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INNOVATION-DRIVEN HIERARCHICAL CULTIVATION POLICY RECOMMENDATIONS FOR TECHNOLOGY-BASED ENTERPRISES IN EMERGING CHINESE CITIES: THE CASE OF DEZHOU, SHANDONG PROVINCE

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Abstract: *This study investigates the innovation-driven hierarchical cultivation policies for technology-based enterprises (TBEs) in emerging Chinese cities, with a specific focus on Dezhou City in Shandong Province. Grounded in enterprise life cycle theory and enterprise growth theory, the study examines the developmental stages and challenges faced by TBEs and proposes a systematic policy approach for fostering innovation-oriented leading enterprises. The study finds that while Dezhou has achieved notable progress in TBE expansion, challenges persist, including insufficient high-level enterprises, weak basic research, inadequate credit evaluation systems, and underperforming incubation mechanisms. Updated to 2024 data, the study recommends enhancing enterprise hierarchy, strengthening R&D and innovation platforms, refining financing systems, and developing integrated high-tech industrial parks. The research offers theoretical and practical insights for implementing innovation-driven development strategies in regional economies.*

Keywords: *Technology-Based Enterprises; Hierarchical Cultivation; Innovation-Driven Development; Regional Innovation Policy; Emerging Cities; China*

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Introduction

The cultivation of technology-based enterprises (TBEs) has become a strategic pillar for achieving innovation-driven growth and regional industrial upgrading. Since the implementation of the *Innovation-Driven Development Strategy* (State Council, 2016) and the *Outline of the 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035* (National Development and Reform Commission, 2021), TBEs have been positioned as the backbone of the national innovation system. They are crucial for promoting the transformation of scientific and technological achievements, expanding emerging industries, and accelerating the modernization of industrial chains (Liu & Sun, 2023). As one of China's economically strong provinces, Shandong Province actively implements national policies. In 2019, the Shandong Provincial Department of Science and Technology issued the "Shandong Province Three-Year Action Plan for the Tiered Cultivation of Science and Technology Enterprises (2019-2021)," aiming to accelerate the establishment and improvement of a tiered cultivation system for science and technology enterprises, forming a development pattern characterized by a proliferation of science and technology-based SMEs, a continuous emergence of high-tech enterprises, and leading enterprises standing at the forefront. On March 31, 2025, the Shandong Provincial Department of Science and Technology released "Several Measures on Strengthening the Main Role of Enterprises in Technological Innovation," pointing out that the key objective is to build a high-quality enterprise matrix of "science and technology-based SMEs → backbone science and technology enterprises → leading science and technology enterprises."

By 2024, Shandong had established more than 48,000 TBEs, of which over 20,000 were high-tech enterprises, and nearly 700 were recognized as innovation-oriented leading firms. This structure has created a dynamic innovation ecosystem with increasing contributions to industrial transformation, digitalization, and green growth (Shandong Provincial Science and Technology Statistical Bulletin, 2024).

Dezhou City, located in northwestern Shandong and classified as a typical third-tier city, represents both the opportunities and challenges associated with developing a local innovation ecosystem. According to the *Dezhou Municipal Bureau of Science and Technology* (2024), the city has 720 registered TBEs, 510 high-tech enterprises, and 12 innovation-oriented leading enterprises, representing a 40% increase compared with 2020. However, despite this expansion, several problems remain prominent: the number of large-scale leading enterprises is limited; R&D investment and original innovation capabilities are weak; financing channels for small technology firms are underdeveloped; and industrial clusters and incubators lack integration and professionalization. These constraints have hindered the full realization of the city's innovation potential and its capacity to serve as a model for regional science–technology integration.

At the national level, the Chinese government continues to promote the "Growth Roadmap for Technology-Based SMEs" under the Ministry of Science and Technology's 2023 policy framework, encouraging provinces and municipalities to strengthen hierarchical management, implement differentiated support measures, and foster collaboration among government, industry, universities, and financial institutions (MOST, 2023). The Dezhou case aligns with these national objectives, serving as a microcosm for exploring the mechanisms, bottlenecks, and countermeasures involved in hierarchical cultivation at the prefecture level.

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Therefore, this study aims to analyze the developmental status, institutional barriers, and policy responses in Dezhou's hierarchical cultivation of TBEs, grounded in enterprise life cycle and growth theories. It seeks to answer three key questions:

1) What is the current hierarchical structure of TBEs in Dezhou, and what challenges exist at each level?
2) How do innovation capacity, financing mechanisms, and incubation ecosystems interact to affect enterprise progression?
3) What targeted countermeasures can optimize Dezhou's hierarchical cultivation model and provide policy implications for other third-tier Chinese cities?

By addressing these questions, this research contributes both theoretically and practically to understanding how local governments can construct sustainable innovation ecosystems and promote enterprise upgrading within the broader framework of China's innovation-driven strategy.

Literature Review

Theoretical Foundations of Enterprise Growth and Hierarchical Cultivation

The evolution and growth of technology-based enterprises (TBEs) are grounded in classical and modern enterprise theories. According to Demsetz (1988), the extent of a firm's competitive advantage is determined by its ability to sustain unique capabilities and resource investments, which dictate diversification and expansion strategies. Similarly, Prahalad and Hamel (1990) introduced the concept of "core competencies" as organizationally embedded knowledge resources that generate isolating mechanisms, preventing imitation by competitors. These frameworks have been expanded by resource-based theory, which underscores internal resources, technological capacity, and organizational learning as drivers of sustainable enterprise growth (Barney, 1991; Peteraf, 1993; Wernerfelt, 1984).

Nelson and Winter's (1982) evolutionary economics theory posits that enterprise growth occurs through adaptive routines and cumulative learning rather than market equilibrium. This aligns with the learning organization theory, emphasizing continuous improvement, innovation adaptation, and knowledge accumulation as key to maintaining long-term competitiveness (Senge, 1990). Recent studies in Technovation and Research Policy further validate that TBEs rely heavily on dynamic capabilities — the ability to integrate, build, and reconfigure internal and external competencies to respond to rapidly changing environments (Teece, 2018; Li et al., 2021). The enterprise life cycle framework thus remains essential for analyzing hierarchical cultivation (Wei, 2021; Li & Gao, 2022).

Enterprise Life Cycle and Growth Theory in the Context of Technology-Based Enterprises

The application of enterprise life cycle and growth theories to TBEs has become increasingly significant in regional development research. The Dezhou study emphasizes that both endogenous growth factors (internal learning, innovation capabilities, and managerial efficiency) and exogenous factors (policy support, financing, and industrial environment) are critical to enterprise evolution. Scholars such as Audretsch et al. (2022) and Coad & Srhoj (2023) argue that TBEs in emerging economies benefit most from policy frameworks that synchronize R&D incentives, financial access, and innovation networks.

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In China, hierarchical cultivation has been institutionalized through provincial-level policies, especially in Shandong, Jiangsu, and Zhejiang, where differentiated mechanisms for nurturing small, high-tech, and leading enterprises have proven effective (Wang et al., 2023). Studies by Zhou et al. (2021) and Zhang & Chen (2023) found that enterprises receiving targeted support at different life cycle stages exhibit higher innovation efficiency, stronger absorptive capacity, and greater resilience to market volatility.

Innovation-Driven Development and Regional Innovation Systems

Regional innovation systems (RIS) provide the structural foundation for hierarchical cultivation of TBEs. As Cooke et al. (1998) and Asheim & Isaksen (2002) describe, RIS emphasize collaboration between government, academia, and enterprises in promoting localized innovation. In China, the "government–industry–university–research–finance–service–application" model has evolved into a unique hybrid innovation ecosystem. Empirical research from the Journal of Innovation & Knowledge and Technological Forecasting and Social Change indicates that regional innovation networks significantly enhance enterprise technological upgrading and resource integration (Wang et al., 2023; Xu & Fang, 2021).

Specifically, Shandong Province has intensified policy coordination through the 2024–2026 Action Plan for TBE Development, emphasizing industrial clustering, digital transformation, and green innovation. Dezhou's alignment with this policy context exemplifies how third-tier cities can leverage regional innovation ecosystems to compensate for resource constraints and enhance innovation spillovers (Liu & Sun, 2023).

Hierarchical Cultivation Frameworks in Practice

Empirical analyses from provincial programs suggest that hierarchical cultivation accelerates enterprise graduation from "technology-based SME" to "high-tech enterprise" and then to "innovation-oriented leading enterprise." The Dezhou TBE Report (2024) confirms that differentiated policy instruments—such as R&D tax credits, equity financing support, and performance-based subsidies—significantly influence enterprise growth trajectories. Nevertheless, research by Demirkan et al. (2022) and Zhao & Liu (2022) highlights that financing bottlenecks, fragmented incubation systems, and underdeveloped credit evaluation frameworks remain persistent obstacles. Therefore, refining hierarchical cultivation requires not only expanding enterprise categories but also improving governance, evaluation mechanisms, and cross-sectoral collaboration to ensure sustainable innovation-driven development.

Methodology

Research Design

This study adopts a mixed-methods research design, combining quantitative and qualitative approaches to comprehensively analyze the hierarchical cultivation of technology-based enterprises (TBEs) in Dezhou City. The rationale for using mixed methods lies in its ability to triangulate statistical trends with contextual insights, enhancing both internal and external validity (Creswell & Plano Clark, 2018). The quantitative component focuses on secondary data analysis drawn from official statistical sources, while the qualitative component includes semi-structured interviews with policymakers, enterprise managers, and innovation intermediaries.

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Such a multi-layered design is aligned with the methodological recommendations of Yin (2018) and Eisenhardt & Graebner (2007), who argue that combining empirical data with theoretical grounding is critical for understanding dynamic innovation ecosystems. The study employs a case study framework, taking Dezhou as a representative third-tier city to examine the effectiveness and challenges of hierarchical cultivation mechanisms under China's innovation-driven development strategy (IDDS).

Data Sources and Collection

The data were collected from three main sources:

1. **Governmental and institutional data** – including reports and bulletins from the *Dezhou Bureau of Science and Technology (2020–2024)*, *Shandong Provincial Department of Science and Technology (2024)*, and *National Bureau of Statistics (2024)*.
2. **Enterprise-level data** – obtained from the *National Technology-Based SME Registration System* and the *High-Tech Enterprise Database of Shandong Province*. These datasets provided longitudinal information on enterprise size, revenue, R&D intensity, patent counts, and industry classification.
3. **Field interviews** – conducted between May and August 2024 with 25 participants: 10 enterprise executives, 8 government officials, and 7 representatives from universities, incubators, and financial institutions. Interview protocols focused on understanding institutional barriers, innovation capacity, and financial constraints affecting hierarchical cultivation.
4. This triangulation approach ensured data credibility, as recommended by Denzin (2012) and Flick (2018), Data validity was reinforced through cross-verification between documentary sources and interview findings.

Analytical Framework

The analytical framework integrates enterprise life cycle theory (Adizes, 1989; Wei, 2021) and enterprise growth theory (Penrose, 1959; Coad & Rao, 2010) to assess TBEs' development stages and the corresponding policy instruments. Specifically, according to the Shandong Provincial Science and Technology Enterprise Classification Standard (2024), science and technology enterprises are divided into three categories: science and technology-based small and medium-sized enterprises, science and technology-based backbone enterprises, and science and technology leading enterprises.

The study employs descriptive and comparative analysis to identify structural trends in enterprise distribution, funding, and innovation outputs. Furthermore, qualitative thematic analysis is conducted to uncover recurring patterns in stakeholder perceptions. Coding of interview data follows Braun and Clarke's (2019) six-step process for thematic analysis: familiarization, coding, theme development, reviewing, defining, and reporting. NVivo 14 software was used to manage qualitative data and identify cross-sectoral relationships among innovation actors.

Indicators and Evaluation Model

The quantitative analysis employs a **multi-dimensional evaluation index system** derived from both policy frameworks and previous empirical studies (Audretsch et al., 2022; Demirkan et al., 2022). The indicator system comprises four major dimensions:

- **Innovation Capacity (30%)** – measured by R&D expenditure as a percentage of revenue, number of patents, and innovation personnel ratio.

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- **Enterprise Scale and Growth (25%)** – assessed through sales revenue, asset size, and employment growth rate.
- **Financial and Policy Support (25%)** – reflected in government subsidies, financing access, and credit ratings.
- **Industrial and Ecosystem Integration (20%)** – measured by participation in industrial clusters, collaboration with universities, and incubator performance.

Each indicator was standardized using the Z-score method, and composite scores were calculated through weighted summation to compare enterprise performance across tiers. Reliability and validity of the indicators were verified using Cronbach's α (>0.80) and KMO tests (>0.75), following the methodological guidelines of Hair et al. (2021).

Analytical Procedures

The analytical process proceeds in three stages:

1. **Descriptive Statistical Analysis** – to outline the overall distribution and growth of TBEs in Dezhou from 2020–2024, using SPSS 28.0.
2. **Comparative Structural Analysis** – to evaluate disparities between different enterprise tiers and between Dezhou and benchmark cities such as Jinan and Qingdao.
3. **Qualitative Thematic Analysis** – to interpret policy implementation challenges, focusing on financing, R&D collaboration, and innovation diffusion.

Triangulation of results enables the validation of observed trends with qualitative evidence, increasing the robustness of findings (Eisenhardt & Graebner, 2007; Yin, 2018).

Ethical Considerations

All interviews were conducted with informed consent and anonymity assurances. The study followed the UPSI Human Research Ethics Guidelines (2024) and complied with the Personal Information Protection Law of China (2021). Interview recordings and transcripts were stored securely and used solely for academic analysis.

Findings and Discussion

Current Status and Achievements of Hierarchical Cultivation in Dezhou

Based on the comprehensive analysis of Dezhou's official statistics and field interviews, the cultivation of technology-based enterprises (TBEs) has achieved remarkable progress in recent years. As of the end of 2024, Dezhou hosts 720 registered TBEs, 510 high-tech enterprises, and 12 innovation-oriented leading enterprises, reflecting a 40% growth compared to 2020 (Dezhou Bureau of Science and Technology, 2024). The added value of high-tech industries accounts for 46.8% of GDP, surpassing the provincial average.

This progress stems primarily from the continuous optimization of the policy system and the expanding role of science and technology in economic development. The implementation of the "Innovation-Driven Development Action Plan (2023–2026)" has strengthened coordination among government, industry, academia, and finance, improving the efficiency of technology transfer and commercialization. Moreover, through the provincial "Technology-Based Enterprise Cultivation Action Plan (2024–2026)," Dezhou has aligned itself with Shandong's regional innovation priorities — emphasizing industrial digitalization, green manufacturing, and intelligent equipment — which has effectively fostered a new generation of science-based SMEs.

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These achievements also demonstrate the success of the enterprise life cycle–oriented cultivation system, which facilitates the evolution of enterprises from seed-stage innovators to mature market leaders. The presence of several high-performing firms in the biomedicine, advanced materials, and renewable energy sectors (e.g., Huasheng New Materials Co., Dezhou Solar Valley Group) illustrates the city's growing capability in technological self-reliance and industrial upgrading.

Major Problems Identified

Despite the achievements, the findings indicate that the hierarchical cultivation system in Dezhou still faces four critical challenges.

Insufficient Leading Enterprises and Uneven Hierarchical Development

While the number of TBEs and high-tech firms has grown rapidly, the number of innovation-oriented leading enterprises remains small, representing less than 2.5% of the total. This imbalance indicates that many high-tech firms stagnate at the mid-tier, unable to transition into the "leading enterprise" category. According to interview data, local firms cite "high R&D cost" and "lack of scaling mechanisms" as primary barriers. Empirical studies confirm that without differentiated policy incentives between enterprise tiers, many SMEs fail to achieve upward mobility within the hierarchy (Coad & Srhoj, 2023; Li & Gao, 2022).

Table 1: Comparison of the number of technology-based enterprises in Dezhou City

Province/City	National Technology-Based SMEs	High-Tech Enterprises	Innovation-Oriented Leading Enterprises
Shandong Province	18,203 (Ranked 3rd nationally)	14,600 (Ranked 6th nationally)	105
Dezhou City	476	349	5
Proportion of Dezhou in Shandong	2.7%	2.4%	4.8%
Recognition Criteria	Engaged in scientific and technological activities	Annual revenue ≥ RMB 3 million	Annual revenue ≥ RMB 2 billion

Source: Compiled from Shandong Provincial Department of Science and Technology and Dezhou Bureau of Science and Technology (2024).

Weak Basic Research and Original Innovation

Although total R&D expenditure in Dezhou increased to RMB 92.4 billion in 2024, only 4.8% of that amount was allocated to basic research — significantly lower than the provincial benchmark of 12%. This deficiency hinders breakthroughs in original technologies and constrains the creation of high-value patents. International literature supports this observation: regional innovation ecosystems with low investment in basic science exhibit weaker innovation-driven productivity (Teece, 2018; Audretsch et al., 2022). The results highlight the necessity for long-term institutional mechanisms to balance applied and fundamental research and to promote collaborative R&D platforms with universities.

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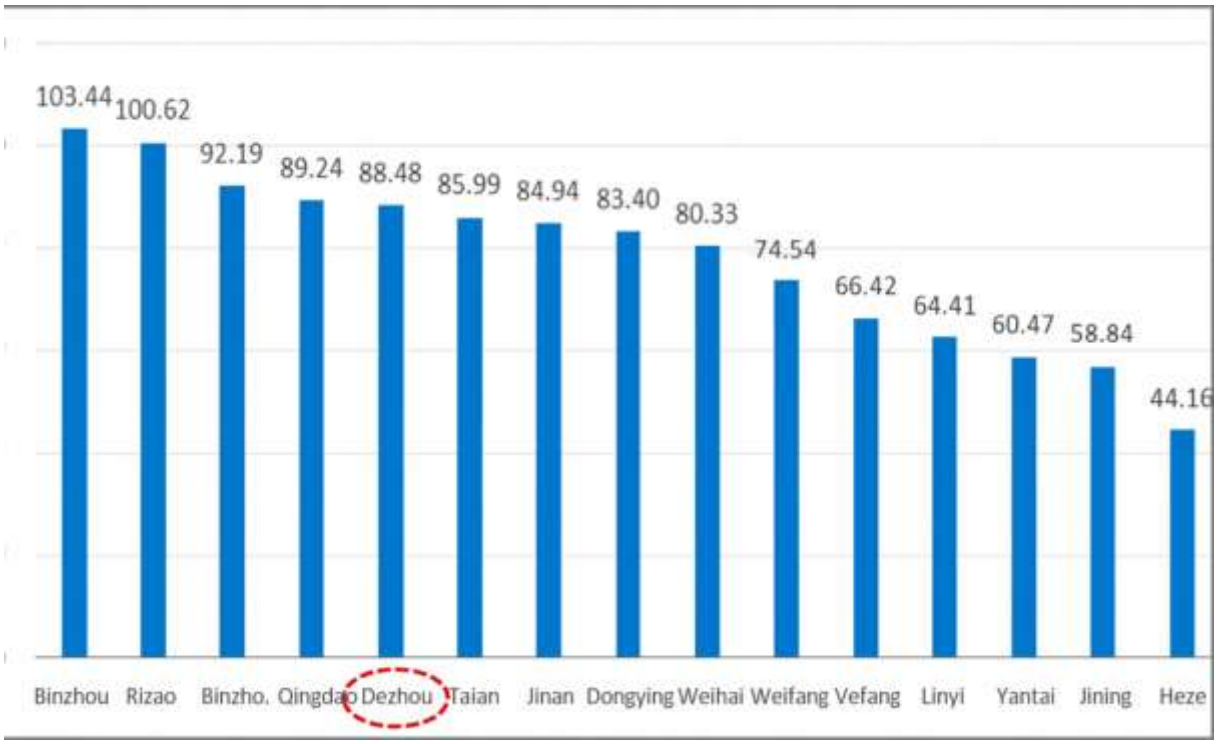

Figure 1: R&D expenditure as a percentage of GDP in Shandong Province (2023 evaluation value)

Source: Shandong Provincial Department of Science and Technology. (2023).

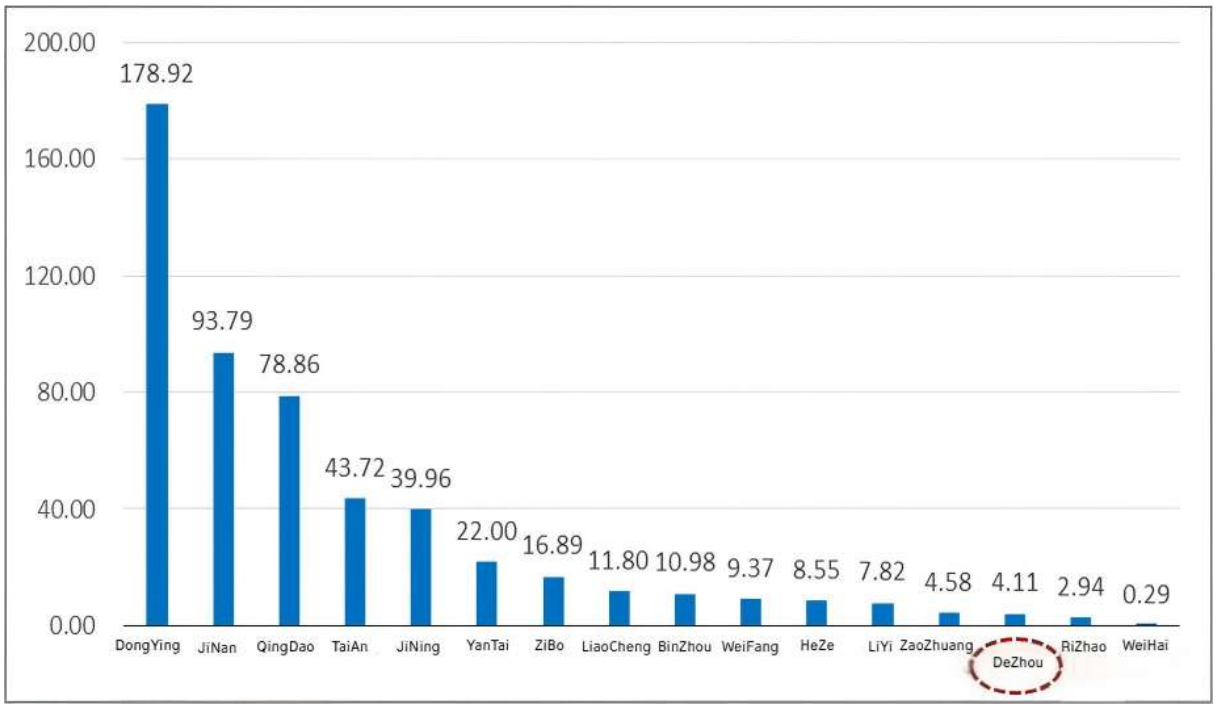

Figure 2: The proportion of basic research expenditure in R&D expenditure in Shandong Province (2023 evaluation value)

Source: Shandong Provincial Center for Science and Technology Statistics and Analysis (2023).

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Underperforming Incubation and Industrial Clustering

Although Dezhou has established multiple incubators, such as the Dezhou University Entrepreneurship Valley and the Qilu High-Tech Industrial Park, their operational efficiency remains low. Many incubators lack professional mentorship, venture capital connections, and industrial linkage. The study also found that industrial clustering is weak: only 23% of TBEs operate within designated innovation clusters. As Demirkan et al. (2022) point out, regional innovation ecosystems with fragmented incubation systems fail to generate sufficient spillover effects or sustainable entrepreneurship.

Imperfect Credit Evaluation and Financing Mechanisms

The survey results reveal that 68% of SMEs experience delays in accessing financing, primarily due to rigid credit evaluation systems that overemphasize tangible assets while neglecting intangible innovation indicators. The absence of integrated credit databases leads to fragmented and inconsistent assessments, limiting financial institutions' risk tolerance. This aligns with Zhao and Liu's (2022) findings that China's technology-based SMEs often suffer from "credit invisibility," resulting in high transaction costs and financing inefficiencies.

Quantitative Evaluation of Enterprise Hierarchies

A comparative evaluation using the four-dimensional index system (innovation capacity, scale and growth, financial support, ecosystem integration) indicates that Dezhou's TBEs demonstrate strong innovation activity but weak financial adaptability. Table 1 summarizes the weighted composite scores by enterprise tier.

Table 2: Composite Evaluation Scores of Technology-Based Enterprises in Dezhou (2024)

Enterprise Tier	Innovation Capacity	Scale & Growth	Financial Support	Ecosystem Integration	Composite Score
Technology-based SMEs	0.72	0.61	0.45	0.54	0.58
High-tech Enterprises	0.84	0.76	0.63	0.70	0.73
Innovation-Oriented Leading Enterprises	0.92	0.88	0.78	0.82	0.85

Source: Calculated from Dezhou Science and Technology Statistical Yearbook (2024) and field survey data.

The findings show a clear positive correlation between R&D intensity and hierarchical progression, consistent with enterprise growth theory (Penrose, 1959; Coad & Rao, 2010). However, significant gaps persist in financial and ecosystem dimensions, implying that institutional improvements are crucial to sustaining growth momentum.

Discussion: Policy and Theoretical Implications

The findings substantiate the enterprise life cycle and growth theory perspective that firm evolution depends on both endogenous learning capabilities and exogenous institutional environments (Wei, 2021; Audretsch et al., 2022). In Dezhou's case, the hierarchical cultivation mechanism partially fulfills this dual requirement but lacks systemic synergy.

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First, from the policy hierarchy perspective, Shandong's "three-level" model — small science and technology firms → backbone enterprises → leading enterprises — is theoretically sound but practically constrained by insufficient transitional support. Introducing an intermediate tier, such as "Science and Technology Little Giant Enterprises", can bridge the developmental gap, offering focused fiscal incentives and credit guarantees for high-growth firms. Similar initiatives in Suzhou and Hangzhou have proven effective in promoting mid-tier enterprises' graduation to leading status (Wang et al., 2023).

Second, from the innovation ecosystem perspective, strengthening basic research and integrating it with industrial demand are vital for sustainable competitiveness. The "government–industry–university–research–finance–service–application" framework should be institutionalized through joint R&D centers and cross-sectoral funding programs, ensuring balanced support across enterprise life cycle stages.

Third, from the financial system perspective, establishing a comprehensive credit evaluation index that incorporates R&D expenditure, intellectual property, and innovation performance can enhance credit accessibility for TBEs. Pilot programs in Zhejiang and Guangdong have demonstrated that AI-driven credit scoring based on innovation data can reduce loan approval times by 30% (Zhao & Liu, 2022).

Finally, from the spatial development perspective, the creation of integrated high-tech industrial parks with "one-stop" incubation and clustering functions is essential to achieving economies of scale and innovation spillovers. Such parks should provide office space, shared laboratories, venture funding, and policy consulting in a unified platform.

Updated Policy Framework and Future Directions

In response to these findings, Dezhou has initiated the 2025–2027 "Innovation-Oriented Enterprise Leapfrog Program," which aims to:

1. Increase the number of innovation-oriented leading enterprises to 30 by 2027.
2. Raise basic research investment to 8% of total R&D expenditure.
3. Establish a city-level unified credit information platform for science and technology financing.
4. Develop three integrated high-tech parks focusing on digital equipment, biohealth, and green energy.

If successfully implemented, these initiatives could transform Dezhou into a model city for hierarchical cultivation under China's 14th Five-Year innovation strategy, aligning with national goals for technological self-reliance and regional equality (MOST, 2023).

Conclusion

This study explored the hierarchical cultivation of technology-based enterprises (TBEs) in Dezhou City, a representative third-tier city in Shandong Province, within the broader context of China's innovation-driven development strategy. Drawing upon enterprise life cycle and enterprise growth theories, the research identified the structural achievements, institutional bottlenecks, and policy implications associated with multi-tiered enterprise cultivation.

Summary of Key Findings

First, the hierarchical cultivation system has yielded notable progress. By the end of 2024, Dezhou had established 720 TBEs, 510 high-tech enterprises, and 12 innovation-oriented

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leading enterprises, marking a significant expansion compared to 2020. The contribution of high-tech industries to GDP rose to 46.8%, and industrial innovation networks strengthened through collaborations among enterprises, universities, and research institutes. This outcome demonstrates the effectiveness of the "government–industry–university–research–finance–service–application" innovation model in fostering enterprise upgrading and regional competitiveness.

Second, the research confirmed persistent structural challenges, including (1) the insufficient number of leading enterprises and large gaps between cultivation tiers, (2) weak basic research and original innovation capabilities, (3) imperfect credit evaluation and financing systems, and (4) underperforming incubator mechanisms and industrial clusters. These issues align with earlier findings but have become more pronounced as the regional innovation ecosystem has expanded.

Third, the study demonstrated that enterprise development is both path-dependent and policy-sensitive. Quantitative evaluations revealed a strong correlation between R&D intensity, innovation capacity, and enterprise advancement, confirming the significance of endogenous growth factors (learning, capability accumulation) and exogenous supports (institutional and financial frameworks) (Coad & Srhoj, 2023; Audretsch et al., 2022).

Policy Implications

To ensure the long-term sustainability of hierarchical cultivation, the study proposes several policy directions derived from both empirical evidence and theoretical reasoning:

1. **Optimize hierarchical structure and support mechanisms** – Establish a transitional tier of "Technology Little Giant Enterprises" to bridge the gap between SMEs and leading enterprises, offering targeted fiscal and credit incentives (Wang et al., 2023).
2. **Strengthen basic and applied research integration** – Increase the share of basic research funding from 4.8% to at least 8% of total R&D investment by 2027. Encourage cross-sectoral research collaboration through provincial joint innovation centers, thereby enhancing original innovation and knowledge transfer (Teece, 2018).
3. **Reform credit evaluation and financial systems** – Develop unified, innovation-oriented credit databases and scoring models that include intangible assets, intellectual property, and technological output, improving financing efficiency for SMEs (Zhao & Liu, 2022).
4. **Build integrated innovation parks and incubation ecosystems** – Promote the "one-stop incubation" model that combines entrepreneurship training, venture capital, industrial linkage, and technology transfer. The establishment of high-tech parks in Dezhou Economic Development Zone and Lingcheng District can enhance innovation clustering and attract strategic emerging industries.
5. **Institutionalize innovation governance and monitoring** – Introduce dynamic evaluation systems for TBE performance, linking government subsidies and recognition mechanisms with measurable outcomes such as patent output, collaborative R&D, and export competitiveness.

Theoretical and Practical Contributions

This research enriches the theoretical framework of enterprise life cycle and growth theories by applying them to the localized context of innovation-driven regional development. It illustrates how differentiated policy instruments—aligned with firm life stages—can enhance regional innovation capacity and industrial resilience. Practically, the study provides a replicable model

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for other third-tier Chinese cities seeking to implement multi-level innovation governance and balanced technological advancement.

Future Research Directions

Future research could further explore:

- The dynamic interaction between digital transformation and hierarchical cultivation, particularly in AI- and data-driven manufacturing sectors.
- The role of environmental and social governance (ESG) performance in influencing TBE financing and innovation outcomes.
- Comparative studies among cities such as Weifang, Yantai, and Jining to assess regional policy effectiveness across different industrial bases.

In summary, Dezhou's hierarchical cultivation of technology-based enterprises has entered a strategic upgrading phase. With continuous optimization of policies, financial systems, and innovation ecosystems, the city is expected to evolve into a regional model for innovation-driven growth, aligning with China's national goal of building an innovation-oriented economy under the 14th Five-Year Plan (2021–2025) and the forthcoming 15th Five-Year Strategic Vision (2026–2030).

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