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Collaborative innovation mechanisms for university artificial intelligence research institutes

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Abstract

University artificial intelligence research institutes are becoming important institutional platforms for connecting academic research, industrial application, technology transfer, and talent development. However, many institutes still face fragmented processes for demand identification, weak project coordination, slow commercialization, and insufficient benefit-sharing arrangements. This review article develops a conceptual mechanism for industry-academia-research collaborative innovation in university AI research institutes. Based on recent literature on university-industry collaboration, knowledge transfer, AI-enabled innovation ecosystems, and Chinese policy developments, the paper analyzes the theoretical foundations, policy background, internal and external drivers, and operational logic of such collaboration. It proposes a four-stage collaborative innovation model composed of demand docking, joint research, achievement transformation, and talent cultivation. It further discusses supporting mechanisms in policy coordination, platform construction, intellectual property management, benefit distribution, evaluation, and ethics. The paper argues that AI research institutes should move beyond loose project-based cooperation and become integrated platforms that align scientific exploration with industrial scenarios, market-oriented transformation, and interdisciplinary training. The proposed framework offers practical guidance for universities seeking to build sustainable AI innovation ecosystems.

Keywords: Artificial Intelligence Research Institute; Industry-Academia-Research Collaboration; Collaborative Innovation; Technology Transfer; Talent Cultivation

1. Introduction

Artificial intelligence has become a strategic technology reshaping scientific research, industrial upgrading and higher education. Universities are no longer only producers of AI theories and algorithms. They are increasingly expected to organize interdisciplinary research, connect with industrial scenarios, support commercialization and cultivate high-level applied talent. In this context, university artificial intelligence research institutes have emerged as an important institutional form. Compared with traditional departments, laboratories or technology transfer offices, such institutes are expected to connect computing resources, disciplinary teams, enterprise needs, policy resources and student training within one organizational platform.

The topic is particularly relevant in China, where policy attention has increasingly shifted from isolated technological breakthroughs to the integrated development of education, science, technology, and talent. These policy signals show that AI innovation is not only a technical issue. It is also a coordination issue involving universities, enterprises, research organizations, local governments, and investment actors.

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Existing studies provide useful theoretical and empirical foundations. The Triple Helix model explains how universities, industry, and government jointly support knowledge-based innovation [1]. Open innovation theory shows why organizational boundaries should be opened to external knowledge flows and market feedback [2]. Absorptive capacity theory explains why enterprises and universities differ in their ability to identify, assimilate, and apply external knowledge [3]. More recent research has further demonstrated that digital platforms, trust, network position, and institutional environment strongly influence collaborative outcomes.

Despite this growing literature, the specific role of university AI research institutes remains underdeveloped. Many universities establish AI institutes, but their internal mechanisms are often unclear. Some institutes remain research-oriented without stable links to enterprise demand. Others pursue projects with enterprises but lack shared governance, intellectual property arrangements and talent development pathways. This paper therefore examines how a university AI research institute can build an industry-academia-research collaborative innovation mechanism. It focuses on five issues: theoretical and policy foundations, internal and external driving forces, an operational collaboration model, supporting mechanisms, and policy recommendations.

2. Materials and methods

This article adopts a conceptual and policy-oriented review method. It is not a systematic review and does not use original survey, interview, or experimental data. Instead, it synthesizes peer-reviewed studies and policy documents related to industry-academia-research collaboration, university-industry engagement, AI innovation ecosystems, knowledge transfer, technology commercialization, and talent cultivation. Sources were identified through Google Scholar, Web of Science, Scopus, SpringerLink, Frontiers, MDPI, and official Chinese policy portals using combinations of keywords such as "university-industry collaboration", "industry-academia-research", "artificial intelligence", "AI research institute", "technology transfer", "knowledge transfer", and "talent cultivation". Sources were selected for theoretical relevance, recency, policy relevance, and direct connection to AI-related collaborative innovation. Literature that focused only on classroom AI applications, purely technical algorithms, or non-university innovation settings was excluded unless it contributed directly to the conceptual framework.

Priority was given to recent studies published from 2025 to 2026, because the institutional and technological environment of AI research is changing rapidly. The selected literature includes studies on AI-enhanced competency transfer hubs, knowledge spillovers, trust in university-industry collaboration, AI patent quality, AI industry innovation networks, and AI-driven university entrepreneurship. Foundational theories such as Triple Helix, open innovation, and absorptive capacity were also included to provide conceptual grounding. A formal State Council policy document was used to clarify the policy background.

The analysis proceeds through conceptual synthesis. First, the paper identifies the theoretical and policy basis of collaborative innovation. Second, it analyzes internal and external driving forces shaping AI research institutes. Third, it constructs a four-stage model consisting of demand docking, joint research, achievement transformation, and talent cultivation. Fourth, it discusses policy, platform, benefit-sharing, evaluation, and ethics safeguards. The purpose is to provide a practical framework rather than a causal test.

3. Results and discussion

3.1. Theoretical foundations and policy background of industry-academia-research collaborative innovation

Industry-academia-research collaborative innovation is rooted in the idea that innovation does not occur inside a single organization. The Triple Helix model emphasizes interactive relationships among universities, industries and governments in a knowledge economy [1]. Universities contribute scientific knowledge, talent and research infrastructure. Enterprises contribute market demand, application scenarios and commercialization capacity. Governments create institutional conditions through policy support, funding, regulation and public platforms. For university AI research institutes, this model explains why a single university cannot complete the full innovation chain alone. AI innovation requires public policy, industrial scenarios, data access, computing infrastructure and applied validation.

Open innovation theory further explains why AI research institutes should avoid closed, campus-only innovation. AI technologies often move quickly from academic discovery to industrial deployment, and industrial needs also feed back into research agendas. Opening research boundaries allows institutes to obtain data, technical problems, testing environments, investment support and market information [2]. Absorptive capacity theory adds another layer:

collaboration only creates value when partners can understand and use each other's knowledge [3]. Enterprises must be able to absorb academic research, while universities must understand industrial constraints such as cost, reliability, compliance, user demand and deployment conditions.

In China, the policy environment increasingly supports such integration. Policy text research has shown that industry-university-research collaboration has long been treated as a mechanism for sustainable development and national innovation [4]. The Artificial Intelligence Plus initiative places AI integration within a broader national agenda of scientific discovery, industrial transformation, education, talent development, and governance [5].

These theoretical and policy developments show that university AI research institutes should not be designed merely as research clusters. They should function as boundary-spanning organizations that connect scientific exploration, industrial problem solving, technology transfer and talent cultivation. Their core task is to reduce the distance between knowledge production and value creation.

3.2. Internal and external driving forces of AI research institute cooperation

The first internal driver is the need for interdisciplinary integration. AI research usually involves computer science, mathematics, engineering, management, law, ethics, medicine, manufacturing, education and public administration. A university AI research institute can gather these disciplines more flexibly than a single department. This matters because many industrial AI problems are not purely algorithmic. They involve data governance, domain knowledge, organizational change, user behavior, security and regulation.

The second internal driver is the transformation of university research evaluation. Universities increasingly face pressure to demonstrate social impact, commercialization value, and contribution to regional development. Studies on knowledge spillovers and AI innovation show that AI can enhance innovation diffusion when knowledge resources and collaboration networks are effectively organized [6]. AI institutes therefore have an incentive to build mechanisms that convert research outputs into patents, prototypes, standards, start-ups, training programs, and policy services.

The third internal driver is talent cultivation. AI talent cannot be trained only through classroom instruction. Students require exposure to real datasets, enterprise problems, interdisciplinary teamwork, and deployment constraints. Research on AI integration with innovation and entrepreneurship education indicates that AI-enabled education can strengthen personalized learning, practical ability, and entrepreneurial skills [7]. Studies on AI-simulated entrepreneurship further suggest that universities need new approaches to prepare students for uncertainty and capability development [8]. AI research institutes can connect graduate education, applied projects, internships, enterprise mentors, and start-up incubation into one talent pipeline.

While internal forces create institutional readiness for collaboration, external pressures create the market pull. The first external driver is industrial demand. Enterprises face pressure to use AI for intelligent manufacturing, finance, health care, education, agriculture, logistics, and public services. However, many firms lack sufficient research capacity, algorithmic expertise, or access to university knowledge. The second external driver is regional innovation competition. Studies of AI industry collaboration networks in China show that network position, institutional environment, and collaboration structure influence innovation performance [9,10]. Regions therefore have incentives to support university AI institutes as nodes in local innovation ecosystems. Sectoral evidence also suggests that AI innovation often develops through lifecycles in which universities, industry, and research organizations interact around applied scenarios [11]. The third driver is policy and funding support. The Artificial Intelligence Plus policy creates a national agenda for integrating AI with science, industry, education, public services, and governance [5]. Research on the digital economy and industry-academia-research collaborative innovation further links such collaboration with the development of new-quality productive forces [12].

At the same time, collaboration is not automatic. Trust, shared expectations and governance arrangements are necessary. Recent evidence from China shows that trust building can increase willingness to collaborate between enterprises and higher education institutions [13]. Research using the quadruple helix perspective also suggests that effective collaboration depends on wider interaction among universities, industry, government and society [14]. AI research institutes therefore need both technical capacity and relational capacity.

The Chinese context also creates specific institutional constraints. University AI research institutes often operate within hierarchical administrative systems in which project approval, budgeting, data access, intellectual property management, and personnel evaluation are distributed across different offices. Research assessment still tends to reward publications and grants more clearly than commercialization, while enterprises usually expect shorter

development cycles and clearer market returns. These features make formal authorization and platform-based coordination especially important. Without them, collaborative projects may remain dependent on personal relationships rather than stable institutional routines.

3.3. A collaborative innovation model: Demand docking, joint research, achievement transformation and talent cultivation

Based on the above analysis, this paper proposes a four-stage collaborative innovation model for university AI research institutes. The model follows the logic of demand docking, joint research, achievement transformation and talent cultivation. These stages should not be understood as a rigid linear chain. In practice, they form a cycle in which market demand informs research, research generates outcomes, outcomes feed back into talent training, and trained talent improves the next round of collaboration.

The first stage is demand docking. AI institutes should establish systematic channels for collecting and evaluating enterprise and public-sector needs. This can include industry advisory committees, regular technology-demand meetings, online demand platforms, joint roadmapping workshops and local government coordination. The goal is to translate broad industrial problems into researchable and deliverable tasks. For example, an enterprise may state that it needs intelligent quality inspection. The institute must further clarify data availability, accuracy requirements, deployment environment, privacy constraints, cost limits and expected outputs.

The second stage is joint research. Once demand is clarified, the institute should organize interdisciplinary teams that include faculty, enterprise engineers, graduate students, data specialists, and project managers. Joint research should combine exploratory and exploitative innovation. Exploratory work focuses on new algorithms, architectures, and scientific questions. Exploitative work focuses on adapting existing AI tools to specific industrial scenarios. Research on China's AI industry collaboration networks shows that network structural characteristics, including degree centrality, closeness centrality, and structural holes, have complex nonlinear relationships with exploratory and exploitative innovation performance [10]. AI institutes should therefore design project portfolios that include frontier research, applied development, and rapid prototyping.

The third stage is achievement transformation. Research outputs must be converted into usable value through patents, software intellectual property, datasets, standards, prototypes, pilot applications, start-ups, or licensing agreements. Studies on AI patents and university-industry collaboration show that patent quality is shaped by collaborative conditions and innovation networks [15]. Achievement transformation should therefore begin early rather than after research has ended. Each joint project should clarify ownership, commercialization route, testing environment, confidentiality, revenue sharing, and follow-up maintenance. Technology transfer offices and AI institutes should work together rather than separately.

The fourth stage is talent cultivation. Every collaborative project should also function as a training environment. Students can participate in demand analysis, model development, field testing, documentation, ethics assessment, and business planning. Enterprise experts can serve as part-time mentors, while faculty can translate project experience into courses, case libraries, and innovation competitions. Talent cultivation should be treated not as a by-product but as a core outcome of the collaboration mechanism.

Table 1 summarizes the proposed model.

Table 1 Four-stage collaborative innovation model for university AI research institutes

Stage	Main task	Key participants	Main outputs
Demand docking	Identify, screen and translate industrial and public-sector needs into researchable AI tasks	Enterprises, government agencies, institute managers, faculty teams	Demand list, project briefs, technical roadmaps
Joint research	Organize interdisciplinary teams for algorithm development, prototype design and scenario testing	Faculty, enterprise engineers, graduate students, data specialists	Models, prototypes, datasets, technical reports

Achievement transformation	Convert research results into patents, software, standards, licensing, start-ups or pilot applications	AI institute, technology transfer office, enterprises, investors	Patents, software, pilot projects, commercialization agreements
Talent cultivation	Embed students and industry mentors into collaborative projects and convert project experience into teaching resources	Students, supervisors, enterprise mentors, curriculum teams	Trained AI talent, cases, courses, internships, innovation teams

3.4. Supporting mechanisms: Policy, platform, benefit distribution, evaluation, and ethics

A collaborative model can operate sustainably only when supported by appropriate safeguards. The first safeguard is policy support. Universities should issue internal rules that define the status, authority, and responsibilities of AI research institutes. Local governments can provide funding, scenario access, data governance guidance, and technology transfer services. National policy already supports AI-enabled integration across science, industry, education, talent, and governance [5]. University-level policy should translate these general directions into operational rules.

The second safeguard is platform construction. An AI research institute should build both physical and digital platforms. Physical platforms include shared laboratories, computing centers, data rooms, innovation studios and demonstration bases. Digital platforms include project management systems, demand databases, expert databases, intellectual property tracking systems, secure data environments and AI-assisted knowledge management tools. Research on AI-enhanced competency transfer hubs shows that AI tools can improve knowledge extraction, competency matching, adaptive project management and feedback optimization in university-industry engagement [16]. Such tools can help institutes manage multiple partners and projects without relying only on informal personal networks.

The third safeguard is benefit distribution. Many collaborations fail because partners disagree about intellectual property, authorship, licensing, revenue sharing or follow-up investment. Benefit-sharing rules should be negotiated before project launch. A practical arrangement may distinguish between background intellectual property, jointly created intellectual property and independently created derivative outcomes. Revenue distribution should consider knowledge contribution, financial contribution, data contribution, equipment contribution and commercialization risk. Transparent rules reduce uncertainty and strengthen trust.

The fourth safeguard is evaluation. AI research institutes should not be evaluated only by papers or grants. A balanced evaluation system should include academic publications, patents, software intellectual property, datasets, standards, enterprise adoption, social impact, student training, start-up incubation, and policy consulting. Research on the digital economy, industry-academia-research collaborative innovation, and new-quality productive forces shows that collaborative innovation is part of a broader transformation process linking digital capacity with productive development [12]. For AI institutes, evaluation should therefore capture both knowledge creation and value realization.

The fifth safeguard is ethics and compliance. AI research requires attention to data security, privacy, algorithmic bias, intellectual property, model transparency, and social responsibility. When universities collaborate with enterprises, these risks become more complex because data and models may move across organizational boundaries. AI institutes should establish review procedures for sensitive data, human-related applications, and high-risk deployment scenarios. Responsible innovation should be embedded in the collaboration process rather than treated as an afterthought. Risk mitigation should also be treated as part of the support system. Common risks include intellectual property disputes, conflicts between enterprise short-term returns and academic long-term exploration, data leakage, talent loss, and unequal benefit distribution. AI institutes can reduce these risks through pre-project agreements, staged review, data-access protocols, dispute-resolution procedures, and transparent rules for authorship, ownership, and revenue sharing.

3.5. Policy implications and future directions

First, universities should clarify the strategic positioning of AI research institutes. An institute should not become only a symbolic platform or a loose alliance of faculty members. It should have stable governance, project management capacity, enterprise interface functions and performance evaluation indicators. Its mission should include scientific research, industrial problem solving, technology transfer and talent cultivation.

Second, universities should build demand-oriented project selection mechanisms. Instead of waiting for enterprises to approach individual professors, institutes can create regular channels for demand collection and technical diagnosis. This helps identify problems that are scientifically meaningful and commercially relevant. It also prevents cooperation from becoming fragmented or dependent on personal relationships.

Third, universities and enterprises should develop joint research portfolios. Some projects should focus on long-term frontier problems, while others should focus on short-term industrial applications. This portfolio logic can reduce the tension between academic timelines and enterprise timelines. It also allows graduate students to participate in projects at different levels of technical maturity.

Fourth, technology transfer should be integrated into the whole project lifecycle. Intellectual property analysis, market evaluation, regulatory assessment and pilot planning should begin during project design. This can shorten the distance between research output and application. University technology transfer centers, incubators, venture funds and local industrial parks should be connected to AI institutes through formal procedures.

Fifth, talent cultivation should be embedded in collaborative innovation. Universities can develop dual-mentor systems, industry-oriented courses, project-based credits, innovation competitions, and internship bases. Enterprise engineers and product managers can participate in teaching, while students can contribute to real research and development tasks.

Looking ahead, university AI research institutes will likely become more important as AI moves from laboratory research to industrial and social deployment. Their success will depend on whether they can cultivate trust, integrate data, develop talent, mobilize capital, and coordinate governance around real problems. The next stage of research should examine actual cases of AI research institutes, compare different governance models, and develop measurable indicators for collaboration quality, commercialization efficiency, and talent outcomes.

4. Conclusion

The central finding of this paper is that university AI research institutes can support collaborative innovation only when they operate as boundary-spanning platforms rather than loose project alliances. Their value lies in linking scientific research, industrial demand, technology transfer, and talent cultivation through stable institutional mechanisms.

The proposed model consists of four linked stages: demand docking, joint research, achievement transformation and talent cultivation. Demand docking ensures that research begins from real technological and industrial needs. Joint research organizes interdisciplinary teams to solve both frontier and applied problems. Achievement transformation converts outputs into patents, software, standards, prototypes and market applications. Talent cultivation embeds student training and industry mentorship into the innovation process.

The paper also emphasized that this model requires safeguards in policy support, platform construction, benefit distribution, evaluation and ethics. Without these mechanisms, collaboration may remain temporary, fragmented and dependent on individual relationships. With them, university AI research institutes can become durable innovation platforms that support regional development, industrial upgrading and high-level AI talent cultivation.

This study has several limitations. Methodologically, it is based on a conceptual and policy-oriented review rather than empirical testing, survey data, or case-based validation. Geographically, the discussion is mainly informed by the Chinese higher education and policy context, although the framework may also be relevant to other countries with strong university-industry-government interaction. Temporally, AI policy and industrial application environments are changing quickly, which means that some institutional arrangements may require further adjustment as technologies and regulations evolve. Future research should conduct interviews, surveys, and comparative case studies of AI research institutes in different regions and university types. Such research can further refine the proposed model and provide stronger evidence for institutional design and policy implementation.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

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