Dual-Path Coupling Mechanism for Initiating University Intellectual Property Information Services in Non-Contractual Contexts: A Co-Evolutionary Analysis of Trust Building and Service Encounters

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Abstract

[Purpose/Significance] This study investigates how university library and information institutions can break through the cognitive and trust barriers of research teams in non-contractual contexts, thereby resolving the "high-demand-low-penetration" dilemma in intellectual property information services. [Method/Process] By integrating Mayer' s organizational trust theory and Grönroos' s service encounter theory, we construct a "trust-encounter" dynamic synergy model. Based on a longitudinal case study of Nankai University from 2018-2024, we employ process tracing method to analyze the service penetration path. [Results/Conclusion] The findings reveal that non-contractual trust follows a three-stage evolutionary pattern of "instrument → cognition → institution," while the service encounter network exhibits a hierarchical diffusion effect of "single-point → chain → ecosystem." Social relationship networks play a core mechanism of "temporal complementarity," and dual-path synergy exhibits a dynamic threshold effect. Based on these patterns and effects, we propose a service ice-breaking paradigm of "rigid-demand-entry—value-added-service-extension—ecosystem-lock-in," providing theoretical basis and practical pathway for the reconstruction of university intellectual property information service systems.

Full Text

A Dual-Path Coupling Model for Service Penetration in Non-contractual Contexts: A Trust-Encounter Synergistic Evolution Perspective

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Abstract

[**Purpose/Significance**] This study investigates how university libraries can overcome cognitive and trust barriers within research teams in non-contractual contexts, aiming to resolve the "high demand-low penetration" dilemma in intellectual property information services. [**Method/Process**] Integrating Mayer' s Organizational Trust Theory and Grönroos' Service Encounter Theory, this study constructs a dynamic "trust-encounter" coupling model. A longitudinal case study of Nankai University (2018–2024) is employed, using the process-tracing method to delineate the service penetration pathway. [**Results/Conclusions**] The findings reveal that non-contractual trust evolves through a three-stage trajectory: "instrumental → cognitive → institutional." Simultaneously, the service encounter network demonstrates a hierarchical diffusion, evolving from "single-point" to "chain" and finally to an ecosystem. Social network ties function as a core mechanism, providing "temporal complementarity" between these paths, and the collaboration between the two paths is subject to a dynamic threshold effect. Based on these patterns, a service breakthrough paradigm of "initiating via rigid needs → extending through value-added services → integrating into an ecosystem" is proposed, offering theoretical and practical insights for restructuring university IP service systems.

Keywords: non-contractual context; intellectual property information services; trust building; service encounter; coupling mechanism

Classification Number: G250.73

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1. Introduction

Against the backdrop of the innovation-driven development strategy, universities serve as strategic pivots in the national scientific and technological innovation system, and the penetration level and effectiveness of their intellectual property information services directly influence the quality and efficiency of research commercialization. Survey data indicate that in 2024, the patent commercialization rate in Chinese universities stood at merely 3.9%, significantly lagging behind the 53.3% industrialization rate of valid invention patents in Chinese enterprises (with rates of 61.4%, 57.8%, and 36.7% for large, medium, and small enterprises, respectively) [1,2]. This substantial gap not only reflects multiple challenges in bridging scientific achievements with market demands but also highlights evident shortcomings in the supply side of university IP information services. In recent years, despite research teams' increasingly urgent demand for advanced services such as patent landscape analysis and risk early warning, the service coverage rate of university IP information service centers remains extremely low, creating a typical "high demand-low penetration" dilemma. The root cause lies in the fact that traditional standardized and contractual service models, driven by administrative mandates, fail to effectively break through the inherent cognitive barriers and trust thresholds of research teams.

Existing research has predominantly focused on service mechanisms within contractual contexts, yielding positive advances in IP risk prevention and service quality management. For instance, Chen Qiyu et al.' s study on the public IP information service system and standardization clarified the role of cooperative contract clauses in regulating rights, responsibilities, and benefits while preventing IP risks [3]. Li Jian' s research on marketing strategies for university library regional IP information services, grounded in the 7Ps marketing theory, further emphasized the importance of contractual relationships in ensuring service quality [4]. Additionally, service practices have explicitly noted that service agreements should be signed to clarify mutual rights and responsibilities when providing IP consulting and training [5]. However, overall, current research suffers from three main limitations: First, discussions on the specific functional mechanisms of contractual services in IP information services lack depth and fail to provide thorough analysis of their underlying logic. Second, existing studies focus primarily on theoretical exploration and deduction, lacking dynamic tracking and empirical deconstruction of the service initiation process. Third, research has overemphasized contractual contexts while relatively neglecting the initial breakthrough mechanisms of trust building and encounter management in non-contractual scenarios, resulting in service promotion that often relies on administrative mandates in practice. This not only exacerbates research teams' sense of alienation but also constrains service effectiveness and sustainability.

In light of these gaps, this study adopts the disciplinary perspective of library and information science, focusing on university libraries and their affiliated IP information service centers (hereinafter referred to as "the Center"). Unlike institutions such as technology transfer offices that depend on administrative authority or contractual frameworks, the library-led service system leverages its vast document resources, professional intelligence analysis tools, and interdisciplinary networks formed through academic exchange hubs, endowing it with unique resource endowments for integrating into research processes through non-contractual means. Therefore, this paper innovatively integrates Mayer's Trust Building Theory [6] and Grönroos' Service Encounter Theory [7] to construct a "trust-encounter" dual-path collaborative framework. The aim is to systematically reveal how library and information institutions can utilize their core assets to achieve initial penetration and deep embedding of IP information services in the absence of administrative mandates or legal contractual constraints, thereby exploring a distinct service breakthrough path characterized by library and information features, diverging from purely contractual technology transfer models.

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2. Theoretical Framework: Dual-Path Collaborative Evolution Mechanism

Breaking the ice for services in non-contractual contexts centers on resolving two major challenges: uncertainty and insufficient cooperation motivation. It should be clarified that the non-contractual context discussed in this paper specifically refers to cooperation models that do not rely on administrative mandates or legal contracts as preconditions during the service initiation phase. This forms a sharp contrast with the contractual models typically adopted by departments such as technology transfer offices. Joint project applications and similar behaviors that emerge later in the case represent natural outcomes of deepened service relationships and accumulated trust capital, rather than prerequisites for service breakthrough. To systematically analyze this phenomenon, this study constructs a "trust-encounter" dual-path collaborative framework.

2.1 Deconstruction of Core Concepts and Dimensional Elaboration

To analyze the internal mechanisms of service breakthrough in non-contractual contexts, this study proposes a "trust-encounter" dual-path collaborative framework. The framework comprises two parallel and interactive evolutionary paths, with core concepts and dimensions elaborated as follows.

2.1.1 Generation of Non-contractual Trust and Its Three-Stage Evolutionary Logic Grounded in Mayer et al.'s organizational trust theory, this study conceptualizes the generation of non-contractual trust as a dynamic accumulation process. This process begins with research teams' initial percep-

tion of the Center' s professional capabilities and gradually deepens through continuous interaction. Its internal structure encompasses three key dimensions: competence credibility, cooperative goodwill, and institutional fairness, providing the theoretical foundation for this study' s "instrumental → cognitive → institutional" three-stage evolutionary path. Fundamentally different from legally constrained contractual trust, non-contractual trust evolves through a trajectory more suited to academic cooperation contexts:

(1) Instrumental Trust Stage: As the starting point for non-contractual trust accumulation, this stage centers on research teams' verification of the Center' s "professional tool efficacy." Trust building at this stage heavily depends on whether the Center can transform its professional capabilities into immediately perceivable instrumental value for researchers through accessible, efficient, and reliable service delivery. Through process reengineering (such as significantly compressing novelty search cycles), the Center fulfills service promises with immediate responsiveness, not only materializing professional capabilities but also enabling research teams to directly perceive the instrumental value of services.

(2) Cognitive Trust Stage: When instrumental trust accumulates to a critical threshold, deepening trust requires bridging the semantic gap between disciplines. This process relies on the Center' s ability to translate IP professional terminology (such as patent layout density and technical efficacy matrices) into discipline-specific concepts familiar to researchers (such as academic citation networks and experimental variable models). Successful knowledge translation is key to achieving cognitive alignment and precisely embedding services into research teams' cognitive maps.

(3) Institutional Trust Stage: At this stage, trust stabilizes and manifests as institutional solidification. Through symbiotic institutional arrangements such as joint project applications and shared IP revenue, the Center' s role transforms from an external service provider to a member of the innovation community. This institutional embedding constructs a stable cooperation network, elevating trust from the interpersonal level to the organizational and institutional level, forming a stabilizer for long-term collaboration.

2.1.2 Hierarchical Evolution of Service Encounters: Single-Point Breakthrough, Chain Extension, and Ecosystem Synergy Drawing on Grönroos' service encounter theory [7], this section analyzes how service encounters, as concrete carriers of value transfer and relationship deepening, demonstrate hierarchical characteristics in non-contractual contexts. This process manifests as a dynamic evolution where the touchpoint network becomes increasingly complex and value density continuously improves.

(1) Single-Point Breakthrough Stage: The strategy at this stage involves precisely identifying and delivering services with high-frequency, rigid characteristics (such as patent novelty searches) with extreme quality and efficiency. The core objective is to establish initial professional credibility and achieve re-

lationship breakthrough through a single high-quality service experience.

(2) Chain Extension Stage: Following successful breakthrough at a single point, the interaction pattern exhibits chain-like transitions along the research value chain. Services transform from independent "products" into interlinked "solutions," achieving synergistic value gains and iterative amplification through demand correlation and bundled combinations. Through deep analysis of research demand correlations, services at this stage shift from providing independent products (such as novelty searches and early warnings) to bundled combinations, forming a gradient product system. This chain extension not only meets composite demands but fundamentally changes research teams' value perception of the Center, positioning it as an indispensable innovation partner.

(3) Ecosystem Synergy Stage: At this stage, services achieve deep embedding and integration with research processes. By incorporating IP analysis functions into research management systems (such as technology roadmap formulation processes), service demand shifts from external input to endogenous drive from research processes themselves. This marks the formation of a service supply–research decision closed loop, indicating that services have evolved from auxiliary tools to critical infrastructure supporting the innovation ecosystem, laying a solid systemic foundation for both parties to construct an innovation community.

2.2 Evolutionary Path of the Dynamic Synergy Mechanism

To analyze the internal mechanism of the "trust–encounter" dual-path collaborative evolution, this study employs process-tracing methodology to systematically organize and cross-validate three types of core evidence from the Center's service practices from 2018–2024: (1) key information from service encounters (such as contact frequency and response time); (2) empirical materials from cooperative outputs (such as joint projects and analysis reports); and (3) semi-structured in-depth interview records (focusing on trust nodes and value perception).

Specifically, to capture the collaborative trajectory of the "trust–encounter" dual paths, this study constructs a multi-source evidence triangulation framework. First, quantitative analysis is applied to interaction frequency and response efficiency in service records. Subsequently, through deep reading and qualitative content analysis of project documents, analysis reports, and interview records, critical events and typical expressions of trust transitions are identified (for example, repeated positive evaluations of response timeliness and recognition of the Center' s ability to accurately understand research needs in interviews). Finally, by correlating and comparing these trends with key events on a timeline, critical nodes and trust-building mechanisms in the dual-path collaborative evolution process are identified.

Combining Ring and Van de Ven' s (1994) three-stage theory of cooperative relationships [8], this study divides the dual-path collaborative process into incubation, deep collaboration, and steady-state periods, analyzing key nodes

at each stage through process tracing:

- **Incubation Period (0–16 months):** Centered on high-frequency, low-level service encounters, instrumental trust is initially accumulated by improving service accessibility and response efficiency. When response efficiency for key services achieves a qualitative leap (such as compressing the patent novelty search cycle from 120 hours to 72 hours) and monthly average basic service encounter frequency stabilizes at $ $3 times, instrumental trust accumulates to a critical threshold.
- **Deep Collaboration Period (16–40 months):** As trust capital crosses the initial threshold, interaction patterns shift from passive response to proactive collaboration. Service touchpoints extend chain-like along the research value chain, constructing cognitive trust through knowledge translation and deep interaction.
- **Steady-State Period (40+ months):** The dual paths form a synergistic resonance effect, trust capital tends toward institutional solidification, and the service network ecologically embeds into research processes, forming a self-organizing cooperative system.

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3. Case Empirical Study: Dynamic Evolution of the Dual-Path Collaborative Mechanism

To validate the stage characteristics proposed through theoretical deduction, the following section reveals the dynamic evolutionary patterns of this collaborative mechanism based on longitudinal service data from the Center (2018–2024).

3.1 Case Background

This study adopts a longitudinal single-case research design, selecting a research team from Nankai University' s College of Artificial Intelligence as the research object. The case selection follows theoretical sampling principles, aiming to deeply analyze the operational logic of "trust–encounter" in research teams with high cognitive barriers. To ensure research depth and validity, we chose a typical scenario with high information density and strong theoretical implications. All data in this case (such as contact frequency and demand types) are derived from publicly available service statistics and cooperation review records of Nankai University Intellectual Property Information Service Center, authorized for use in this study.

The case exhibits three key characteristics: (1) **Disciplinary typicality (high cognitive barrier context):** The AI field features rapid knowledge iteration and significant tacit knowledge characteristics, creating inherent cognitive gaps with IP information services. Achieving service penetration in such high-barrier disciplines is particularly challenging, making successful experiences more the-

oretically significant. (2) **Demand representativeness:** The team produces multiple patents annually and has sustained, diverse demand for advanced services such as patent novelty searches and risk early warnings, representing a typical service object caught in the "high demand-low penetration" dilemma. (3) **Data completeness:** The seven-year cooperation history provides a systematic, complete, and traceable data chain, ensuring the depth and reliability of the case study.

3.2 Three-Stage Collaborative Evolution: Model Validation Based on Longitudinal Case

Longitudinal case data from Nankai University support and refine the theoretical framework. The collaborative evolution trajectory of the "trust-encounter" dual paths can be visually presented through the model in Figure 1 [Figure 1: see original paper].

Figure 1 Trust-Encounter Dual-Path Collaborative Evolution Model
Data source: Constructed based on service records and interview materials from Nankai University Intellectual Property Information Service Center (2018-2024).

As shown in Figure 1, trust building and service encounter evolution exhibit significant coupling and nonlinear characteristics. During the incubation period, the accumulation of instrumental trust and breakthroughs in single-point encounters mutually reinforce each other. When trust levels cross the first threshold (approximately 16 months), cooperation enters the deep collaboration period, where cognitive trust construction provides the psychological foundation for chain service extension, while value-added experiences from chain services further consolidate cognitive trust. Finally, after crossing the second threshold (approximately 40 months), institutional trust solidification and service network ecological embedding jointly drive cooperation into a steady-state symbiotic stage. The model reveals that initial trust establishment is not achieved overnight but is a dynamic process driven by trust capital and service value at critical nodes. The following sections elaborate on the three stages of this collaborative evolution model with case evidence.

3.2.1 Incubation Period (2018-April 2019, within 16 months of cooperation initiation): Instrumental Trust Accumulation and Single-Point Encounter Breakthrough During the initial cooperation phase, the research team harbored doubts about the Center's service capabilities, constituting a typical low-trust, low-penetration scenario. Case data show that the breakthrough began with a single-point encounter: patent novelty search. Through service process reengineering, the Center compressed the search cycle from 120 hours to 72 hours. This significant efficiency improvement produced a strong signaling effect. In subsequent interviews, the team leader repeatedly mentioned that response speed exceeded expectations. Interaction records from this stage indicate that nearly 80% of service encounters occurred intensively at critical nodes

such as project application and completion. These high-frequency, reliable basic service interactions empirically demonstrate that immediate response to and reliable delivery of rigid needs constitute an effective path for instrumental trust generation and accumulation.

3.2.2 Deep Collaboration Period (May 2019–April 2021): Cognitive Trust Construction and Chain Service Extension After instrumental trust was basically established, a critical event propelled cooperation into the deep collaboration period: In May 2019, beyond completing the novelty search, the Center proactively provided a technical competitive landscape brief. Its precise identification of a technology pathway highly aligned with the team' s research direction garnered significant attention from the team leader. Interview data show that this event made the team deeply aware of the strategic value of intelligence services, leading them to proactively invite the Center to participate in their provincial-level soft science project completion work (approximately the 17th month of cooperation). This marked a shift from passive response to proactive collaboration. During this process, the knowledge translation mechanism emphasized in the theoretical framework was fully manifested: Center personnel successfully translated patent claims into experimental variable control models. With the establishment of a weekly demand calibration meeting mechanism, service encounters extended from single novelty searches to chain combinations such as "search + early warning" and "mining + layout," empirically demonstrating how cognitive trust construction drives service network diffusion and value co-creation.

3.2.3 Steady-State Period (May 2021-present): Institutional Trust Solidification and Ecosystem Synergistic Symbiosis The case entered the steady-state period marked by institutional solidification of trust relationships. In early 2022, the team leader proactively consulted the Center on technology pathway selection in a non-preset service context and recommended the Center to lead a special project application in the AI field, indicating that trust had evolved from utility-based instrumental levels to strategic levels based on professional reliability. By the end of 2024, the parties achieved institutional binding through joint project completion, with Center personnel incorporated into the project team, completing a structural transformation from external service provider to internal innovation participant. Correspondingly, the service encounter network achieved ecological embedding, with IP analysis integrated into the team' s technology roadmap formulation process as a fixed component of R&D decision-making. Importantly, new cooperation at this stage was realized through an intergenerational trust transmission mechanism of "academic leader referral–young team undertaking," indicating that structural embedding of strong-tie networks had replaced temporary cooperation as the dominant logic for alliance stability. At this point, the institutional trust and ecosystem synergy stages posited in the theoretical model are fully manifested in the case, with the "trust–encounter" dual-path collaboration ultimately forming a stable

ecosystem lock-in effect.

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4. Theoretical Dialogue: Academic Contributions and Practical Implications

Based on the dynamic patterns revealed through case analysis, this study further engages in dialogue with existing theories on organizational trust, service management, and collaborative innovation. Its innovative contributions are primarily reflected in two dimensions: theoretical construction and practical application.

4.1 Knowledge Innovation at the Theoretical Level

This study achieves breakthroughs in organizational trust, service management, and collaborative innovation theories. By constructing a dialogue framework between dynamic trust and relational networks, it deeply couples Granovetter' s weak tie theory [9], Burt' s structural holes theory [10,11], and Teece' s dynamic capabilities theory [12], significantly enhancing theoretical explanatory power for non-contractual cooperation mechanisms.

4.1.1 Paradigm Innovation in Dynamic Trust Theory: Temporal Complementarity of Tie Strength This study' s findings on the role of social networks form a profound dialogue with Mark Granovetter' s weak tie strength theory and subsequent arguments. Based on longitudinal case process tracing, the core discovery is that beyond traditional static trust views and linear collaboration models, the role of social networks in non-contractual, knowledge-intensive service scenarios exhibits significant temporal complementarity rather than simple substitution. Table 1 presents the dominant relationship types, core functions, and case support at different trust stages. Analysis shows that in the initial trust-building stage, weak ties efficiently triggered cooperation through their information bridge role. As interactions deepened into the cognitive trust period, strong ties' deep interaction became the core mechanism for crossing disciplinary semantic gaps and achieving knowledge fusion. Finally, when trust evolved to the institutional level, the stability and institutional guarantee efficacy embedded in strong tie networks comprehensively surpassed the information control advantages of structural holes, establishing their dominant logic in maintaining long-term symbiotic relationships. This temporal complementarity mechanism provides a core analytical perspective for understanding the evolution of university IP information services from breakthrough to symbiosis.

Table 1: Differentiated Mechanisms of Tie Strength in Non-contractual Trust Evolution and Case Support

Stage	Core Function	Case Support (Nankai University)	Theoretical Dialogue and Revision
Instrumental Trust Period (0–16 months)	Heterogeneous information transmission, low-threshold triggering of cross-disciplinary weak ties	80% of service interactions in first 16 months occurred at critical nodes like project application/completion, mostly triggered by cross-disciplinary weak tie referrals	Confirms Granovetter's weak tie theory [8]: weak ties act as "information bridges" to efficiently trigger initial cooperation
Cognitive Trust Period (16–40 months)	Knowledge translation, demand deepening, cognitive alignment	Weekly demand calibration meetings (strong tie interaction) established; successfully translated "patent claims" into "experimental variable models"	Revises weak tie theory: proves deep interaction of strong ties is key to crossing cognitive gaps and achieving knowledge fusion, rather than causing redundancy
Institutional Trust Period (40+ months)	Institutional symbiosis, risk sharing, intergenerational trust transmission	100% success rate in joint project applications; new cooperation realized through "academic leader referral–young team undertaking" model	Enriches Burt's structural holes theory [17-18]: proves that in trust steady-state period, strong ties' institutional guarantee efficacy (stability) surpasses structural holes' information control advantage (efficiency)

Classic weak tie theory suggests that strong ties, due to network closure, easily lead to information redundancy. This study finds that in specific cooperation stages and knowledge contexts, the mechanism is more complex. The case shows that in the cognitive trust period, weekly demand calibration meetings as typical strong tie interactions significantly promoted deep collaboration. Data reveal that within six months of establishing this mechanism, the team's derived service demands expanded from two basic services to four value-added categories, with service adoption rates increasing from approximately 35% to over 85%. Through such deep interactions, service specialists successfully translated professional terms like patent layout density into disciplinary concepts like experimental variable models.

This study reveals that in non-contractual cooperation requiring deep knowledge fusion, strong ties and structural holes do not simply substitute for each other

but constitute a "temporal complementarity" mechanism. This finding not only falsifies the inherent view in weak tie theory that strong ties necessarily cause information redundancy but also establishes their core position in breaking cognitive barriers and building deep trust, thereby completing an important contextual revision of classic theory for non-contractual, knowledge-intensive service scenarios.

During the instrumental trust period, the Center leveraged its structural holes position connecting multiple colleges to function as an information hub, efficiently matching service resources for demand teams. When cooperation entered the institutional trust period, the cooperation logic shifted toward maintaining long-term stability and risk sharing. In the case, the parties achieved institutional binding through joint project completion and intergenerational trust transmission via academic leaders. At this stage, the high stability constructed through strong ties' joint investment and institutional binding surpassed the efficiency advantages of structural holes, becoming the dominant logic for cooperation evolution. This dynamic evolutionary process further confirms the theoretical validity and explanatory power of the temporal complementarity mechanism.

4.1.2 Systematic Expansion of Service Encounter Theory At the service encounter theory level [7], this study systematically expands Grönroos' (2000) critical moments theory. This classic theory emphasizes the decisive impact of discrete, single-occasion service touchpoints (critical moments) on customer perception but lacks systematic explanation of the internal connections between multiple touchpoints and their collaborative evolution into value networks.

This study' s theoretical contribution lies in expanding the conceptual scope of service encounters from isolated critical moments management to an analytical framework of dynamic construction and collaborative evolution of touchpoint networks. Longitudinal case data clearly reveal that service encounter networks follow a hierarchical evolutionary pattern of "single-point breakthrough → chain extension → ecosystem synergy." This evolution is not a simple quantitative increase but a qualitative leap in value co-creation logic: from establishing initial credibility through efficient novelty searches, to achieving chain synergy and value gains through service combinations like "search + early warning," and finally embedding IP analysis into research processes to fundamentally transform service demand from external triggering to endogenous drive. This networked evolution and value transition not only confirms Vargo and Lusch' s (2016) [13] core proposition in service-dominant logic that value co-creation stems from collaborative integration but also resonates with Chu Jingli et al.' s (2013) [14] proposed evolution 规律 of embedded library services from resource embedding to "capability symbiosis."

More importantly, through process tracing, this study empirically identifies the nonlinear threshold effect of service encounter value gains. Specifically, during

the incubation period, a monthly average of no fewer than three basic service encounters is the necessary frequency threshold for accumulating instrumental trust. During the deep collaboration period, monthly interaction frequency needs to increase to more than four times (including deep interactions such as demand calibration) to effectively trigger cognitive trust and observe significant value gains. This refined conclusion provides crucial theoretical grounding for the precise design and adaptive optimization of university IP information services.

4.1.3 Contextualized Innovation in Organizational Collaboration Theory At the organizational collaboration theory level, this study introduces Uzzi' s (1997) embeddedness theory [15] into the library and information science field, constructing a dual-path collaborative model that reveals the unique internal 规律 of the interaction between relational networks and trust capital in non-contractual cooperation.

Uzzi' s embeddedness theory reveals how social relationships shape economic action, covering relational embeddedness (e.g., trust, commitment) and structural embeddedness (network position). Drawing on Nahapiet and Ghoshal' s (1998) [16] social capital theory, this study further discovers that under the support of library and information institutions' unique resource systems, the two paths of trust building and service encounters can form a dynamic positive feedback loop. Relational embeddedness maintains trust and commitment, providing a micro-social foundation for deepening the trust-building path, while structural embeddedness defines network centrality, offering macro-architectural support for the networked evolution of the service encounter path. Driven by this cycle, service providers can break through the peripheral auxiliary role in traditional research value chains and gradually embed into core segments of the knowledge innovation ecosystem, achieving a role transition from resource supporter to innovation partner.

This discovery reveals the nonlinear nature of non-contractual synergy: it is not a simple linear process of resource input–service output but an evolution from periphery to core driven by the mutual catalysis and cyclical reinforcement of the dual paths, with library core assets as the initial impetus. The model constructed in this study not only provides a new theoretical lens for understanding how library and information institution-based non-contractual cooperation achieves and maintains dynamic balance but also concretely deepens the application context of collaboration theory from general inter-organizational cooperation to the library and information science field, clarifying the internal mechanism through which libraries achieve value transition in the innovation ecosystem. To more intuitively present this study' s positioning and innovation, Table 2 compares it with existing research paradigms across four dimensions: core perspective, research stage, practice orientation, and innovation points.

Table 2: Comparative Analysis of Different Research Paradigms

Dimension	Xiao Zizheng et al. (Service Quality Evaluation)	Zhuang Nan et al. (Public Demand Analysis)	This Study (Dual-Path Collaborative Mechanism)
Core Perspective	Based on CIPP model, constructed a service quality evaluation index system with 36 third-level indicators	Revealed temporal evolution patterns of public IP information service demand types through big data analysis	Analyzed how "trust-encounter" dual paths collaboratively drive service breakthrough in non-contractual contexts through longitudinal case study
Research Stage	Focused on "service outcome evaluation," constructing static evaluation systems emphasizing quantitative judgment of "how good the service is"	Focused on "demand-side characteristics," mining "what users want" in current situation analysis	Focused on "service initiation process," analyzing the mechanism for "how to break the low-penetration dilemma" from 0 to 1
Practice Orientation	Provided "evaluation tools," such as weight assignment for 36 third-level indicators	Provided "demand basis," such as identifying core demand categories like "creation and utilization"	Provided "operational pathways," such as a practical framework of "three-stage trust evolution" and "three-level encounter transition"

Dimension	Xiao Zizheng et al. (Service Quality Evaluation)	Zhuang Nan et al. (Public Demand Analysis)	This Study (Dual-Path Collaborative Mechanism)
Innovation Points	Improved indicator dimensions and quantitative methods for service quality evaluation	Revealed temporal evolution patterns of public service demand	First time positioning the library's "document database + interdisciplinary network" resources as core support for trust accumulation, distinguishing it from pure contractual service frameworks in other fields (e.g., technology transfer offices), and strengthening the theoretical exclusive value of library and information science through concrete practices like "technology translation via Derwent patent database" and "service ecosystem construction through library's cross-school network"

4.2 Paradigm Breakthrough at the Practical Level

The theoretical findings of this study offer direct implications for university IP information service practice. Accordingly, we propose a transformation pathway for practical paradigms at three levels: micro, meso, and macro.

4.2.1 Micro-Level: Capability Reconstruction of Knowledge Service Providers (Library Subject Specialist Orientation) To achieve effective penetration of non-contractual services, university library subject specialists should transform their role from "information intermediary" to "innovation partner." This process requires systematically building four key capabilities around library core resources and network advantages: (1) **Technical translation**

capability: Using patent databases (e.g., Derwent, PatSnap) to translate professional terms like patent layout density and technical efficacy matrices into discipline-specific concepts familiar to researchers (e.g., academic citation networks, experimental variable models) to bridge disciplinary cognitive gaps. (2) **Risk foresight capability:** Based on in-depth mining of 馆藏 patent literature and proficient use of FTO analysis tools, identifying potential infringement risks early in research projects to provide forward-looking early warning support for research decisions. (3) **Value visualization capability:** Using tools like CiteSpace and VOSviewer to transform service outcomes into intuitive knowledge products such as technology evolution heat maps and patent competitiveness radar charts, highlighting strategic service value. (4) **Ecosystem construction capability:** Leveraging the library' s interdisciplinary hub attributes to proactively link campus institutions like technology transfer offices and law schools, building an integrated "IP + law + market" service ecosystem. This capability system, rooted in library-exclusive resources and aimed at deep embedding into research processes, constitutes not only the core competitiveness of library and information institutions in IP information services but also clarifies knowledge service providers' positioning as innovation partners in the innovation ecosystem.

4.2.2 Meso-Level: Governance Innovation for Research-Service Integration—Constructing a "Double Helix" Governance Architecture To address the organizational collaboration fragmentation dilemma proposed by Tsai & Ghoshal (1998) [19], this study recommends constructing a double helix governance architecture adapted to the university' s actual conditions. Through coupling mechanisms of vertical process embedding and horizontal institutional synergy, this architecture forms a closed-loop operation model of "service embedding-value output-resource feedback." In the vertical dimension, the library IP information service system should be embedded into critical research process nodes through institutional arrangements such as the university' s "Research Project Management Measures" : for example, providing technology gap analysis during project initiation to optimize R&D pathways, and jointly formulating patent portfolio strategies with technology transfer offices during 成果转化 to enhance technology transfer valuation. This also provides institutionalized practice scenarios for capability deployment at the micro level. In the horizontal dimension, two synergy mechanisms should be prioritized: First, establish an IP information service innovation joint fund, dynamically extracting a certain proportion from net technology transfer revenues based on service contribution levels. Second, support interdisciplinary teams (e.g., library, computer science, and key laboratory joint teams) in developing analysis tools tailored to the university' s disciplinary characteristics (e.g., patent semantic mining modules for key fields) to continuously enhance service precision and internal adaptability. This governance architecture aims to systematically solve three practical problems: preventing micro-level service capabilities from idling, integrating originally dispersed departmental resources, and providing institutionalized implementation

pathways for macro-level trust capital operation, thereby achieving systematic innovation at the institutional level.

4.2.3 Macro-Level: Revolution in Trust Capital Operation At the macro practical level, trust capital should be elevated from a traditional relationship maintenance factor to a strategic core asset of the service system, constructing a systematic "trust bank" management model to address the "high demand-low penetration" dilemma. The implementation pathway encompasses three levels:

First, in **trust capital savings**, continuous professional value output should serve as the foundation. Relying on the university' s patent database and literature analysis tools, regularly produce visual knowledge products such as "Domain Technology Maturity Reports," proactively providing customized service support for critical nodes like research project initiation and mid-term evaluation. Simultaneously, establish complete service records to systematically document service processes, outcomes, and user feedback, forming a traceable and evaluable trust accumulation mechanism.

Second, in **trust capital withdrawal**, focus should be on key scenarios enabling value realization. For example, participating in evaluation and negotiations during technology transfer to enhance transaction value, assisting in evidence sorting and litigation strategy formulation during patent disputes, and providing professional advice as an independent, trusted intermediary during major project decision-making nodes, thereby effectively converting trust capital at critical junctures.

Finally, in **trust capital appreciation**, systematic upgrading should be achieved through multi-agent institutional synergy. Specific measures include: jointly formulating service quality standards with research management and technology transfer departments, constructing interdisciplinary collaboration networks to provide "IP +" integrated solutions, and establishing continuous feedback and dynamic iteration mechanisms to optimize service effectiveness, ultimately driving cooperation evolution from short-term transactional to long-term symbiotic relationships.

4.3 Practical Implications

Based on the core findings of this study, university IP information service institutions can systematically construct service breakthrough and deepening mechanisms in non-contractual contexts around two dimensions: service processes and evaluation mechanisms.

4.3.1 Constructing a "Diagnosis-Touchpoint-Extension" Dynamic Service System Regarding service processes, a "diagnosis-touchpoint-extension" dynamic service system should be established. For example, deepening demand

diagnosis through weekly communication mechanisms between subject specialists and team secretaries can effectively activate "trust–encounter" dual-path synergy. First, deepen the demand diagnosis mechanism by identifying implicit research needs through a tiered communication system: subject specialists maintain weekly online communication with research team secretaries to ensure information flow efficiency, while Center directors conduct monthly field research or thematic discussions with team leaders to promote precise service embedding into research decision-making processes. Second, focus on service touchpoints with process rigidity and value visibility, such as providing high-quality patent novelty search services at critical nodes like project application to rapidly establish instrumental trust and achieve relationship breakthrough. Finally, promote service extension along the research value chain, providing technology status and trend analysis during initiation, patent risk early warning and competitiveness assessment during R&D, and strengthening patent layout and value evaluation during completion and transformation, thereby achieving systematic coverage across the full research lifecycle.

4.3.2 Optimizing Research Evaluation Systems Regarding evaluation mechanisms, a dual-track evaluation system that values both service contribution and research output should be constructed, shifting the evaluation orientation from task completion to innovation contribution. At the individual level, introduce service value contribution indicators focusing on adoption of patent analysis reports, implementation effectiveness of risk avoidance solutions, and user satisfaction feedback. At the team level, design a research–service integration index to systematically evaluate the supporting role of information services in core outputs such as patent grant rates, technology transfer effectiveness, and project application success rates.

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5. Research Findings, Model Discussion, and Future Directions

Based on the aforementioned theoretical and case analysis, this study not only reveals the initial breakthrough mechanism for IP information services in non-contractual contexts but also comprehensively maps the complete evolutionary path from "breakthrough" to "embedding" and finally to "symbiosis." The effectiveness of this path is simultaneously influenced by contextual factors such as disciplinary characteristics.

5.1 Moderating Effect of Disciplinary Heterogeneity and Its Implications for the Model

The operational effectiveness of the "trust–encounter" dual-path collaborative mechanism constructed in this study is significantly moderated by disciplinary heterogeneity, a key contextual variable. Research shows that cognitive dis-

tance and knowledge characteristic differences between disciplines directly affect trust-building cycles and service encounter thresholds, clarifying the theoretical boundaries and application conditions of the dual-path model.

Based on case data from the AI field (tacit knowledge-dominated), this type of discipline exhibits large cognitive barriers with IP information services, requiring deep knowledge translation (e.g., transforming patent claims into algorithm application scenarios) to construct cognitive trust, resulting in relatively longer trust-building cycles. However, its rigid demand for cutting-edge intelligence objectively lowers service encounter thresholds; once initial service value is verified, penetration rates exhibit acceleration characteristics.

This conclusion has important practical implications: For tacit knowledge-dominated disciplines, focus should be on building cross-disciplinary service teams to enhance knowledge translation and contextualization capabilities; for explicit knowledge-dominated disciplines, prioritize standardized and embedded service process deployment. It should be specifically noted that this study' s model primarily derives from empirical observation in science and engineering contexts. Its adaptability in narrative knowledge production fields such as humanities and social sciences (e.g., whether trust-building paths vary, how service touchpoints are designed) constitutes the theoretical boundary of this dual-path model and represents an urgent frontier for exploration.

5.2 Core Research Findings and Theoretical Implications

Through a seven-year longitudinal case study, this study constructs and validates a "trust–encounter" dual-path collaborative framework. The core findings clarify that breakthrough and deepening of non-contractual services depend on the nonlinear interaction and synergistic resonance between trust-building and service-encounter paths. The theoretical implications of these findings transcend the individual case and are mainly manifested in two aspects:

First, this study provides a clear mechanistic explanation for the role evolution of library and information institutions in the innovation ecosystem. Traditional resource support is a static role description, whereas this model dynamically reveals how library and information institutions, leveraging their unique assets of "document databases + interdisciplinary networks,"achieve a transition from the periphery of the research support system to the core of the innovation ecosystem through the trust–encounter synergy process. This provides a new theoretical discourse for redefining libraries' strategic value in the knowledge economy era.

Second, this study pushes the theoretical discussion of embedded services toward operational mechanism construction. Existing research emphasizes the importance of embedding but lacks process analysis of how to embed. The "single-point → chain → ecosystem" service encounter evolutionary path and the "instrumental → cognitive → institutional" trust-building ladder revealed in this study jointly constitute a diagnostic, designable, and manageable implementation framework for embedded services. This not only responds to Chu

Jingli et al.' s foresight on "capability symbiosis" but also provides concrete process mechanisms and theoretical foundations for its realization.

5.3.1 Institutional Innovation: Constructing Regional IP Information Service Alliances

To overcome resource limitations and service fragmentation in single universities, it is recommended to construct regional IP information service alliances with high-level university libraries as core nodes, achieving institutional-level collaborative innovation. Core measures include: First, establishing a resource integration system of co-construction and sharing. Relying on core units' document resource systems, jointly build cross-university patent databases and jointly procure high-end intelligence analysis tools to significantly reduce service access costs and cognitive thresholds for member units (especially resource-constrained universities). Second, innovating talent flexible mobility and incentive mechanisms. Implement a "subject specialist cross-university rotation program" with supporting joint performance evaluation mechanisms to recognize contributions during mobility periods, thereby promoting rational talent flow and rapid diffusion of best practices. Furthermore, explore contribution-based revenue distribution systems. Attempt to use technologies like smart contracts to enable information services to participate in subsequent revenue distribution based on quantified contributions in technology transfer processes (e.g., adoption rates of patent analysis reports, evaluation support for transaction premiums), thereby ensuring intellectual capital returns for service teams and constructing a sustainable service development model.

5.3.2 Implementation Safeguards and Ecosystem Cultivation

To ensure effective operation and sustainability of collaborative governance mechanisms, it is urgent to construct a multi-dimensional, systematic implementation safeguard system and actively cultivate a healthy service innovation ecosystem. First, at the policy and legal safeguard level, it is recommended to revise local regulations such as the "Industry-University-Research Cooperation Promotion Regulations" to clarify the statutory responsibilities and rights-subject status of university libraries in the IP public service system, providing a solid institutional basis for their deep participation in non-contractual cooperation. Second, at the funding and resource safeguard level, regional collaborative innovation special funds should be established to provide matching subsidies and start-up funding for cross-university IP information services, thereby resolving initial cost pressures and effectively stimulating the enthusiasm of participating entities. Furthermore, at the evaluation and supervision level, the alliance should lead the development of a unified service monitoring platform, incorporating key effectiveness indicators such as the research–service integration index into regional or university scientific and technological innovation capability evaluation systems, thereby scientifically quantifying and demonstrating the actual contribution of IP information services to research output and commer-

cialization. Finally, and most crucially, ecosystem culture cultivation should be achieved through establishing normalized demand docking platforms, selecting and promoting best practice cases, and fostering a consensus culture of "service as innovation" within the academic community, thereby building a sustainable service innovation ecosystem with shared philosophy and value co-creation.

5.4 Research Limitations and Future Directions

This study has several limitations that also point to future research directions:

1. **Cross-context validation of model generalizability.** Future research can conduct comparative studies across universities and disciplines to construct a contingency model of "resource endowment–trust pattern–service effectiveness," testing the adaptability and boundary conditions of the dual-path mechanism constructed in this study in different contexts such as resource-constrained universities (e.g., non- "Double First-Class" institutions) and humanities and social sciences.

2. **Long-term tracking of trust dynamics.** Introducing longitudinal data analysis techniques to track trust evolution trajectories over ten-year or longer periods can help reveal dynamic patterns and key influencing factors of trust capital accumulation and decay, thereby deepening understanding of long-term maintenance mechanisms for non-contractual cooperation.

3. **Mechanism migration and application in emerging scenarios.** As commercialization models evolve, exploring the migration and application value of this trust-building mechanism in scenarios such as technology licensing and entrepreneurship incubation holds great potential. Particularly in the context of generative AI technology, the capability trust-building model for service providers and the core link of knowledge translation may face reshaping—can AI play a role in trust building, and how might this affect dual-path model evolution? These questions make its evolutionary path in the digital intelligence era a frontier urgently requiring exploration.

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Note: Figure translations are in progress. See original paper for figures.