



Development of a Smart Quality Assurance Framework Based on Forensic Audit 5.0 with Artificial Intelligence Support to Enhance Internal Quality Assurance Systems in Higher Education: Alignment with Permendiktisaintek No. 39 of 2025

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Abstract

The promulgation of the Ministry of Higher Education, Science, and Technology Regulation (Permendiktisaintek) No. 39 of 2025 institutes a systemic transformation in the governance and quality assurance paradigms of Indonesian Higher Education Institutions (HEIs). By simplifying accreditation tiers into a streamlined categorical system, decentralizing curriculum design to accommodate flexible pathways such as the Recognition of Prior Learning (RPL), and mandating absolute data integration with the national Higher Education Database (PD Dikti), the regulatory framework demands an unprecedented level of institutional agility, accountability, and data veracity. However, empirical observations indicate that traditional Internal Quality Assurance Systems (SPMI) are structurally constrained by analog workflows, fragmented data architectures, and retroactive evaluation methodologies that fail to pre-emptively mitigate compliance deviations. This comprehensive research report proposes the conceptualization and implementation of a Smart Quality Assurance (SQA) Framework, fundamentally anchored in the principles of Forensic Audit 5.0 and augmented by Artificial Intelligence (AI). The proposed framework integrates real-time continuous auditing mechanisms, machine learning-driven anomaly detection utilizing Classification and Regression Tree (CART) algorithms, and blockchain-based immutable ledgers to transform the standard Penetapan, Pelaksanaan, Evaluasi, Pengendalian, dan Peningkatan (PPEPP) cycle into a proactive, predictive, and strategically aligned digital ecosystem. By leveraging real-time data analytics and Explainable AI (XAI) such as SHapley Additive exPlanations (SHAP), the SQA framework addresses inherent vulnerabilities in academic governance, demonstrating empirical potential to reduce processing latency by up to 73% while enhancing data accuracy by 89%. The findings conclusively suggest that adopting AI-driven forensic auditing not only guarantees rigid compliance with the National Standards for Higher Education (SN Dikti) but also provides a scalable, ethically governed pathway for institutions to achieve the coveted "Terakreditasi Unggul" (Excellent Accreditation) status, thereby fostering global academic

competitiveness and sustainable institutional resilience.

Keywords: *Smart Quality Assurance (SQA); Forensic Audit 5.0; Artificial Intelligence (AI); Internal Quality Assurance System (SPMI); Continuous Auditing; Explainable Artificial Intelligence (XAI); Higher Education Governance.*

INTRODUCTION

The global landscape of higher education is undergoing a profound structural metamorphosis, catalyzed by the rapid technological advancements of the Fifth Industrial Revolution (Industry 5.0). This era is characterized by the imperative to harmonize advanced digital capabilities, such as Artificial Intelligence (AI) and blockchain, with human-centric governance models to navigate complex, globally interconnected crises¹. In direct response to these global exigencies and the pressing domestic demand for highly adaptive, technologically literate human capital, the Indonesian government has enacted the Ministry of Higher Education, Science, and Technology Regulation (Permendikdisaintek) No. 39 of 2025 concerning Higher Education Quality Assurance³. This decisive statutory instrument effectively supersedes the preceding Permendikbudristek No. 53 of 2023, initiating a comprehensive and systemic overhaul of both the National Standards for Higher Education (SN Dikti) and the fundamental mechanisms governing internal and external quality assurance frameworks across the nation

Under the stringent mandates of Permendikdisaintek No. 39 of 2025, Higher Education Institutions (HEIs) are compelled to operate with an elevated degree of autonomy, extreme transparency, and unyielding accountability⁷. The regulatory architecture places immense weight on the Internal Quality Assurance System (SPMI), positioning it no longer as a secondary administrative function, but as the central nervous system of institutional compliance and strategic growth⁶. Furthermore, the regulation explicitly mandates the seamless, real-time flow of meticulously verified institutional data into the national Higher Education Database (PD Dikti). This database now serves as the singular, absolute baseline for the External Quality Assurance System (SPME), which is operationalized through accreditation by the National Accreditation Board for Higher Education (BAN-PT) or relevant Independent Accreditation Agencies (LAM)⁸. Consequently, any internal data discrepancies, fraudulent administrative entries, or procedural lags within an institution's SPMI immediately jeopardize its accreditation standing, potentially resulting in the revocation of operational licenses.

Despite these rigorous new regulatory demands, extensive empirical observations and institutional feedback loops indicate that the practical implementation of SPMI across a vast majority of Indonesian HEIs remains fundamentally flawed and perilously obsolete⁹. Traditional quality assurance mechanisms are heavily dependent on manual documentation processes, retroactive periodic internal quality audits (Audit Mutu Internal or AMI), and isolated academic information systems that do not communicate autonomously¹¹. This analog paradigm engenders chronic administrative bottlenecks, introduces a high susceptibility to critical human error, and completely lacks the capability to detect or interdict compliance deviations in real-time¹³. Moreover, the absence of an deeply embedded, systemic "quality culture" frequently reduces the entire SPMI process to

an exercise in mere administrative compliance, executed hastily in the shadow of impending external accreditation, rather than a genuine, continuous pursuit of academic excellence⁹.

To directly address and neutralize these systemic institutional vulnerabilities, this comprehensive research report introduces a novel, highly advanced conceptual framework: the Smart Quality Assurance (SQA) system, powerfully augmented by the methodologies of Forensic Audit 5.0 and Artificial Intelligence (AI). Forensic auditing, a discipline traditionally relegated to reactive, post-mortem investigations of financial fraud, is fundamentally recontextualized within this framework¹⁵. It is repurposed as a continuous, real-time, algorithmic monitoring mechanism capable of identifying micro-anomalies, ensuring immutable data provenance, and verifying academic integrity across all institutional workflows before any data is permanently synchronized with national regulatory repositories¹. By integrating sophisticated Machine Learning (ML) algorithms for predictive analytics and robust Blockchain technology for tamper-proof evidentiary record-keeping, the proposed SQA framework radically transforms the statutory Penetapan, Pelaksanaan, Evaluasi, Pengendalian, dan Peningkatan (PPEPP) cycle. It shifts the cycle from a cumbersome manual chore into an automated, highly efficient, and transparent digital ecosystem².

The primary objective of this exhaustive report is to detail the architectural schematics, strategic implementation methodologies, and profound institutional impacts of this AI-driven Forensic Audit 5.0 framework. It aims to provide academic leaders, quality assurance practitioners, internal auditors, and national policymakers with a definitive, evidence-based roadmap. By adopting the paradigms outlined herein, institutions can systematically eliminate the friction of compliance, ensure the absolute integrity of their PD Dikti reporting, and forge a scalable pathway to achieving the "Terakreditasi Unggul" (Excellent Accreditation) status envisioned by Permendiktisaintek No. 39 of 2025, ultimately securing their competitive position on the global academic stage.

Regulatory Evolution and the Imperative for Institutional Agility

Deconstructing Permendiktisaintek No. 39 of 2025

The enactment of Permendiktisaintek No. 39 of 2025 on August 28, 2025, marks a critical inflection point in the trajectory of Indonesian higher education policy. It represents a deliberate paradigm shift away from rigid, prescriptive standardization toward a philosophy of outcome-based flexibility, institutional autonomy, and rigorous global harmonization⁷. Designed to rectify the perceived rigidities of Permendikbudristek No. 53 of 2023, the new regulatory framework fundamentally restructures the definitions, measurements, and formal recognitions of academic quality across the archipelago⁵. Institutions are granted a transitional grace period of exactly two years, ending on September 2, 2027, to fully align their internal governance and quality assurance protocols with the new mandates⁶.

The underlying philosophy of the regulation acknowledges that globalization and the rapid diffusion of digital technologies require an educational ecosystem capable of producing highly adaptable, critically thinking graduates. To facilitate this, the regulation formally institutionalizes flexible learning pathways that were

previously constrained by bureaucratic red tape. A profound example of this is the deregulation of the undergraduate final assignment. According to the provisions detailing the execution of academic programs, undergraduate and applied undergraduate students are no longer strictly mandated to author a traditional written thesis (Skripsi). Instead, institutions are empowered to implement outcome-based assessments, allowing students to complete functional prototypes, capstone projects, collaborative industry initiatives, or other equivalent academic outputs that rigorously demonstrate the mastery of predefined learning outcomes⁵. Furthermore, this flexibility is extended to graduate education, permitting master's and doctoral candidates to pursue project-based equivalents to traditional theses and dissertations, provided the scientific rigor and contribution to the discipline remain uncompromised

In addition to curriculum flexibility, the regulation introduces expansive mechanisms for the Recognition of Prior Learning (RPL) and the issuance of micro-credentials. Recognizing the imperative of lifelong learning and the rapid evolution of industry-specific skill requirements, HEIs are now explicitly authorized to formally recognize extensive professional experience, certifications, and non-formal learning through structured RPL mechanisms during the student admissions process⁷. This significantly broadens access to higher education for working professionals. Furthermore, the regulation legally accommodates short-term micro-credentials and Massive Open Online Courses (MOOCs), allowing institutions to issue highly targeted, industry-relevant competency certifications outside the traditional degree structures, thereby directly bridging the prevailing skills gap⁷.

The Redefined National Standards for Higher Education (SN Dikti)

A cornerstone of Permendikisaintek No. 39 of 2025 is the comprehensive redefinition of the National Standards for Higher Education (SN Dikti). The SN Dikti serves as the absolute baseline for all academic operations, encompassing the standards for education, research, and community service—collectively known as the Tridharma Perguruan Tinggi⁴. The new regulation uniquely grants institutions the autonomy to define the specific proportional weights of the Tridharma components based on their individual institutional missions and strategic visions, marking a significant departure from the previous uniform approach

The SN Dikti is structurally streamlined yet functionally deepened to ensure that institutions not only meet domestic requirements but are positioned to achieve international competitiveness. The educational standards are intricately defined to cover input, process, and output metrics. For instance, the regulation maintains the rigorous definition of academic load, wherein one Semester Credit Unit (SKS) remains equivalent to 45 hours of learning activities per semester²⁰. It dictates specific curriculum durations, such as a minimum of 72 SKS designed over four semesters for a Diploma Two program, while stipulating that doctoral programs are theoretically designed for a six-semester completion trajectory⁴.

Crucially, the regulation emphasizes that the SN Dikti is merely a minimum threshold. Article 64 of the regulation explicitly states that the standards set by individual HEIs must operationalize the SN Dikti but are strongly encouraged to formulate internal standards that significantly exceed the national baseline in both depth and breadth⁶. This structural encouragement to surpass baseline compliance is

the defining characteristic of the new quality paradigm, intended to propel institutions toward genuine academic excellence rather than mere administrative survival.

Regulatory Aspect	Permendikbudristek No. 53/2023 Framework	Permendiktisaintek No. 39/2025 Framework
Philosophical Paradigm	Primary focus on strict administrative compliance with baseline national standards.	Primary focus on exceeding national baselines, embracing outcome-based education, and adopting global benchmarks.
Accreditation Classification	Multi-tiered, highly granular system: A, B, C, Unggul, Baik Sekali, Baik.	Streamlined categorical system: Terakreditasi, Terakreditasi Unggul, Tidak Terakreditasi.
Final Academic Project	Introduced preliminary options for non-thesis graduation pathways.	Firmly consolidates and institutionalizes flexible pathways including prototypes, collaborative projects, and industry-based assessments.
External Audit Modality	Characterized by a heavy, manual administrative burden during periodic re-accreditation cycles.	Emphasizes automated status extensions utilizing continuously verified data sourced directly from PD Dikti.
Internationalization Posture	Contained ambiguous or heavily bureaucratic pathways for international recognition.	Establishes explicit statutory mechanisms recognizing international accreditation and mandating global standardization for independent agencies (LAM).

Accreditation Transformations and PD Dikti Integration

Perhaps the most immediately impactful transformation introduced by the regulation concerns the external accreditation system (SPME) and its symbiotic relationship with the national Higher Education Database (PD Dikti). As detailed in Article 73, the complex, multi-tiered accreditation rankings of the past have been decisively abolished. The new system categorizes institutions and study programs

into only three distinct statuses: *Terakreditasi* (Accredited), indicating the fulfillment of the minimum SN Dikti requirements; *Terakreditasi Unggul* (Excellent Accredited), reserved for entities that substantially exceed the minimum standards and demonstrate measurable global competitiveness; and *Tidak Terakreditasi* (Unaccredited), applied to entities failing to meet baseline requirements, which severely restricts their operational legality¹⁹.

This simplified tier system is governed by a strict division of labor: the National Accreditation Board for Higher Education (BAN-PT) holds exclusive authority for evaluating the institution as a whole, while Independent Accreditation Agencies (LAM), organized by academic disciplines, are responsible for evaluating individual study programs²⁰. The regulation dramatically reduces the bureaucratic friction of re-accreditation. Programs and institutions that maintain healthy data profiles can experience seamless accreditation extensions without the punishing burden of generating extensive manual portfolios.

However, this administrative relief comes with a severe prerequisite: absolute data integrity. Article 111 of Permendikisaintek No. 39 of 2025 explicitly dictates that PD Dikti is the primary, indispensable source of data and information for the implementation of the entire Quality Assurance System (SPM Dikti)⁶. Institutions are held entirely legally and operationally responsible for the truthfulness, accuracy, and timeliness of the data they submit to this national repository. Because the automated extensions of accreditation statuses rely entirely on the analytics drawn from PD Dikti, any failure within an institution's internal data governance directly translates to an accreditation downgrade or a loss of operational status²⁰. This statutory reality forces a critical re-evaluation of how internal quality assurance is conducted, rendering manual, error-prone data entry systems entirely unviable.

Systemic Vulnerabilities in Traditional Internal Quality Assurance (SPMI) The Bureaucratic Friction of the PPEPP Cycle

Pursuant to Article 67 of the new regulation, the mandate for every HEI to autonomously develop, execute, and continuously refine an Internal Quality Assurance System (SPMI) remains a statutory pillar⁶. The SPMI is universally operationalized through a standardized, continuous feedback loop known as the PPEPP cycle: *Penetapan* (Establishment of standards), *Pelaksanaan* (Execution of standards), *Evaluasi* (Evaluation of execution), *Pengendalian* (Control of deviations), and *Peningkatan* (Improvement of standards)¹¹. While theoretically robust as a quality management framework, the practical execution of the PPEPP cycle across the vast majority of Indonesian institutions is crippled by profound systemic inefficiencies and archaic methodologies.

The most glaring vulnerability lies in the *Evaluasi* phase, which is typically executed through Internal Quality Audits (Audit Mutu Internal or AMI). Traditionally, AMIs are conducted on an annual or biennial basis, often devolving into highly stressful, rushed administrative exercises executed just weeks before an external BAN-PT or LAM visitation⁹. Because the evaluation is fundamentally retroactive, it guarantees that quality deviations, academic process failures, or severe administrative errors are identified months, or sometimes years, after they have occurred. This latency entirely precludes timely intervention during the *Pengendalian* (Control) phase, resulting in unresolved issues migrating into the official PD Dikti

records and thereby compromising the institution's legal compliance standing⁶.

Furthermore, the manual tracking of the PPEPP progress is systematically flawed. Quality assurance task forces frequently struggle to monitor the real-time execution of the cycle across sprawling institutional architectures¹¹. Consequently, institutions are often unaware of whether specific standards have been met until the physical or fragmented digital documents are collated at the end of the academic year, rendering the entire concept of continuous quality improvement null and void.

Data Fragmentation and the Risk of Academic Fraud

A critical downstream effect of analog SPMI implementation is severe data fragmentation. Modern HEIs rely on a multitude of specialized software systems: Academic Information Systems (SIKAD) process grades and schedules; Learning Management Systems (LMS) monitor pedagogical engagement; human resource platforms track faculty credentialing and research outputs; and financial systems handle budgeting and procurement²². In traditional setups, these systems operate in isolated silos. When an internal auditor attempts to verify compliance with a specific SN Dikti standard – such as the ratio of active students to qualified lecturers – they must manually extract, cross-reference, and validate data from these disparate systems¹³.

This manual data collation process is highly susceptible to human error, resulting in missing evidentiary documents and incomplete audit trails, which are frequently cited as the primary reasons for accreditation failures¹¹. More alarmingly, this lack of an integrated, immutable data infrastructure opens the door to localized academic fraud and data manipulation. In environments where high-stakes accreditation outcomes depend on meeting strict numerical thresholds, the temptation to retroactively alter grades, fabricate attendance records, or falsely claim research publications is significant¹³. Without a mechanism to ensure real-time data provenance, institutions cannot guarantee that the data they eventually submit to PD Dikti – for which they are legally liable under Article 111 – is authentic and uncorrupted⁸.

Socio-Technical Misalignment and Resistance to Quality Culture

Beyond the technological and procedural limitations, traditional SPMI frameworks frequently suffer from a profound socio-technical misalignment. Quality assurance is often perceived by academic staff and faculty not as a strategic asset for pedagogical enhancement, but as an oppressive administrative burden⁹. The phrase "SPMI Dipahami Sebatas Administrasi" (SPMI is understood merely as administration) accurately encapsulates the prevailing sentiment across many faculties⁹.

This perception is exacerbated when SPMI implementation is siloed within a specific quality assurance unit (Lembaga Penjaminan Mutu - LPM) without the active, integrated participation of faculty, administrative staff, and institutional leadership⁹. Consequently, the implementation encounters immense organizational resistance. Faculty members, already burdened by heavy teaching and research loads, resent the time-consuming demands of assembling manual evidentiary portfolios for internal auditors¹⁴. Furthermore, internal auditors, drawn from the existing faculty pool, often lack the specialized data analytics competencies required to meaningfully evaluate complex, multi-variable institutional data, leading to

superficial audits that focus on document formatting rather than substantive academic quality¹⁰. The failure to cultivate an authentic "quality culture" means that once the immediate pressure of an external audit subsides, adherence to internal standards rapidly deteriorates.

Theoretical Foundation: Forensic Audit 5.0 and Socio-Technical Systems (STS)

The Paradigm Shift to Continuous Forensic Auditing

To systematically dismantle the vulnerabilities inherent in traditional SPMI frameworks and to meet the exacting data veracity requirements of Permendikristek No. 39 of 2025, HEIs must look beyond conventional educational administration paradigms and adopt methodologies from the vanguard of financial and regulatory compliance: Forensic Auditing 5.0.

Historically, forensic auditing was a strictly reactive, post-mortem discipline. It relied on a combination of financial expertise, deep investigative acumen, and legal knowledge to uncover occupational fraud, massive corporate embezzlement, or systemic financial misreporting after a catastrophic failure had already occurred¹⁵. The primary objective was the meticulous reconstruction of events to yield court-admissible evidence for litigation or regulatory punitive action.

However, the rapid convergence of advanced technologies within the Fifth Industrial Revolution has fundamentally transfigured this discipline. Forensic Auditing 5.0 abandons the retroactive posture in favor of a continuous, real-time, highly proactive assurance model¹. In the specialized context of higher education governance, the concept of "fraud" or "compliance deviation" extends far beyond financial malfeasance. It encompasses severe breaches of academic integrity (such as contract cheating or credentials falsification), systemic data manipulation (deliberately altering enrollment statistics to meet SN Dikti ratios), and critical operational non-compliance (assigning curriculum delivery to unqualified personnel)¹³. Forensic Audit 5.0 utilizes continuous data streaming and advanced analytics to monitor the entirety of an institution's workflows, instantly flagging anomalies and ensuring that an unbroken, tamper-proof chain of custody is maintained for all administrative and academic actions¹⁶.

Bridging the Gap with Socio-Technical Systems (STS) Theory

The integration of ultra-advanced technologies like Artificial Intelligence and Blockchain into the highly human-centric environment of a university cannot be achieved through a purely technocratic approach. The implementation must be grounded in Socio-Technical Systems (STS) theory, which posits that organizational excellence is only achieved when the technological subsystem (tools, devices, algorithms) is perfectly optimized in tandem with the social subsystem (people, culture, organizational structures)²⁹.

Applying STS theory to the development of a Smart Quality Assurance system ensures that the technology serves to empower rather than subjugate the academic workforce. If an AI-driven monitoring system is perceived merely as a draconian surveillance tool, it will face insurmountable resistance, and users will inevitably find ways to subvert the system¹⁰. Therefore, the Forensic Audit 5.0 framework must be designed with human-centric principles, emphasizing transparency, reducing repetitive administrative burdens, and providing actionable, constructive feedback to faculty². By positioning AI not as an auditor, but as a

strategic co-pilot that facilitates continuous academic enhancement, the institution can foster the elusive, deeply rooted quality culture demanded by modern regulatory frameworks.

Architectural Design of the Smart Quality Assurance (SQA) Framework

The conceptual Smart Quality Assurance (SQA) framework proposed in this report is a sophisticated, multi-layered digital architecture designed to seamlessly overlay and integrate with an institution's existing academic and administrative infrastructure. By operationalizing the principles of Forensic Audit 5.0 through AI and Blockchain, the SQA framework fundamentally metamorphoses the SPMI from a static, post-facto evaluation chore into a dynamic, continuous, real-time assurance ecosystem. The architecture is delineated into four highly integrated operational layers.

Layer 1: Real-Time Data Ingestion and PD Dikti Synchronization

The foundational layer of the SQA framework is dedicated to eradicating the pervasive issue of data silos and manual data entry errors. The framework establishes a highly secure, automated, cloud-based data ingestion pipeline. Utilizing robust Application Programming Interfaces (APIs), this pipeline continuously and autonomously aggregates telemetry from every disparate digital system operating within the HEI, including the SIAKAD, LMS, Human Resources Information System (HRIS), and Research Repositories²².

Upon ingestion, the data does not merely sit in a data lake; it is subjected to immediate, automated cleansing, normalization, and standardization protocols. These protocols are strictly calibrated against the specific, rigid data dictionaries and schema requirements mandated by the national PD Dikti system⁶. By autonomously resolving data redundancies, formatting errors, and conflicting records across different departmental systems, Layer 1 ensures that the baseline data utilized for the subsequent *Evaluasi* (Evaluation) phase is mathematically accurate and instantly ready for national reporting, thereby completely eliminating the risk of punitive actions under Article 111 of Permendiktisaintek No. 39/2025⁶.

Layer 2: Blockchain-Enabled Evidence Immutability and Traceability

To fulfill the rigorous evidentiary requirements of Forensic Audit 5.0, the system must guarantee an undeniable, tamper-proof chain of custody for all institutional data and quality assurance artifacts¹⁶. During the *Pelaksanaan* (Execution) phase of the PPEPP cycle, countless micro-transactions dictate the academic reality of the institution: a dean approves a budget, a faculty member publishes a peer-reviewed article, a curriculum committee ratifies a new syllabus, or a student submits a capstone prototype.

Layer 2 anchors these critical milestones to a permissioned blockchain network. When a significant quality assurance artifact is generated or a critical standard is recorded as met, the digital file and its associated metadata are cryptographically hashed and permanently logged onto the distributed ledger².

- **Decentralized Credential Verification:** The urgency of this layer is amplified by the new mandates surrounding the Recognition of Prior Learning (RPL) and the integration of micro-credentials⁷. Verifying the authenticity of non-traditional external certificates is historically a slow, vulnerable process. By utilizing blockchain, institutions can instantly and irrefutably verify the

cryptographic signatures of prior learning certificates or issue their own micro-credentials that are instantly verifiable by global employers, bypassing slow manual background checks¹³.

- **Absolute Audit Trail Immutability:** When an internal auditor, or subsequently an external BAN-PT or LAM assessor, reviews the institution's compliance portfolio, they query the blockchain ledger. This mechanism provides absolute, mathematical assurance that crucial documents—such as faculty meeting minutes, peer-review grading rubrics, or attendance logs—were not retroactively fabricated or altered simply to satisfy an impending accreditation deadline¹⁷.

Layer 3: Artificial Intelligence and Predictive Learning Analytics

Layer 3 represents the cognitive epicenter of the SQA framework. It is here that the system transitions from merely recording data to actively analyzing and predicting institutional health. Abandoning the flawed methodology of waiting for an annual AMI to uncover deviations, this layer deploys a suite of Artificial Intelligence models to perform continuous, real-time forensic auditing¹⁶.

- **Algorithmic Anomaly Detection:** Advanced Machine Learning (ML) algorithms continuously scan the vast, multi-modal data streams flowing from Layer 1 for statistical outliers and behavioral patterns that indicate potential compliance failures or systemic academic fraud¹⁷. For instance, if the algorithms detect a pattern where a specific study program assigns lecturers to courses entirely outside their credentialed competency domains, or if linguistic analysis detects severe stylistic anomalies in a cohort's final thesis submissions indicative of mass AI-generated contract cheating, the system instantly generates a high-priority forensic "red flag"³².
- **Predictive Analytics for the PPEPP Cycle:** Leveraging vast repositories of historical institutional data and external benchmarking datasets, predictive algorithms—specifically utilizing methodologies like Classification and Regression Trees (CART) and complex deep neural networks—can accurately forecast future compliance trajectories³⁴. The system continuously recalculates the statistical probability of a study program maintaining its *Terakreditasi* status or successfully ascending to the *Terakreditasi Unggul* tier, simulating the impact of various operational interventions before they are enacted³⁴.
- **Natural Language Processing (NLP) for Qualitative SN Dikti Standards:** The SN Dikti framework contains numerous critical qualitative requirements, such as ensuring that faculty research is deeply aligned with current community needs and technological advancements⁴. Layer 3 employs sophisticated NLP models to systematically evaluate unstructured textual data extracted from research grant proposals, course syllabi, and community service reports³³. This allows the SQA system to autonomously verify semantic alignment with the institution's strategic plan and the overarching objectives of the Tridharma, automating a process that previously required hundreds of hours of manual reading by internal auditors.

Layer 4: Explainable AI (XAI) and Strategic Decision Support

A profound impediment to the integration of advanced AI into statutory governance systems is the "black box" phenomenon—the reality that while deep

learning models may produce highly accurate predictions, their internal logic is often impenetrable to human operators¹⁷. In the realm of higher education quality assurance, algorithmic transparency is a non-negotiable ethical and operational requirement; academic leadership and faculty must understand precisely *why* a specific program was flagged for a compliance violation or targeted for intervention.

To resolve this, Layer 4 employs cutting-edge Explainable AI (XAI) techniques, prominently featuring SHapley Additive exPlanations (SHAP) values³¹. SHAP values mathematically deconstruct the AI's complex predictions, translating them into clear, human-readable insights that quantify exactly which variables (e.g., student-to-faculty ratio, publication impact factor, infrastructure deficit) contributed most heavily to the system's conclusions.

These XAI outputs are dynamically surfaced through a highly intuitive, human-centered Smart Dashboard, engineered specifically for executive leadership, deans, and SPMI task forces¹². This decision support interface visualizes the real-time health of the entire PPEPP cycle across the institution. It moves beyond merely reporting data to providing highly actionable, strategically aligned recommendations for the *Pengendalian* (Control) and *Peningkatan* (Improvement) phases. For example, the dashboard might recommend specific, targeted faculty development workshops for a department showing predictive declines in pedagogical effectiveness, or suggest structural curriculum realignments in response to real-time shifts in global industry competency demands.

SQA Architectural Layer	Core Technological Enablers	Primary SPMI / PPEPP Functionality	Forensic Audit 5.0 Contribution
1. Data Ingestion & Sync	Cloud APIs, Automated ETL (Extract, Transform, Load) processes, PD Dikti Data Dictionaries	Forms the absolute baseline for the <i>Penetapan</i> and <i>Evaluasi</i> phases by consolidating fragmented silos.	Eliminates manual data entry errors and ensures total reporting compliance with national standards.
2. Blockchain Ledger	Permissioned Blockchain, Cryptographic Hashing, Smart Contracts	Secures the artifacts generated during the <i>Pelaksanaan</i> phase, verifying RPL and micro-credentials.	Provides an immutable, tamper-proof chain of custody for all institutional evidence, preventing retroactive fraud.
3. AI Cognitive Engine	Machine Learning, CART Algorithms,	Automates the <i>Evaluasi</i> phase; predicts future	Performs continuous, real-time anomaly

	Natural Language Processing (NLP)	performance; analyzes qualitative standards.	detection, flagging compliance breaches or academic fraud instantaneously.
4. Strategic Decision Support	Explainable AI (SHAP values), Interactive Smart Dashboards, Predictive Simulators	Drives the <i>Pengendalian</i> and <i>Peningkatan</i> phases by providing actionable, transparent insights.	Translates complex algorithmic "black box" warnings into transparent, ethically governed strategic interventions.

Empirical Projections and Institutional Impact Analysis

6.1. Overcoming PPEPP Bottlenecks through Concurrent Assurance

The traditional, analog execution of the PPEPP cycle has been historically hindered by its rigidly sequential and heavily bureaucratic nature. The *Evaluasi* phase, conducted through manual AMIs, inevitably creates massive operational bottlenecks, consuming vast amounts of time, institutional budget, and human capital simply to review fragmented evidence¹¹.

By successfully implementing the SQA Framework predicated on Forensic Audit 5.0, the PPEPP cycle undergoes a radical metamorphosis, transforming from a slow, reactive loop into a concurrent, highly dynamic matrix. In this new paradigm, the *Pelaksanaan* (Execution) and *Evaluasi* (Evaluation) phases effectively merge into a single, continuous process. As academic and administrative activities are executed daily and logged into the blockchain-backed Layer 2, the AI engine in Layer 3 simultaneously and instantaneously evaluates these activities against the established *Penetapan* (Standards). Consequently, the *Pengendalian* (Control) mechanism becomes immediate rather than retroactive. If a critical operational metric – such as the ratio of active students to full-time lecturers in a specific engineering program – begins to approach the critical danger threshold defined by SN Dikti, the system automatically triggers escalating alerts to the respective Dean and the LPM. This concurrency allows institutional management to execute corrective interventions months before the issue can metastasize into a national regulatory violation that compromises the institution's PD Dikti standing.

Quantitative Enhancements in Processing Time and Data Veracity

Extensive empirical studies and pilot implementations of similar AI-driven, blockchain-based accreditation frameworks (AI-BAF) in global higher education contexts provide robust, quantifiable evidence regarding the proposed framework's efficacy. Deploying such an advanced SQA system drastically reduces the systemic latency inherent in manual documentation collation and physical verification processes. Prior peer-reviewed research demonstrates that the integration of AI and Blockchain within institutional quality assurance can yield a staggering 73%

reduction in processing time for accreditation-related workflows, coupled with an **89% improvement in overall data accuracy**, leading to a reported **92% stakeholder satisfaction rate**¹³.

From a statistical perspective, let P_{manual} represent the high probability of error in traditional manual data entry, cross-referencing, and verification, and let P_{sqa} represent the error probability utilizing the automated SQA framework. Given that $P_{\text{sqa}} \ll P_{\text{manual}}$, the integration of automated Layer 1 data ingestion and Layer 2 cryptographic verification mathematically minimizes the variance and standard deviation in institutional data quality. Achieving this state of near-perfect data accuracy is not a luxury; it is a critical survival imperative for compliance with Permendiktisaintek No. 39/2025. Because the regulation utilizes PD Dikti as the single, automated source of truth for extending accreditation statuses⁶, completely eliminating data discrepancies ensures that HEIs avoid the devastating punitive measures, operational restrictions, and reputational damage associated with a downgrade to "Tidak Terakreditasi" (Unaccredited) status⁷.

6.3. Pathways to Global Accreditation and "Terakreditasi Unggul"

The philosophical core of Permendiktisaintek No. 39 of 2025 is an explicit mandate to align Indonesian higher education tightly with rigorous international quality standards, aggressively encouraging institutions to seek global accreditation as a marker of true excellence²⁰. Achieving the highest possible national status, *Terakreditasi Unggul*, requires an institution to prove definitively that it does not merely comply with the baseline SN Dikti, but that its operational reality substantially and consistently exceeds those foundational standards⁷.

The SQA Framework provides the precise, scalable infrastructural capacity required to facilitate this strategic escalation. By fully automating the baseline compliance mechanisms—thereby ensuring that the standard *Terakreditasi* status is perpetually secured and never at risk of lapsing—the institution's Quality Assurance Body (LPM) can entirely redirect its finite human resources and strategic focus toward the *Peningkatan* (Improvement) phase of the PPEPP cycle. The advanced AI cognitive engine can be calibrated to ingest complex international accreditation frameworks (such as ABET for engineering, AACSB for business, or FIBAA for social sciences) and conduct continuous, granular gap analyses against the institution's real-time performance metrics. This mechanism of continuous, automated benchmarking allows HEIs to systematically construct the irrefutable evidentiary portfolios required for premier international recognition. By doing so, the institution firmly positions its graduates to compete effectively and seamlessly within the highly demanding global labor market, fulfilling the ultimate vision of the national regulatory shift.

7. Ethical Governance and Strategic Implementation Recommendations

While the technological capabilities of Forensic Audit 5.0 and the proposed SQA framework are transformative, their successful implementation within a university setting requires highly sophisticated navigation of organizational behavior, change management, and ethical governance. Resistance to systemic change is consistently identified in academic literature as the primary barrier to

digital transformation within HEI quality assurance¹⁰. Faculty and administrative staff may instinctively perceive continuous AI monitoring as an invasive, hostile surveillance mechanism, leading to deep cultural pushback, malicious compliance, or active subversion of the system.

To pre-emptively mitigate this, the implementation of the SQA framework must be strictly guided by the principles of Human-Centered Design (HCD) and the aforementioned Socio-Technical Systems (STS) theory²⁹. Institutional leadership must position the technology not as a punitive policing tool designed to catch errors, but as a supportive "learning analytics" partner. The system must be marketed internally as a mechanism that dramatically alleviates crushing administrative burdens, thereby liberating academics to focus their time and cognitive energy on their core pedagogical innovations and research pursuits².

Furthermore, robust ethical AI governance protocols must be established and rigorously enforced. As the landscape of generative AI evolves, institutions must implement clear, transparent policies governing both the acceptable use of AI by students and faculty in academic production, and the institution's own use of predictive AI for auditing purposes²⁶. The XAI layer (Layer 4) is instrumental in this regard, ensuring that the algorithms remain transparent and that their decision-making logic is routinely audited by human overseers. This prevents the crystallization of systemic algorithmic biases that could unfairly penalize specific academic departments, diverse methodologies, or specific demographic groups within the faculty¹⁷.

The strategic realization of the SQA Framework demands a holistic realignment for HEIs:

1. **Aggressive Reprioritization of Digital Infrastructure:** University leadership must aggressively pivot their capital expenditure and IT operational budgets away from maintaining disjointed, legacy software systems. Investments must be immediately redirected toward establishing integrated, hyper-secure cloud architectures, robust API gateways, and enterprise-grade blockchain infrastructure capable of handling massive transactional volume².
2. **Radical Upskilling of the Quality Assurance Workforce:** The traditional role of the internal quality auditor is rendered obsolete by this framework. QA personnel must undergo intensive reskilling programs to evolve from manual administrative checkers into sophisticated data analysts, prompt engineers, and strategic advisors capable of interpreting complex AI-generated forensic insights and translating them into actionable policy¹⁷.
3. **Dynamic Redefinition of Policy Frameworks:** Internal university statutes and academic policies must be rapidly overhauled. They must be updated to govern the ethical integration of AI, to fully accommodate the highly flexible non-thesis graduation pathways, and to establish the rigorous assessment criteria required for the issuance of micro-credentials newly authorized by Permendiktisaintek No. 39/2025⁷.

Conclusion

The promulgation of Permendiktisaintek No. 39 of 2025 constitutes a seismic shift in the Indonesian higher education ecosystem, demanding a radical, uncompromising departure from conventional, document-heavy, and retroactively

focused approaches to quality assurance. To not merely survive, but to thrive within this highly competitive new regulatory environment—an environment where institutional agility, alignment with global standardization, and absolute, unquestionable data integrity are the primary currencies of survival—Higher Education Institutions must embrace comprehensive digital transformation at the deepest systemic levels.

This extensive research report definitively establishes that a Smart Quality Assurance (SQA) Framework, architected upon the vanguard principles of Forensic Audit 5.0 and powerfully driven by the synergistic application of Artificial Intelligence and Blockchain technology, offers a robust, highly scalable solution to the chronic, systemic inefficiencies that plague traditional Internal Quality Assurance Systems (SPMI). By forcefully migrating the entire PPEPP cycle away from a reactive, manual audit process and into a real-time, continuous, algorithmic monitoring ecosystem, institutions can drastically reduce their administrative latency, mathematically eliminate national reporting errors, and proactively interdict compliance deviations long before they escalate into regulatory crises.

Ultimately, the strategic integration of AI-driven continuous forensic auditing must not be viewed merely as an advanced mechanism for statutory compliance; it is a profound strategic catalyst. It liberates vast reserves of academic and administrative human capital, allowing institutions to reallocate those resources toward genuine continuous improvement, aggressive curriculum innovation, and high-impact internationalization efforts. Through the adoption of this technologically augmented, ethically governed approach to internal quality assurance, Indonesian HEIs can confidently achieve, sustain, and leverage the *Terakreditasi Unggul* status. In doing so, they will ensure the continuous production of highly adaptable, ethically grounded, and globally competitive graduates, fully equipped to lead and innovate amidst the complex challenges of the Fifth Industrial Revolution.

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