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A Study on the Evaluation of High-Quality Development of Enterprises in the Context of Digital Transformation: A Case Study of Hualing Steel

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Abstract: In the context of the digital economy, digital transformation of enterprises has become a current hot topic. This study focuses on Hualing Steel to explore how enterprises can achieve high-quality development through digital transformation. The paper employs indicators of efficiency, innovation, and green development, utilizing the entropy and TOPSIS methods to quantitatively assess transformation performance from 2013 to 2023. The analysis yields three key conclusions: (1) Digital transformation has yielded significant outcomes, with the highest comprehensive performance observed in 2021, coinciding with the launch of the 5G smart factory; (2) A structural characteristic of "efficiency improvement leading, with innovation-driven development lagging" is identified; (3) Recommendations are made for deepening the application of digital technologies, optimizing enterprise operation management systems, enhancing innovation-driven development, and improving talent development systems. These findings provide a theoretical framework and practical model for the transformation and upgrading of traditional manufacturing industries.

Keywords: Hualing Steel; high-quality development; digital transformation; entropy value method; Topsis method

1. Introduction

The digital economy, as a new engine driving global economic development, is profoundly reshaping industrial structures and competitive paradigms. China's 14th Five-Year Plan explicitly emphasizes "accelerating digital development and building a digital China," elevating industrial digital transformation to a national strategic priority. Under the dual impetus of the "Digital China" strategy and the "dual carbon" goals, high-quality development of enterprises has become a core pathway for implementing new development concepts. According to the "Guiding Opinions on Promoting High-Quality Development of the Steel Industry" issued by the Ministry of Industry and Information Technology and other departments in 2022, the steel industry is required to achieve a numerical control rate of key processes of ≥80% by 2025, establish over 30 smart factories, and address the industry's three major challenges: tightening resource constraints, rising environmental costs, and product homogenization through digital transformation. As a pillar industry of the national economy, the transformation success of the steel industry directly impacts the implementation quality of the manufacturing power strategy.

Currently, China's steel enterprises face multiple challenges, including structural overcapacity, increasing environmental constraints, insufficient supply of high-end products, intensified homogenization competition, and fluctuating profitability. For steel enterprises, actively embracing digital transformation is not only an inevitable choice to align with the times but also a crucial breakthrough to overcome development bottlenecks and advance towards high-end, intelligent, and green high-quality development. In light of this, this paper focuses on a representative enterprise in the steel industry—Hunan Valin Steel Co., Ltd. (hereinafter referred to as "Hualing Steel"), aiming to establish an evaluation system for high-quality development of enterprises in the context of digital transformation and assess its transformation effectiveness.

2. Definition of Relevant Concepts

2.1. Digital Transformation

Digital transformation is a strategic process where enterprises leverage digital technologies to reorganize production factors (such as talent, capital, and technology), transform business processes and production methods, and ultimately enhance production efficiency (Fischer M et al., 2020). Early research focused on the technological application aspect, defining it as the unidirectional integration of digital technologies into production and operational processes, aiming at the digital transformation of production stages (Lee J, 2015). As digital technologies reshape industrial ecosystems, the concept has expanded to encompass systemic innovation, emphasizing the role of digital technologies in driving organizational change and business model innovation to build core competencies that adapt to dynamic competitive environments (Gurbaxani V, 2019).

In recent years, an increasing number of studies have shown that digital transformation can enhance corporate financial performance. It promotes high-quality development by boosting total factor productivity (Zhu Changning & Li Hongwei, 2024); focuses on optimizing cost structures, particularly by reducing cost stickiness in manufacturing enterprises to improve performance levels (Li Jiujin et al., 2025); and, at the level of management innovation, reconstructs financial control systems through a three-stage empowerment mechanism (building a data foundation → forming digital control capabilities → releasing financial value) (Zhu Jigao et al., 2024). The moderating effect of financial flexibility significantly enhances the impact of transformation on financial performance (Wang Kaiyang et al., 2024).

2.2. High-quality development of enterprises

High-quality development of enterprises is a goal-oriented paradigm driven by innovation and optimal resource allocation, aiming to achieve a high-level balance between economic efficiency and social value, thereby shaping sustainable growth attributes and dynamic competitive advantages (Huang Sujian, 2018). Digital transformation can enhance the level of internal control within enterprises, ultimately promoting high-quality development (Wang Fujun et al., 2023). It facilitates high-quality development by improving capital allocation efficiency and internal control (Liao Zhichao, 2023). Digital transformation has shown significant effects in promoting high-quality development among enterprises in the eastern regions and non-high-tech enterprises (Zhu Changning & Li Hongwei, 2024).

This paper draws on the research perspectives of Ma Zongguo and Cao Lu (2020) to define the concept of high-quality development of enterprises, emphasizing that the core lies in pursuing both high quality and high efficiency, as both are indispensable. Enterprises achieve efficient, high-level, and high-standard creation of economic and social value by continuously enhancing innovation capabilities, meeting diverse market demands, optimizing resource allocation, and seizing market opportunities. This paper references Ma Zongguo (2020) in selecting evaluation indicators for high-quality development in manufacturing enterprises, focusing on three dimensions: high-quality benefit growth, high-quality innovation development, and high-quality green development, to comprehensively analyze and assess the effects of high-quality development in enterprises.

2.3. Digital Transformation, Financial Performance, and High-Quality Corporate Development

During critical phases of digital transformation, centralized management power can help overcome resistance encountered in the transformation process, thereby accelerating the positive impact of digital transformation on high-quality corporate development (Miao Chunxia, 2023). Additionally, digital transformation enhances corporate innovation capabilities and risk-taking levels, further promoting high-quality development (Wang Xi et al., 2023). Technological innovation within enterprises can strengthen organizational resilience, thereby driving high-quality development (Zhang Shaofeng et al., 2023). Chinese manufacturing enterprises can achieve high-quality development through three pathways: market-driven industrial upgrading, integration of technology and finance, and government innovation support (Wang Tingwei et al., 2023). Digital transformation can improve corporate financial performance, facilitating human capital accumulation, increasing R&D investment, and enhancing technology spillovers (Lei Shangjun, 2023). It also helps alleviate financing constraints and secure government policy support, thereby enhancing corporate innovation capabilities (Zhou Hongxing, 2023). The promotion effect of digital transformation on corporate innovation is stronger when agency problems are severe, financing constraints are significant, and risk-taking levels are low. This is because digital transformation effectively improves financial performance, mitigates agency problems, alleviates financing constraints, and enhances corporate risk-taking levels (Pan Hongbo et al., 2022).

2.4. Conclusion

Based on the review of relevant literature, this paper selects Hualing Steel, an early adopter of digital transformation, as a case study to analyze how it achieves high-quality development through financial performance during its digital transformation process, enriching existing case study content. On this basis, the paper employs literature research, case study, and comparative analysis methods, combined with the entropy method and TOPSIS analysis, to explore the impact pathways and effects of Hualing Steel's high-quality development in the context of digital transformation. This provides a reference for enterprises seeking to achieve high-quality development through digital transformation.

3. Evaluation and Analysis of High-Quality Development of Hualing Steel under the Context of Digital Transformation

3.1. Construction of the Evaluation Indicator System for the High-Quality Development of Hualing Steel

3.1.1. Principles for Selecting Evaluation Indicators

The selection and design of financial indicators are crucial for scientifically evaluating a company's financial performance. The more comprehensive and objective the indicators, the more accurately they reflect the company's performance. The selection of indicators in this paper follows these principles:

First is the principle of comprehensiveness: Evaluating a company's financial performance requires a multi-faceted and systematic approach that considers industry characteristics and influencing factors. Typically, evaluations cover profitability, operational efficiency, solvency, and growth potential. Without this comprehensive approach, evaluations can be biased and lack persuasiveness. Given that the subject of this study is the manufacturing industry, where R&D capability significantly impacts financial performance, R&D indicators are also included.

Second is the principle of importance: Indicators should be selected to ensure quality while remaining concise, avoiding redundant data that could affect the efficiency of weight calculations and emphasizing data validity. According to the entropy method's weighting principle, the greater the volatility of an indicator, the higher its weight, and vice versa. Therefore, it is essential to focus on key indicators that reflect core issues within the company. Choosing secondary indicators would result in less insightful evaluation outcomes.

Third is the principle of availability: Priority is given to quantifiable data from reliable and credible sources, as such data are more accessible and justifiable, making them suitable for the entropy method. Non-quantifiable data are challenging to apply using the entropy method, and relying solely on theoretical analysis lacks persuasiveness, making it difficult to effectively evaluate a company's financial performance.

Lastly is the principle of reliability: The data for evaluation indicators must be authentic, reliable, and accurate, with no fabrication or falsification. The indicators selected in this paper are derived from audited annual reports of the company, ensuring credibility and suitability for constructing an evaluation system to scientifically assess the company's financial performance.

3.1.2. Determination of Evaluation Indicators

Based on the actual situation and industry characteristics of Hualing Steel, this paper selects financial data from 2020 to 2024 for entropy value method analysis. Five dimensions—debt-paying ability, operational efficiency, profitability, growth potential, and R&D capability—are selected as first-level indicators, with 16 financial indicators chosen as second-level indicators. As shown in Table 1.

Table 1. Financial Performance Evaluation Indicator System for Hualing Steel

Primary Indicators	Second-Level Indicators	Indicator Nature	Indicator Code
Debt Repayment Capacity	Current Ratio	Moderate Indicator	A1
	Quick ratio	Moderate indicator	A2
	Debt-to-equity ratio	Moderate indicator	A3
Operating capacity	Inventory turnover ratio	Positive indicator	B1
	Accounts receivable turnover ratio	Positive indicator	B2
	Total asset turnover ratio	Positive indicator	B3
Profitability	Operating Profit Margin	Positive indicator	C1
	Return on assets	Positive indicator	C2
	Return on equity	Positive indicator	C3
	Cost-to-income ratio	Positive indicator	C4
	Basic earnings per share	Positive indicator	C5
Development capacity	Total asset growth rate	Positive indicator	D1
	Operating Revenue Growth Rate	Positive indicator	D2
	Operating profit growth rate	Positive indicator	D3
Research and Development Capability	R&D expenditure as a percentage of operating revenue	Positive indicator	E1
	Proportion of technical personnel	Positive indicator	E2

Data source: Sina Finance

3.1.3. Determination of the weights for evaluation indicators

In corporate performance evaluation, scientifically determining the weights of indicators across dimensions is a critical step to ensuring the accuracy and reliability of evaluation results. Currently, mainstream weighting methods can be broadly categorized into subjective weighting methods and objective weighting methods. The Analytic Hierarchy Process (AHP), as a representative of subjective weighting methods, can address multi-level decision-making problems but is prone to being influenced by experts' subjective judgments and lacks authority. Principal Component Analysis (PCA) and Factor Analysis, though objective weighting methods, suffer from unclear economic implications of the transformed indicators in the former and complex operations and high professional requirements in the latter.

In contrast, the Entropy Method objectively assigns weights based on the dispersion of indicators, automatically eliminating redundant indicators while offering the advantages of simplicity in calculation and objective results. This method determines weights by quantifying the information content of each indicator, avoiding human interference, and is suitable for evaluating corporate financial performance, providing a scientific basis for management decisions. Based on its characteristics, the entropy value method is selected for corporate financial performance evaluation. By leveraging its objective and scientific features, it can more accurately evaluate performance and provide direction for corporate development. The entropy value method has a simple and easy-to-operate calculation process, low cost, and strong practical applicability, offering constructive suggestions for corporate high-quality development.

3.2. Determining indicator weights using the entropy value method and evaluating performance using the TOPSIS comprehensive evaluation method

3.2.1. Evaluation Indicators and Indicator Selection

1) Establishing the Evaluation Matrix

When constructing multiple indicator matrices, select a number of evaluation objects (a) and evaluation indicators (b). Let xijrepresent the data corresponding to the jth evaluation indicator under the ith evaluation object (i = 1, 2, ..., m; j = 1, 2, ..., n). Form the original data matrix:

$$X_{ij}=\begin{bmatrix} x11 & x12 & \cdots & x1n \\ x21 & x22 & \cdots & x2n \\ \vdots & \vdots & \cdots & \vdots \\ xm1 & xm2 & \cdots & xmn \end{bmatrix}$$

2) Data Standardization Processing

Since indicators of different natures can significantly influence the results, dimensional effects must be eliminated during calculations. Data normalization is performed as follows:

For positive indicators:

$$y_{ij}=\frac{x_{ij}-\min(x_j)}{\max(x_j)-\min(x_j)}$$

For negative indicators:

$$y_{ij}=\frac{\max\left(x_j\right)-x_{ij}}{\max(x_j)-\min(x_j)}$$

To facilitate identification and calculation, the three moderate indicators of debt-paying ability are standardized and converted into data with the same nature as positive indicators, i.e., positively correlated with financial performance. The standardization process is as follows:

$$y_{ij}=\begin{cases} 2\times\left(x_{ij}-\min(x_j)\right), & \min(x_j)\le x_{ij}\le\left(\min(x_j)+\max(x_j)\right)/2 \\ 2\times\left(\max(x_j)-x_{ij}\right), & \left(\min(x_j)+\max(x_j)\right)/2\le x_{ij}\le\max(x_j) \end{cases}$$

To ensure the validity of the indicators after standardization, 0.0001 is added to the results.

3) Defining standardized values

Calculate the weight of the nth indicator for each evaluation object as follows:

$$P_{ij}=\frac{y_{ij}}{\sum_{i=1}^{m}y_{ij}}$$

4) Calculate entropy values

$$e_j=-\frac{1}{ln_n}\sum_{i=1}^{n}p_{ij}lnp_{ij}$$

5) Calculate the variability of the indicator

Calculate the variability of the jth indicator as follows:

$$g_j=1-e_j$$

6) Calculate the weights of the indicators

Calculate the weight of the jth indicator:

$$w_j=\frac{g_j}{\sum_{i=1}^{m}g_j}$$

7) Calculate the comprehensive score

$$z_{ij}=w_{j*}\,x_{ij}$$

8) Weight the indicators in the standardized matrix to form a weighted normalized matrix.

The traditional approach of the TOPSIS method involves using manually assigned weights, which inherently carries a degree of subjectivity. In this study, based on the weights derived using the entropy weight method, a TOPSIS weighted normalized matrix is constructed:

$$c_{ij}=w_{j*}\,x_{ij}$$

9) Determine the positive ideal solution C+ and negative ideal solution C- based on the attributes of the indicators.

$$C^{+}=[c_1^{+},c_2^{+},\cdots,c_n^{+}];\ C^{-}=[c_1^{-},c_2^{-},\cdots,c_n^{-}]$$

Positive ideal solution:

$$C_j^+ = \begin{cases} max\ C_{ij}\ ,j=1,2,...,n \\ min\ C_{ij},j=1,2,...,n \end{cases}$$

Negative ideal solution:

$$C_j^- = \begin{cases} min\ C_{ij}\ ,j=1,2,...,n \\ max\ C_{ij},j=1,2,...,n \end{cases}$$

3.2.2. Calculate relative proximity and rank evaluation objects

1) Calculate the Euclidean distance:

$$d_i^+ = \sqrt{\sum_{j=1}^{n}\left(c_{ij} - c_j^+\right)^2}, i=1,2,\cdots,m$$

$$d_i^- = \sqrt{\sum_{j=1}^{n}\left(c_{ij} - c_j^-\right)^2}, i=1,2,\cdots,m$$

2) Calculate the relative proximity of the evaluation objects to the positive ideal solution.

$$f_i = \frac{d_i^-}{d_i^- + d_i^+}, i=1,2,\cdots,m$$

Then sort fifrom smallest to largest to obtain the priority order of the evaluation objects.

4. Data collation, analysis, and evaluation

4.1. Hualing Steel Data Processing

Based on the annual report published by Ziguang Guowei, we compiled the numerical values of 16 financial performance evaluation indicators for the years 2020–2024, as shown in Table 2.

Table 2. Original Data of Evaluation Indicators for Hualing Steel

	2020	2021	2022	2023	2024
Current ratio	0.86	0.93	1.17	1.28	0.93
Quick ratio	0.62	0.72	0.92	1.00	0.76
Debt-to-equity ratio (%)	57.54	52.28	51.88	51.67	56.02
Inventory turnover rate (times)	10.44	13.58	12.76	11.07	10.1
Accounts receivable turnover ratio (times)	36.27	49.01	38.75	33.57	31.28
Total asset turnover (times)	1.34	1.74	1.49	1.30	1.03
Operating profit margin (%)	6.97	6.96	5.17	4.55	2.92
Return on Total Assets (%)	10.12	12.57	7.95	6.26	3.27
Return on equity (%)	20.97	24.57	13.42	9.87	3.81
Cost of Sales to Profit Margin (%)	6.72	6.84	5.02	4.41	2.34
Basic earnings per share (RMB)	1.0434	1.4811	0.92233	0.7351	0.2941
Total asset growth rate (%)	9.41	17.53	12.29	11.19	11.27

Revenue Growth Rate (%)	8.58	47.24	-1.71	-2.47	-12.03
Operating profit growth rate (%)	2.89	46.6	-26.78	-14.03	-43.66
R&D expenditure as a percentage of operating revenue (%)	3.72	3.55	3.83	4.15	3.96
Technical staff ratio (%)	13.45	12.65	12	13.77	14.1

Data source: Sina Finance

Using Excel, calculate the entropy values, coefficient of variation, and weights for each indicator to obtain Table 3.

Table 3. Entropy Analysis Results for Hualing Steel's Financial Indicators

Primary Performance Dimension	Second-level Evaluation Indicators	Entropy Value	Differentiation Coefficient	Second-level indicator weights	Level 1 indicator weights
Debt-paying capacity	Current ratio	0.6679	0.3321	0.0818	0.2821
	Quick ratio	0.6599	0.3401	0.0838	
	Debt-to-equity ratio	0.5272	0.4728	0.1165	
Operating Efficiency	Inventory turnover ratio	0.7022	0.2978	0.0734	0.1901
	Accounts receivable turnover ratio	0.7107	0.2893	0.0713	
	Total asset turnover ratio	0.8156	0.1844	0.0455	
Profitability	Operating Profit Margin	0.8197	0.1803	0.0444	0.2258
	Return on assets	0.8116	0.1884	0.0464	
	Return on equity	0.7997	0.2003	0.0494	
	Cost-to-revenue ratio	0.8308	0.1692	0.0417	
	Basic earnings per share	0.8217	0.1783	0.0439	
Development Capacity	Total asset growth rate	0.7243	0.2757	0.0679	0.2076
	Operating revenue growth rate	0.6805	0.3195	0.0787	
	Operating profit growth rate	0.7528	0.2472	0.0609	
Research and Development Capability	R&D expenditure as a percentage of operating revenue	0.8013	0.1987	0.0490	0.0943
	Proportion of technical personnel	0.8158	0.1842	0.0454	

Data source: Compiled using Excel software

As shown in Table 5, the weighting coefficients for profitability and debt-repayment capacity of Hualing Steel are relatively high, at 22.58% and 28.21%, respectively. This indicates that Hualing Steel's financial performance is significantly influenced by profitability and debt-repayment capabilities, necessitating close attention. The single weight of the debt-to-equity ratio reaches 11.65%, highlighting the urgent need for deleveraging in the steel industry. The weight of R&D capability is relatively low (9.43%), reflecting the traditional manufacturing sector's reliance on short-term performance. However, the R&D intensity has increased to 4.17% in 2023, indicating an improving trend.

4.2. Determining evaluation values using the TOPSIS comprehensive evaluation method

Calculation of relative distance and proximity. Based on the normalized and standardized data matrix of Hualing Steel and the weights of each evaluation indicator, a weighted normalized matrix was derived. Then, based on the attributes of each evaluation indicator, the positive and negative ideal solutions were determined for each indicator. The distance from each year to the positive and negative ideal solutions was calculated, and the relative proximity was derived. The results are shown in Table 4.

Table 4. Relative Distance, Proximity, and Ranking of Hualing Steel from 2020 to 2024

Year	Optimal Distance	Worst Distance	Relative Proximity	Rank
2020	0.2121	0.1047	0.3306	4
2021	0.0956	0.2222	0.6993	1
2022	0.1622	0.1436	0.4696	2
2023	0.2187	0.0826	0.2740	5
2024	0.1957	0.1465	0.4281	3

Data source: Compiled using Excel software

Evaluation results reveal: In 2021, the proximity index of 0.6993 ranked first, corresponding to the peak benefit of a 24.57% ROE achieved with the launch of 5G smart factories. In 2022, the proximity index of 0.4696 maintained second place, reflecting contributions to green transformation. In 2023, impacted by the downturn in the industry cycle, the revenue growth rate dropped to -12.03%, and the proximity index fell to 0.2740, exposing risks of external environmental disturbances on the effectiveness of transformation efforts.

4.3. Analysis of Evaluation Results Across Dimensions

This section analyzes the evaluation results across various dimensions to understand the impact of high-quality development on corporate performance at Hualing Steel.

4.3.1. Profitability Analysis

1) Return on Net Assets

As shown in Figure 1, Hualing Steel's return on net assets experienced significant fluctuations, mirroring the industry average. Between 2014 and 2016, the company's return on net assets dropped sharply and even turned negative, falling below the industry average. This decline was primarily due to the challenging industry environment during this period. Weak market demand and economic downturns in major steel-consuming industries such as real estate and construction led to reduced demand, resulting in lower sales volumes for the steel industry. Hualing Steel's return on equity (ROE) was also affected by its own operational issues, including low net asset returns and high costs. During this period, while the industry as a whole was seeking to transition toward high-quality, digital, and green development, Hualing Steel lagged behind.

After 2016, China's economy began to gradually recover, with demand from major steel-consuming industries such as real estate and infrastructure construction increasing. This led to a rise in steel prices and an expansion in sales volumes, resulting in an increase in industry profitability. Meanwhile, Hualing Steel implemented refined management practices and intelligent production upgrades to enhance efficiency and reduce production costs. The company actively promoted the development of a 5G smart factory, jointly releasing the first "White Paper on the Integration of Information Technology and Industrialization." The deployment of intelligent robots and other digital transformation measures enhanced the company's market competitiveness. Hualing Steel has comprehensively reduced energy consumption and vigorously developed a circular economy, continuously promoting green development. With the advancement of digital transformation and high-quality development, Hualing Steel's return on net assets has begun to grow and exceed the industry average, indicating that digital transformation can achieve high-quality development, improved economic benefits, and cost reduction and efficiency gains, quality development, improve economic efficiency, reduce costs, and achieve steady growth.

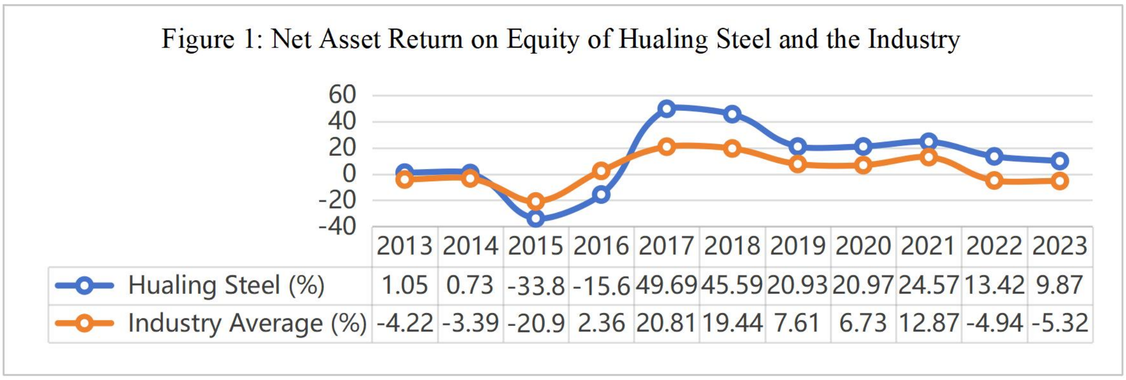


Figure 1. Hualing Steel's ROE compared to the industry average
Data Source: Sina Finance Network

2) Operating Profit Margin

As shown in Figure 2, Hualing Steel's operating profit margin was initially similar to the industry average, but since 2016, it has consistently surpassed the industry average. The year 2016 marked a critical period for Hualing Steel's digital transformation. The company actively optimized product quality and structure, increasing the proportion of high-value-added products. High-end products such as shipbuilding plates, electrical steel raw materials, and automotive plates have enhanced their competitiveness in the market, driving overall profitability.

Hualing Steel has actively integrated cutting-edge technologies such as 5G, big data, machine vision, industrial robots, and artificial intelligence into its production and management processes, successfully establishing "smart production lines" and "smart steel plants." To date, the company has successfully implemented more than 400 information and intelligent projects, achieving full process information coverage. This has significantly improved the intelligence level of key processes such as resource allocation, process optimization, process control, and energy conservation and emission reduction, thereby enhancing the company's operating efficiency and steadily increasing its operating profit margin.

In addition, Hualing Steel has undertaken green and low-carbon transformations, reduced energy consumption, and promoted green manufacturing, enabling the company to develop in a high-quality manner. The company has advanced ultra-low emission and efficiency improvement projects in key processes such as ironmaking, steelmaking, sintering, and coking. It fully utilizes waste heat, waste energy, solid waste, and production (and domestic) wastewater from the steel production process for recycling, processing, and reuse. This approach reduces the final discharge of waste, improves resource and energy utilization efficiency, and increases the company's operating profit margin, ultimately achieving high-quality development.

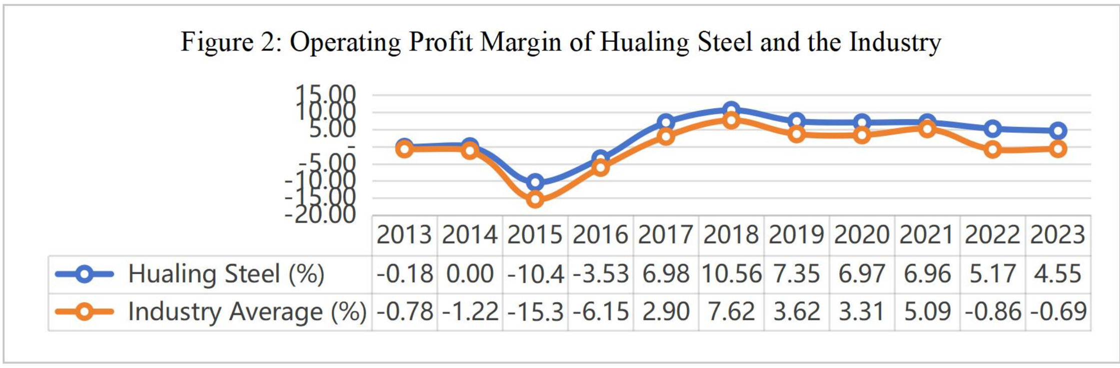


Figure 2. Hualing Steel and Industry Operating Profit Margin
Data Source: Sina Finance Network

4.3.2. Reduction in Period Expense Ratio

As shown in Figure 3, Hualing Steel's period expense ratio was higher than the industry average from 2013 to 2016. However, since 2016, the period expense ratio has significantly decreased, falling below the industry average. This improvement can be attributed to Hualing Steel's implementation of refined management practices, which have continuously optimized internal processes and reduced management costs. Additionally, by optimizing its debt structure, the company has successfully lowered its financial expense ratio. Since 2016, these efforts have contributed to a significant reduction in the period expense ratio, enhancing the company's overall financial efficiency.

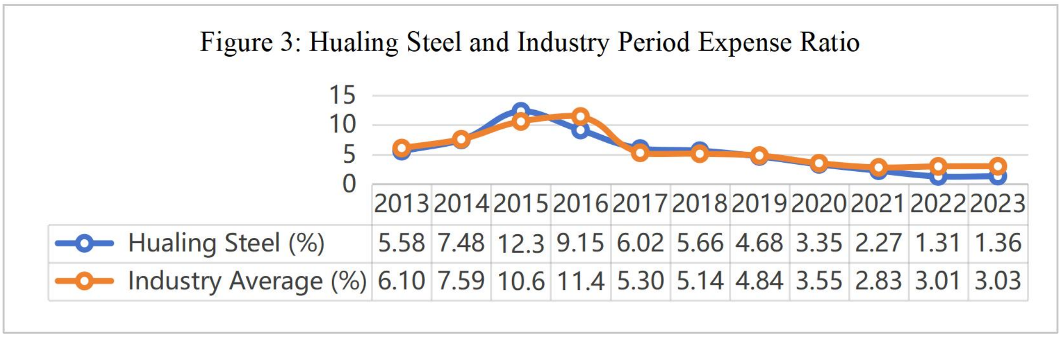


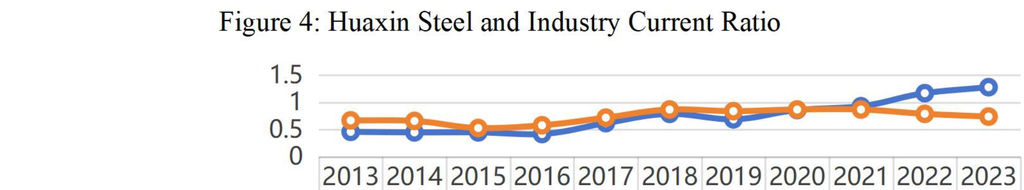
Figure 3. Hualing Steel vs. Industry Period Expense Ratio
Data Source: Sina Finance Network

4.3.3. Debt Repayment Capacity Analysis

1) Current Ratio

The current ratio is an important indicator of a company's short-term debt repayment capability. Generally, the higher the current ratio, the stronger the company's ability to repay short-term debt. As shown in Figure 4, Hualing Steel's current ratio was below the industry average from 2013 to 2020. During this period, Hualing Steel had a relatively high debt-to-equity ratio, which remained above 50%. This high debt ratio led to an increase in current liabilities and a decrease in the current ratio. Due to insufficient market demand, Hualing Steel's inventory and accounts receivable tied up a significant amount of funds, resulting in a decline in the liquidity of current assets and adversely affecting the current ratio.

After 2020, Hualing Steel's current ratio improved and surpassed the industry average. With the onset of digital transformation, Hualing Steel integrated artificial intelligence with production technology to optimize management, continuously reduce production costs, and more accurately predict market demand. This approach reduced inventory accumulation and improved the collection speed of accounts receivable, thereby enhancing the turnover speed of current assets. Since 2021, the company's current ratio has been significantly higher than the industry average. This improvement is attributed to the establishment of a cloud data center under its digital transformation initiative, which accelerated the development of an operational production management information platform and an energy control and efficiency improvement platform, driving the company's high-quality development.



	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Hualing Steel (%)	0.46	0.45	0.45	0.42	0.62	0.79	0.69	0.86	0.93	1.17	1.28
Industry Average (%)	0.67	0.66	0.53	0.58	0.72	0.87	0.84	0.87	0.87	0.79	0.74

Figure 4. Huaxin Steel vs. Industry Current Ratio
Data Source: Sina Finance Network

2) Quick Ratio

The quick ratio is an important indicator of a company's short-term debt-repayment capability. By excluding the impact of inventory, it more accurately reflects whether a company has sufficient current assets to repay short-term debt without relying on the liquidation of inventory. As shown in Figure 5, Hualing Steel's quick ratio was below the industry average from 2013 to 2020. This was due to high inventory levels, poor accounts receivable management, and a high debt-to-equity ratio during this period.

After 2020, Hualing Steel's quick ratio significantly exceeded the industry average. Through digital platform optimization and precise calculation of production and investment scales, the company significantly improved inventory turnover rates, reduced inventory buildup, and increased the proportion of quick assets. By optimizing customer credit management, Hualing Steel shortened accounts receivable collection cycles and reduced customer credit risks. Through debt restructuring, Hualing Steel reduced its debt-to-equity ratio. The lower debt ratio led to a decrease in current liabilities and an increase in the quick ratio. With a low debt ratio, Hualing Steel effectively controlled financial risks, strengthened its cash flow, further improved the quick ratio, and promoted the company's stable and high-quality development.

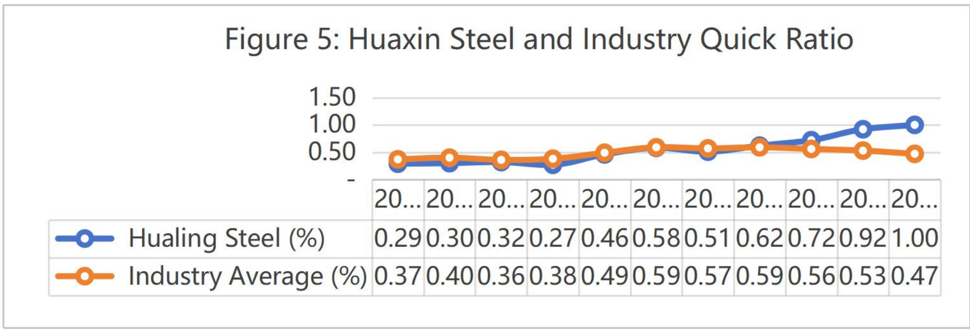


Figure 5. Huaxin Steel's Quick Ratio Compared to the Industry
Data Source: Sina Finance Network

3) Debt-to-Asset Ratio

The debt-to-asset ratio reflects the proportion of total assets financed by debt. A high debt-to-asset ratio indicates that the company has a significant amount of debt and faces greater debt repayment pressure. If the company's operational performance deteriorates or the market environment worsens, it may face significant debt repayment risks, potentially leading to debt default. As shown in Figure 6, from 2013 to 2020, Hualing Steel's debt-to-asset ratio was higher than the industry average. This was because the steel industry as a whole was in a phase of capacity reduction. To respond to industry changes, Hualing Steel actively carried out technological upgrades and equipment modernization, expanded production capacity through mergers and acquisitions, and further increased its market share. These projects required substantial capital investment, thereby increasing the company's debt levels.

After 2020, the debt-to-asset ratio fell below the industry average. Through digital transformation, the company achieved intelligent production and operations, significantly improving production efficiency and operational efficiency. This enabled the company to maintain its production scale while more effectively managing funds and controlling costs, thereby reducing the debt-to-asset ratio. This indicates that the company has sufficient assets to cover its debts, reducing the risk of debt default and enhancing financial stability.

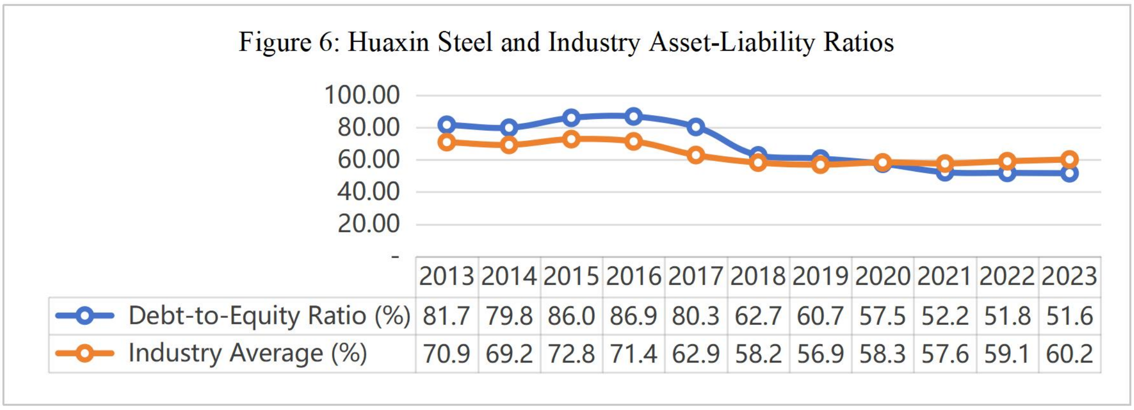


Figure 6. Hualing Steel vs. Industry Debt-to-Equity Ratio
Data Source: Sina Finance Network

4.3.4. Operational Efficiency Analysis

1) Total Asset Turnover Ratio

The total asset turnover ratio reflects the revenue generated per unit of assets. A higher ratio indicates higher asset utilization efficiency and stronger operational capabilities. As shown in Figure 7, Hualing Steel's total asset turnover ratio declined from 2013 to 2016 and remained below the industry average. During this period, Hualing Steel faced industry-wide challenges, including insufficient market demand and severe overcapacity, resulting in low asset utilization efficiency. Additionally, the company's internal management optimization and digital transformation had not been fully implemented, leading to limited improvements in asset turnover efficiency.

After embarking on a comprehensive digital transformation, Hualing Steel achieved full process informatization coverage through the construction of smart production lines and smart steel plants. This allowed for optimized resource allocation and production processes, thereby improving asset utilization rates. As a result, the company's asset turnover ratio exceeded the industry average from 2016 to 2023, reaching 1.74 times in 2021. Hualing Steel's total asset turnover rate has significantly improved and consistently exceeded the industry average, demonstrating the company's significant progress in asset utilization efficiency and operational capabilities.

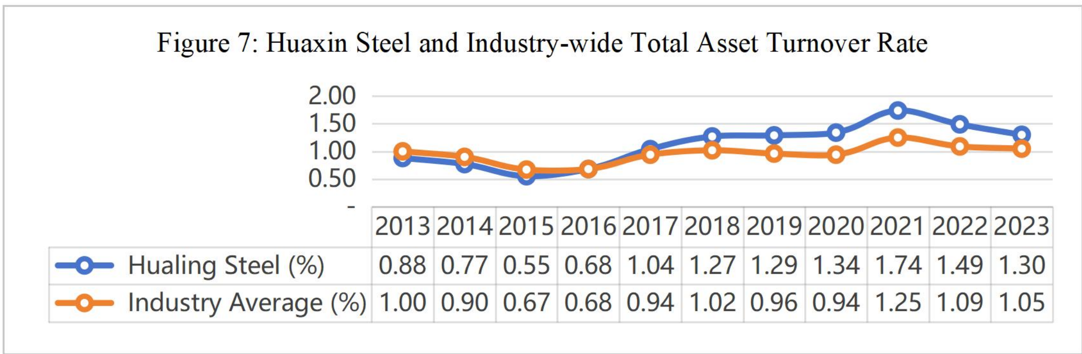


Figure 7. Hualing Steel vs. Industry Total Asset Turnover Rate
Data Source: Sina Finance Network

2) Inventory turnover rate

The inventory turnover ratio reflects the liquidity and management efficiency of a company's inventory. A higher ratio indicates faster inventory turnover, less capital tied up in inventory, and higher inventory management efficiency. As shown in Figure 8, Hualing Steel's inventory turnover rate was relatively low from 2013 to 2017, leading to ineffective inventory management and inventory buildup, which slowed down the turnover speed.

However, after 2017, Hualing Steel's inventory turnover rate generally showed an upward trend. This period marked Hualing Steel's comprehensive digital transformation, during which the company implemented initiatives such as a cloud data center, the Hualing Cloud Innovation Smart Control Platform, and the Hualing Xianggang Smart Production Line. These initiatives reduced production costs, improved operational efficiency, and further enhanced the inventory turnover rate, reaching 13.5 times per year in 2021—significantly higher than the industry average. This demonstrates that Hualing Steel has significant competitive advantages in raw material procurement, production manufacturing, and product sales, enabling it to efficiently convert inventory into sales revenue and achieve high-quality corporate development.

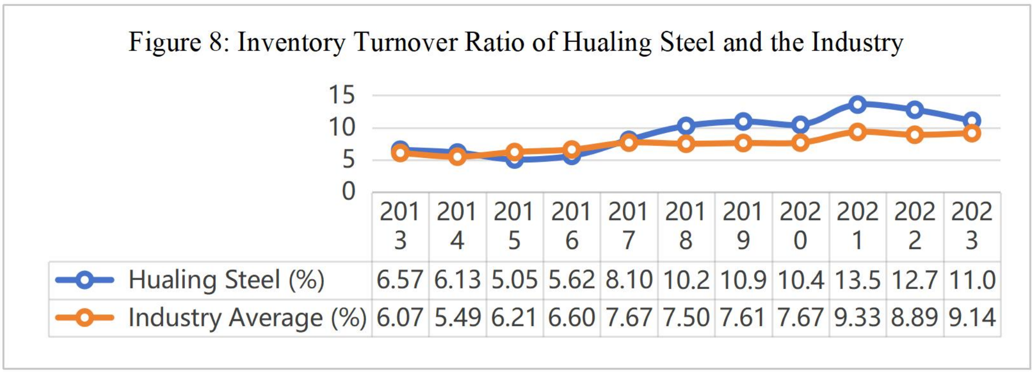


Figure 8. Hualing Steel vs. Industry Inventory Turnover Rate
Data Source: Sina Finance Network

4.3.5. Development Potential Analysis

1) Total Operating Revenue Growth Rate

The total operating revenue growth rate is an important indicator of the growth rate of a company's operating revenue. This indicator reflects the speed of business expansion and market competitiveness of a company within a certain period. As shown in Figure 9, from 2013 to 2016, the steel industry as a whole faced issues of overcapacity and insufficient market demand, resulting in sluggish overall growth. During this period, Hualing Steel had deficiencies in internal management and was unable to effectively enhance its market competitiveness, leading to low growth in total operating revenue.

From 2017 to 2023, Hualing Steel's operating revenue growth rate was higher than that of its peers, but it also exhibited significant fluctuations. Particularly in 2018 and 2019, when digital transformation efforts were intensified, the growth rate was relatively low. This indicates that Hualing Steel should pay closer attention to cost control and asset utilization during its digital transformation process. The operating revenue growth rate is influenced by factors such as the overall industry situation. Hualing Steel needs to better adapt to market changes in the future to achieve high-quality corporate development.

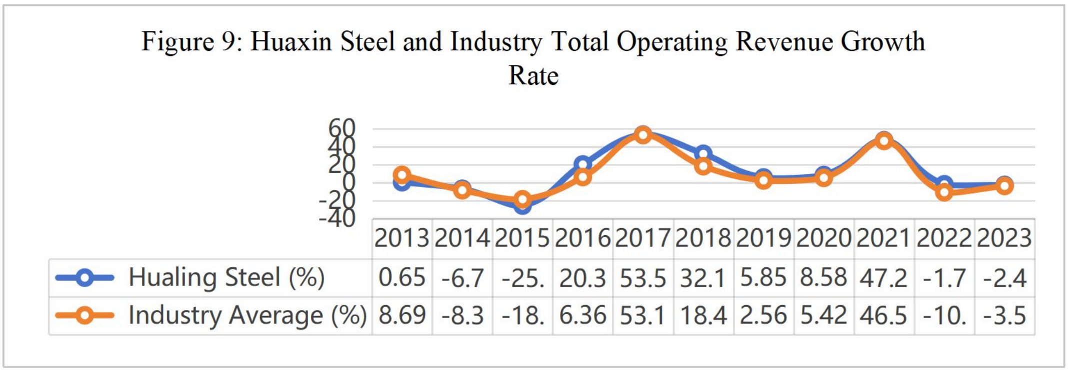


Figure 9. Operating Revenue Growth Rate of Hualing Steel and the Industry
Data Source: Sina Finance Network

2) Net Profit Attributable to Parent Company Growth Rate

As shown in Figure 10, the net profit growth rate attributable to the parent company in the steel industry plummeted in 2015, primarily due to the combined effects of a slowdown in macroeconomic growth, prominent overcapacity issues, and sustained declines in steel prices. Between 2016 and 2023, the net profit growth rate attributable to the parent company of Hualing Steel fluctuated significantly, with some years significantly higher than the industry average and others below it.

In 2017, Hualing Steel's net profit growth attributable to the parent company was relatively high and exceeded the industry average. This was primarily due to the recovery of market demand, optimization of product structure, and the initial success of digital transformation. Overall, Hualing Steel has enhanced its competitiveness and profitability through digital transformation and product structure optimization. However, it still faces certain challenges when the market environment changes.

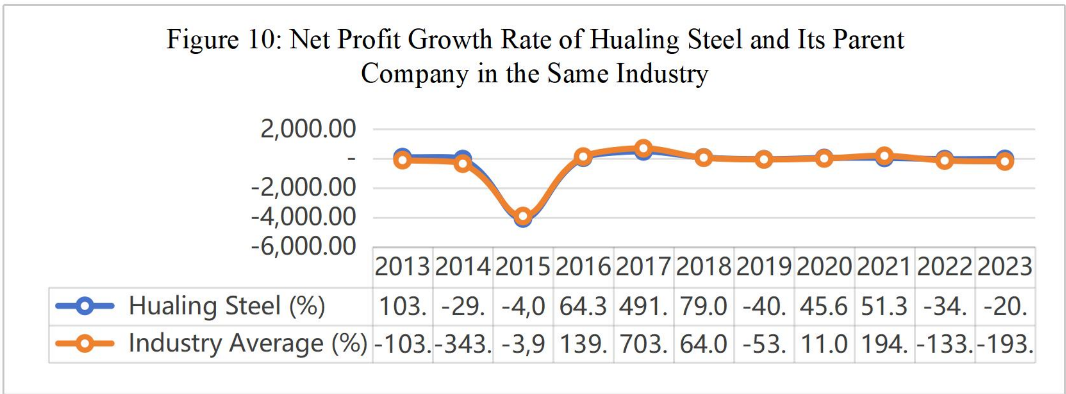


Figure 10. Net Profit Growth Rate of Hualing Steel and the Industry
Data Source: Sina Finance Network

4.3.6. Enhanced Innovation Value

Hualing Steel has continuously increased its investment in research and development (R&D) to enhance its innovation capabilities. R&D intensity refers to the ratio of R&D expenses to operating revenue. Hualing Steel's R&D intensity is shown in Figure 11.

As shown in Figure 11, from 2013 to 2018, R&D expenditures gradually increased, but the proportion of R&D expenditures to operating revenue remained relatively low. For example, in 2013, the company's R&D expenditures were relatively low, with special steel sales of 2.62 million tons, accounting for less than 30% of total sales. From 2018 to 2023, the R&D intensity significantly improved, with the proportion of R&D expenses to operating revenue gradually exceeding 3% and reaching 4.17% in 2023. In 2023, the company's R&D investment reached 6.831 billion yuan, and the proportion of special steel sales increased to 63%.

Since 2018, Hualing Steel has accelerated its digital transformation efforts, promoting the deep integration of technologies such as 5G and artificial intelligence with production sites. For example, Hualing Xianggang's 5G smart factory project was selected for the Ministry of Industry and Information Technology's 5G case study collection, and Hualing Liangang's 5G+AI factory was included in the Ministry of Industry and Information Technology's 5G factory directory. Through sustained R&D investment, Hualing Steel has successfully transitioned from producing ordinary steel to high-end steel. The company has broken through multiple key core technologies through R&D innovation, establishing a differentiated competitive advantage. For example, Hualing Xianggang's "Development and Industrialization of Key Technologies for Third-Generation Ultra-High-Volume Low-Temperature High-Pressure Pipeline Steel" project won the Special Prize for Metallurgical Science and Technology Progress. The enhancement of R&D intensity has also driven Hualing Steel's green and low-carbon transformation, improving the company's long-term sustainable development.

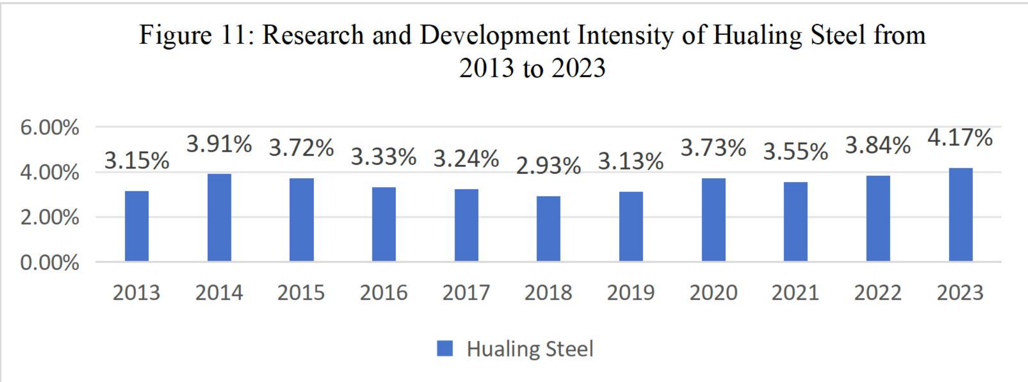


Figure 11. R&D Intensity of Hualing Steel from 2013 to 2023
Data source: Sina Finance Network

4.3.7. Energy Conservation and Emission Reduction

In recent years, Hualing Steel has actively promoted national "dual carbon" and green development policies, continuously increasing investment in national key technologies for the efficient recovery and utilization of secondary energy sources such as dry quenching, waste heat power generation, ultra-high-pressure high-temperature power generation, and subcritical power generation. Through a series of measures including equipment upgrades and technological improvements, the company has significantly enhanced energy efficiency in its production operations. The energy management level of Hualing Steel is analyzed from two aspects: self-generated electricity and comprehensive energy consumption per ton of steel, as shown in Table 5.

Self-generated electricity is one of the key indicators for evaluating a steel company's energy management level, reflecting its ability to recover and utilize secondary energy sources such as waste heat, waste pressure, and coal gas. Hualing Steel's self-generated electricity has shown a steady increase over the years, rising from 7.5 billion kilowatt-hours in 2020 to 9.223 billion kilowatt-hours in 2023, representing an approximate 23% growth. Hualing Steel's comprehensive energy consumption per ton of steel decreases as self-generated electricity increases. In 2022, the comprehensive energy consumption per ton of steel for member units of the China Iron and Steel Association was 551.36 kilograms of standard coal per ton, while Hualing Steel's comprehensive energy consumption per ton of steel was 530 kilograms of standard coal per ton, indicating that its energy consumption level is lower than the industry average and demonstrating its advantages in energy conservation and emission reduction.

In 2022, Hualing Steel fully utilized waste heat and pressure resources to reduce energy loss, upgraded and renovated outdated power generation units, achieving a total self-generated electricity output of over 89.06 billion kWh for the year. This resulted in zero emissions of blast furnace gas, a reduction of 29.6 million GJ in thermal energy losses, a saving of 101,000 tons of standard coal consumption, and a reduction of over 260,000 tons of carbon dioxide emissions, generating significant socio-economic benefits. In 2023, the company strengthened the recovery and utilization of secondary energy, continuously increasing self-generated electricity production. In 2023, self-generated electricity reached 9.223 billion kWh, equivalent to saving 1.05 million tons of standard coal consumption and reducing carbon dioxide emissions by over 2.7 million tons.

Hualing Steel has demonstrated outstanding performance in two key indicators—self-generated electricity and comprehensive energy consumption per ton of steel—reflecting its high level of energy management. Through technological innovation and management optimization, the company has achieved efficient energy utilization and cost control.

Table 5. Energy Consumption of Hualing Steel

Indicator	2018	2019	2020	2021	2022
Comprehensive energy consumption per ton of steel (kilograms of standard coal / ton)	536	525	502	535	530
Self-generated electricity (10,000 kilowatt-hours)	699,126	711,215	746,312	791,068	890,546

Data source: Social Responsibility Report

4.3.8. Reduction in pollutant emissions

The company has adopted advanced and reliable treatment technologies for pollutant control in all production processes. For flue gas treatment in furnaces and kilns, the company employs electrostatic precipitators at the furnace inlet combined with lime-gypsum wet desulfurization and SCR denitrification technology for sintering flue gas, and SDA desulfurization followed by SCR denitrification for coke oven flue gas, targeting pollution sources at their origin. Coke oven gas is purified using the HBF desulfurization process. During the transportation and crushing of raw materials such as coal, coke, iron ore, sintered ore, and steel production materials, membrane-lined baghouse dust collection systems are used to ensure stable compliance with emission standards.

For wastewater discharge, coke oven phenol-cyanide wastewater is treated using A2O2 biological methods and ozone deep treatment, and a large wastewater and cold rolling wastewater treatment system has been constructed. Physical-chemical methods such as flocculation precipitation and sand filtration are employed to ensure that discharged wastewater meets emission standards.

The company is accelerating its low-carbon green transformation and development, strictly phasing out high-polluting and energy-intensive production processes and equipment, actively responding to the national "Three Major Battles" campaign for pollution prevention and control, and in accordance with ultra-low emission standards, is steadily advancing the renovation and construction of various environmental protection facilities. As shown in Table 2, in recent years, Hualing Steel has implemented measures such as ultra-low emission upgrades, clean energy utilization, process upgrades, and environmental facility upgrades, resulting in a significant reduction in pollutant emissions such as COD, ammonia nitrogen, sulfur dioxide, nitrogen oxides, particulate matter, and wastewater discharge, as shown in Table 6:

Table 6. Hualing Steel Pollutant Emission Overview

Type	Unit	2018	2019	2020	2021	2022	2023
COD	ton	390	397	435	419	415	355
Ammonia nitrogen	ton	39	36	32	25	22	18
Sulfur dioxide	ton	12073	12,391	12,120	11,072	10,392	5740
Nitrogen oxides	ton	19,876	17,855	17,977	16,668	16,219	15,867
Particulate matter	ton	24,125	23,525	24,821	22,097	23,996	21,745

Wastewater discharge volume	ton	279,992.32	2,534,209.6	28,710,275	3,030,325.3	296,985,444	26007761

Data Source: Social Responsibility Report

4.4. Comprehensive Dimension Results Evaluation Analysis

4.4.1. Empowerment Mechanisms for Digital Transformation

Hualing Steel has deployed 228 industrial robots, a 5G+visual recognition-based slab automatic transfer system, and other advanced technologies and equipment, achieving a numerical control rate of over 80% in key production processes. The sustained improvement in return on net assets since 2016 demonstrates the direct impact of equipment intelligence on production efficiency. The Quality Intelligence Control Center has achieved full-process quality traceability, with analysis efficiency improving by 60%, supporting the proportion of specialty steel sales increasing from 32% in 2016 to 65% in 2024, verifying the promotional role of data elements in product upgrades.

4.4.2. Structural Advantages and Shortcomings

Hualing Steel's strengths lie in its ability to achieve cost control through digital transformation, with the ratio of operating expenses to revenue decreasing from 3.2% in 2016 to 1.36% in 2023. Its debt-repayment capacity has significantly improved, with the current ratio reaching 1.28 and the quick ratio reaching 1.00 in 2023, both exceeding the industry average.

Existing weaknesses include lagging returns on R&D investment, despite an R&D intensity of 4.17% in 2023, with significant fluctuations in operating profit growth rates. Additionally, there is insufficient cyclical resilience, with the revenue growth rate dropping to -12.03% in 2023 during an industry downturn, and the correlation coefficient plummeting to 0.2740. The entropy method indicates that profitability (22.58% weight) and debt-repayment capacity (28.21% weight) are the primary contributing dimensions, while R&D capability accounts for only 9.43%. This reflects that the current transformation remains dominated by "efficiency improvements," with the efficacy of "innovation-driven" strategies yet to be fully unleashed. This aligns with the asymmetric performance between R&D intensity and profit growth.

5. Policy Recommendations for High-Quality Development of Hualing Steel in the Context of Digital Transformation

In the context of digital transformation, Hualing Steel, as a traditional manufacturing enterprise, can achieve more efficient, greener, and more innovative development by implementing several strategic recommendations. These recommendations aim to deepen the application of digital technologies, optimize operational management systems, strengthen innovation-driven growth, and enhance talent development systems. By adopting these comprehensive measures, Hualing Steel can drive its digital transformation process more effectively, providing both practical reference and theoretical support for the transformation and upgrading of traditional manufacturing industries.

5.1. Deepen the Application of Digital Technologies and Build a Smart Manufacturing System

Accelerate the achievement of a 100% numerical control rate for key production processes, deploy 5G private networks and edge computing nodes in core processes such as rolling and continuous casting. Reduce unplanned equipment downtime by 30% through intelligent maintenance systems to enhance production efficiency. Establish a dual-drive system combining a "data middleware platform + blockchain" to break down data silos across production, supply chain, and energy consumption. Achieve full-lifecycle quality traceability and carbon footprint tracking from raw materials to finished products.

5.2. Optimize the Enterprise Operation Management System and Improve Management Efficiency

Address the issue of overly lengthy decision-making chains in the current "three-tier legal entity" structure by piloting a flat management model combining "production units + digital platforms." Delegate decision-making authority for quality assessment and production scheduling optimization to smart workshops to improve decision-making efficiency. Develop an intelligent evaluation system based on the Balanced Scorecard, incorporating digital indicators such as annual steel production per capita and process cost reduction rates into the KPI evaluation system.

5.3. Strengthen Innovation-Driven Development and Cultivate Core Competitiveness

Focus on high-end fields such as high-strength steel for new energy vehicles and special steel for marine engineering equipment, and establish a special R&D fund. Utilize EPD certification (currently available for six product categories) to build carbon asset trading capabilities, develop a "steel products + carbon emission reduction" combined sales model, and transform environmental protection investments into new profit growth points. Based on the application experience of the existing 228 robots, export standardized solutions for intelligent steelmaking and scrap steel sorting, and cultivate new digital technology service businesses.

5.4. Improve the Talent Development System and Strengthen Intellectual Support

Recruit global experts in industrial AI and implement profit-sharing incentives for major technological breakthroughs. Develop an intelligent training system and conduct comprehensive digital skills training for all employees through "micro-courses + simulated practical training" to ensure that 100% of frontline employees master the operational skills of digital production systems.

References

[1] Zhang Yongshan, Li Xiaobo, and Xing Mingqiang. (2021). "Enterprise Digital Transformation and Audit Pricing." Audit Research, n(03): 62-71.

[2] Ma Zongguo, Cao Lu. (2020). Construction and Measurement of an Evaluation System for High-Quality Development of Manufacturing Enterprises: An Analysis of 1,881 Listed Companies from 2015 to 2018. Science and Technology Progress and Policy, 37(17): 126-133.

[3] Wang Benqiang, Chen Meng, Zheng Shanshan. (2022). Comprehensive Evaluation of Inter-regional Scientific and Technological Innovation Capabilities in Anhui Province Based on the Analytic Hierarchy Process and Entropy Weight Method. Science and Technology Management Research, 42(2): 75-83.

[4] Wijaya E R, Rudianto. (2020). Selection of supplier for the evaluation of procurement of special chemicals using entropy method and Topsis in XYZ Company. IOP Conference Series: Materials Science and Engineering, 909(1).

[5] Mian Fu, Dandan Wang. (2020). Evaluation of Unit Canteen Suppliers Based on Entropy Method and Analytic Hierarchy Process. E3S Web of Conferences, 218.

[6] Lam Weng Siew et al. (2021). Performance Evaluation of Construction Companies Using Integrated Entropy–Fuzzy VIKOR Model. Entropy, 23(3): 320-320.

[7] Miao Chunxia. (2023). Digital Transformation, Management Power, and High-Quality Development of Enterprises. Accounting and Finance Bulletin, (11): 83-87.

[8] Wang Xi, Chen Xuejiao, Cao Jing, et al. (2023-09-11). The Impact of Digital Transformation on Enterprise High-Quality Development: An Enterprise Innovation and Risk-Taking Perspective . Science and Technology Progress and Policies: 1-10.

[9] Zhang Shaofeng, Xu Mengsu, Zhu Yue, et al. (2023). Technological Innovation, Organizational Resilience, and High-Quality Development of Manufacturing Enterprises. Science and Technology Progress and Policy, 40(13): 81-92.

[10] Wang Tingwei, Su Zhenfang, Li Jiazheng. (2023-09-11). Research on the Driving Mechanisms and Pathways of High-Quality Development in Manufacturing from a Configuration Perspective: A Fuzzy Set Qualitative Comparison Analysis. Soft Science:

1-13.

[11] Lei Shangjun. (2023). Has Digital Transformation Driven Industrial Innovation? — Microevidence from Listed Companies. Jiangxi Social Sciences, 43(07): 110-120.

[12] Zhou Hongxing, Huang Songqin. (2023). Can Digitalization Empower Innovation? — The Impact of Digital Transformation on Innovation in Private Enterprises. Economic Dynamics, (07): 69-90.

[13] Pan Hongbo, Gao Jinhui. (2022). Digital Transformation and Enterprise Innovation: Empirical Evidence from Annual Reports of Chinese Listed Companies. Journal of Central South University (Social Sciences Edition), 28(05): 107-121.

[14] Chen Xiaoying. (2017). Evaluation of Financial Performance of Listed Coal Companies in China: A Study Based on the Entropy Method. Journal of Liaoning University of Technology (Social Sciences Edition), 9(4): 44-48.