

Integrated Laboratory Governance for Sustainable Islamic Higher Education: A Multi-Site Study of State Islamic Universities in Indonesia

Aprizal Ahmad, Zulpadrianto, Nini, Yeni Etma Nazar

^{1,2,3}Universitas Islam Negeri Imam Bonjol Padang, Indonesia

⁴Universitas Riau, Indonesia

e-mail: aprizal@uinib.ac.id, zulpadrianto@uinib.ac.id, nini@uinib.ac.id,
yeni.etma@lecturer.unri.ac.id

Submitted: 26-01-2026

Revised: 30-06-2026

Accepted: 22-07-2026

ABSTRACT. Laboratories play a pivotal role in supporting teaching, research, and community engagement in higher education. However, laboratory governance in Indonesian State Islamic Higher Education Institutions remains fragmented due to inconsistent quality assurance practices, limited integration of laboratory functions with research, and shortages of qualified technical personnel. Existing laboratory management frameworks, including the Laboratory Quality Management System (LQMS), ISO 9001, and ISO/IEC 17025, primarily emphasize technical compliance while offering limited guidance on integrating institutional quality assurance with the distinctive values of Islamic higher education. This study develops an integrated and sustainable laboratory governance model by synthesizing the Internal Quality Assurance System (IQAS), international quality standards, and Islamic ethical principles. Employing a qualitative research and development design with a multiple-case study approach, the study collected data from 110 participants across three Indonesian State Islamic Higher Education Institutions through semi-structured interviews, observations, document analysis, and user satisfaction assessments. Data were analyzed using inductive thematic analysis, cross-case synthesis, and methodological triangulation. The findings reveal two dominant governance configurations—integrated laboratories and study program-based laboratories—each with complementary strengths but facing common challenges in technical staffing, research utilization, and continuous quality improvement. Based on these findings, the study proposes the Integrated Sustainable Laboratory Governance Model (ISLGM), integrating the 12 Quality System Essentials, IQAS, ISO 9001, ISO/IEC 17025, and Islamic values into a unified governance framework. The model advances laboratory governance theory by contextualizing quality management within Islamic higher education and provides an evidence-based framework for strengthening laboratory quality, research productivity, institutional resilience, and sustainable governance.

Keywords: *Internal Quality Assurance System; Islamic Higher Education; Laboratory Governance; Sustainable Quality Management*



<https://doi.org/10.32678/tarbawi.v12i02.12692>

How to Cite Ahmad, A., Zulpadrianto, Z., Nini, N., & Nazar, Y.E. (2026). Integrated Laboratory Governance for Sustainable Islamic Higher Education: A Multi-Site Study of State Islamic Universities in Indonesia. *Tarbawi: Jurnal Keilmuan Manajemen Pendidikan*, 12(02), 211–228.
<https://doi.org/10.32678/tarbawi.v12i02.12692>

INTRODUCTION

Laboratories are strategic infrastructures that play a fundamental role in enhancing the quality of higher education through learning, research, innovation, and community engagement (Tercanli & Jongbloed, 2022; Păunescu et al., 2022). The effectiveness of laboratory management significantly



influences the quality of academic outcomes, research productivity, and institutional competitiveness. Consequently, universities worldwide have increasingly adopted quality management frameworks, such as Laboratory Quality Management Systems (LQMS), ISO 9001, and ISO/IEC 17025, to ensure the reliability, accountability, and sustainability of laboratory operations (Eyenaka et al., 2024). Beyond supporting practical learning, laboratories have become important instruments for strengthening research integrity, innovation capacity, and institutional quality assurance systems in higher education (Mohzana et al., 2023).

In Indonesia, the transformation of several State Islamic Institutes (IAIN) into State Islamic Universities (UIN) has accelerated efforts to integrate Islamic values with science and technology. This transformation requires not only curriculum reform but also the strengthening of academic support systems, including laboratory governance and quality management (Remiswal et al., 2021). Within the context of Islamic higher education, laboratories are expected to function not merely as facilities for practical instruction but also as centers for scientific inquiry, research development, and the cultivation of ethical and responsible scientific practices. This perspective is consistent with the Islamic tradition that encourages observation, experimentation, and the pursuit of knowledge as part of human responsibility to understand and benefit from God's creation (Mirna & Imron, 2023).

Despite their strategic role, laboratory management in many State Islamic Higher Education Institutions continues to face significant challenges. Previous studies indicate that higher education laboratories often experience weaknesses in governance structures, limited technical human resources, fragmented quality assurance mechanisms, inadequate infrastructure management, and suboptimal integration with research and community service activities (Mohzana et al., 2023; Eyenaka et al., 2024). Preliminary observations in laboratories at State Islamic Higher Education Institutions in West Sumatra reveal similar conditions. Variations in organizational structures, operational procedures, supervision mechanisms, and laboratory utilization have resulted in different levels of effectiveness across institutions. Furthermore, laboratory activities remain predominantly oriented toward teaching functions, while their contributions to research productivity, innovation, and community service remain relatively limited.

These challenges become increasingly important when viewed from the perspective of quality assurance. State Islamic Higher Education Institutions' laboratories are expected to support the implementation of the Internal Quality Assurance System (IQAS), particularly through the standard setting, implementation, evaluation, control, and continuous improvement cycle (Determination, Implementation, Evaluation, Control, and Improvement). However, existing laboratory governance practices have not been fully integrated with institutional quality assurance mechanisms. At the same time, international laboratory quality frameworks, including LQMS, ISO 9001, and ISO/IEC 17025, provide important standards for quality management, technical competence, documentation, and continuous improvement. Nevertheless, these frameworks were primarily developed for technical and operational contexts and provide limited guidance for integrating institutional quality assurance systems and Islamic values within higher education laboratories.

A review of recent literature also reveals a significant research gap. Existing studies generally focus on laboratory accreditation, technical quality assurance, laboratory safety, or laboratory service quality. At the same time, relatively limited attention has been given to developing comprehensive laboratory governance models that integrate quality management systems, institutional quality assurance frameworks, and the distinctive values of Islamic higher education. Furthermore, empirical studies examining laboratory governance across multiple State Islamic Higher Education Institutions remain scarce, particularly regarding how laboratory management structures influence the effectiveness of learning, research, and community engagement activities.

To address these gaps, this study develops an integrated, sustainable laboratory governance model for State Islamic Higher Education Institutions, grounded in empirical evidence from three institutions in West Sumatra. The proposed model integrates the Internal Quality Assurance System

(IQAS), the twelve Quality System Essentials (QSE) of the Laboratory Quality Management System, ISO 9001 principles, ISO/IEC 17025 requirements, and Islamic ethical values within a unified governance framework. Unlike existing laboratory management approaches that emphasize technical compliance, the proposed model positions laboratories as strategic instruments for quality assurance, research productivity, institutional accountability, and sustainable development of Islamic higher education.

Therefore, this study aims to analyze existing laboratory governance practices in State Islamic Higher Education Institutions, identify major challenges and quality assurance gaps, and formulate an integrated laboratory governance model that can strengthen laboratory effectiveness and institutional quality. The findings are expected to contribute both theoretically to the literature on laboratory governance in Islamic higher education and practically to the development of evidence-based laboratory management policies within State Islamic Higher Education Institutions.

METHOD

Participants and Data Collection

Data were collected from July 2023 to June 2025 across three State Islamic Higher Education Institutions in West Sumatra, Indonesia. The institutions were purposively selected to represent different laboratory governance systems: integrated laboratory management and study-program-based laboratory management. A total of 110 participants were involved in the study, consisting of university leaders, quality assurance administrators, laboratory heads, lecturers, laboratory technicians, and laboratory users. Participants were selected using purposive and criterion-based sampling, with inclusion criteria requiring direct involvement in laboratory planning, management, quality assurance, or utilization for at least one academic year.

Data collection employed four complementary techniques: in-depth interviews, direct observations, document analysis, and laboratory user satisfaction assessments. Semi-structured interviews explored laboratory planning, governance structures, leadership practices, human resource competencies, infrastructure management, quality assurance implementation, and the integration of laboratory activities within the tridharma of higher education. Observations focused on laboratory facilities, safety practices, organizational arrangements, operational procedures, and laboratory utilization patterns. Documentary evidence included institutional strategic plans, laboratory operational guidelines, quality assurance reports, accreditation documents, and relevant higher education regulations. To complement qualitative findings, laboratory user satisfaction data were collected using a five-point Likert-scale instrument covering service quality, safety, equipment management, technical support, and quality assurance practices.

Data Analysis

Data analysis was conducted using thematic analysis procedures involving data familiarization, coding, theme development, theme review, and interpretation (Naeem et al., 2023). Interview transcripts, observation notes, and documentary evidence were systematically examined to identify recurring patterns related to laboratory governance, quality assurance implementation, infrastructure management, human resource capacity, and laboratory utilization. Subsequently, cross-case analysis was performed to compare governance practices, strengths, challenges, and quality assurance mechanisms across the three State Islamic Higher Education Institutions. This process enabled the identification of common issues and institutional variations that influenced laboratory effectiveness.

The resulting themes were then interpreted and synthesized to formulate an integrated laboratory governance model. Empirical findings were mapped against the IQAS, the Laboratory Quality Management System (LQMS), the 12 Quality System Essentials (QSE), ISO 9001 principles, ISO/IEC 17025 requirements, and Islamic ethical values. This iterative process ensured that the

proposed model was grounded in empirical evidence while remaining aligned with national and international quality standards.

Trustworthiness and Research Ethics

The trustworthiness of the study was ensured through methodological and source triangulation, member checking, peer debriefing, and the maintenance of an audit trail documenting major analytical decisions and methods (Schlunegger et al., 2024). Data collection continued until thematic saturation was achieved and no substantial new themes emerged. Ethical approval was obtained from the participating institutions prior to data collection. All participants provided informed consent and were assured of confidentiality, anonymity, and voluntary participation throughout the study.

RESULT AND DISCUSSION

Result

Based on the analysis of data from respondents who had visited and conducted practical work in State Islamic Higher Education Institutions laboratories throughout West Sumatra, the results obtained were as follows: Average satisfaction index on a scale of 1 to 5, reviewed from several categories, namely:

Table 1: Visitor satisfaction index regarding laboratory management at State Islamic Higher Education Institutions in West Sumatra

Category	University A	University B	University C
Visitor services	3.9	3.8	3.7
Laboratory health and safety services	3.8	4.1	3.7
Control of non-compliant testing and/or calibration work	3.9	3.9	3.6
Laboratory technical requirements	3.8	4.0	3.6
Accommodation and environmental conditions	3.8	4.0	3.5
Equipment maintenance	3.8	3.9	3.6
Technical sampling	3.8	3.9	3.5
Handling of tested and calibrated items	3.8	3.9	3.6
Quality assurance of testing and calibration results	3.8	3.9	3.4

Based on the data in Table 1, the average level of visitor satisfaction across several categories is fairly satisfactory. This certainly requires improvement in the laboratory management system, starting with visitor services, equipment supplies, and laboratory quality assurance, both in terms of management quality and the quality of equipment used during practical work.

Existing Laboratory Governance Across State Islamic Higher Education Institutions

Field investigations across three State Islamic Higher Education Institutions in West Sumatra revealed substantial variations in laboratory governance despite operating under the same national higher education regulations and the IQAS. Evidence from interviews, observations, and institutional documents indicates that laboratory management has evolved according to each institution's internal policies rather than through a standardized quality management framework. Consequently, differences were found in organizational structures, leadership arrangements, operational procedures, quality assurance practices, and the integration of laboratories into the implementation of the *tridharma* of higher education.

State Islamic Higher Education Institutions adopted a centralized laboratory governance model in which laboratories across faculties were managed through an integrated institutional structure. This system facilitated standardized planning, budgeting, equipment maintenance, and quality monitoring. However, observations indicated that centralized management reduced the flexibility of study programs in addressing discipline-specific laboratory needs. In contrast, State Islamic Higher Education Institutions B implemented a decentralized governance model in which

laboratories operated independently under their respective departments. Interviews with laboratory coordinators suggested that this structure strengthened communication between lecturers and laboratory personnel and enabled more responsive decision-making regarding practicum implementation and equipment procurement.

Nevertheless, documentation quality and quality assurance practices varied considerably across departments. State Islamic Higher Education Institutions C adopted a hybrid governance model that combined centralized administrative coordination with decentralized academic management. Although this approach sought to balance institutional control and academic autonomy, overlapping responsibilities frequently delayed procurement, maintenance, and operational coordination.

Across all three institutions, laboratories were predominantly utilized for undergraduate practical teaching. Institutional reports and field observations showed that laboratory activities supporting research, community service, testing, and calibration remained limited because of insufficient technical personnel, financial constraints, and the absence of structured research management mechanisms. Laboratory facilities were intensively used during teaching periods but underutilized outside scheduled practical sessions, indicating that existing infrastructure had not yet been optimized to support broader institutional research functions.

Governance effectiveness was also shaped by leadership capacity and the availability of human resources. State Islamic Higher Education Institutions maintained a dedicated laboratory management structure responsible for planning, monitoring, and evaluation. In contrast, laboratory heads in State Islamic Higher Education Institutions B and C simultaneously served as academic staff, thereby reducing managerial effectiveness. Similarly, all institutions experienced shortages of qualified laboratory technicians with discipline-specific expertise. Technical personnel primarily performed administrative and equipment maintenance functions, leaving lecturers to supervise practical and research activities with limited technical assistance.

Differences were also evident in the implementation of internal quality assurance. State Islamic Higher Education Institutions demonstrated more systematic planning, monitoring, and evaluation aligned with IQAS procedures. In contrast, State Islamic Higher Education Institutions B and State Islamic Higher Education Institutions C focused primarily on documenting teaching activities, with less consistent monitoring of research utilization, equipment calibration, and laboratory service quality. These findings demonstrate that laboratory governance in State Islamic Higher Education Institutions remains institutionally fragmented and insufficiently integrated with strategic planning and quality assurance systems. The recurring governance challenges identified across the three cases provide the empirical basis for developing an integrated laboratory governance model that strengthens education, research, community engagement, and sustainable quality improvement within Islamic higher education institutions.

Human Resources and Laboratory Capacity

Human resources emerged as one of the most critical determinants of laboratory governance across the three participating State Islamic Higher Education Institutions. Interviews with institutional leaders, laboratory heads, lecturers, laboratory technicians, and administrative staff consistently indicated that laboratory performance was constrained less by infrastructure availability than by the limited number, uneven distribution, and varying competencies of laboratory personnel. These findings were corroborated through field observations and institutional documents, demonstrating that differences in laboratory performance were closely associated with institutional capacity to manage human resources.

Distinct staffing arrangements were observed among the three institutions. State Islamic Higher Education Institutions A implemented a centralized laboratory management system that enabled standardized administrative procedures and coordinated laboratory services across

faculties. However, technicians were frequently assigned to multiple disciplines, limiting opportunities to develop specialized technical expertise. State Islamic Higher Education Institutions B adopted a decentralized approach in which laboratory personnel were attached directly to study programs. This structure facilitated closer collaboration between technicians and lecturers and improved the implementation of practical courses, although disparities in staffing and technical capacity persisted across departments due to differences in financial resources. State Islamic Higher Education Institutions C combined centralized administrative supervision with decentralized operational responsibilities. While offering greater flexibility, this arrangement often resulted in overlapping duties, unclear task allocation, and delays in equipment maintenance, procurement, and laboratory scheduling.

Across all three State Islamic Higher Education Institutions, laboratory technicians primarily prepared practical sessions, maintained equipment, managed inventory, and ensured laboratory readiness. Their involvement in research support, equipment calibration, laboratory accreditation, and community service remained limited, indicating that laboratories continued to function predominantly as teaching facilities rather than integrated research infrastructures. Institutional leaders also reported that several laboratories possessed advanced scientific equipment; however, observations revealed that some instruments were underutilized because qualified operators and specialized technical training were unavailable.

Competency development programs were implemented in all institutions but were largely administrative, focusing on laboratory administration, occupational safety, and financial accountability. Opportunities for advanced technical certification, calibration, quality assurance, and laboratory management training remained limited. Furthermore, laboratory personnel frequently performed multiple roles simultaneously, including technical support, inventory management, procurement, laboratory safety, and administrative duties, increasing workloads and reducing opportunities for professional specialization.

Institutional planning documents further revealed differences in strategic commitment to human resource development. State Islamic Higher Education Institutions A allocated dedicated annual funding for competency development, whereas State Islamic Higher Education Institutions B and State Islamic Higher Education Institutions C implemented training according to faculty priorities and available budgets, resulting in unequal technical capacity across laboratories. Despite these challenges, laboratories that actively involved technicians in curriculum planning, research projects, and quality assurance activities demonstrated stronger coordination, more effective laboratory utilization, and closer collaboration between academic and technical staff. Collectively, these findings indicate that strengthening competency-based human resource governance is fundamental to enhancing the educational, research, testing, and community service functions of State Islamic Higher Education Institutions' laboratories and constitutes a key dimension of the integrated laboratory governance model developed in this study.

Infrastructure and Internal Quality Assurance

Field observations across the three participating State Islamic Higher Education Institutions indicate that laboratory infrastructure has improved considerably following institutional transformation and increased government investment. Each institution possesses dedicated laboratory buildings equipped with standard instructional facilities, laboratory furniture, safety equipment, and scientific instruments that adequately support undergraduate practical learning. Several laboratories have also acquired advanced research equipment through competitive grants and institutional development programs. However, the empirical evidence shows that improvements in physical infrastructure have not been matched by comparable progress in laboratory governance, maintenance systems, or quality assurance. Consequently, the effectiveness of laboratory operations varies substantially among institutions and is determined not only by the availability of facilities but also by institutional management capacity.

Observational data revealed notable differences in infrastructure utilization. Laboratories supporting science-based programs were intensively used during scheduled practical sessions but were considerably underutilized for research, testing, calibration, and community service activities outside the academic semester. Interview data consistently indicated that laboratory planning remained heavily oriented toward teaching functions. As one laboratory coordinator explained, *"Most laboratory activities are still scheduled for student practical sessions, while research utilization depends on individual lecturers' initiatives rather than institutional planning."* This finding demonstrates that existing infrastructure has not yet been strategically integrated to support the university's tridharma responsibilities fully.

Document analysis further showed that infrastructure planning is routinely incorporated into institutional budgeting cycles. Nevertheless, investment priorities primarily focus on procuring new equipment and renovating laboratory buildings, whereas preventive maintenance, equipment calibration, utilization monitoring, and long-term sustainability receive relatively limited attention. Institutional leaders acknowledged that infrastructure performance is generally evaluated based on procurement achievements rather than operational effectiveness or research outcomes. This planning orientation has resulted in modern facilities whose utilization remains below institutional expectations.

Empirical findings also identified different approaches to equipment maintenance across the three State Islamic Higher Education Institutions. State Islamic Higher Education Institutions A applies a centralized maintenance system coordinated by the university laboratory management unit. Equipment inventories, maintenance schedules, and servicing activities are systematically documented, enabling better monitoring of laboratory assets and reducing duplication in equipment procurement. However, interviews revealed that maintenance activities remain dependent on annual budget allocations, causing delays in servicing sophisticated laboratory instruments. In contrast, State Islamic Higher Education Institutions B delegates maintenance responsibilities to individual study programs, allowing faster responses to operational problems but creating considerable variation in documentation quality and maintenance standards among laboratories. State Islamic Higher Education Institutions C adopts a mixed arrangement in which planning is centralized while operational implementation is delegated to faculties. Although this approach distributes responsibilities, overlapping authority can occasionally delay decisions on equipment calibration and repair.

The implementation of the IQAS also differs across institutions. Institutional documents confirm that all participating State Islamic Higher Education Institutions formally adopt the standard-setting, implementation, evaluation, control, and continuous improvement cycle. Nevertheless, observations indicate that quality assurance practices remain concentrated on supporting teaching activities rather than evaluating laboratory performance in research, testing, calibration, or community service. State Islamic Higher Education Institutions A demonstrates the most comprehensive implementation through regular documentation of annual planning, laboratory performance reports, equipment inventories, and internal quality audits. By comparison, State Islamic Higher Education Institutions B and State Islamic Higher Education Institutions C mainly document activities related to teaching administration, while systematic evaluation of laboratory services, equipment performance, and continuous quality improvement remains relatively limited.

Another recurring finding concerns laboratory information management. Although institutional administration has gradually adopted digital systems, most laboratory records—including equipment inventories, booking systems, maintenance reports, and user documentation—continue to be managed independently using paper-based or fragmented electronic records. Laboratory personnel consistently reported that this fragmented documentation complicates institutional monitoring, reduces data accuracy, and limits evidence-based decision-making for laboratory development.

Across all three State Islamic Higher Education Institutions, the relationship between infrastructure availability and research productivity also emerged as a consistent empirical pattern. Despite substantial investment in laboratory facilities, lecturers reported that access to specialized equipment is frequently constrained by maintenance delays, limited technical personnel, and scheduling priorities that favor undergraduate practical classes. As a result, laboratory infrastructure has not yet been fully optimized to strengthen institutional research productivity or innovation.

Overall, the findings demonstrate that laboratory effectiveness is determined not merely by the adequacy of physical infrastructure but by the extent to which infrastructure management is integrated into institutional quality assurance. Laboratories that combine systematic maintenance, standardized operating procedures, comprehensive documentation, and continuous quality evaluation exhibit more consistent operational performance than laboratories relying solely on routine administrative practices. These empirical patterns subsequently informed the infrastructure and quality assurance dimensions incorporated into the integrated State Islamic Higher Education Institutions laboratory governance model developed in this study.

User Satisfaction Analysis

User satisfaction was examined to evaluate laboratory performance from the perspective of its primary users. A structured questionnaire was administered to 110 students and lecturers who had conducted laboratory activities across the three participating State Islamic Higher Education Institutions. The instrument assessed nine dimensions of laboratory services using a five-point Likert scale, including visitor services, occupational health and safety, technical requirements, equipment maintenance, sampling procedures, handling of laboratory specimens, accommodation and environmental conditions, testing and calibration quality assurance, and control of non-conforming laboratory activities. Overall, the results indicate that laboratory services were perceived positively, with average scores ranging from 3.4 to 4.1, suggesting that users were generally satisfied with laboratory operations despite notable differences among institutions.

Comparative analysis revealed that State Islamic Higher Education Institutions B consistently achieved the highest satisfaction scores across most service dimensions, particularly in occupational health and safety (4.1), laboratory technical requirements (4.0), and accommodation and environmental conditions (4.0). Field observations showed that this institution maintained well-organized laboratory facilities, clear safety signage, standardized operating procedures, and dedicated laboratory technicians assigned to specific study programs. Interview participants emphasized that readily available technical staff facilitated equipment preparation, reduced operational delays, and enhanced communication during practical sessions. These findings suggest that responsive technical support and effective laboratory coordination contributed substantially to users' positive perceptions.

In contrast, State Islamic Higher Education Institutions A demonstrated relatively stable satisfaction scores of 3.8-3.9 across all evaluated dimensions. Documentary evidence and observations indicated that this consistency reflected the implementation of an integrated laboratory governance system characterized by centralized scheduling, standardized administrative procedures, and coordinated equipment maintenance. Although users appreciated the consistency of laboratory services, several interviewees noted that centralized management occasionally limited operational flexibility because technical decisions often required institutional approval. Consequently, while laboratory services remained reliable and standardized, administrative procedures sometimes slowed responses to urgent operational needs.

Among the three institutions, State Islamic Higher Education Institutions C recorded the lowest satisfaction levels, particularly for testing and calibration quality assurance (3.4), accommodation and environmental conditions (3.5), technical sampling (3.5), and laboratory technical requirements (3.6). Observational data identified several operational constraints, including limited laboratory space, aging equipment, irregular maintenance schedules, and

insufficient technical personnel to support simultaneous laboratory activities. Interview participants further explained that laboratory technicians frequently managed multiple laboratories, resulting in delayed equipment preparation and maintenance. These conditions reduced operational efficiency and affected users' perceptions of laboratory service quality.

Across the three State Islamic Higher Education Institutions, user satisfaction was influenced not only by the availability of physical facilities but also by the effectiveness of laboratory governance. Institutions with clear organizational structures, adequate technical staffing, systematic equipment maintenance, and responsive laboratory services consistently achieved higher satisfaction levels than those experiencing fragmented management and limited technical capacity. Furthermore, the lowest ratings for testing and calibration services indicate that laboratory functions remain predominantly oriented toward supporting practical instruction rather than research and professional laboratory services. The convergence of questionnaire results, interviews, observations, and document analysis demonstrates that user satisfaction reflects the overall quality of laboratory governance rather than infrastructure alone. These empirical findings therefore provide important evidence that strengthening governance mechanisms, human resource capacity, maintenance systems, and institutional quality assurance is essential for improving laboratory performance and serves as a key foundation for developing the integrated State Islamic Higher Education Institutions laboratory governance model presented in the subsequent section.

Cross-case Analysis

The multiple-case study enabled a systematic comparison of laboratory governance across the three participating State Islamic Higher Education Institutions. Data triangulation from interviews, field observations, institutional documents, and user satisfaction surveys revealed five recurring themes that consistently emerged despite differences in institutional structures and laboratory management arrangements. These common patterns indicate that laboratory governance challenges are systemic rather than institution-specific, providing a robust empirical basis for developing an integrated governance model.

The *first* recurring theme concerns fragmented laboratory governance. Across all State Islamic Higher Education Institutions, laboratory management remained dependent on faculty-level regulations, resulting in substantial variation in organizational structures, planning systems, maintenance procedures, documentation, and reporting mechanisms. One laboratory coordinator explained that “*each faculty develops its own laboratory management procedures because there is no institutional governance framework integrating planning, budgeting, supervision, and quality assurance across all laboratories.*” Field observations confirmed inconsistencies in inventory systems, equipment maintenance schedules, and quality monitoring, demonstrating the absence of an integrated institutional governance framework.

The *second* theme relates to limited technical human resource capacity. Participants consistently identified shortages of qualified laboratory technicians as a major obstacle to laboratory performance. Observations showed that technicians simultaneously handled equipment preparation, maintenance, inventory management, scheduling, and administrative reporting, leaving limited capacity for calibration, preventive maintenance, research support, and laboratory innovation. Although several study program-based laboratories operated more efficiently than centrally managed laboratories, shortages of technically competent personnel remained evident across all institutions.

The *third* theme highlights the imbalance in the functions of the laboratory within the Tridharma of Higher Education. Teaching activities overwhelmingly dominated laboratory utilization, while research support, testing services, calibration, innovation, and community engagement remained underdeveloped. Institutional documents further demonstrated that laboratory performance indicators focused primarily on practical teaching rather than research productivity or community service outcomes.

The *fourth* theme concerns the partial implementation of the IQAS. Although all State Islamic Higher Education Institutions had established institutional quality assurance mechanisms, laboratory quality management was largely administrative and accreditation-driven. Field observations identified inconsistencies in preventive maintenance records, laboratory audits, equipment validation, and continuous quality improvement practices, indicating that the standard setting, implementation, evaluation, control, and continuous improvement cycle had not yet been fully embedded in laboratory governance.

The *fifth* theme demonstrates the close relationship between governance quality and user satisfaction. Comparative analysis showed that State Islamic Higher Education Institutions with more systematic scheduling, responsive technical support, clearer safety procedures, and better maintenance practices consistently achieved higher satisfaction scores than institutions with weaker governance systems. Interview findings confirmed that users valued effective technical assistance and well-organized laboratory management as much as the availability of physical infrastructure.

Development of the Integrated State Islamic Higher Education Institutions Laboratory Governance Model

The final objective of this study was to develop an integrated laboratory governance model that responds to the empirical challenges identified across the three participating State Islamic Higher Education Institutions. Rather than directly adopting existing laboratory-quality frameworks, the proposed model emerged from the synthesis of qualitative findings from interviews, observations, documentation analysis, and cross-case comparisons. The model, therefore, represents a contextual governance framework grounded in institutional realities while incorporating internationally recognized laboratory-quality management principles.

The cross-case analysis revealed five recurring institutional issues that consistently influenced laboratory performance across the participating State Islamic Higher Education Institutions: fragmented governance structures, limited technical human resource capacity, inadequate integration of laboratories within the Tridharma of Higher Education, partial implementation of the IQAS, and variations in user satisfaction associated with laboratory management quality. These themes constituted the empirical basis for developing the integrated governance model.

The resulting model consists of four interconnected governance dimensions. The first dimension establishes the institutional foundation by aligning laboratory development with the university vision, strategic planning, the Tridharma of Higher Education, and Islamic values. The second dimension focuses on governance mechanisms, including organizational leadership, laboratory management, human resource development, infrastructure planning, information systems, documentation, and quality assurance. The third dimension operationalizes laboratory quality through the Twelve Quality System Essentials (QSEs), which function as an integrated management system rather than as independent technical components. The final dimension represents institutional outcomes, namely improved educational quality, research productivity, community engagement, quality assurance performance, and sustainable laboratory governance.

Empirical evidence demonstrated that the relationships among these dimensions were derived directly from field findings. Weak organizational coordination highlighted the need for integrated governance, shortages of laboratory personnel underscored the importance of competency-based human resource planning, and limited research utilization underscored the importance of balancing laboratory functions across education, research, and community service. Likewise, user satisfaction findings underscored the strategic roles of equipment management, service quality, and continuous improvement in strengthening laboratory performance.

The model, therefore, extends existing laboratory governance approaches by integrating Laboratory Quality Management System (LQMS) principles, the IQAS, and Islamic institutional values into a single governance framework tailored to the characteristics of State Islamic Higher Education Institutions. Rather than positioning laboratories solely as technical facilities, the

proposed model conceptualizes laboratory governance as a strategic institutional system that simultaneously supports academic quality, research excellence, organizational accountability, and ethical responsibility in Islamic higher education.

Discussion

Based on research conducted on laboratories at State Islamic Higher Education Institutions in West Sumatra, it was found that the laboratory management system was implemented in accordance with internal regulations set by each State Islamic Higher Education Institution. Data analysis showed variations in laboratory management practices across State Islamic Higher Education Institutions, reflected in differences in organizational structure, operational procedures, and monitoring mechanisms. These variations in management systems result in different performance outcomes across institutions, both in operational effectiveness and in the utilization of laboratories in academic activities.

Based on the study's results, implementing an integrated laboratory system and a study-program-based laboratory management system at State Islamic Higher Education Institutions in West Sumatra has different implications for meeting IQAS standards. In the integrated laboratory system, centralized management contributes positively to the fulfillment of quality control and evaluation standards, particularly in planning, supervision, and documentation of laboratory activities. However, the research findings show that the limited number of technical personnel with competencies aligned with the scientific fields of the study programs has resulted in the standards for the implementation of practical learning processes not being fully met.

In the context of IQAS, this condition indicates a gap between implementation standards and human resource standards, as the role of laboratory managers is more focused on administrative functions, such as supervision and scheduling, rather than on technical assistance and oversight of equipment use. In addition, integrated laboratory activities are still dominated by educational activities, so that the fulfillment of research and community service standards in the standard setting, implementation, evaluation, control, and continuous improvement cycle has not been balanced.

Meanwhile, the study program-based laboratory management system demonstrates higher compliance with the learning implementation standards in IQAS, as units with direct scientific relevance are responsible for management. The research findings indicate that this system supports the fulfillment of process and graduate competency standards through the implementation of more contextually and target-oriented practicums. However, from the IQAS perspective, the development of study program-based laboratories as testing, calibration, and research and community service support laboratories still requires strengthening in terms of facility and infrastructure standards, organizational structure standards, and quality evaluation and improvement mechanisms. Thus, this study shows that the optimization of State Islamic Higher Education Institutions' laboratories requires the integration of the laboratory management system with the IQAS framework as a whole through the application of the standard setting, implementation, evaluation, control, and continuous improvement cycle, so that laboratories can function as strategic instruments in ensuring and improving the quality of Islamic higher education.

Laboratories are academic support facilities at educational institutions that are systematically managed for testing, calibration, and/or limited-scale production activities in the context of education, research, and community service (*Menteri Pendayagunaan Aparatur Negara dan Reformasi Birokrasi*, 2019). The concept of a campus that prioritizes the essence of higher education to generate and develop science and technology, as well as prepare individuals to develop themselves and their potential to become productive and useful members of society, certainly requires optimal laboratory management. Hence, learning facilities and management need attention. Non-practical

and practical learning facilities are vital and need to be equipped with comfortable rooms, teaching aids, and competent human resources in their fields.

In addition to learning facilities, standardized laboratory management is also required. The design of Islamic Higher Education Institutions' laboratory management is based on the laboratory quality management system (LQMS). Laboratory development in the Islamic Higher Education Institutions environment requires a structured quality management system to ensure the accuracy, reliability, and reproducibility of learning and research outcomes. The Laboratory Quality Management System (LQMS) is a formal framework that documents the organizational structure, processes, and procedures to ensure consistent laboratory operational quality (Pillai & Fox, 2025)

The urgency of implementing LQMS is increasingly relevant in the context of the global research reproducibility crisis, as highlighted by Nature (Baker, 2016). Therefore, PTKI needs to develop laboratory management that not only meets academic standards but also upholds scientific integrity and Islamic ethical values—twelve quality system essentials (QSEs) frameworks for laboratories in the context of Islamic Higher Education Institutions. State Islamic Higher Education Institutions' laboratory management design is adapted from the 12 Quality System Essentials (QSEs) in the Laboratory Quality Management System Handbook elaborated by Laboratory Quality Management System Fundamentals (Pillai & Fox, 2025), with the integration of ISO 9001 principles (Natarajan, 2017) and ISO/IEC 17025, as shown in Table 2.

Indicator	Explanation	Implementation at State Islamic Higher Education Institutions
Organization	The laboratory structure must have clear governance, quality policies, quality manuals, and management review mechanisms. Leadership demonstrates a commitment to a culture of quality in accordance with the principles of ISO 9001:2015 (Tampubolon et al., 2025).	Establishment of a Laboratory Quality Assurance Unit at the faculty of State Islamic Higher Education Institutions level; preparation of laboratory quality manuals; annual management review meetings involving leaders.
Facilities & Safety	The laboratory environment must meet occupational safety and research ethics standards. Regulations such as 29 CFR 1960 from the Occupational Safety and Health Administration emphasize inspection and risk control (Ateeq et al., 2024).	Preparation of laboratory OSH SOPs; periodic safety training; routine inspections; integration of life protection values (hifz al-nafs) into safety policies.
Personnel	The competence of lecturers, laboratory assistants, and students is determined through job descriptions, training, and periodic evaluations. A culture of safety must be strengthened (Ménard & Trant, 2025).	Laboratory technician certification; risk-based training; good laboratory practice (GLP) workshops; annual competency evaluations.
Equipment	Instruments must be calibrated, preventive maintenance performed, and validated to ensure the traceability of measurement results in accordance with ISO/IEC 17025 (Panagiotidou et al., 2025).	Annual calibration schedule; maintenance logbook; calibration contracts with accredited institutions; digital damage reporting system.
Procurement & Inventory	Materials and reagents must meet the principles of fitness for use and supplier traceability. Stock control prevents expiration and research disruption (Wijesena, 2025).	Barcode-based inventory system; supplier evaluation; goods receiving procedures; automatic expiration date monitoring.
Process Management	Practical and research processes are mapped through process mapping and QC to reduce variability (Misztal & Ratajszczak, 2025).	Preparation of practical process flowcharts; quality control standards; experimental variable control checklists; routine supervision.
Documents & Records	All SOPs, forms, and records must be documented and controlled to ensure accountability and replication of research (McFadden et al., 2022).	Centralized document control system; version control; cloud digital archives; periodic document audits.

Indicator	Explanation	Implementation at State Islamic Higher Education Institutions
Information Management	The information system ensures data security, academic integrity, and intellectual property protection.	Implementation of Laboratory Information Management System (LIMS); periodic data backup; cyber security policy; copyright protection of research results.
Assessment	Internal and external audits and participation in external quality assessment (Dhara et al., 2024) to ensure compliance with standards.	Laboratory quality audits twice a year; proficiency testing participation; reporting audit results to PTKIN leadership.
Nonconformity Management	Any deviations are analyzed through root cause analysis and followed up with corrective and preventive actions.	Incident reporting form, quality investigation team, post-incident evaluation meetings, and non-compliance database.
User Satisfaction	Students, lecturers, and partners are internal and external customers whose satisfaction must be measured.	Semesterly satisfaction surveys, user feedback forums, and laboratory service evaluations based on quality indicators.
Continuous Improvement	Quality improvement is based on the Plan–Do–Check–Act cycle as per ISO 9001:2015.	Annual improvement programs; benchmarking between PTKINs; KPI-based laboratory quality targets; continuous improvement reports.

The State Islamic Higher Education Institutions laboratory management design, adapted from the 12 Quality System Essentials (QSE), Table 1 shows that the laboratory quality system cannot be understood merely as a set of technical procedures, but rather as a comprehensive institutional governance architecture. Analysis of the design table shows that each QSE indicator has structural, cultural, and strategic implications for State Islamic Higher Education Institutions. In terms of organization, a clear governance structure, quality policies, and management review mechanisms form the main foundation of the quality system. This principle aligns with the risk-based quality management approach in ISO 9001, which emphasizes leadership and top management involvement. In State Islamic Higher Education Institutions' practice, the implementation of these indicators is highly dependent on the commitment of the rector and dean to make laboratories an integral part of the tridharma strategy. Without leadership support, the quality system risks becoming an administrative formality, as the audit society literature has criticized (Sulaiman, 2023).

Facility and safety indicators emphasize that laboratories must meet strict occupational safety standards. Regulations such as 29 CFR 1960 issued by the Occupational Safety and Health Administration emphasize the importance of routine inspections and risk control. However, research by Ménard and Trant (2025) shows that academic laboratories globally still face weaknesses in building a proactive safety culture. In State Islamic Higher Education Institutions, safety implementation is not yet fully grounded in a safety culture but remains reactive to incidents. This indicates the need to shift from a compliance approach to a safety culture grounded in moral and institutional responsibility. In terms of personnel indicators, the competence of lecturers and laboratory assistants is a determinant of the success of the quality system. The ISO/IEC 17025 standard emphasizes the importance of validating technical competence and procedural traceability. Implementation at State Islamic Higher Education Institutions still faces challenges, including limited risk-based training and formal certification for laboratory assistants. In fact, the literature on higher education quality management emphasizes that an institution's quality is largely determined by the professionalism of its human resources (Ponomarenko et al., 2022).

Equipment indicators are directly related to research integrity. Measurement traceability is a fundamental requirement in ISO/IEC 17025 to ensure the validity of results. Delays in calibration or in the documentation of maintenance practices can reduce the reproducibility of research. This condition is relevant to the scientific replication crisis, so equipment management must be incorporated into a strategy to maintain academic credibility (Hicks, 2023). In terms of procurement and inventory, the principles of fitness for use and supplier traceability are crucial to

ensure the consistency of experimental results. Inventory management that has not been fully digitized in some State Islamic Higher Education Institutions indicates gaps in the risk mitigation system. The literature on supply chain management emphasizes that good inventory control improves operational stability and reduces potential losses.

Furthermore, process management indicators emphasize the importance of process mapping and quality control (QC) to minimize variability. Misztal and Ratajszczak (2025) show that uncontrolled process variability significantly affects the consistency of laboratory results. In the context of State Islamic Higher Education Institutions, not all practicum processes are documented through systematic process maps, so quality evaluations are often partial. Document and record indicators serve as an accountability infrastructure. Controlled documentation enables transparency and replication of research. Asserts that institutional legitimacy is built through publicly verifiable practices (Damian et al., 2022). Therefore, implementing a version-control-based document control system is an urgent need to improve academic trust.

In terms of information management, digital transformation through the implementation of a Laboratory Information Management System (LIMS) is part of modern governance. Data security and intellectual property rights protection are not only technical matters but also related to academic integrity. The digitization of information systems strengthens evidence-based governance and minimizes the risk of data manipulation. Assessment indicators through internal and external audits, including participation in external quality assessment, serve as organizational learning mechanisms. Laboratories that participate in external proficiency testing show increased consistency in quality (Cherie et al., 2024). In State Islamic Higher Education Institutions, audits are still perceived as an administrative obligation rather than a strategic reflection tool.

In the nonconformance management indicator, the application of root cause analysis is an important element in systemic improvement. However, the culture of blaming individuals remains an obstacle in some laboratory practices. Modern quality management literature emphasizes the importance of a systemic approach over the personalization of errors. The user satisfaction indicator places students and lecturers as internal customers. This paradigm aligns with the service quality approach in higher education, which emphasizes stakeholder orientation (Mansoor & Hussain, 2024). Periodic satisfaction surveys at State Islamic Higher Education Institutions show a correlation between the digitization of laboratory services and increased user satisfaction.

Finally, the Plan–Do–Check–Act (PDCA) cycle-based continuous improvement indicator in ISO 9001 is central to the sustainability of quality systems. Without periodic evaluation and measurable performance targets, quality systems tend to stagnate (Busnawir, 2025). The integration of PDCA with the value of public benefit broadens the meaning of improvement as an institutional obligation oriented towards public benefit (Valencia, 2023). Overall, this discussion shows that the implementation of the 12 QSEs at State Islamic Higher Education Institutions is still in a transitional stage, moving from administrative compliance to integrated quality management. The integration of international standards and institutional ethical values is a distinguishing factor that can strengthen the legitimacy and competitiveness of State Islamic Higher Education Institutions laboratories in the global higher education ecosystem.

CONCLUSION

This study demonstrates that laboratory governance in State Islamic Higher Education Institutions remains fragmented across organizational structure, quality assurance implementation, human resource capacity, and laboratory utilization, thereby limiting laboratories' strategic contributions beyond teaching to research, testing services, calibration, and community engagement. Addressing these challenges, the study proposes the Integrated Sustainable Laboratory Governance Model, which constitutes its primary theoretical contribution by integrating the IQAS, the twelve

Quality System Essentials (QSE), ISO 9001 principles, ISO/IEC 17025 requirements, and Islamic ethical values into a unified governance framework. By extending laboratory governance beyond conventional compliance-oriented approaches, the proposed model reconceptualizes laboratories as strategic institutional assets that simultaneously strengthen quality assurance, research productivity, organizational accountability, and sustainable development within Islamic higher education. From a practical perspective, the model provides an evidence-based framework for institutional leaders and policymakers to align laboratory governance with the standard setting, implementation, evaluation, control, and continuous improvement quality cycle, enhance the competencies of laboratory personnel, institutionalize continuous quality improvement, and optimize laboratory functions to support academic excellence and innovation. Nevertheless, the findings are derived from three State Islamic Higher Education Institutions in West Sumatra and may therefore not fully capture the diversity of governance practices across Indonesian Islamic higher education institutions. Future research should validate the proposed model across broader institutional settings, employ longitudinal and mixed-method designs to evaluate its implementation and organizational impact, and develop robust performance indicators to measure laboratory effectiveness, research productivity, quality assurance maturity, and institutional sustainability.

ACKNOWLEDGMENT

In preparing and writing this article, the author received support, guidance, and advice from various parties. Therefore, the author would like to express his appreciation and gratitude to the Ministry of Religious Affairs of the Republic of Indonesia and the Institute for Research and Community Service of Universitas Islam Negeri Imam Bonjol for providing financial support for this research. Gratitude is also extended to the leadership and academic community of the State Islamic Higher Education Institutions in West Sumatra, as well as all parties who have contributed and been involved directly or indirectly in the implementation of this research. The author acknowledges that this article still has limitations and requires improvement. Therefore, constructive criticism and suggestions from readers are highly appreciated as material for improving and developing future research.

BIBLIOGRAPHY

- Ateeq, A., Milhem, M., & Alzoraiki, M. (2024). Strengthening Workplace Safety: A Comprehensive Review and Enhancement Strategy for Alba's Occupational Health and Safety Policies. *Business Development via AI and Digitalization: Volume 1*, 313-321. https://doi.org/10.1007/978-3-031-62102-4_26
- Baker, M. (2016). *1,500 scientists lift the lid on reproducibility*. Nature Publishing Group UK, London.
- Busnawir, B. (2025). Continuous Improvement Cycle-Based Evaluation: An Effective Control Strategy For Program Success. *Indonesian Journal of Education (INJOE)*, 4(3), 645-654. <https://felifa.net/index.php/INJOE/article/view/312>
- Cherie, N., Adane, K., Wolde, M., Nigus, M., & Deress, T. (2024). Evaluating proficiency testing implementation and identifying challenges that government comprehensive specialized hospital laboratories in northwest Ethiopia faced as they participated in the external quality assessment scheme: A document-based, interview-driven evaluation. *American Journal of Clinical Pathology*, 162(3), 261-268. <https://doi.org/10.1093/ajcp/aqae037>
- Damian, E., Meuleman, B., & van Oorschot, W. (2022). Transparency and replication in cross-national survey research: Identification of problems and possible solutions. *Sociological Methods & Research*, 51(2), 499-526. <https://doi.org/10.1177/0049124119882452>

- Eyenaka, F. D., Nsit, A., Umoren, F. A., & Bichi, K. (2024). Laboratory and library facilities: investigating their potencies in promoting student interest and performance in science subjects. *Information Science*, 6(1), 161-176.
- Hicks, D. J. (2023). Open science, the replication crisis, and environmental public health. *Accountability in Research*, 30(1), 34-62. <https://doi.org/10.1080/08989621.2021.1962713>
- Mansoor, T., & Hussain, S. (2024). Impact of knowledge-oriented leadership on sustainable service quality of higher education institutes. *VINE Journal of Information and Knowledge Management Systems*, 54(4), 705-724. <https://doi.org/10.1108/VJIKMS-09-2021-0176>
- McFadden, E., Jackson, J., & Forrest, J. (2022). Documentation: Essential Documents and Standard Operating Procedures. In *Principles and Practice of Clinical Trials* (pp. 369-387). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-52636-2_45
- Ménard, A. D., & Trant, J. F. (2025). Analysis of safety-related incidents reported at a major North American petrochemical processing facility between 2016 and 2020. *ACS Chemical Health & Safety*, 32(2), 186-193. <https://doi.org/10.1021/acs.chas.4c00120>
- Menteri Pendayagunaan Aparatur Negara dan Reformasi Birokrasi. (2019). *Peraturan Menteri Pendayagunaan Aparatur Negara dan Reformasi Birokrasi Republik Indonesia Nomor 7 Tahun 2019 Tentang Jabatan Fungsional Pranata Laboratorium Pendidikan*.
- Mirna, M. K., & Imron, K. (2023). Metode Pembelajaran Karya Wisata (Studi Tour) Dalam Telaah Tafsir Al-Qur'an Surah Al-Ankabut Ayat 20 Dan Hadist. *Jurnal Ilmu Pendidikan Muhammadiyah Kramat Jati*, 4(2), 84-90. <https://doi.org/10.55943/jipmukjt.v4i2.90>
- Misztal, A., & Ratajszczak, K. (2025). Possibilities of using contemporary quality management methods and tools for the sustainable development of the organization. *Sustainability*, 17(2), 617. <https://doi.org/10.3390/su17020617>
- Mohzana, M., Murcahyanto, H., Fahrurrozi, M., & Supriadi, Y. N. (2023). Optimization of management of laboratory facilities in the process of learning science at a high school. *Jurnal Penelitian Pendidikan IPA*, 9(10), 8226-8234. <https://doi.org/10.29303/jppipa.v9i10.5249>
- Naeem, M., Ozuem, W., Howell, K., & Ranfagni, S. (2023). A step-by-step process of thematic analysis to develop a conceptual model in qualitative research. *International journal of qualitative methods*, 22, 16094069231205789. <https://doi.org/10.1177/16094069231205789>
- Natarajan, D. (2017). *ISO 9001 Quality management systems* (pp. 1-250). Cham, Switzerland: Springer International Publishing.
- Panagiotidou, E., Chountalas, P. T., Magoutas, A. I., Georgakellos, D. A., & Lagodimos, A. G. (2025). Systematic identification and validation of critical success factors for ISO/IEC 17025 implementation. *Administrative Sciences*, 15(2), 60. <https://doi.org/10.3390/admsci15020060>
- Păunescu, C., Ruohonen, A., Spencer, N., & Vavură, N. M. (2022). Management framework for higher education institution-based community innovation labs. *Management & Marketing*, 17(1). <https://doi.org/10.2478/mmcks-2022-0021>
- Pillai, S. P., & Fox, E. (2025). Laboratory quality management system fundamentals. *Frontiers in Bioengineering and Biotechnology*, 13, 1578654. <https://doi.org/10.3389/fbioe.2025.1578654>
- Ponomarenko, N., Polyansky, P., Shkurat, I., Romanenko, M., & Tolochko, S. (2022). Quality management of higher education for increasing the competitiveness of labor resources. *International Journal for Quality Research*, 3(16), 817-830. <https://dspace.mnau.edu.ua/jspui/handle/123456789/12587>
- Prasatiawati, E. (2025). Taujih al-Qiraat and Its Hermeneutical Implications in Surah Yunus. *Jurnal Ilmiah Al-Mu'ashirah: Media Kajian Al-Qur'an dan Al-Hadits Multi Perspektif*, 22(2), 255-266. <https://doi.org/10.22373/jim.v22i2.32072>
- Remiswal, Z., & Zalnur, M. (2021). Kontribusi Fasilitas Belajar dan Tata Kelola Laboratorium Terhadap Efektivitas Praktikum Virtual pada Masa Pandemi. *Jurnal Riset Fisika Edukasi Dan Sains*, 8(1), 37-45. <https://doi.org/10.22202/jrfes.2021.v8i1.4775>

- Schlunegger, M. C., Zumstein-Shaha, M., & Palm, R. (2024). Methodological and data-analysis triangulation in case studies: A scoping review. *Western Journal of Nursing Research*, 46(8), 611-622. <https://doi.org/10.1177/01939459241263011>
- Sulaiman, N. A. (2023). External audit quality: its meaning, representations, and potential conflict in practice. *Accounting, Auditing & Accountability Journal*, 36(5), 1417-1440. <https://doi.org/10.1108/AAAJ-02-2020-4443>
- Tampubolon, B. D., Anggundari, W. C., & Anggraeni, P. (2025). Leadership style analysis in an organization based on SNI ISO 9001: 2015. *International Journal for Quality Research*, 19(2). <https://doi.org/10.24874/IJQR19.02-09>
- Tercanli, H., & Jongbloed, B. (2022). A systematic review of the literature on living labs in higher education institutions: potentials and constraints. *Sustainability*, 14(19), 12234. <https://doi.org/10.3390/su141912234>
- Valencia, P. L. V. (2023). Establishment of a centralized policy framework for IT/IS governance based on a PDCA method. In *2023 IEEE 15th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment, and Management (HNICEM)* (pp. 1-6). IEEE. <https://doi.org/10.1109/HNICEM60674.2023.10589150>
- Wijesena, G. H. D. (2025). *Development of a Computerized Chemical Stock and Order Management System for Educational Institutions*. 15(2), 18–22.

