

Analysis of the Status Quo, Bottlenecks, and Influencing Factors of the Transformation of Scientific and Technological Achievements in Higher Vocational Colleges in Guangdong Province

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Abstract

Against the backdrop of the national innovation-driven development strategy and the high-quality development of vocational education, higher vocational colleges have become important sources of technological innovation and skilled talent development. The effectiveness of their scientific and technological achievements transformation directly affects regional economic upgrading. Taking 14 Guangdong higher vocational colleges selected for the first round of the national “Double High Plan” as research samples, and drawing on the Action Plan for Special Operations on Patent Conversion and Utilization (2023-2025) and Guangdong’s 2024 reform on job-related achievement management, this study employs the TOE (Technology-Organization-Environment) framework to analyze the prominent issues of dormant patents, weak supply-demand matching, and uneven institutional implementation. The findings indicate that insufficient technological maturity, lack of transfer institutions, biased evaluation mechanisms, and policy implementation blockages are key constraints. Correspondingly, this paper proposes countermeasures such as adopting single-listing management for job-related achievements, co-establishing concept validation and pilot-scale testing platforms, reconstructing classification-based evaluation systems, and cultivating professional technology transfer teams. These recommendations aim to support the construction of the “New Double High Plan” and enhance vocational education’s contribution to the development of new, quality productive forces.

Keywords

Guangdong Province, Higher Vocational Colleges, Double High Plan,

1. Introduction

1.1. Research Background and Policy Evolution

The transformation of scientific and technological achievements serves as a critical bridge between research and industrial application and plays a vital role in fostering new quality productive forces. As China's economic growth enters a "new normal," vocational education has shifted from being primarily "employment-oriented" to balancing employment with industrial services (Wu, 2021). The revised Vocational Education Law (Ministry of Education of the People's Republic of China, 2022) explicitly mandates vocational schools to "carry out scientific and technological research and technology promotion," thereby affirming the legitimacy and necessity of scientific research and technological transformation in higher vocational institutions.

Yet the persistent issue of "high output but low conversion" remains prominent, with patents often being produced to meet evaluation or project requirements rather than actual market needs (Zhang et al., 2025). In response, the State Council issued the Action Plan for Special Operations on Patent Conversion and Utilization (2023-2025), which focuses on revitalizing dormant university patents (General Office of the State Council, 2023).

1.2. Basis for Selection of Research Objects

This study selects 14 higher vocational colleges in Guangdong Province that were selected for the first round of the national "High-level Vocational Schools and Professionals Construction Plan" (referred to as the "Double High Plan") as empirical research objects (Chen & Li, 2025). These 14 institutions include Dongguan Polytechnic, Guangdong Industry Polytechnic, Guangdong Polytechnic of Science and Technology, Guangdong Polytechnic of Water Resources and Electric Engineering, Guangdong Polytechnic of Industry and Commerce, Guangdong Mechanical & Electrical Polytechnic, Guangdong Food and Drug Vocational College, Guangzhou Panyu Polytechnic, Guangzhou Railway Polytechnic, Guangzhou Civil Aviation College, Shenzhen Polytechnic University, Shenzhen Institute of Information Technology, Shunde Polytechnic, and Zhongshan Torch Polytechnic.

Selecting these 14 institutions as samples provides strong representation: First, they represent the highest level of vocational education in Guangdong Province and even the nation. Their research funding input, patent application volume, and technical service income account for the "lion's share" of the total among the more than 80 higher vocational colleges in the province. Second, these institutions are located in the core area of the Pearl River Delta and are most closely integrated with industry; their exploration in the transformation of scientific and technolog-

ical achievements serves as a bellwether. Analyzing the practical samples of these “head” institutions not only provides a glimpse into the overall landscape of scientific research transformation in the province’s vocational colleges but also identifies common institutional blockages that exist even under the most favorable resource conditions, providing replicable and scalable experiences for other institutions.

2. Status Quo and Characteristics of Scientific and Technological Achievement Transformation in Guangdong “Double High” Institutions

Based on the Annual Report on the Quality of Higher Vocational Education (2021-2024) of each school and relevant bibliometric analysis. Specifically, this study adopted a quantitative data extraction method to systematically compile and analyze statistical indicators such as patent outputs, growth rates, and technical service income from these reports. The transformation of scientific and technological achievements in Guangdong’s “Double High Plan” institutions presents significant characteristics of “simultaneous improvement in quantity and quality, diverse models, and strong regional stickiness.”

2.1. General Overview: Scaled Research Output with Significant Head Effect

Patent output maintains high growth. Survey data indicate that in the past three years, the total volume of patent applications from the 14 “Double High” institutions in Guangdong has remained high, with an average annual growth rate exceeding 10%. Among them, the proportion of invention patents has increased year by year, indicating that higher vocational colleges are gradually transforming from “appearance design” to “technological breakthroughs.” For instance, Shenzhen Polytechnic University and Guangdong Industry Polytechnic have long ranked at the forefront of national higher vocational colleges in terms of patent authorization volume; their cumulative authorized invention patents and annual new additions combined have reached a magnitude ranging from hundreds to thousands. This indicates that Guangdong higher vocational colleges already possess strong capabilities in the source supply of technological innovation.

Technical service income rises steadily. With the deepening of industry-education integration, the funds received by higher vocational colleges for technical services through horizontal projects, technological development, and technical consulting have risen year by year (Zhang & Yang, 2023). According to item-by-item statistics from the annual quality reports of each school, the total annual funds received for consolidated horizontal technical services (including technological development, income from achievement transformation, technical consulting, etc.) by these 14 institutions in 2024 ranged from tens of millions to hundreds of millions of yuan (with significant variation among schools). Most institutions have witnessed double-digit growth in horizontal income over the past three

years, with an average annual growth rate exceeding 10%. Notably, the annual horizontal income of dominant institutions such as Shenzhen Polytechnic University and Shunde Polytechnic has broken through the 100-million-yuan mark, making them important forces serving the technological upgrading of regional small and medium-sized enterprises (SMEs). This demonstrates that higher vocational colleges are no longer purely teaching units but are gradually becoming integral components of the regional technological innovation system.

2.2. Transformation Characteristics: Diverse Models and Strong Regional Stickiness

Transformation forms expand from single to diverse. Traditional achievement transformation mainly relied on the direct transfer or licensing of patent rights, which was often a “one-off deal” lacking follow-up services. In recent years, with the advancement of pilot reforms in granting rights, Guangdong higher vocational colleges have begun to explore deep transformation models. For example, Shunde Polytechnic co-built R&D entities with enterprises through “technology as equity contribution,” achieving the deep integration of technology and capital; Shenzhen Institute of Information Technology encouraged research teams to “leave their posts for entrepreneurship” carrying their achievements, incubating high-tech enterprises. This “technology + talent + service” package delivery method not only solves the technical problems of enterprises but also achieves high-quality employment of talent and deep value-added of achievements.

Service orientation presents strong regional stickiness. The scientific research activities of Guangdong higher vocational colleges have distinct “localized” characteristics, closely docking with the industrial layout of the Guangdong-Hong Kong-Macao Greater Bay Area “9 + 2” urban agglomeration. For instance, Zhongshan Torch Polytechnic focuses closely on the lighting industry in Guzhen, developing intelligent lighting control systems; Dongguan Polytechnic serves advanced manufacturing, tackling automation production line transformations. This precise docking of “one school, one brand” and “one professional group to one industrial chain” results in a relatively high implementation rate of scientific and technological achievement transformation. Surveys show that the main service targets of scientific and technological achievement transformation in these institutions are concentrated on “Specialized, Refined, Differential, and Innovative” (SRDI) SMEs in the region, effectively solving the pain point of SMEs being unable to establish independent R&D centers.

3. Prominent Problems and Bottlenecks

Despite the impressive aggregate data, in-depth investigations and interviews reveal that the transformation of scientific and technological achievements in Guangdong higher vocational colleges still suffers from the coexistence of “false fire” (superficial prosperity) and “obstruction,” primarily reflected in the following three structural contradictions (Li et al., 2023).

3.1. Structural Contradiction of “High Output, Low Conversion”

“Many patents, few conversions” remains a stubborn illness plaguing higher vocational colleges. First, the phenomenon of “sleeping” existing patents is severe. The survey found that the original intention of many patent applications was to meet the indicator requirements for teacher title evaluation, project conclusion, or school performance assessment. These patents lacked consideration of market application scenarios at the beginning of the project, and the technical routes were disconnected from market demand, leading to them being shelved immediately after authorization and making it difficult to transform them into realistic productive forces. Second, the proportion of invalid patents is too high. Although the total volume of patents is large, the proportion of utility model patents and design patents remains high, while high-value invention patents with core technical barriers are scarce. According to the 2022 China Patent Survey Report, the industrialization rate of invention patents in Chinese universities is only 3.9%, and it is even lower for higher vocational colleges. A large number of scientific research achievements stop at the laboratory sample stage, failing to cross the “Valley of Death” from sample to product (Fang, 2023).

3.2. “Broken Chain” in the Pilot Scale-Up Stage

For scientific and technological achievements to move from the laboratory to the production line, they need to undergo a series of engineering maturation processes such as concept validation, small-scale trials, and pilot scale (intermediate) trials.

Lack of validation platforms. Currently, the on-campus training bases of most higher vocational colleges mainly serve teaching purposes. Equipment updates lag behind the industrial frontline, and there is a lack of concept validation centers and pilot bases with production-level conditions. Laboratory results often remain at the prototype principle stage, and industrial indicators such as process stability, yield rate, and cost control cannot be verified on campus.

Difficulty in enterprise undertaking. In the survey, enterprises generally reflected that university achievements are “too advanced” or “too theoretical.” Measured by Technology Readiness Level (TRL), that is to say a globally recognized scale from 1 to 9 estimating the maturity of technologies, the achievements of higher vocational colleges are mostly at TRL 3-4 (laboratory validation stage), while enterprises, especially SMEs, need mature technologies at TRL 7 or above (engineering application stage). This supply-demand mismatch causes enterprises to be “afraid to accept or unable to accept,” forming a chasm between technology supply and industrial undertaking.

3.3. “Temperature Difference” in Management System Implementation

Although the state and Guangdong Province have granted universities significant autonomy in top-level design, the revision and execution of management systems

at the school level often lag, presenting a phenomenon of “hot at the top, warm in the middle, and cold at the bottom.”

1) Heavy concerns in execution. Despite the provincial “exemption from liability for due diligence” policy, actual supervision by auditing and disciplinary inspection departments lacks specific exemption details and negative lists. Functional departments and management personnel still harbor a mentality of “fear of taking responsibility and fear of state asset loss” when approving sensitive matters such as equity contribution and low-price licensing. Particularly in the pricing link, once the transformation price is lower than the assessed price, it is easy to trigger compliance risks, leading to cumbersome approval processes and even a conservative mindset of “better not to transfer than to make mistakes.”

2) Misalignment of incentive mechanisms. Existing incentive policies focus mostly on cash rewards after transformation, lacking mechanisms such as equity incentives and option incentives that can form long-term interest binding with enterprises. Meanwhile, for technology transfer personnel engaged in transformation services, there is a lack of clear channels for professional title promotion and performance recognition, leading to instability in professional teams and an inability to provide high-quality transformation services.

4. Analysis of Influencing Factors: Deep Analysis Based on the TOE Framework

The transformation of scientific and technological achievements is a complex system affected by the coupling of multiple factors. This study introduces the Technology-Organization-Environment (TOE) theoretical framework to systematically attribute the structural contradictions identified in the previous section such as the “low conversion rate,” “broken chain,” and “implementation temperature difference” to specific dimensions.

4.1. Technology Dimension: Insufficient Achievement Maturity and Applicability

The attributes of the technology itself are the internal cause of transformation, determining whether the achievement has the potential for transformation.

Limited technological content. Compared with research-oriented universities, higher vocational colleges are limited by faculty structure and research conditions, resulting in relatively weak primitive innovation capabilities. Most achievements belong to process improvement types, appearance design types, or micro-innovations of existing technologies, lacking core key technologies with independent intellectual property rights. This results in weak bargaining power for achievements in the market, making it difficult to generate high transformation returns or attract large capital intervention.

Lack of pilot testing capability. Technological maturity directly affects the investment willingness of enterprises. Due to the lack of necessary test equipment, venues, and pilot funding support, achievements cannot complete engineering

validation. Technical risks are not released before entering the market, causing enterprises to often shy away from higher vocational achievements due to uncontrollable risks. The shortcoming in the technology dimension is the fundamental reason for “having achievements but no transformation.”

4.2. Organization Dimension: Poor Internal Mechanisms and Resource Allocation

Resource allocation, management mechanisms, and cultural atmosphere within the organization are key variables for transformation.

Absence of transformation institutions. Among the 14 institutions surveyed, although most have established scientific research offices or industry-education integration offices, very few have established independent, market-oriented “Technology Transfer Centers.” Existing management personnel are mostly administrative staff, lacking compound talents who understand technology, law, markets, and business negotiation. This leads to a lack of professional support in the full-chain services of achievement mining, value assessment, supply-demand docking, and negotiation and signing, resulting in the loss of a large number of potential transformation opportunities.

Deviation of the evaluation baton. For a long time, the professional title evaluation system of higher vocational colleges has been deeply influenced by the evaluation standards of ordinary undergraduate institutions, with an inertia of “valuing vertical projects over horizontal services” and “valuing paper publication over achievement transformation.” With limited energy, teachers inevitably prioritize papers and vertical projects with higher cost-performance ratios, while viewing achievement transformation—which is time-consuming, laborious, and risky—as a “dangerous path.” This evaluation orientation directly weakens the endogenous motivation of teachers to engage in achievement transformation, leading to the alienation of scientific research work into “research for indicators.”

4.3. Environment Dimension: Shortcomings in Policy Ecology and Market Mechanisms

The external environment provides the soil and nutrients for achievement transformation. Insufficient policy synergy. Although the science and technology departments vigorously promote transformation, the regulatory focus of finance, auditing, and state-owned asset departments has not been fully unified. Specifically regarding the management of job-related scientific and technological achievements as state-owned assets, there is still a lack of detailed operational guidelines on how to find a balance between “maintaining and increasing value” and “encouraging transformation.” This is the main external pressure leading to conservative decision-making by university management.

Imperfect financial support system. The high-risk nature of scientific and technological achievement transformation dictates that it requires diversified capital support. Currently, social venture capital (VC) and angel investment targeting

early-stage scientific research achievements in higher vocational colleges are very scarce. Government guidance funds mostly focus on high-precision and cutting-edge projects, while the “micro-innovation” projects of higher vocational colleges serving SMEs often struggle to gain financial favor, causing many potential projects to die due to a lack of pilot funding.

Information asymmetry. There is a lack of efficient and precise regional platforms for matching the supply and demand of scientific and technological achievements. Universities do not know the real needs of enterprises, and enterprises have no way of knowing what “stock” universities have. Both parties are still in a state of inefficient point-to-point communication, lacking systematic data network support.

5. Countermeasures to Enhance the Efficacy of Scientific and Technological Achievement Transformation

Aiming at the aforementioned problems and causes, and combining the latest spirit of Guangdong Province’s 2024 reform on deepening the management of job-related scientific and technological achievements, the following optimization paths are proposed to clear the “meridians” of transformation.

1) Institutional Breakthrough: Implementing “Single Listing Management” and “Due Diligence Exemption”

Institutional innovation is the foundation for stimulating transformation vitality. Higher vocational colleges should seize the policy window period, boldly reform, and break shackles.

Implement single listing management for job-related scientific and technological achievements. Specifically, this refers to a management mechanism where job-related scientific and technological achievements are classified as a separate asset class, distinct from general administrative or fixed assets, to facilitate more flexible disposal and valuation processes. It is suggested that institutions establish an asset management system for job-related scientific and technological achievements distinct from general state-owned assets, based on the Implementation Plan for Deepening the Reform of Management of Job-related Scientific and Technological Achievements in Guangdong Province (2024-2027) (*General Office of the People’s Government of Guangdong Province, 2024*). It should be clarified that acts such as investment via valuation, transfer, and licensing of job-related scientific and technological achievements are no longer included in the assessment scope of preserving and increasing the value of state-owned assets. Approval processes should be simplified, unnecessary asset assessment filings canceled, and researchers and management departments truly granted greater autonomy in disposal, thereby reducing the institutional transaction costs of transformation.

Schools should formulate detailed internal implementation rules for due diligence exemption, clarifying that under the premise of not seeking illegal interests and following democratic decision-making procedures, relevant responsibilities will be exempted for transformation failures caused by errors in technical route

selection or changes in the market environment. By drawing “red lines” and “bottom lines,” the worries of management personnel and researchers can be eliminated, creating a scientific research ecology that encourages innovation and tolerates failure.

2) Platform Empowerment: Co-Building Concept Validation and Pilot Scale-Up Bases

Improving technological maturity is the key to solving the supply-demand misalignment. Higher vocational colleges should make full use of “Double High” construction funds and industry-education integration resources to make up for the shortcomings in pilot testing.

Substantive construction of pilot platforms. Relying on municipal industry-education consortia and industry-education integration communities, higher vocational colleges should unite with leading enterprises, SRDI enterprises, and industrial parks in the region to co-build and share “Concept Validation Centers” and “Pilot Scale-up Bases.” Utilizing the production equipment and scenarios of enterprises, secondary development and engineering tests can be conducted on laboratory results to improve the TRL level of achievements, bringing them to a level directly applicable by enterprises.

Establish transformation-specific guidance funds. Schools can extract a portion of funds from horizontal research income or achievement transformation proceeds to establish a “Scientific and Technological Achievement Transformation Guidance Fund” or “Seed Fund.” These funds should be specifically used to support concept validation and pilot scale-up of early-stage projects with market prospects, exerting the leverage effect of fiscal funds to mobilize social capital participation.

3) Mechanism Reconstruction: Optimizing Evaluation Systems and Activating Endogenous Motivation

Changing the evaluation baton so that teachers engaged in transformation gain “both fame and fortune” is fundamental to solving the lack of motivation.

Implement classification evaluation reform. Add a “Scientific and Technological Achievement Transformation” separate track or review group in professional title reviews. Break the tendency of “judging solely by papers and awards,” and take technical transaction volume, horizontal project funds received, and economic and social benefits generated by achievement application as core evaluation indicators. For teachers who have made major contributions to achievement transformation, “direct appointment” or “green channel” promotion can be implemented, truly realizing that “papers are written on products, and research is done in engineering.”

Optimize income distribution mechanisms. Fully implement the pilot reform of “granting rights before transformation” and explore granting researchers ownership or long-term usage rights of job-related scientific and technological achievements. regarding income distribution, further increase the distribution proportion for research teams (suggested not lower than 70%), and strictly imple-

ment the national policy that “cash rewards for the transformation of job-related scientific and technological achievements by researchers are included in performance wage management and are not subject to total amount restrictions,” allowing researchers to create wealth through technology and stimulating innovation vitality.

4) Team Construction: Cultivating Professional Technology Managers

Professional people should do professional things to build a full-chain service system.

Introduce and cultivate high-level technology managers. Higher vocational colleges should form a composite technology transfer service team that understands technology, markets, law, and management. On one hand, through “bringing enterprises into education,” enterprise executives, patent agents, and investors can be hired as part-time technology managers; on the other hand, professional training for on-campus research management personnel should be strengthened, encouraging them to obtain professional qualifications as technology managers to improve the specialization level of services.

Build a digital supply-demand docking platform. Make full use of big data and artificial intelligence technologies to build or access provincial and municipal public service platforms for scientific and technological achievement transformation. With the help of platform resources such as the “Guangdong University Scientific and Technological Achievement Transformation Center,” verify, grade, and classify the patents accumulated within the school to establish a “Transformable Patent Resource Database.” Through algorithms, precise pushes can be made to relevant enterprises to achieve intelligent matching of technology supply and industrial demand, solving the problem of information asymmetry.

5) Model Innovation: Deepening Industry-Education Integration and Exploring “Order-Based” R&D

Relying on “Double High” construction, explore transformation paths with vocational education characteristics to solve supply-demand misalignment from the source.

Promote “Order-based” R&D. Change the traditional “research first, transfer later” model and implement the “Open Competition Mechanism” (Jiebang Guashuai). Enterprises set the questions (proposing technical pain points), schools answer the questions (organizing teams to tackle key problems), and enterprises accept the results. This reverse innovation model guided by demand can ensure the applicability and transformation rate of achievements from the source. This approach is particularly beneficial for the “Specialized, Refined, Differential, and Innovative” (SRDI) SMEs mentioned in Section 2.2, as it effectively addresses their specific challenge of lacking independent R&D centers by outsourcing technical pain points directly to school teams.

Explore a “School-Enterprise Community with a Shared Future.” Encourage higher vocational colleges to co-incubate technology-based SMEs with industry-leading enterprises using technology as equity contributions. Through equity ties,

the intellectual resources of the school are deeply bound with the capital and market resources of the enterprise, forming a close cooperative relationship of risk-sharing and benefit-sharing, realizing the transformation from “simple technology transfer” to “all-factor collaborative innovation.”

6. Conclusion

At present, as the new round of scientific and technological revolution and industrial transformation accelerates, the transformation of scientific and technological achievements in higher vocational colleges is no longer a “by-product” of scientific research work, but a “compulsory question” for serving the high-quality development of the regional economy. As the leaders of vocational education, Guangdong’s “Double High” institutions possess a good foundation for the transformation of scientific and technological achievements but also face challenges in terms of institutional mechanisms, technological maturity, and supply-demand docking.

However, it is important to acknowledge the limitations of this study. Since the research samples are the top 14 “Double High” institutions in Guangdong, which possess superior resources and policy advantages, the findings may not be fully generalizable to general vocational colleges with limited funding and weaker industrial connections. Future research could expand the scope to include a broader range of institutions to verify the universality of these bottlenecks.

In the future, with the implementation of the Implementation Plan for Deepening the Reform of Management of Job-related Scientific and Technological Achievements in Guangdong Province, higher vocational colleges should seize the opportunity to effectively clear the blockages and checkpoints of scientific and technological achievement transformation through a combination of measures such as implementing single listing management, strengthening pilot scale-up, reconstructing evaluation systems, and cultivating professional teams. This will not only release the huge innovation potential of higher vocational colleges but also inject a steady stream of “vocational education momentum” into the industrial upgrading of Guangdong Province and the Guangdong-Hong Kong-Macao Greater Bay Area, truly realizing the organic connection between the education chain, talent chain, industrial chain, and innovation chain, and contributing vocational education strength to the construction of a powerful nation in education and science and technology.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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