Business Fora | 2026, Vol. 9, No.1, 106 – 124 | ISSN Online: 3028-1326 | ISSN Print: 3028-1334
DOI: https://doi.org/10.62718/vmca.bf-baiij.9.1.SC-0926-010

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Institutional Conditions and Science and Technology (S&T) Achievement Transformation Performance in Vocational Undergraduate Universities in Henan Province, China

Article History:

Initial submission:	21 September 2026
First decision:	28 September 2026
Revision received:	08 November 2026
Accepted for publication:	15 November 2026
Online release:	21 November 2026

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Abstract

This study explored how faculty perceptions of policy mechanisms, institutional support, and innovation governance relate to the transformation performance of scientific and technological achievements, specifically patent commercialization, industry collaboration intensity, and talent-embedded technology diffusion, within vocational undergraduate universities in Henan Province, China. Employing a quantitative descriptive-correlational research design, primary survey data were gathered from 363 full-time faculty members and paired with official institutional records across four accredited vocational undergraduate universities in Henan Province. Given the four institutional observations (n = 4), the analysis provides exploratory patterns of directional association rather than population-wide generalizable causal relationships. Although faculty view policy frameworks and industry engagement channels favorably, actual transformation performance varies widely between institutions. Evaluation system alignment, i.e., formally integrating technology transfer outcomes into annual appraisals and title promotion criteria, and dedicated transfer infrastructure demonstrated the strongest positive associations with commercialization success and R&D contract value (r_s = .80 to 1.00). Conversely, expanding external networking channels alone proved insufficient to guarantee transformation outcomes. Ultimately, technology transfer effectiveness in vocational undergraduate institutions depends primarily on internal structural coherence and faculty evaluation alignment rather than the superficial expansion of external networks, underscoring the need for administrators to prioritize internal system alignment and professionalized support infrastructure to maximize regional innovation impact.

Keywords: policy incentive mechanisms, institutional support, innovation governance, science and technology (S&T) transformation performance, undergraduate vocational institutions, China

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INTRODUCTION

The transformation of scientific and technological (S&T) achievements into practical and economically valuable applications has become increasingly important to China's shift toward an innovation-driven economy. This priority is especially relevant to vocational undergraduate universities, a relatively new type of higher education institution that combines undergraduate education with an applied and industry-oriented mission. In Henan Province, the 2025 Vocational Education Regulations further emphasize the role of these institutions in regional innovation and industry–education integration (Henan Provincial People's Congress, 2025).

Yet translating research outputs into practical innovations remains a challenge. Vocational undergraduate universities operate at the intersection of academic research and industry needs, but conventional academic incentives may not always align with their applied mission. At the same time, technology-transfer mechanisms, and university–industry–government linkages remain underdeveloped or fragmented (Liu et al., 2025; Li, 2021; Xu, 2022). These conditions can make it difficult for research achievements to move beyond the

university and generate wider value through patent commercialization, industry collaboration, and the transfer of technology through talent and project-based partnerships. The issue is particularly relevant in Henan, where the four Ministry-accredited vocational undergraduate universities differ in their institutional development and regional industrial environments.

Henan Province is accelerating its economic transition toward an innovation-driven model centered on advanced manufacturing, equipment intelligence, and regional industrial modernization. The 2025 Henan Provincial Statistical Communiqué on National Economic and Social Development, released on April 16, 2026, reported a substantial growth in high-tech manufacturing, strategic emerging industries, and new energy vehicles. These trends highlight Henan's industrial upgrading and the growing demand for scientific and technological achievement transformation in vocational undergraduate institutions. This structural shift is legally anchored in the Henan Provincial Vocational Education Regulations (enacted May 29, 2025; effective September 1, 2025), which mandate the alignment of vocational higher education with regional industrial layouts to drive technology transfer and science-education integration (Henan Provincial People's Congress, 2025). Following national reforms, four institutions were accredited by the Ministry of Education as vocational undergraduate universities in the province through May 2026. However, despite their explicit mandate to serve local enterprise needs, empirical evidence regarding technology transfer capacity within this emerging sector remain scarce. While previous studies have considered policy incentives, institutional support, and innovation governance as important influences on university innovation, these factors have often been examined independently (Cai & Liu, 2015; Luo, 2023; Xu, 2022; Zheng, 2023). Few studies have investigated how these institutional conditions work together to shape multidimensional transformation performance—specifically patent commercialization outcomes, industry collaboration intensity, and talent-embedded technology diffusion (Perkmann et al., 2013; Si, 2022; Xu, 2016; Zong, 2023).

A closer examination of these conditions can help clarify whether the existing policy, institutional, and governance environment is adequate for supporting the distinctive innovation role of vocational undergraduate universities. This study therefore examines these factors in the Henan context to identify the institutional conditions associated with S&T achievement transformation and to provide evidence that may help strengthen technology-transfer capacity, university–industry collaboration, and innovation governance. More broadly, the findings may contribute to the continuing development of vocational undergraduate education and its role in regional innovation and economic development.

Research Objectives. This study sought to examine the faculty perception of the policy mechanisms, institutional support, innovation governance, and their relationships with S&T achievement transformation performance governance in the four vocational undergraduate universities in Henan Province, China. Specifically, it addressed the following questions:

1. What is the level of policy mechanisms, institutional support, and innovation governance as perceived by faculty members in the four universities?

2. What is the level of S&T achievement transformation performance of the four universities in terms of patent commercialization, industry collaboration; and talent-embedded technology diffusion?

3. How do the four universities compare in terms of policy mechanisms, institutional support, innovation governance, and transformation performance?

4. What patterns of association can be observed between the dimensions of policy mechanisms, institutional support, and

innovation governance and the individual indicators of S&T achievement transformation performance across the four universities?

Theoretical Framework. The theoretical foundation of this study integrates three complementary perspectives: the Policy Tool Framework, Institutional Theory, and Network Governance Theory. These perspectives were selected because they provide direct theoretical support for the study's three principal institutional factors; policy mechanisms, institutional support, and innovation governance and collectively explain the policy, organizational, and interorganizational conditions surrounding the transformation of scientific and technological (S&T) achievements in vocational undergraduate institutions.

The policy dimension is grounded in the policy-tool framework of Rothwell and Zegveld (1985), which classifies government innovation instruments according to how they support and shape innovation activities. The framework distinguishes supply-side, environmental-side, and demand-side instruments. Supply-side instruments provide resources and capabilities for innovation, whereas environmental-side instruments shape the institutional conditions within which innovation actors operate. This framework is relevant to the study's policy mechanisms, comprising financial, administrative, and legal/intellectual property incentives. Financial incentives provide resources for research and technology transfer, while administrative and legal/IP incentives establish enabling conditions, reduce procedural barriers, and provide greater certainty for innovation actors. The framework therefore provides a basis for understanding how policy instruments can facilitate or constrain S&T achievement transformation (Rothwell & Zegveld, 1985).

Institutional theory, particularly Scott's (2008) three-pillar framework, provides the theoretical basis for examining institutional support. The theory conceptualizes institutions through regulative, normative, and cultural-cognitive elements that establish rules, expectations, and shared understandings that shape organizational behavior. In S&T achievement transformation, institutional arrangements determine whether faculty and institutions have the structures, incentives, and procedures necessary to move research outputs toward application and commercialization. Accordingly, this study examines institutional support through technology transfer infrastructure, evaluation system alignment, and legal-procedural safeguards. These dimensions reflect the organizational structures, institutional expectations, and formal procedures that can facilitate or constrain technology transfer activities. Institutional Theory thus explains how organizational arrangements and expectations shape institutional capacity for S&T achievement transformation (Li, 2021; Scott, 2008; Zong, 2023).

Innovation governance is grounded in Network governance theory, which focuses on the structures and processes through which interdependent organizations coordinate activities and pursue collective outcomes (Provan & Kenis, 2008). This perspective is particularly relevant to vocational undergraduate institutions, where S&T achievement transformation requires interaction among universities, enterprises, government agencies, and other innovation actors. The study therefore examines innovation governance through cross-sectoral coordination, industry engagement channels, and knowledge-sharing networks. These dimensions capture the mechanisms through which organizations coordinate innovation activities, establish university–industry linkages, and exchange knowledge and technical resources. Network Governance Theory consequently provides a basis for understanding how interorganizational coordination and collaboration can support the transformation of S&T achievements.

These three perspectives provide complementary explanations of the conditions

surrounding S&T achievement transformation. The Policy Tool Framework addresses the policy environment and incentives that shape innovation activities; Institutional Theory addresses the organizational structures, expectations, and procedures that build institutional capacity; and Network Governance Theory addresses the interorganizational relationships through which knowledge, resources, and expertise are mobilized.

These perspectives therefore provide a coherent theoretical foundation for examining policy mechanisms, institutional support, and innovation governance in relation to S&T achievement transformation performance, operationalized through patent commercialization outcomes, industry collaboration intensity, and talent-embedded technology diffusion. Rather than relying on a single theory to explain the multidimensional transformation process, the framework recognizes that S&T achievement transformation occurs within interconnected policy, institutional, and collaborative environments.

Conceptual Framework. Figure 1 illustrates the conceptual framework of this study. The framework hypothesizes that policy mechanisms, institutional support, and innovation governance are associated with the transformation performance of S&T achievements.

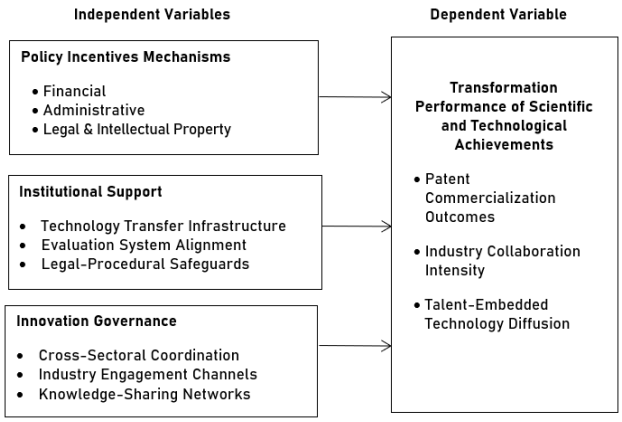

Figure 1
Conceptual Framework of the Study

It further recognizes the interrelationships among the three independent variables, suggesting that they function as complementary components of an integrated technology transfer ecosystem rather than isolated influences.

Scope and Limitations. This study examined policy mechanisms, institutional support, innovation governance, and S&T achievement transformation performance in the four Ministry-accredited vocational undergraduate universities in Henan Province, China, as of May 2026. Faculty perceptions of the three institutional factors were outsourced and gathered through an online questionnaire, while transformation performance data were obtained from institutional records, focusing on patent commercialization, industry collaboration, and talent-embedded technology diffusion.

The study focused on institutional-level patterns by aggregating faculty responses within each university and comparing them with the corresponding transformation performance indicators. As only four universities were included, the findings are exploratory and should not be interpreted as broadly generalizable relationships. The study was also limited by its reliance on faculty perceptions, institutional records from the most recent academic year, and a cross-sectional design. It did not include the perspectives of industry partners or government agencies. Despite these limitations, the inclusion of all eligible vocational undergraduate universities in Henan provides an initial view of how institutional conditions and governance may be associated with S&T achievement transformation in this emerging sector.

LITERATURE REVIEW

Scientific and technological (S&T) achievements refer to research and development outputs with potential for practical application. In China, the concept has expanded beyond invention patents to include utility models, software copyrights,

process innovations, technical standards, integrated circuit designs, and new plant varieties (Liu et al., 2025). Their value therefore extends beyond direct commercial returns to improvements in industry and regional innovation capacity (Miao, 2021). This broader understanding is particularly relevant to vocational undergraduate universities, whose often leads to research focused on practical production and enterprise needs. Xu (2022) described this as application-oriented transformation, in which existing knowledge and technologies are adapted to address specific industry problems. Such outputs may include process improvements, technical solutions, utility models, software, and forms of expertise that are not easily captured through patents alone. Across this literature, a clear area of agreement emerges technology transfer in applied institutions extends beyond formal patent commercialization to encompass informal pathways such as technical consulting, joint R&D, process optimization, and talent embedded technology diffusion (Perkmann et al., 2013, 2021; Si, 2022; Xu, 2016, 2022).

For this reason, S&T achievement transformation in vocational undergraduate universities is better understood through both formal commercialization and broader forms of knowledge and technology transfer. Perkmann et al. (2013) noted that university-industry engagement extends beyond patents and licensing to consulting, contract research, and collaborative activities. In vocational institutions, these forms of engagement may be especially important because research is closely tied to practical industry needs. Transformation performance can thus be reflected in patent commercialization, industry collaboration, and the transfer of knowledge and expertise through people and applied projects. These three dimensions provide the basis for examining transformation performance in the present study.

Policy incentives are one set of conditions that may encourage such transformation. Drawing on Policy Tool Theory (Rothwell & Zegveld, 1985), this study considers financial, administrative, and legal and intellectual property (IP) incentives. Financial rewards can encourage researchers to pursue commercialization, particularly when they can share in the benefits generated from their work (Goldfarb & Henrekson, 2003). However, their effect may depend on the support available to researchers. Zheng (2023), for example, found that financial incentives in Chinese universities were more effective when accompanied by intermediary services, while Chen et al. (2021) identified administrative approval requirements, regulatory ambiguities, and weaknesses in technology-transfer support mechanisms continue to constrain the effective commercialization of S & T achievements in Chinese universities. Administrative incentives are also important because faculty may be reluctant to engage in technology transfer when academic evaluation continues to favor publications over applied contributions (Guan et al., 2005; Li, 2021). Debackere and Veugelers (2005) similarly found stronger transfer performance where evaluation and career systems recognized technology-transfer activities. In addition, legal and IP arrangements can give researchers confidence in commercializing their scientific and technological achievements, although institutional and operational barriers continue to constrain effective implementation of technology transfer in higher vocational institutions (Zhang et al., 2025; Pan, 2019). Thus, policy support is unlikely to depend on financial rewards alone; its effectiveness also rests on appropriate evaluation systems, clear rights, and workable procedures.

Beyond internal capacity, transformation also depends on how universities connect with external partners. Innovation governance, informed by Network Governance Theory (Provan & Kenis, 2008) and the Triple Helix framework (Etzkowitz & Leydesdorff, 2000), emphasizes sustained interaction among universities, industry, and government. Cai and Liu (2015) showed that regional innovation systems in China develop through different forms of university-industry-government interaction, while Ansell and Gash (2008)

emphasized the importance of leadership, institutional arrangements, and collaborative processes in sustaining such relationships. However, these connections are not always well integrated. Xiang et al. (2026) found strong policy and industry involvement in China but relatively weak university-industry coupling. In vocational education, industrial colleges and other joint platforms provide opportunities to strengthen these links through co-investment, curriculum development, dual-appointment faculty, and shared governance (Si, 2022). University-industry engagement can also take the form of collaborative research, consulting, contract research, and joint supervision (Perkmann et al., 2013), allowing knowledge and expertise to move continuously between academic and industry settings.

This exchange is particularly relevant to vocational institutions because technology transfer does not always occur through formal commercialization. Si (2022) identified talent-embedded transformation as an important pathway through which graduates carry technologies and practical knowledge into industry, while Xu (2016) highlighted the role of dual-qualified faculty in connecting academic and workplace environments. In this context, industry partnerships, technical services, faculty engagement, and graduate employment can all contribute to the circulation and application of knowledge. Innovation governance, therefore, extends beyond formal coordination to include the relationships and networks through which practical knowledge is shared.

Despite general consensus on the necessity of baseline financial rewards and aligned evaluation frameworks (Debackere & Veugelers, 2005; Goldfarb & Henrekson, 2003; Zong, 2023), contradictory and divergent findings exist in the literature regarding legal IP reforms and external governance. On one hand, legal reforms such as mixed ownership policy are posited to empower faculty entrepreneurship by reducing transaction costs (Gao et al., 2023; Pan, 2019). On the other hand, regional empirical studies reveal a persistent policy implementation gap where legal entitlements are neutralized by administrative risk aversion and complex approval delays (Luo, 2023). Furthermore, while classical Triple Helix model suggests that expanding external linkages directly elevates commercialization (Etzkowitz & Leydesdorff, 2000), recent evidence highlights an 'industry engagement paradox', demonstrating that expanding broad external channels without prior internal structural alignment yields week university-industry coupling and diminishing returns (Qiu, 2020; Xiang et al., 2026).

The literature points to a common theme: S&T achievement transformation depends on more than the production of research outputs. Policies need to provide meaningful incentives and workable rules; institutions need the capacity and evaluation systems to support applied research; and universities need sustained relationships with industry and government through which knowledge can be shared and applied. However, these factors have largely been examined separately and predominantly in research-intensive university settings. Their combined influence remains less understood in vocational undergraduate universities, particularly in Henan Province, where the applied mission and industry orientation may shape transformation in distinctive ways.

METHODOLOGY

Research Design. This study used a descriptive-correlational research design. The descriptive component was used to describe the study variables as they occur in vocational undergraduate universities, while the correlational component examined the relationships among policy mechanisms, institutional support, innovation governance, and transformation performance for exploration purposes and not for hypothesis testing given that the analysis was at the institutional level (n = 4).

Population and Sampling. The target population comprised 3,867 full-time faculty members from the four Ministry of Education-accredited vocational undergraduate universities in Henan Province offering scientific and technological (S&T) program offerings, designated as Universities A–D. These four institutions constituted the entire population of vocational undergraduate universities in the province meeting the study's inclusion criteria and were therefore included through a census approach at the institutional level. At the respondent level, faculty inclusion criteria required them to hold full-time employment status at one of the four participating universities; be affiliated with an S&T academic department or program offering; have completed at least one full academic year of continuous service at their current institution to ensure sufficient exposure to institutional policies and research infrastructure; and be aged 25 to 60 years. To determine the sample size, Yamane formula was applied at a 5% margin of error. There were 363 faculty respondents selected through stratified random sampling, with institutional affiliation as the basis for stratification. These results in 131 respondents from University A, 80 from University B, 77 from University C, and 75 from University D. Primary data were collected from the sampled 363 faculty members, while secondary data on transformation performance were obtained from institutional records of all four universities.

Research Instrument. Data on the independent variables were collected from faculty respondents using a researcher-made questionnaire consisting of 45 items across nine subdimensions, with each subdimension grounded in the study's theoretical framework. The item development was deductively guided by Policy Tool Theory (Rothwell & Zegveld, 1985), Institutional Theory (Scott, 2008), and Network Governance Theory (Provan & Kenis, 2008), allocating 5 items per subdimension to ensure thorough construct coverage while minimizing respondent fatigue (Nunnally & Bernstein, 1994). Responses were measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Content validity was established through expert-jury evaluation. Content validity was established through expert-jury evaluation involving a panel of five expert reviewers, both from the Philippine and China, holding doctoral degrees in educational management, public administration, or science and technology policy. The validation framework of Goods and Scates (1972, as cited in Oducado, 2020), the panel evaluated the items. Pilot testing with 30 full-time faculty members yielded Cronbach's α coefficients ranging from 0.807 to 0.856 across the subscales, indicating acceptable to good internal consistency. Concurrently, face validity was confirmed through a preliminary layout review with potential respondents outside the sample to ensure visual clarity and unambiguous instructions. Data on transformation performance were obtained separately as secondary data from designated institutional representatives based on official institutional records for the most recent academic year.

Future research may conduct confirmatory validity assessment in larger and more diverse samples In scale development, when survey items are operationalized directly from explicit, well-established policy frameworks and theoretical constructs rather than inductively generated from exploratory qualitative data, subscale structures are predetermined a priori by theory rather than discovered empirically (Boateng et al., 2018; DeVellis, 2012; Hinkin, 1995). Methodological literature emphasizes that applying exploratory factor analysis to pre-structured, policy-mandated subscales in early-stage contextualized research carries a risk of sample-specific capitalization on chance, which can artificially distort established theoretical dimensions (Haynes et al., 1995; Morgado et al., 2018). Furthermore, establishing foundational content and face validity through expert qualitative review alongside high internal consistency reliability across subscales (Cronbach's $\alpha \geq 0.80$) provides a psychometrically sound and sufficient foundation for descriptive and inferential analysis without requiring post-hoc statistical re-specification or numerical validity

indexing (Boateng et al., 2018; DeVellis, 2012; Lynn, 1986; Nunnally & Bernstein, 1994; Oducado, 2020).

Data Gathering. Formal approval was obtained from the authorized officials of the four participating universities. Primary data were collected from 363 full-time faculty members using a validated online questionnaire administered through Wenjuanxing and distributed via the universities' research offices or authorized faculty WeChat groups. Participants provided informed consent before completing the survey, with a reminder sent one week after distribution. Data collection lasted approximately five to six weeks. Secondary data on transformation performance were obtained separately from designated university representatives based on official records for the most recent academic year. Survey responses were screened for completeness and validity, and invalid responses were excluded. All data were securely stored, with access limited to the researcher and research adviser, and results were reported in aggregate to protect participant and institutional confidentiality.

Data Analysis. Mean and standard deviation were used to describe the policy mechanisms, institutional support, and innovation governance, while transformation performance was summarized using the institutional indicators of patent commercialization, industry collaboration, and talent-embedded technology diffusion. Spearman's rank-order correlation was used to describe the direction and strength of associations across the four universities. Given the small number of institutional observations (n = 4), the results were interpreted as exploratory evidence of association rather than as statistically generalizable relationships, and no formal significance testing was conducted. This approach shifts the analytical focus entirely toward evaluating descriptive directional trends, pattern recognition, and ordinal alignment among the variables. The resulting correlation coefficients are utilized as stable diagnostic indicators to map out operational relationships within the institution, rather than as tools to generalize to an external population.

Ethical Considerations. The study obtained ethical clearance from the Central Philippine University Research Ethics Review Board. Informed consent was obtained from all participants. Anonymity and confidentiality were maintained throughout. Participation was voluntary, with no compensation provided. Data were stored securely and will be destroyed after five years.

RESULTS

Policy Mechanisms, Institutional Support, and Innovation Governance in Vocational Undergraduate Universities. Table 1 presents the descriptive statistics for policy mechanisms, institutional support, and innovation governance. All dimensions of policy mechanisms and institutional support were rated "good," with mean scores ranging from 3.31 to 3.37. Industry engagement channels was the only dimension rated "very good," with a mean score of 3.43 (SD = 0.79).

Across policy mechanisms, financial incentives (M = 3.32, SD = 0.80), administrative incentives (M = 3.33, SD = 0.85), and legal/IP incentives (M = 3.31, SD = 0.79). Grounded in Policy Tool Theory (Rothwell & Zegveld, 1985), these results suggest that vocational undergraduate institutions have established foundational supply-side (financial) and environmental-side (administrative and legal/IP) policy mechanisms. The narrow mean range (3.31 to 3.33) indicates that no single policy incentive type clearly dominates in practice. As Goldfarb and Henrekson (2003) noted, direct financial rewards provide essential baseline motivation; however, administrative, and legal mechanisms function as critical environmental tools that reduce procedural transaction costs, allowing faculty to act on financial motivators effectively without encountering administrative bottlenecks or implementation gaps (Luo, 2023; Zheng, 2023).

For institutional support, faculty members

recognized a consistent level of organizational backing across technology transfer infrastructure (*M* = 3.33, *SD* = 0.86), evaluation system alignment (*M* = 3.32, *SD* = 0.90), and legal-procedural safeguards (*M* = 3.31, *SD* = 0.78). Interpreted through Scott's (2008) Institutional Theory, these ratings reflect established regulative capacity (transfer infrastructure and procedural safeguards) and normative expectations (evaluation alignment). In applied higher education, institutional support must function as an integrated ecosystem to bridge the gap between research outputs and practical application (Siegel et al., 2003). Crucially, aligning faculty evaluation criteria with applied research mandates helps resolve the structural "mission mismatch" in applied institutions, where institutional charters mandate regional industry service while conventional appraisals continue to favor paper-centric academic publications (Li, 2021; Zong, 2023).

Within innovation governance, a clear numerical hierarchy emerged across the three subdimensions, namely, industry engagement channels (*M* = 3.43, *SD* = 0.79); knowledge-sharing networks (*M* = 3.37, *SD* = 0.80); cross-sectoral coordination (*M* = 3.35, *SD* = 0.84) which means *good*. The higher rating for industry engagement channels (*M* = 3.43) highlights a defining structural characteristic of vocational undergraduate institutions. Driven by government directives for industry-education integration (Henan Provincial Vocational Education Regulations, 2025; Ministry of Education of the People's Republic of China, 2019), these universities have actively established physical platforms for university-enterprise interaction (Si, 2022; Wang & Zhang, 2026). Grounded in Network Governance Theory (Provan & Kenis, 2008) and the Triple Helix Model (Etzkowitz & Leydesdorff, 2000), external channels provide vital avenues for identifying market demand; however, translating physical collaboration channels into substantive technology transfer requires tight internal coordination, professional technology transfer brokerage, and aligned evaluation incentives (Perkmann et al., 2013, 2021; Qiu, 2020).

Table 1

Policy Mechanisms, Institutional Support, and Innovation Governance in Undergraduate Vocational Universities as Perceived by the Faculty Respondents

Category (*n* = 363)	Mean	*SD*	Description
Policy Mechanisms			
Financial Incentives	3.32	0.80	Good
Administrative Incentives	3.33	0.85	Good
Legal and IP Incentives	3.31	0.79	Good
Institutional Support			
Technology Transfer Infrastructure	3.33	0.86	Good
Evaluation System Alignment	3.32	0.90	Good
Legal-Procedural Safeguards	3.31	0.78	Good
Innovation Governance			
Cross-Sectoral Coordination	3.35	0.84	Good
Industry Engagement Channels	3.43	0.79	Very Good
Knowledge-Sharing Networks	3.37	0.80	Good

Note. Scale: 1.00–1.80 Very Poor, 1.81–2.60 Poor, 2.61–3.40 Good, 3.41–4.20 Very Good, 4.21–5.00 Excellent

Transformation Performance of S&T Achievements. Table 2 presents the transformation performance data across the three dimensions. Substantial inter-institutional variation was observed, with University B consistently outperforming other institutions across all indicators, while University D recorded the lowest values.

The marked performance disparities between University B and University D highlight that technology transfer capacity is highly uneven within the vocational undergraduate tier. These differences do not reflect variations in intrinsic institutional quality, but rather differences in organizational maturity, internal support structures, and regional industrial alignment (Zong, 2023).

Across all four universities, absolute output volumes are significantly higher for industry collaboration intensity (e.g., technical services *M* = 328) and talent-embedded technology diffusion (e.g., tech-employed graduates *M* = 785) than for formal patent commercialization outcomes (e.g., patents transferred *M* = 11; spin-offs *M* = 1). This pattern provides empirical support for the conceptualization of technology transfer in applied institutions advanced by Perkmann et al. (2013, 2021). For vocational institutions, research outputs consist predominantly of incremental process innovations, utility models, and practical technical solutions that are difficult to capture

through formal patent licensing alone (Xu, 2016, 2022). Consequently, transformation occurs primarily through "academic engagement" contract research, technical consulting, and human capital diffusion via dual-qualified faculty and graduate employment rather than formal "academic entrepreneurship" (Perkmann et al., 2013; Si, 2022; Xu, 2016).

Table 2

Transformation Performance of S & T Achievements

Category (n = 4)	Vocational University				Mean
	A	B	C	D	
Patent Commercialization					
Patents transferred/commercialized	9	15	13	8	11
Licensing contract value (million CNY)	2.13	3.17	2.60	1.85	2.40
Spin-off enterprises created	1	2	2	1	1
Number of equity participation arrangements	2	3	2	1	2
Royalty income (million CNY)	0.46	0.63	0.60	0.39	0.51
Industry Collaboration Intensity					
Industry-funded R&D projects	55	108	62	43	66
Collaborative R&D contract value (million CNY)	16.5	26	19.8	10.8	18.12
Enterprise consulting engagements	185	245	140	126	176
Technical services provided	310	530	260	213	328
Long-term partnership agreements	30	45	28	19	31
Talent-Embedded Technology Diffusion					
Curricula integrating S&T achievements	23	35	26	16	25
Students in applied R&D activities	680	860	610	390	645
Graduates in tech-intensive positions	890	950	800	410	785
Enterprises satisfied with graduates	195	380	230	106	225
Faculty technical service engagements	200	230	185	115	186

Note. Data provided by institutional representatives based on institutional records for the most recent academic year.

Relationships Between the Policy Mechanisms and the Transformation Performance. Table 3 shows positive associations between the three policy mechanism dimensions and the different indicators of transformation performance of S&T achievement. Administrative incentives had the strongest pattern, with r_s = 1.00 for several indicators, including patents transferred or commercialized, licensing contract value, royalty income, industry-funded R&D projects, collaborative R&D contract value, curricula integrating S&T achievements, and enterprise satisfaction with graduates. Financial incentives also showed positive associations, ranging from rs = .40 to .89, while legal and IP incentives ranged from rs = .40 to .89.

The primacy of administrative incentives (r_s = 1.00) over pure monetary rewards (r_s = 0.80) illuminates a core operational dynamic within Policy Tool Theory (Rothwell & Zegveld, 1985). Financial rewards serve as supply-side tools that provide baseline motivation for commercialization (Goldfarb & Henrekson, 2003). However, financial incentives cannot operate effectively in a vacuum. As Zheng (2023) observed, faculty members in provincial universities frequently encounter administrative friction, complex approval workflows, and unclear disbursement procedures that neutralize monetary incentives.

Administrative incentives operate as environmental-side policy tools that shape the institutional working environment (Rothwell & Zegveld, 1985). By establishing flexible working time allocation policies (M = 3.35) and streamlined project initiation workflows (M = 3.34), administrative incentives reduce procedural transaction costs. This procedural enablement allows faculty to pursue applied research and technology transfer without incurring administrative penalties or compromising their core instructional duties (Debackere & Veugelers, 2005; Hülsbeck et al., 2013).

Table 3

Institutional Patterns of Association Between Policy Mechanisms and Transformation Performance

Category (n = 4)	Financial	Administrative	Legal and Intellectual Property
	r_s	r_s	r_s
Patent Commercialization			
Patents transferred/commercialized	0.80	1.00	0.80
Licensing contract value (million CNY)	0.80	1.00	0.80
Spin-off enterprises created	0.89	0.89	0.89
Number of equity participation arrangements	0.63	0.95	0.63
Royalty income (million CNY)	0.80	1.00	0.80
Industry Collaboration Intensity			
Industry-funded R&D projects	0.80	1.00	0.80
Collaborative R&D contract value (million CNY)	0.80	1.00	0.80
Enterprise consulting engagements	0.40	0.80	0.40
Technical services provided	0.40	0.80	0.40
Long-term partnership agreements	0.40	0.80	0.40
Talent-Embedded Technology Diffusion			
Curricula integrating S&T achievements	0.80	1.00	0.80
Students in applied R&D activities	0.40	0.80	0.40
Graduates in tech-intensive positions	0.40	0.80	0.40
Enterprises satisfied with graduates	0.80	1.00	0.80
Faculty technical service engagements	0.40	0.80	0.40

Note. n = 4 universities. r_s = Spearman's rank-order correlation coefficient. Coefficients are reported as exploratory measures of association and are not subjected to formal significance testing because of the small number of institutional observations.

Relationships Between the Institutional Support and the Transformation Performance. As shown in Table 4, all three dimensions of institutional support were positively associated with the transformation indicators. Technology transfer infrastructure and evaluation system alignment showed the strongest patterns, with *rs* values ranging from .80 to 1.00. Both reached *rs* = 1.00 for patents transferred or commercialized, licensing contract value, royalty income, industry-funded R&D projects, collaborative R&D contract value, curricula integrating S&T achievements, and enterprise satisfaction with graduates.

Grounded in Scott's (2008) Institutional Theory, these strong empirical associations suggest that internal organizational capacity and structural alignment serve as primary drivers of technology transfer across both regulative and normative pillars. First, the perfect rank-order correlation (r_s = 1.00) for technology transfer infrastructure underscores the essential role of professionally managed Technology Transfer Offices (TTOs), intermediary brokerage, and proof-of-concept funding in bridging the "valley of death" between research outputs and market adoption.

Second, evaluation system alignment operates through the normative pillar by resolving the structural "mission mismatch" in applied higher education, where institutional charters mandate regional industry service but annual appraisals continue to reward paper-centric publication counts. As Zong (2023) documented, evaluation misalignment is the primary institutional barrier preventing faculty from commercializing research; formally integrating patent commercialization, industrial contracts, and technical services into title promotion criteria and workload calculations transforms technology transfer into an expected core duty, thereby elevating commercialization productivity. Finally, legal-procedural safeguards (r_s = .40 to .89) mitigate administrative liability risks and institutional uncertainty, providing faculty innovators with the procedural confidence required to engage in commercialization and spin-off creation.

Table 4

Institutional Patterns of Association Between Institutional Support and Transformation Performance

Category (n = 4)	Technology Transfer Infrastructure	Evaluation System Alignment	Legal-Procedural Safeguards
	rs	*rs*	*rs*
Patent Commercialization			
Patents transferred/commercialized	1.00	1.00	0.80
Licensing contract value (million CNY)	1.00	1.00	0.80
Spin-off enterprises created	0.89	0.89	0.89
Number of equity participation arrangements	0.95	0.95	0.63
Royalty income (million CNY)	1.00	1.00	0.80
Industry Collaboration Intensity			
Industry-funded R&D projects	1.00	1.00	0.80
Collaborative R&D contract value (million CNY)	1.00	1.00	0.80
Enterprise consulting engagements	0.80	0.80	0.40
Technical services provided	0.80	0.80	0.40
Long-term partnership agreements	0.80	0.80	0.40
Talent-Embedded Technology Diffusion			
Curricula integrating S&T achievements	1.00	1.00	0.80
Students in applied R&D activities	0.80	0.80	0.40
Graduates in tech-intensive positions	0.80	0.80	0.40
Enterprises satisfied with graduates	1.00	1.00	0.80
Faculty technical service engagements	0.80	0.80	0.40

Note. n = 4 universities. r_s = Spearman's rank-order correlation coefficient. Coefficients are reported as exploratory measures of association and are not subjected to formal significance testing because of the small number of institutional observations.

Table 5 shows a similar pattern across the three innovation governance dimensions. Cross-sectoral coordination, industry engagement channels, and knowledge-sharing networks all had positive associations with the transformation indicators. The three dimensions showed r_s = .80 for patents transferred or commercialized, licensing contract value, royalty income, industry-funded R&D projects, collaborative R&D contract value, curricula integrating S&T achievements, and enterprise satisfaction with graduates. Spin-off enterprises had a somewhat stronger association at r_s = .89, while equity participation arrangements showed r_s = .63. The lower coefficients, at r_s = .40, were found for enterprise consulting engagements, technical services, long-term partnership agreements, student participation in applied R&D, graduate placement in technology-intensive positions, and faculty technical service engagements.

Grounded in Network Governance Theory (Provan & Kenis, 2008) and the Triple Helix Model (Etzkowitz & Leydesdorff, 2000), these empirical patterns confirm that while external governance networks support S&T achievement transformation, their operational

effectiveness relies fundamentally on internal institutional coupling. Although governance networks strongly associate with formal commercialization outcomes and major R&D contracts (r_s = .80 to .89), their comparatively weaker relationships with informal technical services and talent diffusion (r_s = .40) illustrate the "industry engagement paradox" in regional higher education. As Perkmann et al. (2013, 2021) observed, university–industry partnerships succeed through the depth and operational quality of engagement rather than the sheer breadth or volume of physical collaboration channels. Expanding external networking platforms such as industrial colleges, joint labs, or campus makerspaces yields diminishing returns unless supported by internal evaluation alignment, professional TTO brokerage, and robust legal-procedural safeguards.

Table 5

Institutional Patterns of Association Between Innovation Governance and Transformation Performance

Category (n = 4)	Cross-Sectoral Coordination	Industry Engagement Channels	Knowledge-sharing Networks
	rs	*rs*	*rs*
Patent Commercialization			
Patents transferred/commercialized	0.80	0.80	0.80
Licensing contract value (million CNY)	0.80	0.80	0.80
Spin-off enterprises created	0.89	0.89	0.89
Number of equity participation arrangements	0.63	0.63	0.63
Royalty income (million CNY)	0.80	0.80	0.80
Industry Collaboration Intensity			
Industry-funded R&D projects	0.80	0.80	0.80
Collaborative R&D contract value (million CNY)	0.80	0.80	0.80
Enterprise consulting engagements	0.40	0.40	0.40
Technical services provided	0.40	0.40	0.40
Long-term partnership agreements	0.40	0.40	0.40
Talent-Embedded Technology Diffusion			
Curricula integrating S&T achievements	0.80	0.80	0.80
Students in applied R&D activities	0.40	0.40	0.40
Graduates in tech-intensive positions	0.40	0.40	0.40
Enterprises satisfied with graduates	0.80	0.80	0.80
Faculty technical service engagements	0.40	0.40	0.40

Note. n = 4 universities. r_s = Spearman's rank-order correlation coefficient. Coefficients are reported as exploratory measures of association and are not subjected to formal significance testing because of the small number of institutional observations.

DISCUSSION

Policy Mechanisms, Institutional Support, and Innovation Governance in Vocational Undergraduate Universities. Faculty members generally viewed the universities have established policy mechanisms to encourage and facilitate the transformation of S&T achievements, although these mechanisms may not yet be consistently experienced as very strong. Grounded in Policy Tool Theory (Rothwell & Zegveld, 1985), these policy mechanisms encompass supply-side instruments (financial incentives) that provide direct resources and environmental-side instruments (administrative and legal supports) that reduce institutional friction It appears that there is no particular type of policy incentive that clearly stood out from the others, as financial, administrative, and legal incentives received uniform baseline ratings. This may mean that incentives are present as part of the institutional system, but their effectiveness in motivating researchers may still depend on how accessible, timely, and responsive they are in actual practice. As Goldfarb and Henrekson (2003) noted, direct financial rewards motivate faculty when revenue distribution is transparent and accessible; however, as documented by Luo (2023), opaque disbursement workflows and administrative delays create a persistent "policy implementation gap" in regional higher education. Furthermore, Zheng (2023) demonstrated that monetary rewards yield limited behavioral change unless accompanied by administrative enablement that lowers procedural transaction costs.

A similar pattern was observed for institutional support. Grounded in Scott's (2008) Institutional Theory, institutional support operates through regulative mechanisms (technology transfer infrastructure and legal safeguards) and normative expectations (faculty evaluation systems). The faculty generally recognize the presence of institutional structures and procedures that support the movement of research outputs toward application. But the ratings indicate room for improvement, particularly in ensuring that infrastructure, evaluation practices, and administrative or legal procedures work together rather than operate as separate requirements. In applied higher education, a major institutional barrier is the structural "mission mismatch," wherein institutional charters mandate regional industry service while annual appraisals continue to

reward paper-centric academic publication counts (Guan et al., 2005; Li, 2021; Zong, 2023). For vocational undergraduate universities, where research is closely connected with practical and industry-oriented applications, institutional support needs to make the transformation process easier for faculty to navigate from developing an innovation to protecting, transferring, and applying it. Professionally managed Technology Transfer Offices (TTOs) and clear legal-procedural safeguards serve as organizational orchestrators that bridge early-stage research with market validation, lowering risk and transaction costs for faculty innovators (Baglieri et al., 2018; Chen et al., 2025; Debackere & Veugelers, 2005; Siegel et al., 2003).

In terms of innovation governance, the perception of the faculty showed a relatively higher rating for industry engagement. They recognized that industry connection is central to the applied orientation of vocational undergraduate education, aligning directly with state and provincial directives for university–industry integration (Henan Provincial People's Congress, 2025; Ministry of Education of the People's Republic of China, 2019). Moreover, the faculty found that the opportunities to interact with enterprises and other external stakeholders as relatively well established. Operational platforms such as industrial colleges, joint laboratories, and campus-based makerspaces provide functional conduits for collaboration (Si, 2022; Wang & Zhang, 2026). Such connections can provide avenues for identifying industry needs, testing research outputs, developing applied solutions, and creating opportunities for technology transfer. Grounded in Network Governance Theory (Provan & Kenis, 2008) and the Triple Helix Model (Etzkowitz & Leydesdorff, 2000), these external linkages facilitate continuous knowledge flow and talent-embedded technology diffusion across regional industrial clusters (Perkmann et al., 2013, 2021; Xu, 2022).

The universities have the basic policy, institutional, and governance conditions needed to support S&T achievement transformation, however, there is a need for continued strengthening of the entire support system. In particular, the comparatively higher rating for industry engagement can be built upon by further improving incentives, technology transfer infrastructure, evaluation systems, and procedural support so that connections with industry can translate more effectively into actual transformation of S&T achievements. As Perkmann et al. (2013, 2021) and Xiang et al. (2026) emphasized, expanding external networking platforms without corresponding internal evaluation reform and TTO brokerage capacity leads to the "industry engagement paradox," where external channels generate superficial interaction rather than substantive commercial outputs. Strengthening internal allocative efficiency and administrative coordination ensures that external industry partnerships yield measurable scientific, technological, and economic impact (Qiu, 2020; Zong, 2023).

Transformation Performance of S&T Achievements. The undergraduate vocational universities showed a variation in transformation performance, with University B consistently reporting higher values across most indicators while University D reporting lower values. In provincial higher education, such performance variations reflect differences in internal organizational capacity, Technology Transfer Office (TTO) professionalization, and regional resource allocation rather than sheer research input or baseline academic competence (Miao, 2021; Zong, 2023). These differences, however, should not be interpreted as difference in institutional quality because the indicators measure different aspects of transformation which may be affected by institutional size, research portfolio, industry opportunities, and availability of resources (Qiu, 2020; Zong, 2023). Moreover, S&T achievement transformation must be viewed as multi-dimensional and takes several forms from patent licensing and commercialization to industry-funded research, technical services, curriculum integration, student involvement, and technology-related employment. S&T

achievements are also taking place through teaching, student participation, graduate employment, employer feedback, and faculty engagement in technical services. In applied vocational contexts, research outputs are characteristically organized around short-cycle, problem-driven projects led by "dual-qualified" faculty acting as boundary spanners to deliver practical technical assistance (Si, 2022; Xu, 2016, 2022).

In other words, transformation is not limited to the commercialization of patents; it also involves bringing technological knowledge into the university's teaching and talent-development functions and extending it into industry through faculty and graduates. Through "talent-embedded technology diffusion," students and graduates function as human "technology carriers," diffusing practical know-how, process improvements, and utility innovations directly into regional enterprise workflows without relying exclusively on formal patent transactions (Si, 2022; Xu, 2016). This broader view is particularly appropriate for vocational undergraduate universities, whose contribution to innovation can be reflected not only in financial returns from intellectual property but also in the application and diffusion of technology through industry collaboration and talent development (Etzkowitz & Leydesdorff, 2000; Provan & Kenis, 2008; Rothwell & Zegveld, 1985; Scott, 2008).

Relationships of Policy Mechanisms, Institutional Support, and Innovation Governance with the Transformation Performance. The correlation results suggest that policy mechanisms, institutional support, and innovation governance are related to the transformation performance of S&T achievements, although the strength of these relationships varies across different indicators. The findings reveal important patterns: a) financial incentives can encourage faculty to participate in patent commercialization and other high value technology transfer transactions, but financial rewards are more useful when supported by administrative arrangement that make participation easier. Flexible work arrangements reduced procedural requirements, and institutional recognition can help faculty take part not only in commercialization but also in applied research, industry projects, and technical services.

Viewed through Rothwell and Zegveld's (1985) Policy Tool Framework, both financial and administrative incentives appear to serve different complementary purposes. Financial incentives, including cash rewards and royalty-sharing arrangements, can give researchers a direct reason to pursue the transfer and commercialization of their work. This is consistent with Goldfarb and Henrekson (2003), who emphasized the importance of allowing researchers to benefit from the commercial value of their research. At the same time, financial rewards may have limited value when faculty still have to deal with complicated procedures or limited institutional assistance. Zheng (2023) similarly noted that financial incentives in Chinese universities are more effective when accompanied by administrative support and intermediary services. In this sense, incentives do not work in isolation; researchers also need an institutional environment that allows them to act on those incentives.

Institutional support also showed meaningful relationship with transformation performance, particularly technology transfer infrastructure and evaluation system alignment. The findings suggest that having structures in place to support technology transfer matters because faculty need practical assistance when moving an S&T achievement from research into application. For instance, a dedicated Technology Transfer Office (TTO), can provide assistance with intellectual property, licensing, contracts, and other aspects of commercialization. This is consistent with Siegel et al. (2003) and Chen et al. (2025), who highlighted the role of professionally managed TTOs in improving technology transfer processes. Moreover, clear legal and procedural guidelines are important because these can reduce uncertainty and make it easier

for researchers to participate in activities involving intellectual property, licensing, and industry partnerships. Grimaldi et al. (2011) identified clear institutional arrangements as important in reducing the transaction costs associated with technology transfer.

Furthermore, aligning academic evaluation systems is a powerful driver of technology transfer performance. In many higher education settings, faculty face a classic structural conflict where academic evaluation remains heavily publication-centered, actively discouraging researchers from pursuing applied or commercial work. As Zong (2023) observed, evaluation misalignment stands as the primary institutional barrier preventing Chinese university faculty from commercializing research outputs.

When universities formally integrate patent commercialization, industrial R&D, and technical services into annual performance appraisals and professional promotion tracks, faculty behavior shifts fundamentally. This aligns directly with Debackere and Veugelers (2005), who demonstrated that classification evaluation systems recognizing technology transfer significantly boost commercial output. Viewed through Scott's (2008) Institutional Theory, evaluation alignment operates through the normative pillar—reshaping organizational values and professional role expectations so that technology transfer evolves from an optional extracurricular activity into an expected core duty.

For innovation governance, the three dimensions (cross-sectoral coordination, industry engagement channels, and knowledge-sharing networks) were also positively associated with several aspects of transformation performance. However, the relationships were generally less pronounced for indicators such as enterprise consulting, technical services, long-term partnerships, student participation in applied R&D, graduate placement in technology-intensive positions, and faculty technical service engagements. This suggests that having channels for external engagement does not automatically translate into stronger transformation outcomes. What appears to matter is how these relationships are organized and supported within the university.

This finding strongly corroborates Perkmann et al. (2013), who emphasized that university–industry partnerships succeed through the depth of engagement rather than the sheer breadth of channels. As Xiang et al. (2026) pointed out, Chinese institutions often exhibit strong policy involvement but relatively weak university-industry coupling in practice. Additionally, Qiu (2020) noted in central China that increasing R&D inputs or network links does not produce proportional transformation outcomes unless supported by internal organizational capacity.

Given these results, the Henan Provincial Department of Education and the Department of Science and Technology should standardize academic evaluation frameworks across vocational undergraduate institutions by formally integrating patent commercialization and industry-funded research into provincial title promotion criteria. Provincial authorities should also expand proof-of-concept seed funding to bridge the early-stage development gap and establish clear legal protective guidelines to reduce administrative liability risks for faculty innovators engaging in technology transfer.

At the institutional level, university administrators must adopt a strategy centered on internal alignment by incorporating technology transfer outcomes directly into annual faculty evaluations, teaching workload calculations, and career advancement pathways. Administrators should prioritize the professionalization of TTOs by staffing them with specialists in intellectual property management and legal brokerage, while critically evaluating and streamlining external industry engagement channels to focus resources on high-impact, outcome-oriented partnerships.

For academic practice and future inquiry, faculty members and industry partners should cultivate talent-embedded diffusion pathways by actively involving students in applied R&D projects and integrating regional technological achievements into academic curricula. Industry partners ought to shift from superficial networking toward structured, long-term collaborative contracts and early-stage co-development. Finally, future researchers should employ qualitative interviews, longitudinal designs, and mixed methods approaches to further investigate the operational dynamics of the industry engagement paradox and measure the long-term impacts of specialized technology transfer career tracks on spin-off creation and commercial success. Additionally, scholars should expand research through multiregional studies across diverse provincial ecosystems and comparative international studies to benchmark regional technology transfer frameworks against global applied higher education models.

DISCLOSURES

Author contributions. Baozheng Yang: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Writing-original draft | Rodalyn E. Daylo: Statistical tests, Supervision, Writing – review & editing.

Conflict of interest. The authors declare no conflict of interest.

Funding source. This research received no external funding.

Artificial intelligence use. AI tools supported initial drafting of text; final revisions and accountability rest with the authors.

Ethics approval. Ethical clearance was obtained from the Research Ethics Review Board, Central Philippine University with RERB Code 2026-251-PG-YANG BAOZHENG

Data availability statement. Due to ethical restrictions, some data are not publicly available but may be obtained from the corresponding author upon reasonable request.

Acknowledgments. The researchers extend sincere gratitude to the administration and faculty of the four participating vocational undergraduate institutions in Henan Province and all those whose generous cooperation and support paved the way for the completion of this study.

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