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# Real-Time Cost Control in State-Owned Construction Enterprises: Deconstructing Control Latency through the Integration of Internal Audit and AIS

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**A B S T R A C T**

State-owned enterprises (SOEs) operating within the construction sector face a unique and precarious ecosystem characterized by high financial complexity, intense public accountability pressures, and significant exposure to chronic cost overrun risks. While internal audit (IA) and accounting information systems (AIS) function as established control mechanisms within these entities, they frequently operate in bureaucratic isolation—IA serving as a retrospective compliance function and AIS acting as a passive transaction repository. This functional disconnection creates a critical control latency gap where financial deviations materialize, compound, and metastasize before detection. This study employed a single holistic case study design grounded in a sociotechnical systems paradigm to explore the integration of IA and AIS at PT MM, a subsidiary of a prominent Indonesian construction SOE. Data were collected over a six-month period through eighteen in-depth semi-structured interviews, extensive participatory observation of audit cycles, and comprehensive documentation analysis. Thematic analysis was rigorously applied to deconstruct the socio-technical dynamics of integration. The investigation revealed that prior to integration, IA functions were hindered by a compliance trap, detecting financial anomalies only after 80-90% of project completion. The strategic integration of real-time AIS data into audit workflows transformed the IA function from a policing role to a strategic digital assurance partner. Specifically, a pilot integration in the dock maintenance 2024 project enabled continuous variance analysis, resulting in an 8% reduction in total project costs through the early detection of material price deviations. In conclusion, the synergy between risk-based internal audit (RBIA) and AIS transforms financial control from reactive verification to proactive mitigation. Success depends not merely on technical connectivity but on a cultural shift towards collaborative governance, positioning digital assurance as a critical driver of resilience.

## 1. Introduction

The construction industry serves as the physiological backbone of economic development in emerging markets, driving growth through the creation of essential infrastructure. In Indonesia, this strategic sector is predominantly anchored by state-owned enterprises (SOEs), or Badan Usaha Milik Negara (BUMN). These entities are tasked with a paradoxical and demanding dual mandate: they must act as agents of national development, delivering public value through large-scale projects such as dams, toll roads, and maritime facilities, while simultaneously operating with the financial viability, efficiency, and regulatory rigor expected of private, profit-oriented corporations.[1] This inherent tension creates a unique breeding ground for financial risk. The structural complexity of construction projects—characterized by fragmented supply chains, geographically dispersed sites, long-term revenue recognition cycles based on percentage-of-completion, and high capital turnover—exacerbates the classic principal-agent problem. Project managers stationed

on remote sites possess superior, immediate information regarding daily operations, while corporate headquarters relies on periodic, often lagged reports, creating an environment ripe for information asymmetry.[2]

Historically, the governance mechanisms designed to bridge this information gap and mitigate risk have relied on two distinct, often siloed, pillars: the internal audit (IA) function and the accounting information system (AIS). Internal audit is mandated to provide independent assurance regarding the effectiveness of governance and controls, while the AIS serves as the technological backbone for collecting, processing, and reporting financial data.[3] Theoretically, these pillars should support one another; the AIS provides the single source of truth, and IA verifies its integrity. However, within the context of many bureaucratically rigid SOEs, these functions have drifted into operational isolation. Internal audit has traditionally operated on a cyclical, retrospective basis, essentially performing autopsies on projects after significant capital has been deployed.[4] Meanwhile, the AIS, despite the advent of sophisticated enterprise resource planning (ERP) tools, is frequently relegated to the role of a transaction processing engine, utilized primarily to satisfy statutory reporting requirements rather than to drive operational insight or strategic decision-making.[5]

This operational divorce results in a phenomenon this study identifies as control latency. Control latency is defined as the time lag between the occurrence of a financial deviation—such as an unauthorized budget shift, a vendor pricing error, or an inventory discrepancy—and its detection by oversight bodies.[6] In the construction sector, where profit margins are razor-thin, and projects operate on strict critical paths, high latency is often fatal. A deviation that goes undetected for three months can compound into a material cost overrun that is irreversible by the time it is flagged in a semester audit.[7] While existing literature on continuous auditing and continuous monitoring has discussed the theoretical benefits of reducing this latency, much of it focuses on the technological implementation of automated scripts in high-volume transaction environments like banking or retail. There remains a significant scarcity of in-depth, qualitative inquiry into the process, human dynamics, and organizational behavior involved in integrating IA and AIS within the project-based, high-pressure environment of construction SOEs.[8]

This research offers a twofold novelty to the existing body of knowledge. First, it empirically documents the transition from traditional compliance auditing to integrated digital assurance within the unique institutional context of an Indonesian SOE. This provides a rare black box view of internal corporate transformation, moving beyond theoretical models to observe the messy, complex reality of implementation in a developing economy. Second, it proposes a conceptual model of Risk-Based Synergy, demonstrating how AIS data can be operationalized to fuel risk-based internal audit (RBIA) methodologies dynamically, effectively redefining the three lines model for the digital age.[9,10] The primary aim of this study is to analyze how the integration of Internal Audit and Accounting Information Systems functions as a comprehensive mechanism for financial risk control in SOE construction projects. Specifically, the study aims to: identify the technical and cultural catalysts that enable early risk detection through real-time data integration; investigate the impact of this synergy on managerial decision-making and project cost efficiency; and theorize the shift in organizational power dynamics resulting from the transition to a high-transparency control environment.

## 2. Methods

To capture the nuanced reality of organizational transformation, this study utilized a qualitative approach grounded in Sociotechnical Systems Theory. Unlike purely positivist approaches that might view the implementation of a new software module as a mechanical inputs-outputs equation, the Sociotechnical perspective recognizes that the social system (culture, power, human behavior, resistance) and the technical system (software, workflows, data

architecture) are inextricably linked. The success of digital assurance depends on the joint optimization of both systems. Consequently, we adopted an Interpretivist stance to analyze the data, viewing the audit process not as a search for objective truth but as a negotiation of meaning between auditors, who value compliance and accuracy, and project managers, who value physical progress and operational flexibility. The research design was a single holistic case study. PT MM represents a critical case in the context of Indonesian SOEs. It is a large-scale entity currently undergoing a government-mandated digital transformation (2023-2024), effectively providing a natural laboratory to observe the before and after conditions of IA-AIS integration. This design allows for a thick description of the causal mechanisms that broad quantitative surveys cannot capture, enabling the researchers to trace the specific pathways through which integration leads to risk reduction.

The research focused on PT MM, a subsidiary of a major state-owned construction firm. PT MM handles complex infrastructure projects including maritime facilities, dock maintenance, and heavy civil engineering. The selection was purposive, driven by the firm's strategic initiative to pilot a digital audit board in early 2024. The unit of analysis was the process of integration itself, spanning across the corporate headquarters (where Audit and Finance reside) and the decentralized project sites (where data originates).

Data collection was conducted over a comprehensive six-month period (January–June 2024) to ensure data saturation. Three primary techniques were employed to build a robust chain of evidence: In-Depth Semi-Structured Interviews (N=18): We conducted interviews with a diverse range of actors to capture multiple perspectives on the integration process. The sample included: Strategic Level (3): The Head of Internal Audit, The Chief Financial Officer, and the Head of IT. These interviews focused on the strategic intent, resource allocation, and high-level barriers; Operational Level (10): Four Senior Project Managers, Four Site Finance Officers, and Two Risk Management Officers. These interviews probed the lived experience of the new system, focusing on usability, resistance, and behavioral changes; Technical Level (5): Three Senior Auditors and Two System Implementers. These interviews focused on the technical challenges of API integration and data accuracy; This sample size was determined by the saturation point, where subsequent interviews ceased to yield new thematic insights regarding the integration barriers or benefits. Participatory Observation: The researcher acted as an observer in monthly project cost review meetings and audit closing sessions. To mitigate the Hawthorne effect (where subjects change behavior because they are observed), the researcher adopted a non-intrusive approach, documenting interactions, body language, and argumentation styles without intervening in the decision-making process. Observations focused on how data from the AIS was presented, challenged, and used to justify operational decisions in real-time. Documentation Analysis: To triangulate the interview and observation data, we analyzed a wide range of internal documents including the Audit Charter (to verify historical audit cycles), the Risk Register (to track risk identification timelines), specific Audit Finding Reports from 2023 (pre-integration) and 2024 (post-integration), and system log files. This allowed us to quantitatively verify the claims of efficiency gains and trace the digital footprint of specific audit interventions.

Data were analyzed using Thematic Analysis following the six-phase framework by Braun and Clarke. The coding process was deductive, specifically looking for sociotechnical themes such as boundary Objects (how the system translates data), Information Asymmetry (how power shifts), feedback loops (how speed of data changes behavior), and Panopticism (surveillance effects). The analysis moved beyond describing what happened to explaining the causal mechanisms of why the integration reduced risk.

## 3. Results

The initial phase of the study involved a forensic examination of the pre-integration state. Informants consistently described a condition we term the compliance trap, where the Internal Audit function was bureaucratically active but operationally ineffective regarding risk mitigation due to severe timing issues. Document analysis confirmed that operational audits were historically scheduled based on project milestones, typically occurring only when a project reached 80% to 90% physical completion. This structural delay meant that the feedback loop of the control system was too slow to correct the trajectory of the project. Financial deviations that occurred early in the project lifecycle would compound for months before being formally detected. By the time auditors arrived, the budget was exhausted, and funds for ghost vendors or inefficient procurement were already disbursed. The audit function was effectively auditing the ashes rather than preventing the fire. Figure 1 provides a schematic representation of the fundamental structural flaw identified in the pre-integration control environment of State-Owned Enterprises (SOEs), termed here as structural latency. The diagram is organized into four horizontal swimlanes representing the distinct operational layers of the organization: the Physical Reality (the construction site), the Shadow System (informal spreadsheets), the Official AIS (statutory reporting), and Internal Audit (governance). The horizontal axis represents the project lifecycle, progressing from inception to the post-mortem phase. The visualization elucidates the critical disconnection between the physical reality lane, where material transactions and risk events occur in real-time, and the internal audit lane, which operates on a lagged, cyclical schedule. The figure highlights a specific latency zone—a temporal gap spanning the execution phase (20-80% completion)—where financial risks, such as the vendor pricing error identified in the study, are allowed to materialize without detection. Within this zone, the diagram illustrates a risk metastasizing bar, visualizing how a minor financial deviation in the early stages compounds over time into a material cost overrun. Crucially, the figure demonstrates that while the shadow system lane captures data in near real-time to facilitate daily project survival, this data is hermetically sealed from the official AIS lane due to the lack of integration. Consequently, the Internal Audit function is depicted as receiving data only at the post-mortem phase, rendering the audit process a reactive autopsy rather than a preventive control. This graphical arrangement theoretically grounds the concept of the compliance trap, showing that auditors are structurally condemned to irrelevance not by a lack of skill, but by the architecture of the information flow. The visual gap between the occurrence of a risk event and its verification signifies the precise economic cost of information asymmetry, serving as the baseline against which the subsequent integration intervention is measured.

A critical finding was the existence of shadow systems driven by the usability friction of the legacy AIS and the lack of value it provided to field operations. While PT MM possessed a sophisticated ERP, Project Managers viewed it as a compliance burden—a system they had to feed for headquarters but which gave them no operational insight. Consequently, real decision-making happened on offline spreadsheets kept on-site laptops. This behavior created a dual reality. The AIS contained lagged, batched data entered at the end of the month to satisfy accounting rules, while the spreadsheets contained real-time operational reality used to manage concrete pours and labor shifts. Internal Audit, restricted to viewing the AIS, was effectively auditing a ghost of the project, while the real risks lived in the inaccessible spreadsheets. Figure 2 illustrates the concept of Organizational Decoupling through a split-screen schematic that contrasts the Official AIS (System A) against the shadow spreadsheets (System B). This figure visually deconstructs the Dual Reality observed at PT MM, where the organization effectively operates two parallel accounting systems with divergent purposes and user bases.

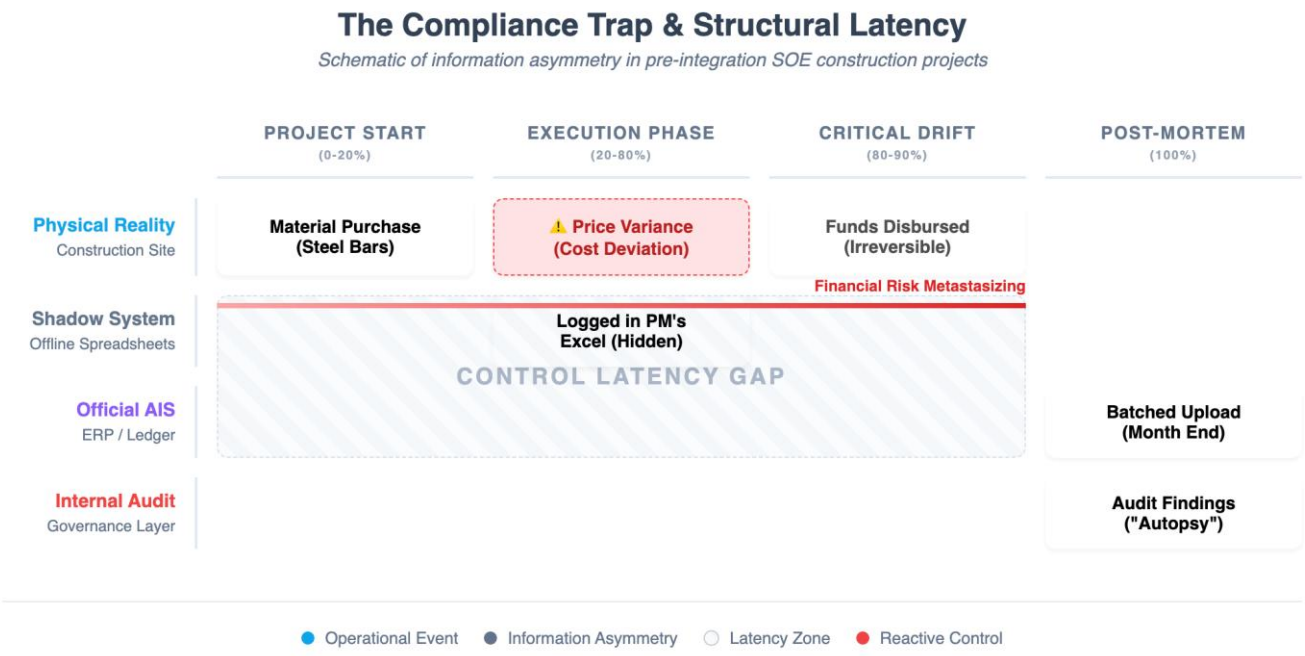


Figure 1. The compliance trap and structural latency.

The left panel, representing the Official AIS, is characterized as a ghost system. The attributes listed highlight its role as a lagging indicator, updated via batched monthly uploads and aggregated by generic cost codes. This system serves the principal (Headquarters) and acts as the primary domain for statutory compliance and formal audit. Conversely, the right panel depicts the Shadow System—the myriad Excel spreadsheets maintained locally by Project Managers. This system is characterized as a leading indicator, offering real-time granularity down to the unit and vendor level, utilized primarily for operational survival and logistics management. The central visual element is the disconnect zone, a barrier representing the friction of manual data entry and bureaucratic silos. This barrier prevents the granular, high-value data from the shadow system from flowing into the Official AIS, thereby blinding the internal audit function. The figure includes an audit scope boundary graphic, visually demonstrating that traditional audit procedures are circumscribed to the Official AIS, leaving the Shadow System—where the actual financial risks and operational truths reside—essentially invisible. This visualization supports the study's application of Institutional Theory, suggesting that the SOE maintains the Official AIS for external legitimacy (isomorphism) while actual work is coordinated through the informal shadow infrastructure. The figure underscores that the primary risk to the organization is not the absence of data, but the sequestration of high-quality data within unauthorized, unauditable silos.

The turning point occurred with the strategic initiative to bridge this gap. The integration involved granting internal audit read-only but real-time API access to the granular project cost modules, effectively bypassing the monthly batching process. The study documented a specific pilot case: the dock maintenance Project 2024. In this project, auditors utilized a custom-built dashboard that pulled live data from the AIS to compare the actual cost of work performed (ACWP) against the budgeted cost of work performed (BCWP) on a weekly basis.

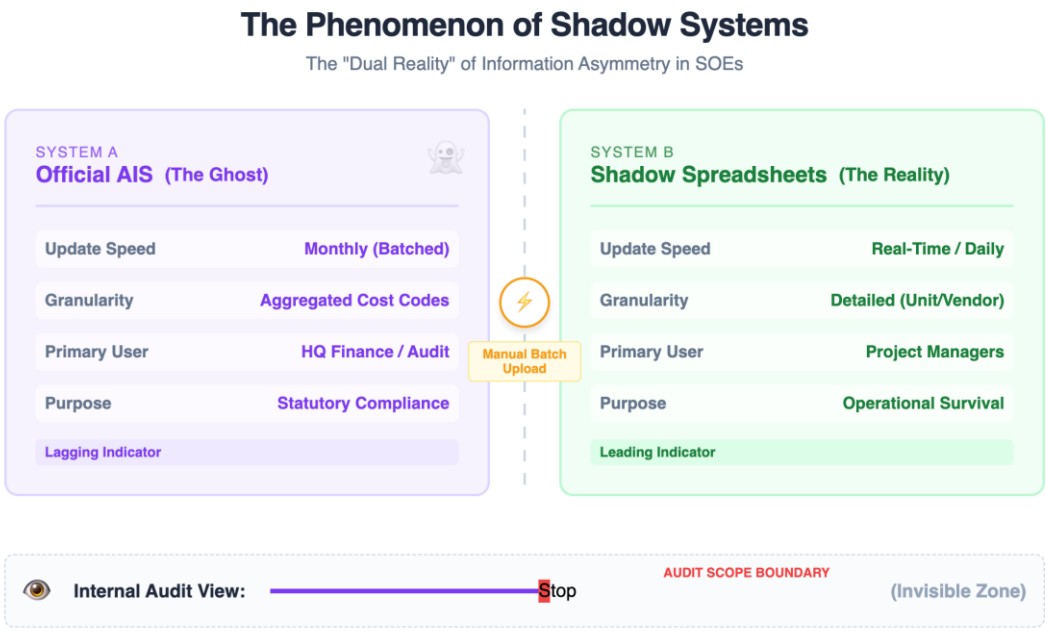


Figure 2. Comparison of official AIS vs. shadow spreadsheets (The Dual Reality).

The efficacy of this mechanism was proven in Week 6 of the project when the dashboard flagged a statistical anomaly: a spike in the unit cost for steel reinforcement bars. Under the old system, this variance would have been buried in a monthly aggregate report. Under the integrated system, the risk score of the procurement cycle turned red immediately. Auditors queried the project manager within 48 hours, revealing a vendor pricing error in the master agreement. By correcting this immediately, the project avoided overpayment on the remaining material volume. Figure 3 presents a composite diagram detailing the technical and processual architecture of the intervention, specifically modeled on the dock maintenance project 2024 pilot case. The visualization is divided into two logical sections: the upper section depicts the digital bridge architecture, and the lower section illustrates the specific case study workflow. The architectural section visualizes the dissolution of the silos described in Figure 2. It shows the establishment of a read-only API bridge connecting the source ERP database directly to the audit dashboard. This connection is depicted not merely as a data pipe, but as a logic engine capable of transforming raw transactional data (Purchase Orders, Material Receipts) into audit insights through automated variance analysis algorithms. The visual emphasis on real-time variance analysis highlights the shift from periodic sampling to continuous population testing. The lower section of the figure traces the narrative arc of the specific intervention cited in the results. It maps the four-step sequence: (1) Data Input, where the site issues a purchase order; (2) System Alert, where the API detects a unit price deviation exceeding the 5% threshold; (3) Audit Action, where the human auditor intervenes within 48 hours to freeze procurement; and (4) Outcome, resulting in the correction of the Master Agreement. This flow demonstrates the system's function as a boundary object, translating the physical engineering event (ordering steel) into a financial risk signal (price variance) visible to the auditor. By visualizing the immediacy of the alert system, Figure 3 provides the mechanistic explanation for the feed-forward control capability, proving that the integration allows for corrective action to be taken before the financial commitment becomes irreversible.

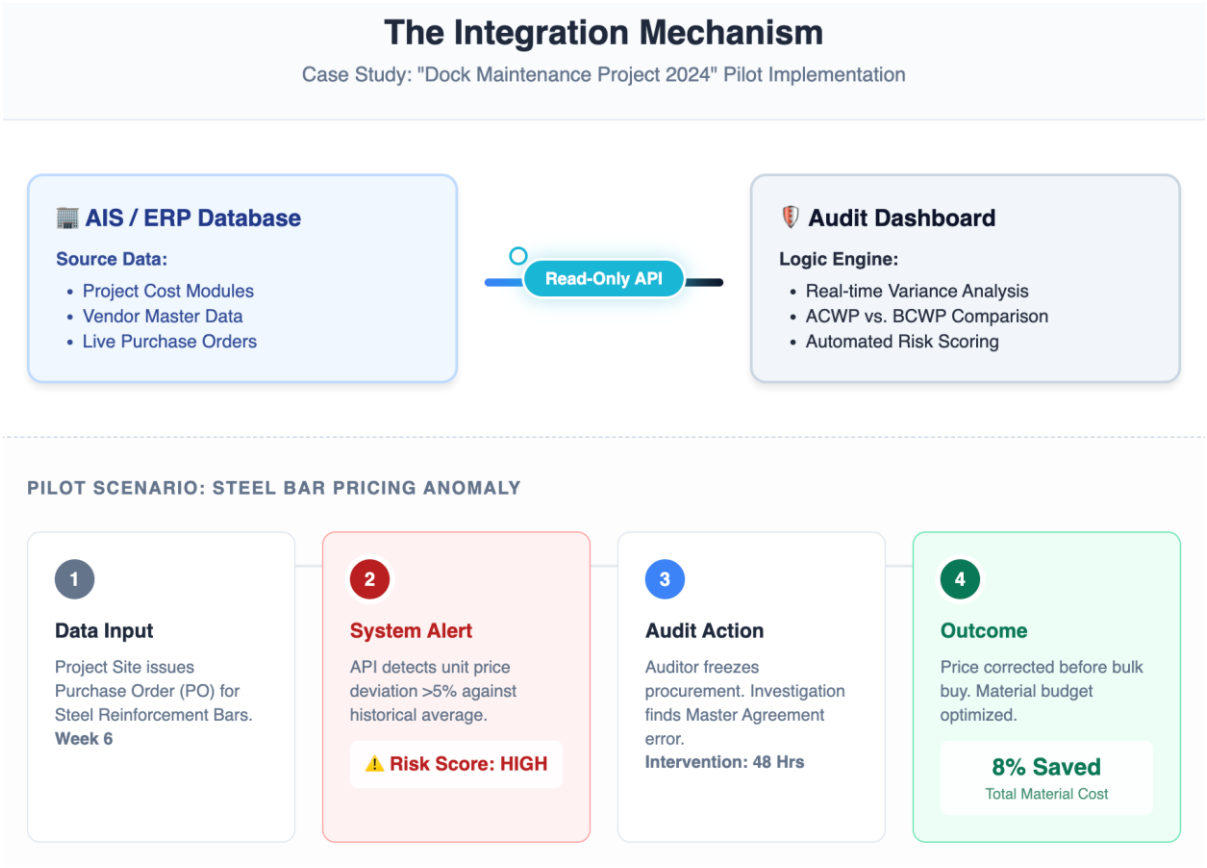


Figure 3. The integration mechanism.

Figure 4 utilizes a chronological swimlane diagram to map the temporal dynamics of the risk response mechanism. The grid is structured to show the interplay between three distinct actors—site operations (Physical Reality), the AIS (Digital Sensor), and internal audit (Strategic Action)—across the critical timeline of the dock maintenance project. The diagram contrasts the normal Ops flow with the specific incident timeline. It captures the exact moment of the purchase order issue in Week 6, Day 2, and visually traces the vertical integration that allows this event to instantly trigger a detection event in the AIS lane and a subsequent action event in the audit lane. The vertical connectors in the diagram represent the real-time data flow that bypasses traditional bureaucratic hierarchies. This visual arrangement emphasizes the speed of the feedback loop; the time between the risk event (the erroneous PO) and the corrective intervention is compressed to less than 48 hours, a drastic reduction from the traditional cycle. The lower portion of the figure introduces a ghost timeline, a counterfactual bar chart that scientifically quantifies the latency gap avoided by the new system. It visually compares the 6-week detection point of the integrated system against the 24-week detection point of the traditional semester audit. This comparative element highlights the 18 Weeks Saved, serving as a graphical representation of the cost avoidance theory. By visualizing the timeline that didn't happen (the 18 weeks of compounding error), Figure 4 powerfully illustrates the preventive nature of Digital Assurance, moving the audit function from a detective control (finding errors) to a preventive control (stopping errors).

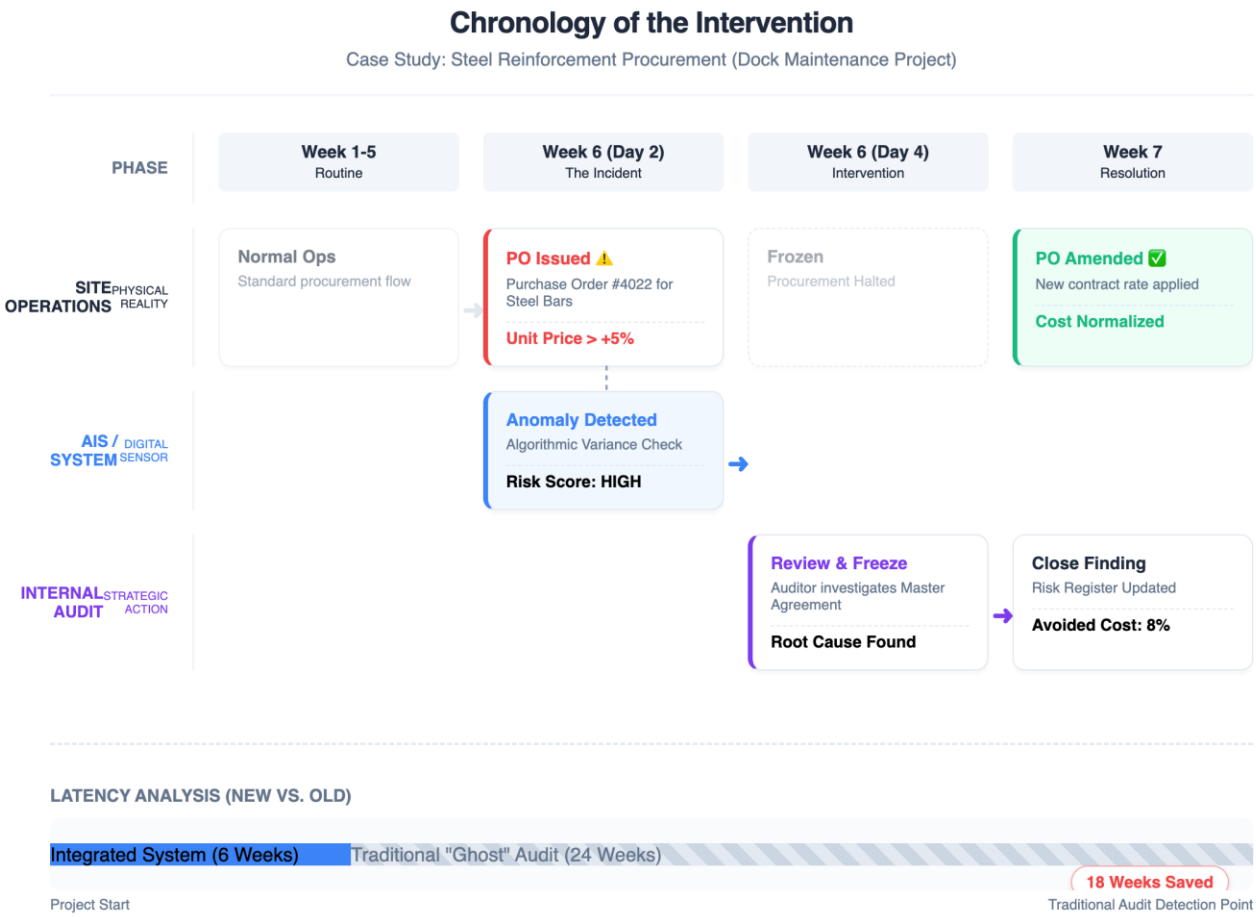


Figure 4. Chronology of the dock maintenance intervention.

Figure 5 is designed as a scientific results dashboard, synthesizing the quantitative findings of the study into four distinct metric visualizations. This figure serves to translate the qualitative process improvements into tangible economic value, utilizing the data derived from the pilot project. The primary visual is the total project efficiency card, which highlights the 8.0% reduction in total material costs. This metric is presented not in isolation but as the result of a comparative analysis between the projected cost trajectory (based on the identified pricing error) and the actualized cost. The visualization reinforces the concept of avoided cost, distinguishing it from simple budget underspending. Adjacent to the efficiency metric is the detection latency timeline, which graphically contrasts the old way (Week 24 detection) with the new way (Week 6 detection). This bar chart visually quantifies the reduction in information asymmetry. The dashboard also includes a cost avoidance split-bar chart, which visualizes the potential overrun (12% risk) versus the actual overrun (0%). This visualizes the effectiveness of the intervention in fully mitigating the specific identified risk. Finally, the audit man-hours donut chart illustrates the 33% efficiency gain in audit labor, showing the reduction from 120 hours to 80 hours. This reinforces the finding that digital integration does not increase the auditor's workload but rather reallocates it from manual data verification to high-value strategic analysis. Collectively, Figure 5 provides the empirical evidence base for the study's claims regarding the economic viability of the IA-AIS integration.

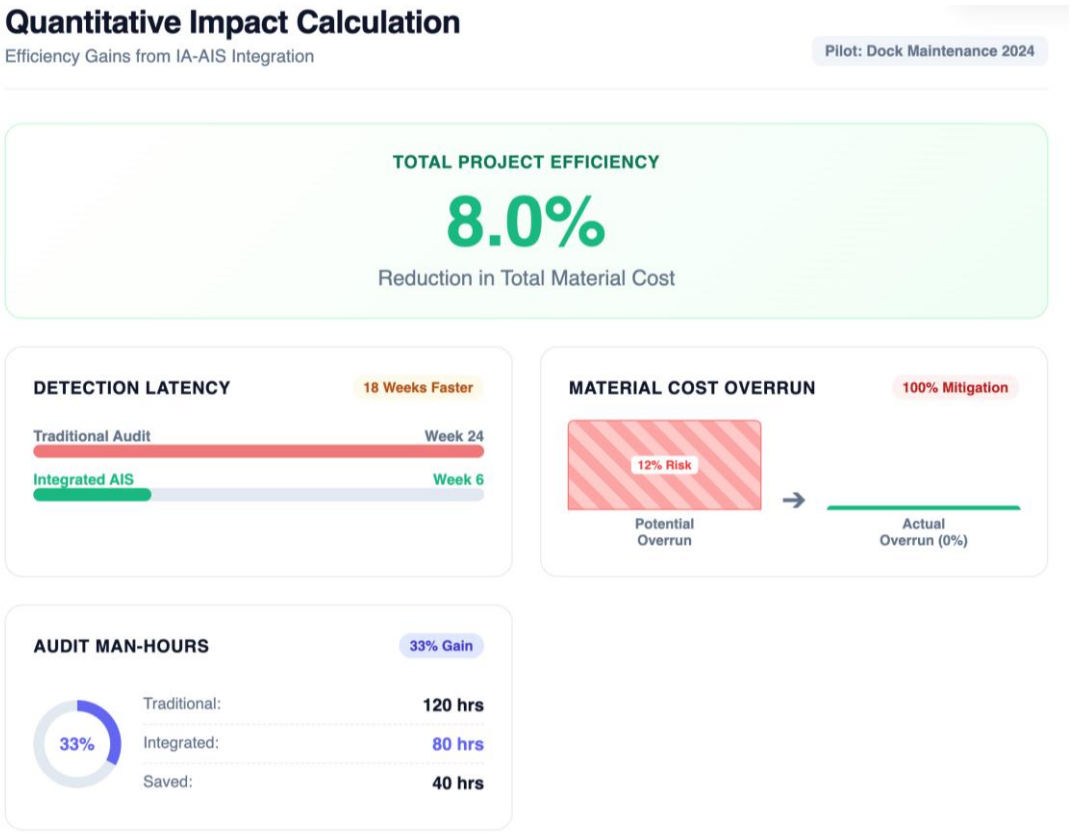


Figure 5. Quantitative impact calculation of the intervention.

The technical integration catalyzed a significant cultural transformation. The sociotechnical analysis revealed a shift in the balance of power from the periphery (project sites) to the center (HQ). The integration effectively dismantled the information monopoly held by project managers. Previously, PMs could smooth earnings or hide cost overruns in the short term. With real-time integration, headquarters could see the raw data flows. Initial resistance was high, with project managers describing the new dashboard as a panopticon. However, over time, the sentiment shifted as the transparency began to act as a shield, validating legitimate delays and resource needs. Furthermore, auditors shifted from a policing role to a consulting role, helping PMs forecast cash flow bottlenecks using the data. Figure 6 offers a sociotechnical model visualizing the profound shift in organizational power dynamics and culture resulting from the integration. The figure is structured to illustrate the transition from a model of peripheral, hidden power to one of centralized, visible transparency, utilizing the theoretical framework of Foucault's Panopticism. The panopticon model section features a network diagram where the Headquarters (Audit) acts as the central node with direct visibility into the peripheral nodes (Project Sites). The connection beams represent the real-time data feeds that create a state of permanent visibility. This visual structure demonstrates how the integration centralizes power, dismantling the information monopolies previously held by site managers. The diagram acknowledges the tension inherent in this shift, labeling the transition from peripheral power to centralized power. The evolutionary timeline section creates a phased roadmap of the behavioral response to this transparency. It traces the cultural trajectory through three distinct phases: (1) Resistance, characterized by defensive behaviors and big brother

anxiety; (2) Internalization, where discipline becomes self-regulated as users adapt to the system; and (3) Collaboration, where the transparency is leveraged as a tool for joint problem-solving. Finally, the role shift matrix at the bottom of the figure maps the transformation of the auditor's identity from Policeman to strategic consultant, and the project manager's identity from gatekeeper to collaborator. This figure synthesizes the qualitative interview data into a cohesive theoretical model, demonstrating that the ultimate output of the integration is not just cleaner data, but a fundamental re-engineering of the social contract within the firm.

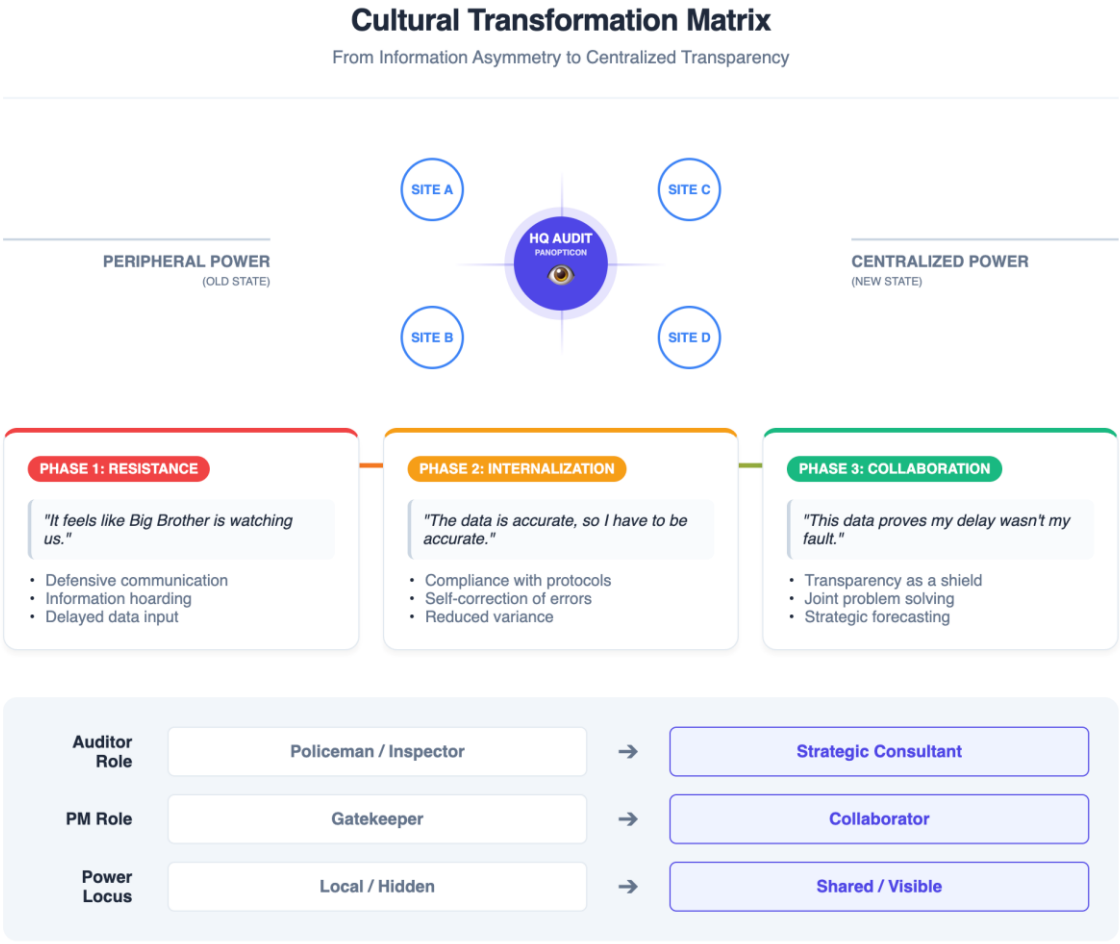


Figure 6. Evolution of stakeholder perceptions and behaviors.

**4. Discussion**

The findings of this study provide empirical support for a reimagined approach to internal auditing in the digital era. By moving beyond the static three-line model, the integration of IA and AIS creates a dynamic, fluid network of assurance. Figure 7 presents the risk-based synergy model, the primary theoretical contribution of this study. This comprehensive framework visualizes the structural, processual, and sociological mechanisms required to transition an SOE from a traditional, high-latency control environment to an integrated state of digital assurance.[11] The figure is architected as a layered systems model, emphasizing that effective risk control is not merely a technological product but an emergent property resulting from the joint optimization of

technical infrastructure, audit processes, and organizational culture. The diagram is organized into three interacting verticals: the theoretical lens (Left), the structural hierarchy (Center), and the Empirical Impact (Right), all unified by a continuous feedback loop. The structural hierarchy (Center Stack). At the core of the model lies a three-tiered pyramid representing the operational hierarchy of the integration. The technical layer (Enabler): The foundational tier represents the integrated data architecture. This layer visualizes the technological prerequisites identified in the study—specifically, the establishment of a read-only API bridge that connects the peripheral project ERP modules directly to the central audit dashboard. In the pre-integration state, this layer was characterized by shadow systems (disconnected spreadsheets). The model posits that without this foundational connectivity, the single source of truth is fractured. This layer functions as the organization's digital nervous system, capable of sensing financial stimuli (expenditures) in real-time.[12] The process layer (Mechanism): The middle tier represents the operationalization of dynamic risk-based internal audit (RBIA). Unlike traditional static audit plans, this layer depicts an agile process where audit scope is determined algorithmically by live data variances. It illustrates the shift from cyclical verification to continuous monitoring.[13] Here, the AIS functions not just as a ledger but as a logic engine that calculates risk scores (price variance >5%) to trigger immediate audit interventions, as demonstrated in the Dock maintenance pilot. The social layer (Outcome): The apex of the pyramid represents collaborative governance. This layer visualizes the ultimate goal of the integration: a cultural transformation where the relationship between auditor and project manager shifts from adversarial (policing) to cooperative (consulting). The model argues that technology and process are merely vehicles to achieve this higher-order social state, where transparency is internalized as a professional norm rather than imposed as a bureaucratic constraint. The theoretical lens (Left Column) The left vertical anchors the model in established management theory, validating the study's interpretivist approach. Sociotechnical systems theory: The model explicitly maps the interaction between the technical layer (API) and the social layer (Culture), positing that the success of the integration depends on the joint optimization of both. The friction observed in Phase 1 of the implementation (Big Brother anxiety) is explained here as a temporary misalignment between the technical capacity for surveillance and the social capacity for accountability. Control theory: By highlighting the feed-forward capability, the model integrates Cybernetic Control Theory. It suggests that the reduction of control latency to near-zero allows the organization to correct system deviations (cost overruns) before they become irreversible, fundamentally altering the physics of risk management. Boundary object theory: The figure identifies the integrated dashboard as a boundary object—a shared artifact that translates the physical language of engineering (material volumes) into the financial language of audit (budget variance). This translation mechanism is crucial for bridging the epistemic gap between the two siloed communities of practice.[14] The empirical impact (Right Column) The right vertical maps these theoretical constructs to the specific, tangible outcomes observed at PT MM. Cultural shift (Panopticism): This node captures the transition from resistance to partnership. It references Foucault’s concept of Panopticism, where the permanent visibility created by the AIS induces a self-disciplining effect among project managers (The Glass House Effect). The model illustrates that over time, external surveillance transforms into internal self-regulation. Cost avoidance (Economic Value): This node quantifies the mechanism of the 8% efficiency gain. It visualizes how the early intervention capability (enabled by the Process Layer) allows for the pre-emptive correction of pricing errors, distinguishing avoided cost as the primary economic metric of digital assurance. Reduced asymmetry (Agency Theory): Finally, this node addresses the resolution of the principal-agent problem. By eliminating the shadow systems, the model demonstrates how the integration

restores the principal's (HQ) visibility into the agent's (Site) actions, thereby reducing monitoring costs and mitigating moral hazard. The continuous feedback loop encircling the entire structure is the continuous feedback loop. This element signifies that the risk-based synergy model is not static. The insights generated in the social layer (a strategic decision to renegotiate a vendor contract) are fed back into the technical layer (updating the vendor master data), creating a virtuous cycle of continuous improvement. This loop closes the system, ensuring that the audit function evolves in lockstep with the changing operational reality of the construction projects.[15]

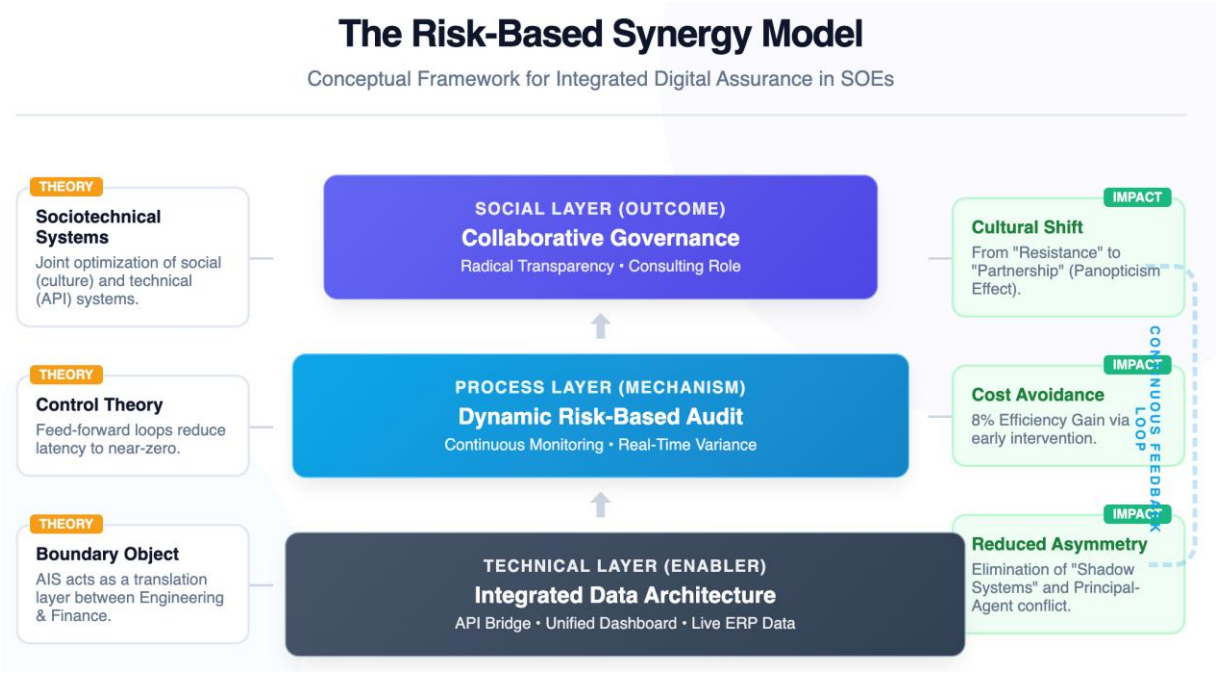


Figure 7. The risk-based synergy model.

The core theoretical contribution of this study is the deconstruction of control latency through the lens of systems dynamics and control theory. In Control Theory, a system requires a feedback loop to maintain stability. The effectiveness of the control is determined by the speed and accuracy of this feedback relative to the rate of change in the system. The construction project can be viewed as a dynamic system of stocks (budget, materials) and flows (expenditures, usage). Financial risk manifests as a systemic drift where the project's actual state diverges from its planned state. In the pre-integration state, the audit feedback loop was structurally slower than the project's metabolic rate. Expenditures occurred daily, but feedback occurred semi-annually. This high latency allowed entropy (disorder/cost overrun) to increase unchecked. The digital integration introduces a feed-forward control mechanism. By analyzing data in real-time, the system can predict the final state of the budget based on current trends. This aligns with the cybernetic view of organizations, where the AIS acts as the sensory organ and IA acts as the corrective actuator. The study validates that reducing latency does not merely speed up reporting; it fundamentally changes the nature of the risk. A risk caught in Week 6 is a manageable deviation, whereas the same risk caught in Week 24 is a catastrophic loss. Thus, the physics of time is a critical variable in audit theory.[16]

Drawing on Star and Griesemer's concept of boundary objects, the integrated dashboard functions

as a crucial translation device. In complex construction projects, different communities of practice speak different languages. Engineers operate in the physical domain (tensile strength, cubic meters of concrete, progress percentages), while Auditors and Finance staff operate in the financial domain (accruals, cash flow, compliance). Historically, these languages were untranslatable, leading to the shadow systems where engineers kept their own reality separate from finance. The integrated dashboard creates a *lingua franca*. It translates the physical event (steel arriving on site) immediately into a financial event (budget consumption), visible to both the Engineer and the Auditor simultaneously. This shared visibility forces a convergence of narratives. The Project Manager cannot claim everything is on track if the dashboard shows a budget variance of 15%. This shared reality is the mechanism that enforces discipline, not the threat of punishment. The AIS becomes a robust boundary object because it is plastic enough to adapt to local needs (PMs use it for logistics) yet robust enough to maintain a common identity across sites (Auditors use it for variance analysis).

From the perspective of agency theory, the integration resolves the classic conflict between the principal (Corporate HQ/State) and the agent (Project Manager). Agency theory posits that agents will act in their own self-interest, potentially shrinking duties or misallocating resources, unless monitored. However, monitoring is traditionally expensive (Agency Costs). The pre-integration state was characterized by high monitoring costs (traveling auditors, manual checks) and high information asymmetry.[17] The IA-AIS integration drastically reduces the marginal cost of monitoring. By automating the verification of transactions, the principal gains near-perfect visibility into the agent's actions without the need for physical presence. This reduction in information asymmetry mitigates moral hazard. Knowing that their actions are visible in real-time, agents are less likely to engage in opportunistic behavior such as gold-plating (adding unnecessary features) or earnings management (hiding costs). The study suggests that digital integration shifts the agency contract from one based on trust to one based on verified transparency.[18]

The cultural transformation observed strongly resonates with Michel Foucault's concept of Panopticism. The integrated AIS functions as a digital Panopticon—a central tower (HQ/Audit) that can see into the many cells (Project Sites) without being seen. Foucault argues that the possibility of surveillance induces a state of conscious and permanent visibility that assures the automatic functioning of power. The project manager's initial reaction (Big Brother is watching) reflects the awareness of this new visibility. However, Foucault also notes that discipline eventually becomes internalized. Over time, the external surveillance of the auditor is replaced by the self-regulation of the manager. The manager checks the dashboard before the auditor does, correcting their own behavior to avoid the red flag. Thus, the power of the audit function is exercised not through intervention, but through the architecture of the system itself. The digital tool disciplines the organization even when the auditor is not looking.[19]

Finally, Institutional Theory provides insight into the shift from shadow systems to integration. Organizations often engage in decoupling—creating formal structures (like the official ERP) to satisfy external legitimacy requirements (regulators, state auditors) while actual work is performed in informal structures (Excel spreadsheets). This decoupling allows the organization to appear compliant while maintaining flexibility. The integration project forced a recoupling of the formal and informal systems. By making the audit dependent on the live AIS data, the organization forced the shadow systems into the light. This transition is often painful because it removes the buffer that decoupling provides. However, this study argues that for SOEs facing high public scrutiny, recoupling is essential for genuine accountability. The move from ritualistic compliance (auditing the ghost) to substantive control (auditing the reality) represents a maturation of the institutional logic within the enterprise.[20]

## 5. Conclusion

The digital transformation of State-Owned Enterprises is frequently framed as a technological upgrade, but this study demonstrates that it is fundamentally a governance restructuring. The integration of internal audit and accounting information systems at PT MM serves as a potent mechanism for dismantling the functional and informational silos that have long plagued construction project management. By bridging the gap between the retrospective verification of Audit and the operational data flow of AIS, the organization achieved three critical outcomes: Transparency: It collapsed the information asymmetry between the field and the headquarters, effectively replacing a culture of trust with one of verified reality. Proactive Mitigation: It shifted the control paradigm from detecting the fire to detecting the smoke, evidenced by the tangible 8% cost avoidance in the pilot project, validating the feed-forward capabilities of the system. Strategic Reorientation: It liberated auditors from the drudgery of manual compliance, allowing them to act as strategic partners who contribute to the financial resilience of the project rather than merely cataloging its failures. For managers of SOEs and policymakers, the implication is clear: the AIS must be viewed not merely as a passive bookkeeping tool, but as the digital nervous system of the enterprise. When this nervous system is connected to the brain of Internal Audit, the organization gains the reflexes necessary to survive in the high-risk environment of modern infrastructure development. Success, however, depends less on the code and more on the organizational courage to embrace a culture of radical transparency.

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