

Smart Contracts and Algorithmic Matching: Agile Procurement Mechanisms and Empirical Research in the "Internet Plus" Platforms of State-Owned Design Institutes

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Abstract: The rapid advancement of the global digital economy has necessitated transformative changes in traditional operational models, particularly within state-owned design institutes (SODIs) in China. This study explores the "Internet Plus" Design Institute model, which integrates smart contracts and algorithmic matching to enhance procurement efficiency, supplier management, and risk governance. By leveraging institutional reforms, intelligent tiered review systems, and dynamic supplier capability profiling, the model addresses inefficiencies rooted in rigid hierarchies and manual processes. Empirical implementation demonstrates significant improvements in approval cycle times, resource matching precision, and proactive risk mitigation. The findings highlight a replicable pathway for SODIs to balance regulatory compliance with operational agility, fostering innovation and competitiveness in the digital era.

Keywords: "Internet Plus" Design Institute; Smart Contracts; Algorithmic Matching; Agile Procurement; Digital Transformation; Supplier Risk Management

1. Introduction

The acceleration of the global digital economy has fundamentally reshaped the organizational logic and operational paradigms of industries worldwide [1]. In China, this transformation has been further institutionalized through the national strategy of building a "Digital China". Within this context, central state-owned enterprises (CSEEs) are positioned not only as market participants but also as key implementers of national innovation and modernization goals [2]. For design institutes affiliated with CSEEs, which serve as the

backbone of infrastructure planning, engineering design, and technological consulting, digital transformation has shifted from being a strategic aspiration to an existential imperative [3]. Despite their critical role, traditional design institutes have long struggled with deeply entrenched inefficiencies. Their operational models are characterized by rigid hierarchies, fragmented workflows, and over-reliance on manual labor for tasks such as drafting, data transcription, and routine document processing. These inefficiencies not only slow down project delivery but also divert highly trained professionals away from high-value activities, such as advanced simulation, integrated design optimization, and knowledge-based innovation [4]. Meanwhile, growing project complexity, compressed timelines, and heightened sustainability requirements are exerting unprecedented pressure on design institutes, exposing the mismatch between outdated managerial mechanisms and contemporary demands [5]. The challenges extend beyond internal operations. Procurement processes remain dominated by cumbersome approval hierarchies and fragmented communication channels, producing significant delays and cost escalations [6]. Supplier management suffers from mismatches between closed institutional pools and rapidly evolving market capabilities, resulting in innovation bottlenecks and suboptimal resource allocation [7]. Risk governance systems, rooted in static credential checks and archival record-keeping, fail to capture dynamic risks such as financial distress, technological obsolescence, or compliance breaches. Collectively, these systemic shortcomings create a paradox: mechanisms designed to safeguard institutional stability inadvertently constrain flexibility, resilience, and competitiveness. These structural

dilemmas, digital platforms and data-driven management practices offer promising solutions [8]. The emergence of the "Internet Plus" paradigm provides an opportunity to bridge the gap between state-owned institutional requirements and the agility of market-oriented platforms [9]. By embedding intelligent subcontracting, supplier profiling, and integrated risk management into institutional frameworks, design institutes can not only streamline processes but also unlock new capacities for innovation, collaboration, and value creation. This transformation is not confined to design services alone; rather, it holds wider implications for the modernization of CSEEs across diverse functional domains [10].

Through this study, we aim to provide both practical insights and theoretical underpinnings for the digital evolution of design institutes within the CSEE sector. It offers an in-depth exploration and practical demonstration of managerial innovation pathways intrinsic to the "Internet Plus" Design Institute model. These pathways are instrumental in boosting the institutes' market competitiveness and overall operational performance, ensuring their competitiveness in the digital era. Furthermore, the findings and innovative management methodologies identified possess significant transferability. They offer valuable lessons and adaptable frameworks applicable to CSEEs seeking similar transformative innovations across diverse functional domains beyond design services. Ultimately, the study contributes to propelling the comprehensive technological upgrading, innovation-driven development, and enhanced capacity for sustainable, high-value creation within CSEE-affiliated Design Institutes in the burgeoning digital economy.

2. Exploration and Analysis of the Internet-Enabled Design Institute Model

The rise of the "Internet Plus" concept has opened new opportunities for the modernization of design institutes. Although commercial crowdsourcing platforms, such as Zhubajie and Upwork, have proven effective in integrating resources in both domestic and international markets, their operational models are difficult to reconcile with the formal structures and regulatory requirements of state-owned enterprises. Rules governing

procurement in central enterprises and broader state-owned enterprise standards limit the flexibility required for rapid subcontracting. At the same time, concerns over data security and control restrict the seamless incorporation of external platforms with internal systems such as ERP and BIM. In response, state-owned design institutes have developed the "Internet-Enabled Design Institute" model. This framework aims to create a digitally supported subcontracting environment that aligns with institutional norms while introducing innovative management practices. The approach emphasizes five main areas of reform. First, it strengthens compliance to ensure that subcontracting activities remain secure and fully monitored within state-owned enterprise parameters. Second, it redesigns workflows to combine the responsiveness of digital platforms with the rigorous quality assurance processes of design institutes. Third, it standardizes the specification of design outsourcing tasks to improve procurement efficiency. Fourth, it introduces structured evaluation of supplier capabilities to ensure alignment with project requirements. Fifth, it establishes incentive systems that promote collaborative value creation between internal teams and external partners.

The effectiveness of this model is illustrated through a pilot implementation in a state-owned design institute. The study constructs a threefold theoretical framework that integrates institutional reform, technological facilitation, and organizational development. The model demonstrates a transformation pathway that both respects regulatory constraints and leverages the advantages of digital platforms, providing a replicable approach for other design institutes seeking operational modernization and enhanced market competitiveness.

2.1 Institutional Constraint Breakthrough: Pre-established Framework Agreements and Intelligent Tiered Review

The traditional procurement approval system is mired in a fundamental contradiction between rigid control and operational agility, necessitating institutional restructuring to alleviate systemic burdens. The four-tier approval chain creates institutional blockages, forcing design institutes into a dilemma where "process integrity" and "operational

effectiveness" cannot coexist. To comply with state-owned asset supervision requirements, individual procurement processes require excessive review resources, resulting in severe delays in responding to urgent needs and creating a vicious cycle where compliance costs continuously erode operational value. This contradiction fundamentally stems from a structural disconnect between closed approval loops and open market demands.

The solution lies in establishing a dual-track intelligent governance system that balances "risk and value." By implementing pre-established framework agreements for centralized procurement, annual high-frequency, low-value procurement needs can be incorporated into an audited compliance framework, eliminating repetitive approval processes for individual projects. Simultaneously, an intelligent tiered review engine is developed to deconstruct procurement supervision policies into programmable rules, enabling millisecond-level risk diversion: low-risk procurements are automatically approved, while high-risk projects are routed for manual review. Together, these mechanisms create a symbiotic system of "institutional burden reduction + precise risk control," ensuring compliance with state-owned asset supervision while achieving internet-level responsiveness. When approval cycles are reduced from weeks to hours, and manual intervention is focused on genuinely high-risk scenarios, the procurement system shifts from a "control-first" logic to a "value creation" paradigm that equally prioritizes empowerment and risk management. This provides foundational support for state-owned enterprises to achieve agile transformation under strict regulatory environments.

2.2 Supply-Demand Matching Reconfiguration: Intelligent Demand Analysis and Supplier Capability Matching

The traditional supplier matching model is constrained by a fundamental contradiction between manual experience-based approaches and the overwhelming volume of procurement demands, necessitating a restructuring of resource coupling logic through intelligent analytical methods. Under the dual constraints of closed resource pools and ambiguous demand specifications, procurement personnel

are compelled to manually decode technical requirements from poorly articulated procurement documents. The fragmented nature of communication through telephone and email exchanges further exacerbates information distortion, ultimately reducing supplier selection to an experience-driven guessing game. This low-dimensional matching approach not only fails to capture high-quality specialized technical resources across various niche domains but also perpetuates persistent misalignment between project design and execution phases.

The solution lies in constructing a digital mirror system that accurately reflects both demand characteristics and supplier capabilities. By employing natural language processing engines to conduct atomic-level deconstruction of ambiguous requirements, semantically vague procurement requests can be transformed into quantifiable parameter systems. Concurrently, dynamic capability profiles are established for suppliers, moving beyond superficial credential records to continuously monitor core performance indicators including technological upgrades and contract fulfillment quality. These two components are integrated through intelligent algorithms to achieve millisecond-level precision matching, thereby fundamentally overcoming the randomness inherent in manual screening processes. When technical requirements achieve pixel-perfect alignment with professional competencies, and when resource acquisition evolves from targeted searches to comprehensive scanning, the matching mechanism completes its paradigm shift from experience-based estimation to algorithm-driven decision making. This transformation not only unlocks previously constrained market supply potential but also establishes a resilient resource ecosystem foundation for design institute

2.3 Supplier Supervision Redefinition: Commercial Early Warning System and Capability Profiling for Dual-Cycle Risk Immunity

Traditional supplier supervision systems suffer from a fundamental misalignment between static control mechanisms and dynamic risk factors, urgently requiring the establishment of an organism-inspired risk defense framework. Current management practices remain limited

to archival storage of qualification certificates, demonstrating incapacity to detect real-time operational anomalies among suppliers, evaluate actual contract fulfillment performance, or identify systemic risks such as credential lending arrangements. This severe disconnect between paper-based management practices and operational realities leaves design institutes operating in a regulatory vacuum characterized by delayed risk recognition and reactive remedial measures.

The breakthrough strategy involves implementing a dual-cycle "innate-adaptive" risk immunity mechanism. The innate immunity layer addresses the critical need for millisecond-level risk response by integrating dynamic data sources including business credit databases and judicial litigation records to establish a rule-based real-time risk interception network. This system can trigger circuit breakers within 0.2 seconds when detecting major risks such as supplier operational abnormalities or legal disputes. The adaptive immunity layer focuses on capability evolution assessment, employing machine learning techniques to continuously analyze contract fulfillment data streams and predict latent risks such as technological capability deterioration or quality fluctuations before they materialize. These two layers form a complementary organic system: while the innate immunity mechanism rapidly intercepts visible threats, the adaptive immunity component thoroughly eliminates hidden risk factors. This paradigm shift from passive control to active defense transforms risk management from a cost center into a value generator, simultaneously constructing protective barriers for business continuity while providing diagnostic support for the continuous improvement of high-quality suppliers.

3. Exploration and Analysis of the "Internet Plus" Design Institute

The Internet-Enabled Design Institute Model achieves transformative outcomes through three interconnected mechanisms: First, the "intelligent pre-establishment of centralized procurement framework agreements" comprehensively addresses annual small-value design subcontracting needs, eliminating repetitive approval processes for individual projects. Second, "digital alignment of

requirements and deliverables" enables atomic-level matching between procurement needs and delivery standards through intelligently generated embedded requirement confirmations and online CA signatures. Third, a dual-cycle mechanism combining commercial early warnings and machine learning shifts risk control from post hoc remediation to proactive prevention. Ultimately, this model reconstructs the value creation paradigm for state-owned design institutes through the dialectical unity of "institutional rigidity ensuring compliance" and "technological flexibility enabling efficiency" (Figure. 1).

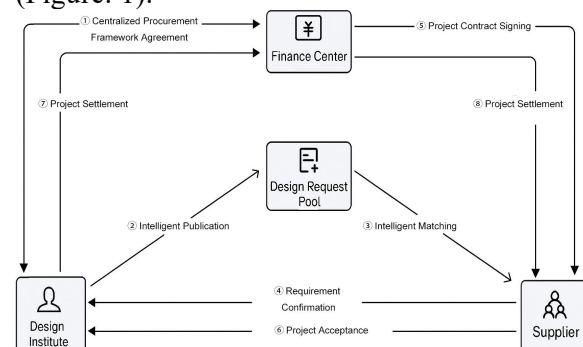


Figure 1. The Innovative Digital Contracting Workflow for Design Institutes and Suppliers

3.1 Intelligent Pre-establishment of Centralized Procurement Framework Agreements: Institutional Burden Reduction

The intelligent pre-establishment of centralized procurement framework agreements represents a fundamental institutional innovation for state-owned design institutes. Under traditional models, small-value procurement processes were trapped in repetitive approval cycles. Each routine outsourcing required multi-level approvals across departments, branches, institute leadership, and group companies. This not only compromised operational timeliness but also created systemic inefficiencies through redundant audit processes and delayed urgent needs. While satisfying formal compliance requirements, this fragmented review system embodied an inherent contradiction between procedural completeness and operational effectiveness.

The new mechanism achieves institutional restructuring through annual framework agreements. By establishing pre-approved compliance frameworks that incorporate high-frequency procurement needs, it triggers

three paradigm shifts: (1) Zeroing approval frequency eliminates repetitive project-level reviews, transforming institutional costs from continuous sunk costs to strategic investments; (2) Granular risk control decomposes regulatory rules into algorithmic instructions, enabling second-level approval for low-risk procurements and targeted interception of high-risk projects; (3) Redefined accountability shifts legal and audit functions from trivial verification to framework governance, elevating regulatory effectiveness. The core innovation lies in transforming institutional design from a "brake" constraining operations to a "transmission system" enabling agile productivity, where compliance investments become continuous empowerment, and approval logic evolves from "review every transaction" to "framework foundation plus intelligent adaptation."

3.2 Intelligent Analysis of Design Subcontracting Needs: Smart Matching and Recommendation of Supplier Resources

The intelligent parsing of design subcontracting requirements and precise matching of supplier resources constitutes a cognitive revolution overcoming traditional resource mismatches. Conventional approaches suffered from dual ambiguities: vague technical requirements turned specifications into guessing games, while supplier capability assessment was limited to superficial credential reviews. This combination of "semantic misunderstanding" and "capability blindness" reduced matching to experience-based randomness, failing to identify niche specialists while perpetuating project execution misalignments.

The intelligent matching engine reconstructs resource coupling logic through digital mirroring of requirements and capabilities. Natural language processing penetrates ambiguous requirements, decomposing them into quantifiable parameter systems that make technical elements atomically explicit. Simultaneously, dynamic capability profiles for suppliers transcend basic business license information to continuously track technological evolution and historical performance. When parameterized requirement matrices interact algorithmically with evolutionary capability maps, resource matching ascends from manual

low-dimensional selection to comprehensive precision guidance. This transformation redefines procurement from "subjective filtering through experience" to "ecosystem connectivity through data," unleashing long-tail supply potential while building resilient resource foundations.

3.3 Online Confirmation of Subcontracting Requirements: Delivery Standard Alignment

The essence of online confirmation of subcontracting requirements lies in using digital contracts to overcome the cognitive disjunctions that traditionally arise in procurement delivery standards. In the era of paper-based agreements, the alignment of delivery standards between design institutes and suppliers often stalled at the stage of formal signatures. Technical parameters, subject to repeated manual transcription, suffered severe distortions, while digital certification through official seals degraded into a hollow symbol of legal formality. The inherent limitations of physical media repeatedly produced the paradox whereby "both parties sign the same document but do not share the same understanding of delivery standards." This systemic gap inevitably sowed the seeds of rework and disputes in subsequent stages.

The intelligent confirmation system constructs a digital neural pathway for the alignment of standards. Through the structured embedding of contractual provisions, confirmation documents automatically generate standardized expressions of core delivery parameters. Online certification is no longer a discrete node of legal validation but functions as the entry point into a dynamic delivery matrix. Suppliers can instantly visualize three-dimensional building information models, material specification trees, and other multi-dimensional standards. When the act of certification is deeply integrated with the digital delivery repository, the traditional fractured process of "first contract, then alignment" is reconstituted into a closed-loop paradigm of "contract as alignment." This is not merely a technological enhancement but represents a paradigmatic transformation in the philosophy of delivery: a shift from passive remedies based on retrospective interpretation toward proactive prevention through the sharing of digital baselines, ultimately

eliminating the institutional costs generated by cognitive asymmetries at the source of the contractual relationship.

3.4 Platform-Centered Contracting Hub and the Reconstruction of Legal Relations

The essence of a platform-centered contracting hub lies in reconstructing the chain of rights and responsibilities through a triangular contractual framework. Under the traditional model, the linear contractual relationship between design institutes and suppliers exposed the institutes to systemic risks such as inaccurate qualification verification and regulatory overload in performance monitoring. When suppliers unexpectedly went bankrupt or committed serious misconduct, design institutes, as both contracting parties and direct bearers of liability, faced risks with no mechanism for transfer. This binding of rights and responsibilities has become a structural barrier to resource openness in high-risk digital ecosystems.

The proposed mechanism breaks the cycle of risk transmission by elevating the legal relationship. Suppliers enter into standardized subcontracting agreements with the platform operator, which acts as a specialized risk filter, performing four-dimensional checks (qualification compliance, professional authenticity, creditworthiness, and historical performance). In this framework, the design institute assumes the role of beneficiary rather than direct contracting party. This institutional shift generates three profound transformations: (1) Risk insulation: supplier-related risks such as fraudulent qualifications or financial crises are fully isolated from the design institute; (2) Professionalized regulation: the platform, leveraging dynamic data networks, intercepts risks in real time—such as linking to commercial integrity databases, achieving a level of regulatory precision beyond the limits of manual oversight; (3) Resource openness: freed from the burdens of legal recourse, design institutes can securely access a broader ecosystem of supply networks.

This transformation represents more than a reallocation of contractual roles; it embodies an evolution in the philosophy of risk governance. As the framework of rights and responsibilities shifts from linear accountability to triangular balance, and as risk management is transformed from a financial

liability into a specialized service, highly regulated industries gain a sustainable institutional foundation for resource openness. The platform hub thereby functions as a converter between compliance and agility, simultaneously fortifying the security of state-owned assets and enabling design institutes to embed themselves within the digital ecosystem.

4. Conclusions and Prospectives

This study shows that the "Internet Plus" Design Institute approach can successfully balance the strict regulatory requirements of state-owned enterprises with the flexibility offered by digital platforms. Innovations such as pre-defined framework agreements, intelligent alignment between project demands and supplier capabilities, and mechanisms for managing risks in both routine and exceptional cases have proven effective in shortening approval cycles, improving resource utilization, and addressing emerging operational risks. The positive results from pilot implementations highlight the model's capacity to modernize state-owned design institutes while remaining compliant with supervision standards for state assets.

Future research should explore how to extend this model to other sectors within central state-owned enterprises, especially those with intricate supply chains and strict regulatory oversight. The incorporation of advanced technologies, including blockchain for secure contract execution and artificial intelligence for predictive analytics, could further enhance transparency and decision-making efficiency. Collaboration across industries may also improve the model's flexibility and applicability in international contexts, where digital innovation must coexist with rigid institutional frameworks. Overall, this framework not only facilitates the digital advancement of state-owned design institutes but also offers insights into achieving sustainable, innovation-driven development within the broader public sector.

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