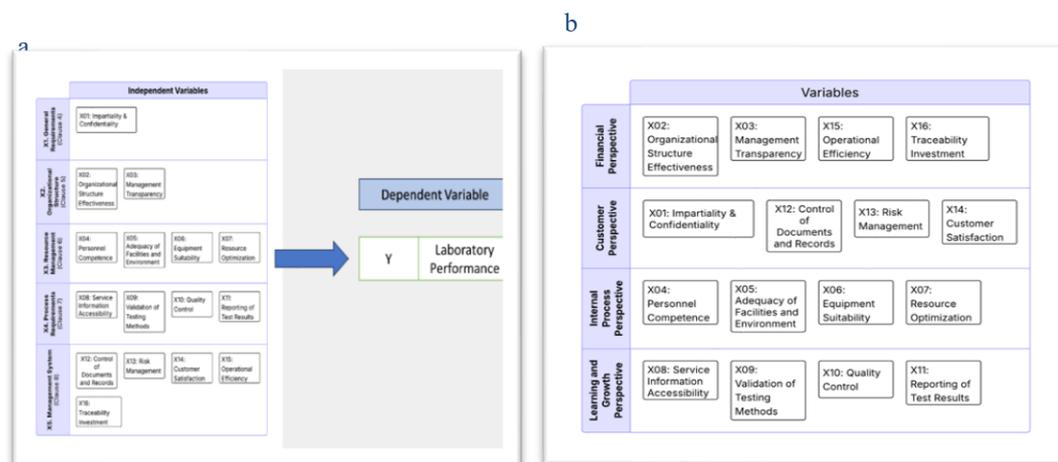
This study is motivated by the need to systematically evaluate the challenges encountered in implementing ISO/IEC 17025:2017 in construction materials testing laboratories and to analyze its impact on operational performance and quality system sustainability. The primary focus of this research is on laboratories managed by regional governments that have recently adopted the standard and are currently undergoing the accreditation process. Rather than examining the technical aspects of construction material testing, this study emphasizes the managerial and performance evaluation dimensions of laboratory operations.

The main objectives of this study are to:

- Identify the key success factors and barriers in the implementation of ISO/IEC 17025:2017;
- Evaluate its impact on laboratory performance improvement; and
- Formulate effective and sustainable strategies to strengthen the quality management system.

Through this approach, the research aims to make a meaningful scientific contribution by developing an evaluation framework based on international quality standards, while also providing practical and applicable policy recommendations to enhance service quality in public-sector laboratories. This study employs a mixed methods approach with an explanatory sequential design, facilitating a more comprehensive analysis of the phenomenon under investigation. Quantitative data were collected through the administration of a structured Likert scale questionnaire (1–5) to 60 respondents, comprising laboratory personnel and service users.

The research instrument was developed based on 16 variables systematically derived from ISO/IEC 17025:2017 requirements, which were categorized into five main dimensions and subsequently linked to laboratory performance indicators, as illustrated in Figure 1(a). These variables were then strategically mapped onto the four perspectives of the Balanced Scorecard framework, thereby integrating the international quality standard with a comprehensive strategic evaluation framework for laboratory performance assessment, as depicted in Figure 1(b).



**Figure 1.** (a) Structure of variables based on ISO/IEC 17025:2017 clauses; (b) Mapping of variables into the four Balanced Scorecard perspectives.

Data collection employed a mixed-methods approach, combining structured questionnaires, in-depth interviews, and direct observations. Quantitative data were analyzed through descriptive statistics, validity and reliability testing, classical assumption tests, and multiple regression. Qualitative data were examined using thematic analysis and structured evaluation checklists. These analyses identified variables with significant and minimal influence on laboratory performance, forming the empirical basis for constructing a Balanced Scorecard.

Figure 2 outlines the research flow for assessing ISO/IEC 17025:2017 implementation in a government laboratory. The process begins with problem identification and literature review, followed by data collection and analysis. Key findings inform the integration of influential factors into a Balanced Scorecard framework to formulate strategic recommendations aimed at enhancing laboratory performance and public service accountability.

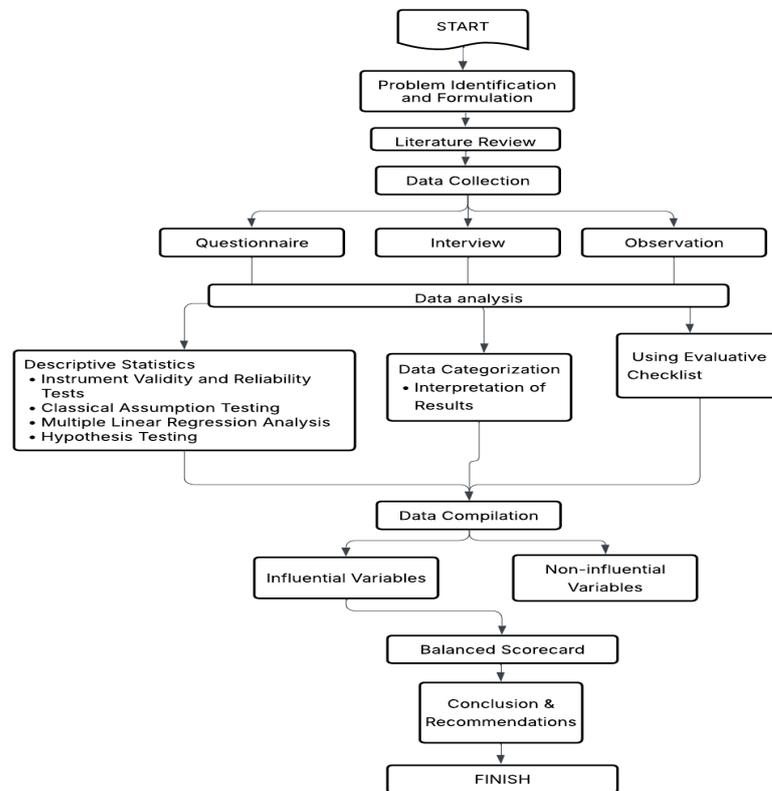


Figure 2. Research Flowchart

## RESULT AND DISCUSSION

### Respondent Characteristics and Instrument Validity

This study engaged 60 respondents selected through purposive sampling, comprising 30 internal laboratory personnel and 30 external service users. The selection criteria for internal respondents included: (1) direct involvement in ISO/IEC 17025:2017 implementation processes, and (2) comprehensive understanding of laboratory operational procedures. External respondents were systematically selected based on the following categories: (1) internal government units within the same organizational hierarchy, (2) government institutions external to the parent organization, and (3) private sector clients, including construction firms, consultants, contractors, and other non-governmental entities. The demographic analysis revealed a predominance of male respondents—80% among internal personnel and 86.7% among service users—reflecting the characteristic gender distribution within Indonesia's construction sector. The most represented age group among internal personnel was 48–57 years (40%), while external users were predominantly above 56 years old (33.3%). Regarding professional roles, technicians constituted the largest proportion of internal respondents (33.3%), followed by analysts (16.7%) and sample receiving officers (13.3%). This composition is deemed representative of the typical organizational structure within construction materials testing laboratories.

Validity testing confirmed that all questionnaire items achieved statistical validity, with correlation coefficients exceeding the critical r-value of 0.254 (for  $n = 60$ ,  $\alpha = 0.05$ ). Reliability analysis demonstrated strong internal consistency, with Cronbach's Alpha coefficients ranging from 0.784 to 0.891. Classical assumption testing further confirmed that the dataset satisfied all prerequisites for multiple linear regression analysis: normal distribution (Kolmogorov-Smirnov test,  $p > 0.05$ ), absence of multicollinearity ( $VIF < 10$ ), homoscedasticity (Breusch-Pagan test,  $p > 0.05$ ), and no autocorrelation (Durbin-Watson = 1.97). These findings ensure the statistical validity and reliability of the analytical procedures, thereby supporting robust research conclusions.

### Data analysis and findings

Data were systematically collected through structured observations, in-depth interviews with laboratory management, and quantitative analysis of questionnaire responses. Multiple regression analysis identified three statistically significant variables influencing laboratory performance: transparency in management practices ( $\beta = 0.206$ ;  $p = 0.030$ ), investment in measurement traceability systems ( $\beta = 0.229$ ;  $p = 0.044$ ), and validity of testing methodologies ( $\beta = 0.226$ ;  $p = 0.023$ ). Additionally, both quantitative and qualitative analytical approaches identified four other strategically important variables: service information accessibility ( $\beta = -0.176$ ), risk management effectiveness ( $\beta = 0.124$ ), customer satisfaction levels ( $\beta = 0.169$ ), and resource optimization efficiency ( $\beta = 0.148$ ). The selection of these variables was conducted as part of an integrated strategic approach utilizing the Balanced Scorecard (BSC) framework, designed to ensure equilibrium across all performance perspectives—despite not all variables achieving statistical significance. Based on the multiple linear regression results, the Financial Perspective demonstrated the highest contribution to laboratory performance (34.5%;  $\beta = 0.345$ ;  $p = 0.004$ ), followed by the Customer Perspective (30.2%;  $\beta = 0.302$ ;  $p = 0.018$ ). Although the Learning and Growth Perspective (19.0%) and Internal Process Perspective (12.1%) did not achieve statistical significance, they were retained to ensure strategic coherence and strengthen long-term institutional capacity development.

Based on the analyzed variables, seven strategic objectives were systematically established to enhance the performance of the UPTD Construction Materials Laboratory. These objectives are comprehensively integrated into the Balanced Scorecard strategic map, as illustrated in Figure 3, and serve as the foundational framework for developing a laboratory scorecard focused on public service quality enhancement and testing accountability assurance.

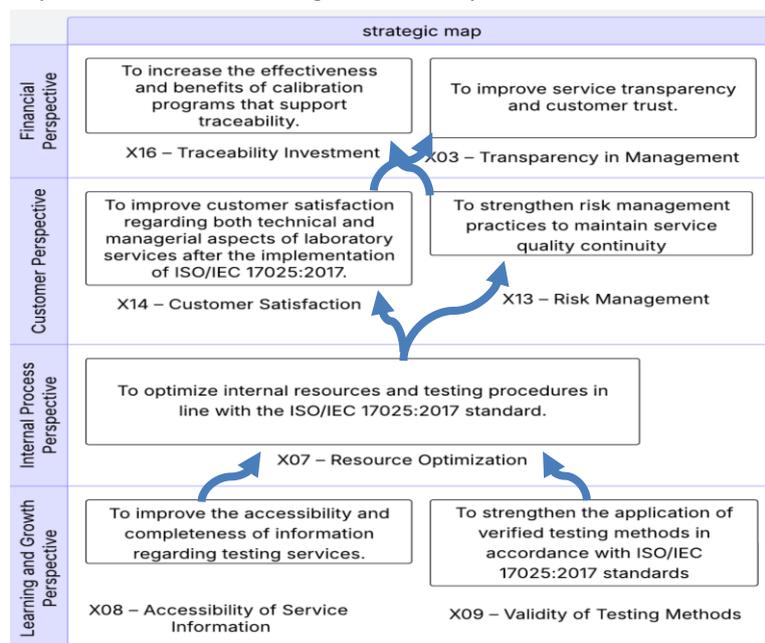


Figure 3. Balanced Scorecard Strategic Map

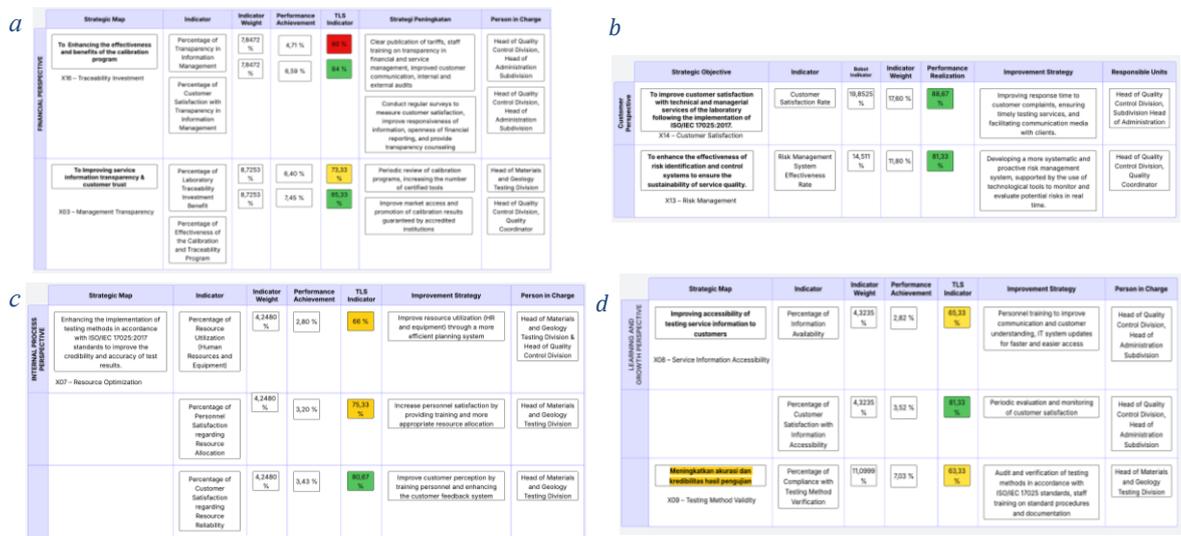
To objectively and systematically measure performance achievement, a comprehensive set of Key Performance Indicators (KPIs) was developed, characterized by specificity, measurability, and empirical foundation derived from questionnaire data and systematic field observations. The establishment of these KPIs serves not only to strengthen a previously unstructured performance monitoring system but also functions as a strategic initiative in supporting the long-term sustainability of the ISO/IEC 17025:2017 accreditation process. Through rigorous regression analysis, each variable and indicator was assigned a statistical weight based on its respective  $\beta$  coefficient value, accurately reflecting the magnitude of its significant contribution to overall laboratory performance. The detailed weightings and corresponding performance indicators are comprehensively presented in Table 1.

**Table 1.** Weighted Scorecard of Research Variables

Variable Code	Variable Description	Weight (%)	KPI Description	KPI Weight (%)
X03	Transparency in Management	15.6943	Percentage of Transparency in Information Management	7.8472
			Percentage of Customer Satisfaction on Transparency	7.8472
X16	Investment in Traceability	17.4507	Percentage of Calibration and Traceability Program Effectiveness	8.7253
			Percentage of Benefits from Traceability Investment	8.7253
X13	Risk Management	14.5110	Percentage of Risk Management System Effectiveness	14.5110
X14	Customer Satisfaction	19.8530	Percentage of Customer Satisfaction	19.8530
X07	Resource Optimization	12.7440	Percentage of Resource Utilization (HR and Equipment)	4.2480
			Percentage of Staff Satisfaction with Resource Allocation	4.2480
			Percentage of Customer Satisfaction on Resource Reliability	4.2480
X08	Service Information Accessibility	8.6471	Percentage of Information Availability	4.3235
			Percentage of Customer Satisfaction on Information Accessibility	4.3235
X09	Validity of Testing Methods	11.0999	Percentage of Compliance with Testing Method Verification	11.0999
<b>Total</b>				<b>100.0000</b>

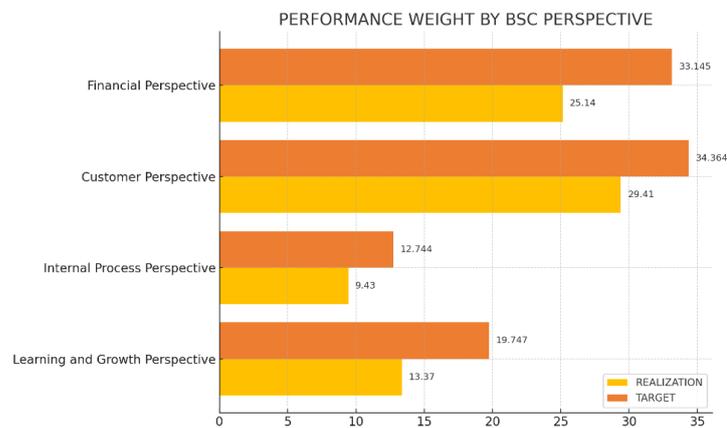
The findings from the performance evaluation were subsequently transformed into a comprehensive data-driven scorecard, functioning not only as a measurement instrument that accurately reflects the laboratory's performance achievement levels, but also as a strategic framework for systematic continuous improvement initiatives. This scorecard is specifically designed to align with the fundamental principles of public accountability and transparent performance management, while concurrently supporting the institution's strategic quality policy direction and operational excellence objectives. A detailed visualization of the constructed scorecard framework is presented in Figure 4: Research-Based Performance Scorecard.

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**Figure 4.** Research-Based Scorecard: (a) Financial Perspective; (b) Customer Perspective; (c) Internal Process Perspective, and (d) Learning and Growth Perspective.

The comprehensive performance evaluation of the UPTD Construction Materials Testing Laboratory utilizing the Balanced Scorecard methodology yielded an overall performance achievement score of 77.351%. This result demonstrates the effectiveness and operational efficiency of the quality management system implementation following the strategic adoption of ISO/IEC 17025:2017. The proportional contribution distribution of each Balanced Scorecard perspective to the aggregate performance is systematically presented in Figure 5, which effectively illustrates the strategic equilibrium between the laboratory's long-term strategic objectives and day-to-day operational achievements.



**Figure 5.** Performance Achievement vs Target by BSC Perspective

**CONCLUSION**

Based on the comprehensive findings of this study, it can be concluded that the implementation of ISO/IEC 17025:2017 at the UPTD Construction Materials Testing Laboratory has demonstrated a positive impact on overall laboratory performance, achieving an aggregate performance score of 77.351%. However, several critical challenges remain, particularly in the domain of management transparency, which—along with other key aspects such as measurement traceability, resource optimization, accessibility of service information, and testing method

validity is categorized under the “yellow” performance level. These findings indicate moderate compliance but also highlight the need for targeted improvements to strengthen organizational accountability, enhance service quality, and foster greater public trust. To ensure the long-term sustainability of standard implementation and continuous performance enhancement, several strategic recommendations are proposed, including:

- Transparent publication of comprehensive service tariffs and fee structures;
- Strengthening of financial accountability systems and reporting mechanisms;
- Routine equipment verification and calibration procedures following established protocols;
- Enhanced documentation and systematic training on current testing methodologies and best practices;
- Strategic utilization of digital technologies for improved operational efficiency; and
- Active collaboration with external stakeholders to reinforce institutional capacity building and service quality enhancement.

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