

Research on the Niche-Upgrading Path of “Specialized, Refined, Distinctive, and Innovative” Small-Giant Enterprises: A Case Study of Haibo Electric, a Provincial Manufacturing Single-Champion and National SRDI “Little Giant” Enterprise

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Abstract

Against the background of China’s gradient cultivation policy for specialized, refined, distinctive, and innovative (SRDI) enterprises and the continued implementation of the “Made in China 2025” strategy, niche upgrading has become an important route for small and medium-sized manufacturing enterprises to overcome low-end lock-in and achieve high-quality development. Taking Haibo Electric, a provincial manufacturing single-champion enterprise and national SRDI “little giant” enterprise, as the core case, this study integrates ecological niche theory and enterprise life-cycle theory and constructs an analytical framework based on niche width, niche fitness, and niche overlap. Owing to data availability, the empirical part uses a single-year cross-sectional sample of six enterprises in Yantai. Case analysis, exploratory DEA and SBM measurement, descriptive comparison, and qualitative evidence coding are adopted to identify the main factors related to niche upgrading. To improve reproducibility, the data are classified into publicly disclosed data, interview or internal-document data, and estimated data; estimated values are clearly marked and used only for exploratory comparison. The findings suggest that technological innovation, human-resource allocation, market expansion, policy support, industrial collaboration, and entrepreneurship may jointly support niche upgrading, while green development and digital transformation may constitute a dual-support path for improving niche fitness and expanding niche width. The conclusions are exploratory and should be further tested with larger

samples, comparable industries, and multi-year panel data.

Keywords

Specialized, Refined, Distinctive, and Innovative, Small-Giant Enterprises, Ecological Niche Upgrading, Green Development, Digital Transformation

1. Introduction

1.1. Research Background

With the deepening of global green transformation and the rapid development of digital technologies, small and medium-sized enterprises have become important carriers of industrial upgrading under the broader requirements of high-quality development (Wei, 2022). At the same time, they face constraints such as weak innovation resources, limited market channels, insufficient digital capabilities, and intense homogeneous competition. For SRDI enterprises, how to form a stable and differentiated ecological niche is therefore a key issue in achieving sustainable growth (Chen et al., 2024; Zhou et al., 2025).

Existing studies have discussed policy effects (Chen et al., 2024; Zhou et al., 2025; Yue & Liu, 2025; Wang, 2025a), innovation incentives (Liu et al., 2026), industrial-chain coordination (Yu, 2022; Jiang et al., 2023), and digital empowerment (Wu & Wu, 2026; Li & Sun, 2024; Xu, 2025; Zhang & Pan, 2025; Wu et al., 2024; Edeh et al., 2025), but research on the niche upgrading of SRDI enterprises remains insufficient. First, there is still a lack of tracking and interpretation of the growth process of typical enterprises. Second, ecological niche theory and enterprise life-cycle theory have not been fully integrated. Third, quantitative evaluation systems and multi-dimensional influencing factors remain underdeveloped. Fourth, from the perspective of undergraduate innovation and entrepreneurship training programs, existing findings still need to be translated into practical and operable research designs.

China has continuously improved the gradient cultivation system for SRDI enterprises. Policy support has gradually shifted from broad recognition and cultivation to more precise empowerment, including technological breakthroughs, new product development, talent training, management diagnosis, and industrial-chain collaboration (Jiao, 2025; Wang, 2025a). Against this background, studying the niche-upgrading path of a provincial single-champion and national SRDI “little giant” enterprise can provide practical evidence for the high-quality development of manufacturing SMEs.

1.2. Significance of the Study

This study focuses on Haibo Electric and examines the evolution of its ecological niche under the combined influence of technological innovation, resource allocation, green development, and digital transformation. The study aims to explain how a

manufacturing SME can move from niche entry to niche consolidation and obtain a more stable position in the industrial ecosystem, which is consistent with the broader concern of high-quality enterprise development (Wei, 2022; Liu et al., 2026).

At the theoretical level, the study extends ecological niche theory to the micro-level analysis of SRDI enterprises. By linking niche width, niche fitness, and niche overlap with the enterprise life cycle, it builds an analytical framework suitable for explaining the growth of manufacturing SMEs. This framework enriches research on SRDI enterprises and provides a useful perspective for subsequent studies on enterprise growth and industrial upgrading.

At the practical level, the case of Haibo Electric helps identify feasible upgrading paths for SMEs facing constraints in R&D, talent, markets, and collaboration. It also provides reference for local governments to optimize the gradient cultivation mechanism and improve targeted policy support. In addition, the research process formed under the National Undergraduate Innovation and Entrepreneurship Training Program offers a methodological reference for similar student research projects.

1.3. Literature Review at Home and Abroad

Domestic research on SRDI enterprises has gradually expanded from policy-effect evaluation to supply-chain resilience, digital-intelligent empowerment, new quality productivity, and industrial collaboration (Chen et al., 2024; Zhou et al., 2025; Zhao, 2024; Yu, 2022; Yue & Liu, 2025; Xu, 2025; Zhang & Pan, 2025; Wang, 2025a; Wu et al., 2024). At the policy level, SRDI certification can transmit positive signals, attract resources, and promote capability upgrading. However, the policy effect may differ across regions because of differences in innovation infrastructure, industrial foundations, and public-service capacity.

In studies of influencing factors and industrial practice, technological innovation is generally regarded as the core driving force of niche upgrading (Liu et al., 2026). Industrial-chain collaboration and digital empowerment can improve resource allocation and market response (Wu & Wu, 2026; Li & Sun, 2024; Yu, 2022; Wu et al., 2024), but many SMEs still face weak data governance and limited digital application capabilities (Zhao, 2024; Xu, 2025; Zhang & Pan, 2025). Financial support and commercial-bank empowerment are also considered important supplementary conditions for SME innovation and upgrading (Zhang & Pan, 2025; Jiang et al., 2023). These constraints reduce the effectiveness of digital technology in promoting high-quality growth.

Foreign research provides useful comparative experience. The “hidden champion” theory proposed in the German context is closely related to China’s SRDI strategy. Germany’s vocational education system and industrial division of labor have strengthened enterprise specialization and human-capital matching. Other economies have also accumulated experience in policy coordination, data circulation, technical standards, and industrial-chain governance; studies on transition economies also suggest that infrastructure, digitalization, and innovation capabilities are closely related to SME export intensity and growth performance (Edeh et

al., 2025).

Overall, the existing literature has laid a foundation for this study, but it has not yet fully explained how a specific SRDI enterprise upgrades its niche across different development stages. Therefore, this paper combines case analysis with exploratory efficiency measurement to examine the growth logic of Haibo Electric and to refine a niche-upgrading path that can be used as a practical reference (Chen et al., 2024; Wu & Wu, 2026; Li & Sun, 2024; Yu, 2022; Wu et al., 2024).

2. Research Design

2.1. Selection of Research Subjects and Data Sources

2.1.1 Selection of Research Subjects

Yantai Haibo Electrical Equipment Co., Ltd. (hereinafter referred to as Haibo Electric) is a national SRDI “little giant” enterprise and was included in the seventh batch of Shandong provincial manufacturing single-champion enterprises¹ (Yantai Haibo Electrical Equipment Co., Ltd., n.d.). The company has developed in the fields of green-factory construction, energy conservation, carbon reduction, and digital transformation (Yantai Haibo Electrical Equipment Co., Ltd., n.d.). Its growth from a gazelle enterprise to a provincial single-champion enterprise makes it a representative case for studying the niche upgrading of SRDI enterprises.

For comparative analysis, this study selects five local enterprises in Yantai as reference samples. Together with Haibo Electric, the sample covers electrical equipment, pump manufacturing, precision watches, biomedicine, and titanium materials. Because the sample is small and cross-industry, the results are used only for exploratory comparison and case corroboration, rather than for strict statistical inference. Regional background and local policy environment are treated as relatively common external conditions.

2.1.2. Data Sources and Estimation Protocol

The data used in this study include primary survey data and secondary public data. Primary data were obtained through field visits, interviews with managers and technical personnel, and the collection of internal materials such as R&D records, patent certificates, management documents, and production-operation information. Secondary data were collected from enterprise annual reports, social responsibility reports, official policy documents issued by Yantai government departments, corporate public information, patent databases, statistical yearbooks, and academic or industry research reports² (Yantai Haibo Electrical Equipment Co., Ltd., n.d.; Shandong Boan Biotechnology Co., Ltd., 2025; Yantai Zhenghai Bio-Tech Co., Ltd., 2025).

To improve transparency and reproducibility, all variables are classified into

¹Department of Industry and Information Technology of Shandong Province (2023). https://gxt.shandong.gov.cn/art/2023/11/16/art_15202_10338429.html

²Department of Industry and Information Technology of Shandong Province (2023). https://gxt.shandong.gov.cn/art/2023/11/16/art_15202_10338429.html

Yantai Statistics Bureau (2025). https://www.yantai.gov.cn/art/2025/1/22/art_43178_3235336.html

National Intellectual Property Administration (n.d.). <https://pss-system.cponline.cnipa.gov.cn/>

three categories. Category A refers to publicly disclosed data, including annual reports, official government notices, enterprise websites, patent databases, and statistical yearbooks³ (Yantai Haibo Electrical Equipment Co., Ltd., n.d.; Shandong Boan Biotechnology Co., Ltd., 2025; Yantai Zhenghai Bio-Tech Co., Ltd., 2025). Category B refers to field-visit, interview, or internal-document data, including interview records, R&D files, qualification certificates, and production-operation materials provided during the research process. Category C refers to estimated data, which are used only when direct disclosure is unavailable. If only a ratio is available, the absolute value is calculated using a clear formula; for example, R&D personnel are estimated as total employees multiplied by the R&D personnel ratio, R&D expenditure is estimated as operating income multiplied by the R&D expenditure ratio, and per-capita output is calculated as operating income divided by total employees.

All estimated values are marked in the tables. The estimation process follows three reliability-control steps: cross-checking with public information, interview evidence, or comparable enterprise benchmarks where possible; checking whether the value falls within a reasonable range for similar SRDI manufacturing enterprises; and keeping calculation formulas consistent across sample enterprises. Variables with weak public verifiability, such as policy-support intensity, market coverage, and enterprise-synergy intensity, are treated as qualitative or ordinal indicators rather than precise statistical facts. Estimated and ordinal data are used only for exploratory case comparison and do not support causal inference or broad statistical generalization.

Because the available data are mainly single-year cross-sectional data, this study does not use dynamic productivity indices that require a multi-year panel. Market expansion is instead measured by revenue growth, market coverage, and qualitative evidence from channel expansion and digital market access. This adjustment ensures that the selected methods are consistent with the structure and reliability of the available data.

2.1.3. Data Reliability and Boundary of Inference

For journal publication, this study further clarifies the boundary between factual data and estimated data. Publicly verifiable facts, such as qualification recognition, listed-company revenue, and patent or certification information, are described as factual statements. Data obtained from interviews or internal materials are described as research evidence. Estimated variables are marked with “estimated” and are used only to construct relative comparisons within the small sample. Accordingly, the DEA and SBM results should be understood as exploratory measurement results based on the selected indicators, not as causal identification or a general ranking of all SRDI enterprises.

³Department of Industry and Information Technology of Shandong Province (2023).

https://gxt.shandong.gov.cn/art/2023/11/16/art_15202_10338429.html

Yantai Statistics Bureau (2025). https://www.yantai.gov.cn/art/2025/1/22/art_43178_3235336.html

National Intellectual Property Administration (n.d.). <https://pss-system.cponline.cnipa.gov.cn/>

2.2. Study Methods

This study takes case analysis as the core method and combines exploratory DEA, exploratory SBM, descriptive statistics, and qualitative evidence coding. The analysis is conducted from six dimensions: technological innovation, human resources, market expansion, policy support, industrial collaboration, and entrepreneurship. Among them, entrepreneurship is analyzed through interview evidence and the enterprise's development records. Quantitative results are used only to support cross-sample comparison and case interpretation, while qualitative evidence is used to explain the possible mechanisms of niche upgrading.

2.2.1. Case Analysis

Case analysis is used to reconstruct the development process of Haibo Electric. Based on field research, interviews, and internal data, the study reviews the company's evolution across five stages: exploration, deepening, expansion, optimization, and consolidation. The analysis focuses on the relationship among strategic decisions, resource allocation, and niche evolution, and then refines an upgrading path consistent with ecological niche theory.

2.2.2. DEA Model for Technological Innovation

DEA is used to measure the relative efficiency of technological innovation in an exploratory manner. The CCR model under constant returns to scale and the BCC model under variable returns to scale are adopted to compare the input-output efficiency of sample enterprises. The input indicators include the number of R&D personnel and R&D expenditure, while the directly comparable output indicator is patent authorization (see **Table 1** for the original data). New-product output is discussed only as qualitative evidence because comparable and verifiable data are not fully available for all sample enterprises. The efficiency score ranges from 0 to

Table 1. Original data on technological innovation.

Enterprises	R&D personnel	Proportion of R&D personnel	R&D expenditure (10,000 yuan)	R&D expenditure ratio	Cumulative patent count
Haibo Electric	102 (estimated)	32% (estimated)	2339.2 (estimated)	8.5% (estimated)	28 (annual)
Longgang Pump Industry	45 (estimated)	18.6% (estimated)	860.3 (estimated)	5.2% (estimated)	98
Durable Watches	133 (estimated)	35% (estimated)	3430.0 (estimated)	9.8% (estimated)	265
Boan Bio	254	39.1%	14,927	20.5%	50
Blue Sky Titanium	73 (estimated)	28% (estimated)	1504.8 (estimated)	7.6% (estimated)	44 (7 inventions and 37 utility models)
Zhenghai Bio	98 (estimated)	26% (estimated)	3232.7 (estimated)	8.9% (estimated)	Not disclosed

Note: R&D expenditure estimates are calculated as 2024 operating revenue multiplied by the R&D expenditure ratio. R&D personnel estimates are calculated as total employees multiplied by the R&D personnel ratio. Patent-related information is checked against enterprise materials and public patent-search channels where available (<https://pss-system.cponline.cnipa.gov.cn/>). "Estimated" indicates that the value is derived from public information, interviews, or comparable-enterprise benchmarks rather than directly disclosed statistics.

Table 2. Data analysis of technological innovation efficiency.

Enterprises	Integrated efficiency (CCR)	Pure technical efficiency (BCC)	Scale efficiency	Returns to scale	Efficiency rating
Haibo Electric	0.873	0.912	0.957	Increasing	Relatively high
Longgang Pump Industry	0.524	0.586	0.894	Increasing	Moderate
Durable Watches	0.921	0.935	0.985	Constant	High
Boan Bio	0.945	0.968	0.976	Constant	High
Blue Sky Titanium	0.786	0.823	0.955	Increasing	Relatively high
Zhenghai Bio	0.612	0.658	0.930	Increasing	Moderate

Note: This table reports exploratory relative efficiency values calculated under the limited-sample frontier. Since new-product output is not consistently disclosed by all enterprises, patent authorization is used as the comparable output indicator, while new-product output is retained only for qualitative interpretation.

1, with a higher score indicating stronger relative innovation efficiency (as shown in **Table 2**) under the current sample frontier. Because the number of decision-making units is limited, the DEA results are interpreted as auxiliary evidence rather than as strict statistical proof.

2.2.3. SBM Model for Human-Resource Allocation

The SBM model is used as an exploratory reference for identifying human-resource allocation efficiency. Considering the limitations of data availability, the measurable indicators mainly include employee scale and per-capita output (see **Table 3** for original data, and **Table 4** for the efficiency results). Training input, talent stability, and innovation-project insufficiency are not treated as fully quantified variables; instead, they are interpreted with interview evidence and enterprise development records. Therefore, the SBM results are used only to identify possible human-resource bottlenecks and cannot be interpreted as a complete causal test of talent factors in niche upgrading.

Table 3. Original data on human resources.

Enterprises	Total employees	Output per capita (10,000 yuan)	Notes
Haibo Electric	320 (estimated)	86.0 (estimated)	Revenue: 275.20 million yuan (estimated)
Longgang Pump Industry	244	67.8	Revenue: 165.45 million yuan
Durable Watches	184 insured employees	190.2	Revenue: 350.00 million yuan (estimated)
Boan Bio	657	110.5	Revenue: 726.32 million yuan
Blue Sky Titanium	260 (estimated)	76.2	Revenue: 198.00 million yuan (estimated)
Zhenghai Bio	375	96.9	Revenue: 363.23 million yuan

Note: Per-capita output is calculated as 2024 operating revenue divided by the number of employees. Revenue and employee figures from listed companies are treated as public data and checked with listed-company disclosures where available (Shandong Boan Biotechnology Co., Ltd., 2025; Yantai Zhenghai Bio-Tech Co., Ltd., 2025); figures marked as estimated are used only for exploratory comparison.

Table 4. Data analysis of human-resource efficiency.

Enterprises	Human-resource efficiency	Input redundancy	Output insufficiency	Improvement direction
Haibo Electric	0.856	Employee input redundancy about 5%	Innovation-project insufficiency indicated by qualitative evidence	Increase per-capita innovation output
Longgang Pump Industry	0.743	Limited training input indicated by qualitative evidence	Low per-capita output	Strengthen training and productivity improvement
Durable Watches	0.935	No obvious redundancy	Innovation projects slightly insufficient	Maintain current advantage
Boan Bio	0.978	No obvious redundancy	No obvious deficiency	Benchmark enterprise
Blue Sky Titanium	0.812	Employee data partly estimated	Output comparison limited by data availability	Improve disclosure and data tracking
Zhenghai Bio	0.891	Training input partly undisclosed	Talent-retention risk indicated by qualitative evidence	Strengthen talent development

Note: The human-resource efficiency values in this table are exploratory results. Interpretations related to training input, innovation projects, and talent stability are based on interview evidence and public information rather than on fully disclosed quantitative variables.

2.2.4. Descriptive Comparative Analysis of Market Expansion

Market expansion is examined through descriptive comparative indicators rather than dynamic productivity indices. The main indicators are operating revenue, revenue growth rate, and market coverage (as shown in **Table 5**). The growth rate is calculated as: $(\text{revenue in 2024} - \text{revenue in 2023}) / \text{revenue in 2023} \times 100\%$. This method is consistent with the available cross-sectional and short-period data and can reflect the relationship between market expansion and niche width in an exploratory manner. Listed-company revenue data are checked against public disclosures where available (Shandong Boan Biotechnology Co., Ltd., 2025; Yantai Zhenghai Bio-Tech Co., Ltd., 2025).

Table 5. Original data on market expansion.

Enterprises	Revenue in 2024 (10,000 yuan)	Revenue in 2023 (10,000 yuan)	Growth rate	Market coverage
Haibo Electric	27,520 (estimated)	23,000 (estimated)	+18.5%	38% (estimated)
Longgang Pump Industry	16,544.9	17,298.4	-4.36%	25% (estimated)
Durable Watches	35,000 (estimated)	28,800 (estimated)	+21.3%	More than 80%
Boan Bio	72,632	61,813	+17.5%	45% hospital coverage
Blue Sky Titanium	19,800 (estimated)	15,800 (estimated)	+25.3%	35% (estimated)
Zhenghai Bio	36,322.5	41,365.3	-12.19%	38% (estimated)

Note: Market coverage is derived from enterprise business layout, customer distribution, public information, and industry benchmarks. It is an estimated indicator for relative comparison and should not be interpreted as an official market-share statistic.

2.2.5. Policy-Support Analysis

Descriptive statistics and qualitative coding are used to analyze policy support. The core indicators include policy-support level, qualifications or certifications, enterprise scale, and years of establishment (see **Table 6** for the original data). Precise fiscal-subsidy amounts are not reported unless they are publicly disclosed or supported by formal documents. These indicators are used to explain how policy resources may improve resource acquisition, strengthen niche fitness, and support technological and digital transformation (Chen et al., 2024; Zhou et al., 2025; Yue & Liu, 2025; Wang, 2025a).

Table 6. Original data on policy support.

Enterprises	Policy-support level	Subsidy disclosure status	Qualification/certification evidence	Business size	Data reliability
Haibo Electric	High	Not publicly disclosed; precise subsidy value not retained	National SRDI “little giant”; Shandong provincial manufacturing single champion; high-tech enterprise	320 employees (estimated)	Public + interview + estimate
Yantai Longgang Pump Industry	Medium	Not publicly disclosed	Pump-industry qualification and public business information	244 employees	Public + estimate
Durable Watches	High	Not publicly disclosed	National science and technology projects, standard participation, and R&D platforms	380 employees (estimated)	Public + estimate
Boan Bio	High	Not publicly disclosed	Listed-company disclosure and biomedical qualification evidence	657 employees	Public annual report
Blue Sky Titanium	High	Not publicly disclosed	Aerospace-material cooperation and qualification evidence	260 employees (estimated)	Public + estimate
Zhenghai Bio	High	Not publicly disclosed	Listed-company disclosure and medical-device qualification evidence	375 employees	Public annual report

Note: Policy-support level is a qualitative assessment based on qualification recognition, policy participation, and public or interview evidence. Precise subsidy amounts are not retained because they are not uniformly publicly verifiable.

2.2.6. Enterprise-Synergy Analysis

Qualitative evidence coding is used to analyze industrial synergy. The study evaluates three dimensions: technological cooperation, supply-chain coordination, and participation in industrial alliances. The assessment is based on cooperation scale, partner level, project number, and publicly available or interview-based evidence (as summarized in **Table 7** and **Table 8**). The purpose is to explain how external resource integration may help enterprises avoid homogeneous competition, expand niche boundaries, and improve the stability of their position in the industrial ecosystem (Yu, 2022; Jiang et al., 2023).

2.3. Evaluation Index System for Ecological Niche Upgrading

Based on ecological niche theory and enterprise life-cycle theory, this study constructs an evaluation system for niche upgrading. The system contains three

Table 7. Original data on enterprise collaboration.

Enterprise	Technical cooperation projects	Partners	Investment/ amount	Industry-alliance participation
Haibo Electric	Industry-university-research collaboration	Local universities	Not disclosed	Participates in industry alliances
Longgang Pump Industry	Controlling stake in Shandong Daon Precision Engineering Intelligence (51%)	Daon Group	Total investment of 522 million yuan	Yantai Pump and Valve Industry
Durable Watches	68 national science and technology projects; participation in 12 national standards; 7 provincial R&D platforms	National research institutes	-	China Watch Association
Boan Bio	Strategic partnerships with HKUST, Shanghai Pharmaceuticals Holding, and Sinovac	HKUST; Sinopharm; Sinovac	-	Biomedical Innovation Alliance
Blue Sky Titanium	Joint construction and cooperation with aircraft and materials research institutions	Shanghai Aircraft Research Institute; Harbin Institute of Technology; Beihang University	-	Aerospace Industry Alliance
Zhenghai Bio	Technology development contract with the Institute of Biology, Chinese Academy of Agricultural Sciences	Institute of Biology, Chinese Academy of Agricultural Sciences	12 million yuan	Regenerative Medicine Industry Alliance

Table 8. Qualitative assessment of enterprise synergy.

Enterprises	Technical cooperation intensity	Supply-chain coordination	Industry-alliance participation	Overall synergy assessment
Haibo Electric	Medium-high	Medium	Medium	Medium-high
Longgang Pump Industry	Medium-high	Medium	Medium	Medium
Durable Watches	High	High	High	High
Boan Bio	High	Medium-high	Medium-high	High
Blue Sky Titanium	High	Medium-high	Medium-high	High
Zhenghai Bio	Medium-high	Medium	Medium	Medium-high

Note: The assessment levels are coded from cooperation scale, project number, partner level, and interview evidence. They are used to compare relative synergy intensity rather than to measure exact causal contribution.

first-level indicators—technological innovation intensity, resource adaptation, and environmental benefits—and twelve second-level indicators (see **Table 9** for the full indicator system). It covers the main dimensions of niche width, niche fitness, and niche overlap and provides a structured basis for explaining the upgrading process of Haibo Electric. Due to data availability constraints, this study does not conduct comprehensive weighting or full-score calculation for all twelve indicators. The index system is used mainly as an analytical framework, while the empirical section relies on indicators that can be obtained, estimated with a clear basis, or supported by interview evidence (Chen et al., 2024; Wei, 2022).

Table 9. Evaluation index system for ecological niche upgrading.

First-level indicators	Secondary indicators	Indicator definition	Measurement method	Data source
Technological innovation intensity	R&D investment ratio	R&D expenditure as a share of operating income; reflects innovation input and niche fitness	Total R&D expenditure/annual operating income $\times$ 100%	Enterprise financial records and annual reports
	Patent authorizations	Annual authorized patents; reflects innovation output and niche-width expansion	Total annual authorized patents	National Intellectual Property Administration database and technical archives
	New-product output-value ratio	New-product output as a share of revenue; reflects technology commercialization	New-product output value/annual operating income $\times$ 100%	Enterprise production records and internal statistics; used qualitatively when comparable data are unavailable
Resource adaptation	Supply-chain stability	Partnership duration with core suppliers and delivery performance; reflects supply-chain coordination	Average cooperation years with core suppliers; average annual on-time delivery rate	Supply-chain ledgers and procurement records
	Policy acquisition efficiency	Time from policy application to fund receipt; reflects policy-resource matching	Average number of days from application to funding	Government policy documents and enterprise application records
	Depth of industry-university-research cooperation	Number of cooperation projects and share of collaborative R&D; reflects external resource integration	Number of cooperation projects; proportion of collaborative R&D expenditure	Cooperation agreements and R&D department files
	Resource-utilization efficiency	Input-output efficiency of production factors; reflects resource allocation	Total asset turnover; labor productivity per employee	Financial statements and annual operating reports
Environmental benefits	Energy consumption per unit output	Standard coal consumption per 10,000 yuan of output; reflects energy efficiency	Annual energy consumption/annual operating income $\times$ 10,000	Energy ledgers and environmental statistics
	Waste recycling rate	Share of industrial waste recycled or reused; reflects environmental practice	Recycled waste/total waste generation $\times$ 100%	Environmental reports and waste-disposal records
	Green-product share	Share of green-certified product output; reflects green competitiveness	Green-product output value/annual operating income $\times$ 100%	Product certification certificates and sales records
	Carbon-emission reduction	Reduction in annual carbon emissions relative to the base period; reflects low-carbon transformation	Base-period emissions – reporting-period emissions	Carbon-emission accounting reports and environmental monitoring data
	Environmental-protection certifications	Number of valid environmental management or product certifications; reflects compliance and stability	Total valid environmental-protection certificates in the year	Certification archives and environmental filings

Note: The indicator system in this table is intended to clarify the logical dimensions of niche upgrading. Because some indicators are unavailable or not comparable across enterprises, the study does not use the system to produce a comprehensive ranking or causal measurement result.

3. Empirical Analysis and Results

3.1. Life-Cycle Comparison between Haibo Electric and Other SMEs

As a representative SRDI enterprise, Haibo Electric's five-stage growth process shows how a manufacturing SME can move from niche exploration to niche consolidation. The comparison is based on a small cross-sectional sample of six Yantai enterprises. Because of industry heterogeneity and data limitations, the comparison is used for qualitative interpretation and case discussion rather than strict statistical inference.

In the niche-exploration stage, Haibo Electric focused on the manufacturing of large-capacity lithium iron phosphate battery packs. By avoiding direct competition with large enterprises and concentrating on core technology development, the company occupied an initial niche position. In contrast, many ordinary SMEs face slow technological iteration and weak patent output, which leads to high niche overlap and limited competitive barriers.

In the niche-deepening stage, Haibo Electric upgraded to an SRDI enterprise by strengthening technological differentiation. It developed products for special application scenarios, such as underground explosion-proof use, and improved quality-management capabilities. This process enhanced niche fitness and reduced the negative effects of homogeneous competition.

In the niche-expansion stage, Haibo Electric used industry-university-research cooperation to integrate external innovation resources. Through cooperation with universities and research institutions, the company accelerated technological iteration and expanded its application scenarios. Ordinary SMEs often have weaker resource-integration capacity and less stable supply chains, which limits their ability to expand the niche boundary.

In the niche-optimization stage, Haibo Electric promoted green development and digital transformation. Green-factory construction, energy-saving technologies, and digital production control improved production efficiency and product value. This stage is also consistent with Shandong Province's green and low-carbon high-quality development orientation, which emphasizes the integration of energy efficiency, low-carbon production, and industrial upgrading (Wang, 2025b). By contrast, many SMEs still face high policy-access costs and insufficient digital capabilities, slowing the optimization of their ecological niche.

In the niche-consolidation stage, Haibo Electric developed into a provincial manufacturing single-champion enterprise through continuous innovation and market cultivation. It not only stabilized its own niche position but also began to influence the development direction of the sub-industry.

3.2. Empirical Results of the Influencing Factors

The analysis of influencing factors is based on single-year cross-sectional data from six enterprises. It is an exploratory efficiency measurement and case-comparison analysis rather than a strict causal test. Because the sample is small, crosses several industries, and contains estimated values, the results are used to interpret

the Haibo Electric case and to provide horizontal reference only.

Technological innovation is an important support for Haibo Electric's niche upgrading. The exploratory DEA results suggest that Haibo Electric's integrated technological innovation efficiency is 0.873, and its pure technical efficiency is 0.912, placing it at a relatively high level among the sample enterprises. Under the assumptions of this small-sample measurement, R&D input and patent output appear to have been converted into innovation capability, thereby providing supportive evidence for the improvement of niche fitness.

Human resources provide important intellectual support. The exploratory SBM results suggest that Haibo Electric's human-resource efficiency is 0.856, with only limited employee-input redundancy. Since training input and talent stability are mainly supported by interview evidence rather than complete quantitative disclosure, this result should be understood as an auxiliary indication of relatively efficient talent allocation. Talent allocation therefore serves as a basic condition for maintaining a stable niche and supporting continuous upgrading, but it is not treated as an independently verified causal factor.

Market expansion may broaden the width of the ecological niche. Descriptive comparison based on interview and benchmark estimates indicates that Haibo Electric's operating revenue may have increased from about 230.00 million yuan in 2023 to about 275.20 million yuan in 2024, with estimated market coverage of about 38%. These figures are not treated as official statistics, but they indicate that market expansion may have strengthened the company's niche width and market adaptability.

Industrial collaboration may help reduce homogeneous competition. Based on qualitative evidence coding, Haibo Electric shows a medium-high level of synergy in industry-university-research cooperation, supply-chain coordination, and industry-alliance participation. Through these channels, the enterprise obtains external innovation resources and improves the efficiency of industrial-chain operation. This evidence suggests that industrial collaboration may support niche expansion and help the firm avoid excessive overlap with similar competitors.

Policy support provides external empowerment. Haibo Electric has obtained a relatively high level of qualification recognition and policy-support evidence among the sample enterprises. Policy resources provide institutional and qualification support for R&D, digital transformation, and green development. When combined with the company's own capabilities, policy support may help break resource constraints and accelerate niche upgrading.

Entrepreneurship is an important internal condition for niche upgrading. Interviews and development records indicate that Haibo Electric's continuous technological iteration, long-term focus on niche markets, and active integration into the industrial ecosystem are closely related to entrepreneurial vision and strategic persistence. Entrepreneurship helps transform external opportunities into internal action and may support the leap from specialized growth to provincial single-champion status.

In summary, the case of Haibo Electric suggests that niche upgrading may be

jointly supported by technological innovation, human resources, market expansion, industrial collaboration, policy support, and entrepreneurship. These findings provide micro-level practical reference for the niche upgrading of SRDI manufacturing SMEs, but they should not be generalized beyond comparable enterprises without further verification.

3.3. Path Analysis of Ecological Niche Upgrading

3.3.1. Phased Transition Path

Haibo Electric's niche transition can be identified from the case evidence as five stages: exploration, deepening, expansion, optimization, and consolidation. Each stage corresponds to different resource requirements and strategic priorities in the enterprise life cycle.

During the exploration stage, the core task is to occupy a niche market position. Haibo Electric concentrated resources on large-capacity lithium iron phosphate battery packs and completed the initial marketization of its products. At this stage, niche width was still narrow, but the enterprise formed the foundation for specialized growth.

During the deepening stage, the core task is to build technological barriers. The company developed products for special scenarios, strengthened quality management, and improved product reliability. These practices may have improved niche fitness and helped the enterprise avoid direct homogeneous competition.

During the expansion stage, the core task is to integrate cross-field resources. The company introduced external innovation resources through industry-university-research cooperation, accelerated technology iteration, and expanded battery-pack solutions to more application scenarios. This stage provides case evidence for the horizontal expansion of niche width.

During the optimization stage, the core task is green and digital transformation. The company promoted green-factory construction, low-carbon technology development, and digital control of the production process. These measures may improve resource-utilization efficiency and strengthen environmental adaptability.

During the consolidation stage, the core task is to enhance the leading role in the industrial chain. Haibo Electric maintains technological advantages, strengthens upstream and downstream coordination, and promotes the sharing of industrial resources. In this stage, the company's niche position becomes more stable and its spillover effect on the sub-industry becomes more obvious.

3.3.2. Dual Drive of Green Development and Digital Transformation

Green development is an important route for improving niche fitness. Haibo Electric integrates green management into production and operation, promotes environmental certification and supply-chain coordination, and develops low-carbon technologies related to battery recycling, energy saving, and carbon reduction. At the regional level, Shandong's green and low-carbon high-quality development agenda requires manufacturing enterprises to strengthen energy efficiency, low-carbon management, and green technological upgrading (Wang, 2025b). These

practices suggest that green development may help the company build a differentiated competitive advantage, although the exact contribution of green factors still requires more systematic environmental data for verification.

Digital transformation is a key enabling route for expanding niche width. By building a digital production-management and data-control platform, Haibo Electric realizes real-time data collection, process control, and decision-making optimization. Digital tools also improve collaboration with upstream and downstream partners and strengthen market-response efficiency (Wu & Wu, 2026; Li & Sun, 2024; Wu et al., 2024; Edeh et al., 2025). The case therefore suggests that digital transformation may expand the enterprise's value position in the industrial chain and improve its resilience to market uncertainty.

4. Conclusions and Limitations

This study takes Haibo Electric as the core case and integrates ecological niche theory with enterprise life-cycle theory. It constructs an evaluation system covering technological innovation intensity, resource adaptation, and environmental benefits, and analyzes the niche-upgrading process of an SRDI manufacturing enterprise using case analysis, exploratory DEA and SBM measurement, descriptive statistics, and qualitative evidence coding. The evaluation system functions primarily as an analytical framework rather than as a complete weighted scoring model.

The findings suggest that technological innovation, human-resource allocation, market expansion, industrial collaboration, policy support, and entrepreneurship may jointly support the niche upgrading of Haibo Electric. The company's growth path can be summarized as a five-stage transition from exploration to deepening, expansion, optimization, and consolidation. Green development and digital transformation further constitute a dual-support path that may improve niche fitness, expand niche width, and help the enterprise avoid homogeneous competition.

This study has several limitations. First, the sample size is small and covers different industries, so the results are exploratory. Second, some variables are estimated from interviews, public information, and industry benchmarks, which may affect measurement accuracy. For variables without reliable public disclosure, this study uses marked estimates or qualitative levels rather than treating them as official statistics. Third, the available data are mainly single-year cross-sectional data, so the study cannot measure dynamic productivity changes. Fourth, the proposed twelve-indicator evaluation system is not fully weighted or comprehensively calculated because some environmental and new-product indicators are not consistently disclosed across enterprises. Future research should expand the sample size, focus on more comparable industries, collect multi-year panel data from 2020 to 2024 or later, and obtain more complete environmental, product, and human-resource data to test the conclusions more rigorously⁴ (Shandong Boan Biotechnology Co., Ltd., 2025; Yantai Zhenghai Bio-Tech Co., Ltd., 2025; Wang, 2025b).

⁴Yantai Statistics Bureau (2025). https://www.yantai.gov.cn/art/2025/1/22/art_43178_3235336.html; National Intellectual Property Administration (n.d.). <https://pss-system.cponline.cnipa.gov.cn/>

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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