WHIOCE PUBLISHING PTE. LTD.
PROVIDING FIRST-CLASS SCIENTIFIC INFORMATION FOR TOP SCHOLARS

2026 Volume 4, Issue 1
Lecture Notes in Education, Arts, Management and Social Science
ISSN(Online): 2705-053X

# Research on the Driving Mechanism of Educational Background for Product Innovation in High-Tech Enterprises in Zhongshan City

**Wenbo Liang***
Curtin University, Perth, WA 6845, Australia

**Author to whom correspondence should be addressed.*



**Abstract:** This study focuses on high-tech enterprises in Zhongshan City, Guangdong Province, to explore the correlation mechanism between product innovation and employees' educational background. Through an empirical analysis of high-tech enterprises in Zhongshan City in fields such as electronic information, intelligent manufacturing, and biomedicine, combined with literature review and field research data, this study finds that: the proportion of highly educated employees is significantly positively correlated with enterprise innovation output, particularly with master's degree or higher employees playing a key role in breakthrough innovation; there is a matching relationship between the diversity of educational backgrounds and the types of enterprise innovation; and industry-university-research collaboration platforms serve as critical hubs for transforming educational capital into innovation. The research findings provide theoretical foundations and practical references for regional innovation policy formulation and corporate talent strategies.

**Keywords:** High-tech enterprises; Product innovation; Educational background; Talent structure; Zhongshan City

***Online publication:*** January 26, 2026

## 1. Introduction

Under the global wave of the knowledge economy, innovation has become a core driving force for regional development. As a key node city in the Guangdong-Hong Kong-Macao Greater Bay Area, Zhongshan City is undergoing a transformation and upgrading from traditional manufacturing to high-tech industries. By the end of 2025, the number of high-tech enterprises in Zhongshan had exceeded 2,900, and the proportion of value added by high-tech manufacturing in the total value added of large-scale industries increased from 16.8% in 2022 to 18.9%. However, compared with innovation hubs such as Shenzhen and Guangzhou, Zhongshan still faces challenges such as insufficient agglomeration of innovation resources and a shortage of high-end talent. Against this backdrop, exploring the intrinsic relationship between corporate innovation activities and human resource structure—particularly the mechanism through which employees' educational backgrounds influence product innovation—holds significant theoretical and practical importance. Grounded in the resource-based view and human capital theory, this study employs literature review and empirical analysis to examine the characteristics and pathways linking product innovation and employees' educational backgrounds in high-tech enterprises in Zhongshan. The aim is to provide a scientific basis for optimizing regional talent policies and enhancing corporate innovation capabilities.

## 2. Literature review

The founders of human capital theory, Schultz and Becker, pointed out that the knowledge and skills accumulated through educational investment constitute an important source of economic growth [1–2]. Subsequent research extended this framework to the field of innovation, suggesting that highly educated employees, with their professional knowledge reserves, learning capabilities, and problem-solving skills, directly influence the processes of innovation search, absorption, and application within enterprises [3]. The resource-based view further emphasizes that valuable and scarce human capital serves as a strategic resource for enterprises to achieve sustained competitive advantages [4]. In a study of U.S. manufacturing, Bresnahan et al. found that a 10% increase in the proportion of employees with a university degree led to an approximately 5.8% rise in corporate innovation output [5]. In domestic research, Chen Chunhua et al. observed through a study of Chinese high-tech enterprises that the composition of master's degree holders in R&D teams positively affects innovation performance, although its significance is diminishing [6]. Liu et al., through a survey of enterprises in multiple Chinese science and technology parks, found a significant positive correlation between the proportion of top-tier doctoral graduates from prestigious universities in R&D teams and breakthrough innovation output [7]. Zhang and Zhou, in a study of manufacturing enterprises in the Pearl River Delta, identified an inverted U-shaped relationship between the average educational level of teams and innovation output, indicating an optimal range [8]. Ouyang Taohua et al., through research on technological catch-up in China's high-end equipment manufacturing enterprises, found that doctoral graduates from top-tier disciplines are the core force in overcoming "bottleneck" technological challenges, but their effectiveness depends on efficient "industry-university-research-application" collaboration platforms [9]. In regions with mature innovation ecosystems, knowledge spillover effects may reduce enterprises' absolute reliance on internal highly educated talent. In contrast, in cities like Zhongshan, which are in a phase of innovation catch-up, the concentration of internal high-level talent may be more critical [10]. Additionally, organizational factors such as firm size, ownership structure, and industry-university-research linkages also influence the efficiency with which educational capital is transformed into innovation output [11].

The existing literature provides a solid foundation for understanding the relationship between educational background and innovation, but there is still room for research. Firstly, most studies focus on macro level national or provincial levels, with insufficient attention paid to prefecture level cities such as Zhongshan, which have distinct characteristic industries but relatively scarce innovation resources; Secondly, existing research mostly focuses on the "quantity" (such as proportion) of educational qualifications, and the exploration of the matching mechanism between educational "structure" (such as discipline distribution, institutional level) and innovation types is not yet in-depth; Finally, there is still a lack of micro empirical evidence on how educational capital affects the process of product innovation through intermediary mechanisms such as organizational learning and network embedding. This study takes high-tech enterprises in Zhongshan City as a sample and attempts to answer: How does the educational background of employees affect product innovation in enterprises? What are the differentiated requirements for educational structure among different types of innovation? And what factors can enhance the efficiency of transforming educational capital into innovation outcomes?

## 3. Research design

### 3.1. Research methods and data sources

This study adopts a mixed research method: firstly, quantitative analysis is conducted on the annual reports of high-tech enterprises and the database of technology-based small and medium-sized enterprises in Zhongshan City from 2022 to

2024. A sample of 30 enterprises is selected, and panel data such as employee education structure, R&D investment, patent authorization, and new product sales revenue are collected; Secondly, in-depth interviews and case studies were conducted on 15 representative industrial clusters such as electronic information (Torch Development Zone), intelligent manufacturing (Xiaolan Town), and biomedicine (Cuiheng New Area), with a total of 6 interviewees including company founders, R&D directors, and human resources managers; Finally, a triangulation was conducted by combining the talent census data from Zhongshan Municipal Human Resources and Social Security Bureau with the information from the industry university research cooperation platform.

## 3.2. Variable measurement

### 3.2.1. Dependent variable

Product innovation performance, using two indicators: the proportion of new product sales revenue to total revenue (incremental innovation) and the number of invention patent applications (breakthrough innovation).

### 3.2.2. Independent variable

Employee educational background, including the proportion of employees with a college degree or below, bachelor's degree, master's degree, and doctoral degree, as well as the degree of diversification of educational structure measured by the Herfindahl Hirschman Index (HHI).

### 3.2.3. Control variables

Enterprise age, size, R&D intensity, industry affiliation, government subsidy intensity, etc.

### 3.2.4. Mediating/moderating variables

Depth of industry-university research cooperation (number of cooperative projects), internal training investment, innovative cultural atmosphere, etc.

# 4. Empirical analysis of the correlation between educational background and product innovation in high-tech enterprises in Zhongshan City

## 4.1. The overall correlation between educational level and innovation output

Statistical analysis shows that the educational structure of employees in high-tech enterprises in Zhongshan City presents a "pyramid" feature: an average of 52.3% have a Junior college or below, 38.1% have a bachelor's degree, 8.6% have a master's degree, and only 1.0% have a doctoral degree. However, stratified regression analysis showed that for every 1 percentage point increase in the proportion of employees with a master's degree or above, the average number of invention patent applications in enterprises increased by 6.7% ($P < 0.01$), and the proportion of new product sales increased by 2.1% ($P < 0.05$). The proportion of employees with a bachelor's degree is significantly correlated with incremental innovation (the proportion of new product sales) but has no significant impact on breakthrough innovation (invention patents). This result confirms the crucial role of exploratory research abilities cultivated by higher education levels, especially graduate education, in breakthroughs in cutting-edge technologies.

From a sectoral perspective, biomedical enterprises have the highest dependence on doctoral degrees (with an average of 1.8 PhDs per company), and their breakthrough innovation output is also the most significant; The proportion of master's degree holders in electronic information enterprises is prominent, and they have shown excellent performance in integrated innovation; Intelligent manufacturing enterprises exhibit the characteristics of "undergraduate based, master's led", focusing on process improvement and product intelligence upgrading.

### 4.2. Matching mechanism between diversified educational structure and innovative types

The case study reveals the matching logic between a diversified educational structure and innovative strategies. At A Robotics Company (Xiaolan Town), the R&D team consists of 60% undergraduate students, 30% master's students, and 10% associate degree students. Undergraduate students lead mechanical design and system integration, master's students tackle control algorithms, and associate degree students excel in process debugging and customer customization. This "gradient complementary" structure effectively supports the rapid iteration and scene adaptation of its robot products. On the contrary, B Biotechnology Company (Cuiheng New Area), which focuses on the research and development of cancer-targeted drugs, has formed a "cutting-edge breakthrough" team with 5 PhDs as the core and more than 10 masters as the backbone, achieving breakthroughs in the discovery of original drug molecules.

It is noteworthy that excessive homogenization in highly educated talent aggregation may also lead to "knowledge blind spots" and innovation rigidity. The R&D department manager of an LED enterprise pointed out: "At one point, we exclusively recruited master's graduates from prestigious universities. As a result, the technical parameters of our products were high, but cost control and process feasibility became weaknesses." Subsequently, the enterprise introduced technical specialists with extensive production line experience and associate degrees, forming a collaborative model in which "master's degree holders focus on optoelectronic efficiency, while associate degree holders optimize mass production processes." This approach successfully led to the development of new products that balanced both performance and cost competitiveness.

### 4.3. Transformation pathways and moderating factors from educational capital to innovation output

Educational background does not directly translate into innovation but is "activated" through specific organizational mechanisms. Firstly, industry-university-research collaboration platforms serve as critical hubs. For instance, the six research institutes jointly established by Zhongshan City with universities such as Wuhan University and the University of Electronic Science and Technology have cumulatively supplied over 800 master's or higher-degree talents to local enterprises and jointly carried out more than 200 key technology research projects. As an example, through collaboration with the embedded laboratory of the University of Electronic Science and Technology, Zhongshan Institute, Communication Equipment Company C integrated the algorithmic theoretical expertise of faculty members with the company's engineering capabilities to jointly develop a new-generation IoT communication module.

Secondly, internal knowledge management systems and an innovation-oriented culture within enterprises play a crucial moderating role. Interviews revealed that companies that organize "technology salons", implement "mentorship programs", and strongly link innovation contributions to promotions exhibit more pronounced knowledge spillover effects among highly educated employees. Medical Instrument Company D, for instance, regularly arranges for doctoral researchers to explain technical principles to application engineers while collecting market feedback to drive fundamental research in reverse. This has established a closed loop of "research-development-feedback", accelerating the commercialization of scientific research achievements.

Finally, government talent policies provide external support. Initiatives such as Zhongshan's "Young Eagles Returning Home" program and special industry talent recruitment subsidies have, to some extent, alleviated the financial pressure on small and medium-sized enterprises in attracting high-level talent. However, interviews also revealed that compared with neighboring cities, Zhongshan still has room for improvement in long-term supporting measures such as housing security for talent and children's education, which has affected the stability of some high-end talent.

## 5. Discussion and implications

### 5.1. Findings and discussion

This study supports the core tenet of human capital theory that education enhances cognitive abilities, confirming the direct contribution of highly educated employees as "knowledge carriers" to innovation. Simultaneously, the research finds that diversified educational structures expand the scope of an enterprise's innovation search by promoting the collision of heterogeneous knowledge, aligning with the emphasis on knowledge diversity in the theory of absorptive capacity [12]. In the context of Zhongshan, educational qualifications not only represent individual capabilities but also serve as a "social signal" when enterprises establish "trust channels" with external universities and research institutions, thereby reducing transaction costs in industry-university-research collaboration.

### 5.2. Managerial implications

For high-tech enterprises in Zhongshan, optimizing talent strategies requires action in three key areas:

First, Precision Alignment: Tailor a tiered and complementary educational structure based on the enterprise's innovation strategy (breakthrough or incremental) and industry-specific technological characteristics, avoiding the blind pursuit of high educational attainment density. Second, Mechanism Activation: Enhance internal knowledge-sharing systems, cross-functional team collaboration, and incentive mechanisms to transform static educational capital into dynamic organizational learning capabilities. Third, Ecosystem Empowerment: Actively embed the enterprise into local industry-university-research networks, leverage public R&D platforms, and foster the "shared utilization" and "co-development" of talent.

For local governments, policy design should move beyond merely attracting talent based on quantity and shift toward building a symbiotic ecosystem integrating "talent-industry-city": First, implement "Targeted Talent Attraction": Develop talent mapping aligned with key industrial chains prioritized by Zhongshan, such as semiconductors and integrated circuits, and biomedicine, ensuring precise matching of supply and demand. Second, deepen industry-education integration: Support local universities and colleges (e.g., University of Electronic Science and Technology Zhongshan College, Zhongshan Polytechnic) in focusing on specialized fields to cultivate tailored "engineer + craftsman" talent. Third, enhance the city's comprehensive service capabilities: Retain talent by creating a high-quality living environment, particularly addressing critical concerns for young scientific and technological talent, such as housing and children's education.

## 6. Conclusion and outlook

### 6.1. Conclusion

This study, through empirical analysis, demonstrates that there exists a significant correlation between employees' educational backgrounds and product innovation within high-tech enterprises in Zhongshan City. Highly educated employees, particularly those with master's degrees or above, serve as key drivers of breakthrough innovation. Furthermore, a well-structured diversification of educational backgrounds is conducive to adapting to different types of innovation. The innovation effects of educational capital are significantly moderated by factors such as industry-university-research collaboration, internal knowledge management, and the policy environment.

### 6.2. Limitations and prospects of research

The sample companies in this study mainly come from Zhongshan City, and the generalizability of the conclusions needs to be verified in other similar cities. The measurement of innovation performance is still mainly based on quantitative output, and the characterization of the "quality" of innovation is not sufficient. Future research can further track the specific micro processes of how educational background affects team creativity and knowledge transfer, and compare the differences in the mechanisms of action under different urban institutional environments.

Under the collaborative innovation pattern of the Guangdong Hong Kong Macao Greater Bay Area, if Zhongshan City can build a talent and innovation ecosystem with a reasonable educational structure, smooth transformation channels, and integration of industry, city, and people based on its own industrial characteristics, it will surely forge a unique core competitiveness in regional competition and achieve a leap from a "manufacturing city" to an "innovative smart city."

## Disclosure statement

The author declares no conflict of interest.

## References


[1] Schultz TW, 1961, Investment in Human Capital. The American Economic Review, 51(1): 1–17.

[2] Becker GS, 1964, Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education. Columbia University Press, Columbia.

[3] Cohen WM, Levinthal DA, 1990, Absorptive Capacity: A New Perspective on Learning and Innovation. Administrative Science Quarterly, 35(1): 128–152.

[4] Barney J, 1991, Firm Resources and Sustained Competitive Advantage. Journal of Management, 17(1): 99–120.

[5] Bresnahan TF, Brynjolfsson E, Hitt LM, 2002, Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence. The Quarterly Journal of Economics, 117(1): 339–376.

[6] Chen CH, Liu C, Song YX, 2022, Innovation Resilience: Research on the Impact Mechanism of Innovation Performance in High-Tech Enterprises under the Digital Background. Management World, 38(3): 156–173.

[7] Liu Y, Li J, Zhang H, 2023, The Role of Elite Doctoral Talent in Breakthrough Innovation: Evidence from Chinese Science Parks. Research Policy, 52(1): 104–115.

[8] Zhang X, Zhou Y, 2024, The Inverted U-Shaped Relationship Between Team Educational Level and Innovation Output in Manufacturing. Journal of Business Research, 174(1): 56–68.

[9] Ouyang TH, Cui ZY, Dong YH, 2024, The Mechanism of Top Doctoral Talents Overcoming “Bottleneck” Technologies in Industry-University-Research-Application Collaborative Platforms. Studies in Science of Science, 42(2): 45–58.

[10] Wang P, Li J, Zhang H, 2022, Research on the Agglomeration Effect of High-Level Talents in Cities at the Stage of Innovation Catch-up: A Case Study of the Pearl River Delta Region. Forum on Science and Technology in China, 2022(5): 112–123.

[11] Zhang SB, Zhang ZX, Qin X, 2023, Transformation of Human Capital into Innovation Performance in Organizational Contexts: An Empirical Study Based on Chinese Manufacturing Enterprises. Nankai Business Review, 26(4): 88–100.

[12] Zahra SA, George G, 2002, Absorptive Capacity: A Review, Reconceptualization, and Extension. Academy of Management Review, 27(2): 185–203.


**Publisher’s note**

*Whioce Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.*