

The Effectiveness of Digital Transformation in Home Appliance Manufacturing Enterprises

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Abstract. This study takes Gree Electric Appliances as the research object, focusing on its digital transformation process from 2013 to 2023. By adopting the case study method and quantitative analysis, and constructing a multi-dimensional framework combining financial and non-financial indicators, it explores the effectiveness of digital transformation in home appliance manufacturing enterprises. The research shows that Gree's transformation has gone through three stages: the initial phase of informatization construction, the improvement of production intelligence, and the construction of a digital ecosystem. At the operational level, the introduction of intelligent equipment and the industrial internet has achieved improvements in production efficiency, optimization of defect rates, and enhancement of inventory turnover. At the financial level, there is a significant positive linear correlation between the degree of digital transformation and total operating revenue; however, in the short term, there is a significant negative correlation with return on equity (ROE), which reflects the "transformation pains" caused by investment in the early stage of transformation. This study enriches the theory of effectiveness evaluation for digital transformation in the manufacturing industry and provides experience for the transformation of home appliance and similar manufacturing enterprises. In the future, the home appliance manufacturing industry needs to deepen the integration of technology and business, and enhance global competitiveness through full-chain digital integration.

Keywords: Manufacturing industry; digital transformation; Gree Electric Appliances.

1. Introduction

Against the backdrop of the accelerated evolution of the new round of global scientific and technological revolution and industrial transformation, the digital economy has become one of the core indicators for measuring national competitiveness. According to the China Digital Economy Development Research Report released by the China Academy of Information and Communications Technology (CAICT), the scale of China's digital economy reached 53.9 trillion yuan in 2023, accounting for over 40% of Gross Domestic Product (GDP). This milestone data indicates that the digital economy has become the core engine driving the high-quality development of China's economy [1]. From a global perspective, the integration of digital technology and the real economy is reshaping industrial structure. Developed countries such as the United States and the European Union are seizing the competitive high ground by deploying cutting-edge fields such as artificial intelligence (AI) and the industrial internet.

The Chinese government has successively issued a series of strategic plans, including the 14th Five-Year Plan for Digital Economy Development and Made in China 2025, providing clear directional guidance and policy support for the digital transformation of industries [2,3]. The rapid iteration of information technology, especially the maturity and application of technologies such as 5G, big data, AI, and industrial internet, has laid a solid technical foundation for the digital transformation of the manufacturing industry and promoted the transformation of traditional manufacturing models toward intelligence and servitization.

However, amid the overall positive development trend, the digital transformation of the manufacturing industry—especially home appliance manufacturing enterprises—still faces numerous challenges. The home appliance industry is characterized by mass production and diverse product varieties, which impose high requirements on the flexibility and responsiveness of the supply chain. In recent years, affected by factors such as fluctuations in raw material prices and rising labor costs,

enterprises have been under increasing pressure to control costs. At the same time, consumer demand has become increasingly diversified and personalized, and the demand for "small-batch, multi-batch" customized production has posed a severe test to traditional production models. More notably, the intensified internal competition in industry has led products into a "price war," continuously compressing enterprises' profit margins. Against the background of the restructuring of the global industrial chain, the need to enhance core competitiveness has become increasingly urgent. As a key path to solving these problems and improving enterprises' global competitiveness, the evaluation of the effectiveness and exploration of the model of digital transformation have become important issues to be addressed in both academic and practical circles.

Based on this, this study takes Gree Electric Appliances as the research object, focusing on its digital transformation process from 2013 to 2023. It uses the case study method to conduct an in-depth analysis of its transformation path, key measures, and implementation effects. In terms of research methods, quantitative analysis is adopted: financial indicators such as profitability, operational efficiency, and cost control are calculated based on enterprise annual report data, and statistical analysis and trend judgment are conducted using tools such as Excel. At the same time, combined with non-financial indicators, a multi-dimensional analysis framework integrating financial and non-financial indicators is constructed to comprehensively evaluate the effectiveness of Gree Electric Appliances' digital transformation.

The significance of this study lies in: through in-depth analysis of the case of Gree Electric Appliances' digital transformation, it enriches the theoretical system for evaluating the effectiveness of digital transformation in the manufacturing industry, provides a new perspective and theoretical support for relevant academic research, supplements case studies on digital transformation in the home appliance industry, and offers referable experience and insights for the digital transformation of other home appliance enterprises and even manufacturing enterprises.

2. Background and Process of Gree Electric Appliances' Digital Transformation

Zhuhai Gree Electric Appliances Inc. was founded in 1991 and listed on the Shenzhen Stock Exchange in November 1996. In its early stage, Gree Electric Appliances mainly relied on assembling household air conditioners for profit; now, it has developed into a diversified and technology-driven global industrial manufacturing group, covering two major fields: household consumer goods and industrial equipment. Its products are sold to more than 190 countries and regions. As a leading enterprise in China's home appliance industry, it ranks 436th in the Fortune Global 500.

2.1. Initial Phase of Informatization Construction

When the digital wave first emerged, Gree Electric Appliances still mainly relied on traditional manufacturing and sales models. Internal processes were mostly manual, there were barriers to information flow between departments, and data sharing efficiency was low. To break this situation, Gree focused its digital transformation on basic informatization construction, marking the first step in its digital journey. During this phase, Gree invested substantial resources to systematically build the framework of the internal enterprise information system [4].

In the financial field, a professional financial informatization management platform was introduced to digitalize processes such as accounting treatment, fund management, and cost accounting. This not only reduced errors in manual bookkeeping but also enabled the real-time generation of various financial statements, providing timely and accurate data support for management decision-making. In the human resources module, the informatization system realized the full-process online management of employee recruitment, salary management, performance appraisal, and training and development. This freed the department from tedious transactional work and allowed it to focus more on the formulation and implementation of talent strategies. The launch of the office automation system completely changed the traditional office model: document

circulation, approval processes, and meeting management were all completed online, significantly shortening the office cycle and improving internal collaboration efficiency.

2.2. Improvement of Production Intelligence

With the increasingly fierce market competition and the continuous upgrading of consumers' demands for product quality and personalization, the traditional production model could no longer meet Gree's development needs. Against this background, from 2018 to 2020, Gree increased its investment in digital transformation, shifting its focus to the intelligent upgrading of the production link and striving to achieve the leap from "manufacturing" to "intelligent manufacturing." Gree actively laid out the construction of smart factories and introduced a large number of advanced automated production lines and industrial robots [5].

During this phase, in air conditioner production workshops, processes such as welding, assembly, and testing were gradually replaced by robots. This not only reduced the intensity of manual labor but also significantly improved the consistency and qualification rate of products due to the high precision and stability of robot operations. At the same time, sensors were installed on production equipment to collect real-time data on equipment operation, production progress, and quality inspection. This data was transmitted to the central control system, enabling full-process visual monitoring of the production process.

With the help of big data analysis technology, the system could conduct in-depth mining of production data, timely detect abnormalities in the production process and issue early warnings, helping managers make quick adjustments and improving the flexibility and risk resistance of production. After upgrading and transformation, Gree's production efficiency was significantly improved, and product quality reached a new level, earning the enterprise greater advantages in market competition.

2.3. Construction of a Digital Ecosystem

Since 2021, digital transformation has become the core strategy for enterprise development. Gree Electric Appliances further deepened its digital transformation, widely applying advanced technologies such as industrial internet, big data, and AI to all links of enterprise operations, and making every effort to build a digital and intelligent manufacturing system and a sound and stable digital ecosystem.

On the sales side, Gree vigorously promoted the construction of digital stores to provide consumers with a new shopping experience. The intelligent shopping guide screen could accurately recommend suitable products according to consumers' needs and display detailed product parameters, performance advantages, and user reviews. The cloud shelf broke the space limitation of traditional stores: consumers could browse a large number of products through touch screens, realizing the model of "small store, large inventory." The introduction of these digital devices not only improved the convenience and satisfaction of consumers' shopping experience but also created a new retail model integrating online and offline channels, connecting the entire consumer chain.

In terms of services, Gree established a comprehensive digital service system. The intelligent customer service system could provide 24/7 consulting services for users. Through natural language processing technology, it accurately understood users' questions and provided solutions, greatly improving the response speed and efficiency of services. For some complex equipment failures, Gree used remote fault diagnosis technology: engineers could quickly determine the cause of the fault through the operation data uploaded by the equipment without on-site visits, and guide users in maintenance or arrange personnel for on-site services, saving users a lot of time and energy.

In addition, Gree also realized digital upgrading in supply chain management, Research and Development (R&D) and design, and other links. Through the industrial internet platform, Gree achieved real-time data sharing with suppliers, improving the collaboration efficiency and responsiveness of the supply chain. In R&D and design, AI technology was used for product simulation and optimization, shortening the R&D cycle and improving the market adaptability of new

products. Today, Gree's digital ecosystem has initially taken shape, realizing full-chain digital integration from product design, production and manufacturing, sales and services to supply chain management, injecting strong impetus into the sustainable development of the enterprise.

3. Analysis of the Effectiveness of Gree Electric Appliances' Digital Transformation

3.1. Financial Performance Analysis

Based on official documents such as the annual reports disclosed by Gree Electric Appliances, the frequency of digital transformation-related terms in the annual reports since 2013 was counted. These terms mainly include artificial intelligence technology, blockchain technology, cloud computing technology, big data technology, and digital technology. In this section, the frequency of digital transformation terms is used as the explanatory variable, while total operating revenue and return on equity (ROE) are used as explained variables respectively. Simple linear regression analysis is applied to explore the correlation between them.

Table 1. Regression between the degree of digital transformation and total operating revenue (2013-2023)

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-19.017	9.684	-1.963	0.073	-40.117	2.081
Total Operating Revenue	2.80E-10	6.38243E-11	4.3796556960	0.0008968451	4.0467E-104	1.859E-10

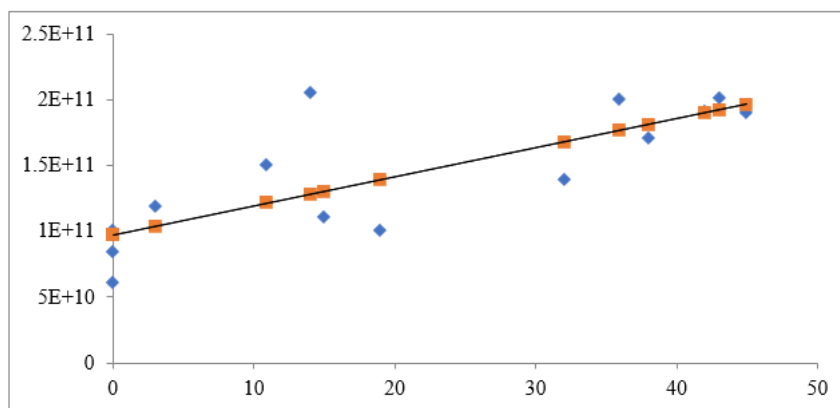


Fig 1. Regression equation between the degree of digital transformation and total operating revenue (2013-2023). (Picture credit: Original)

According to the Table 1 and Figure 1, the significant F-value in the analysis of variance is 0.00009, which is much smaller than the common significance level, indicating that the regression equation is overall significant—i.e., there is a significant linear relationship between digital transformation-related indicators and Gree Electric Appliances' operating revenue. At the same time, the P-value of the digital transformation process is 0.000089, which is also less than 0.01. This also shows that under the current data, the impact of digital transformation-related indicators on Gree Electric Appliances' operating revenue is significant and has a positive promoting effect.

Table 2. Regression between the degree of digital transformation and ROE (2013-2023)

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.350094	0.034252	10.221	2.98E-06	0.27261	0.427578
Return on Equity (ROE)	-0.00259	0.001119	-2.31537	0.045832	-0.00512	-6E-05

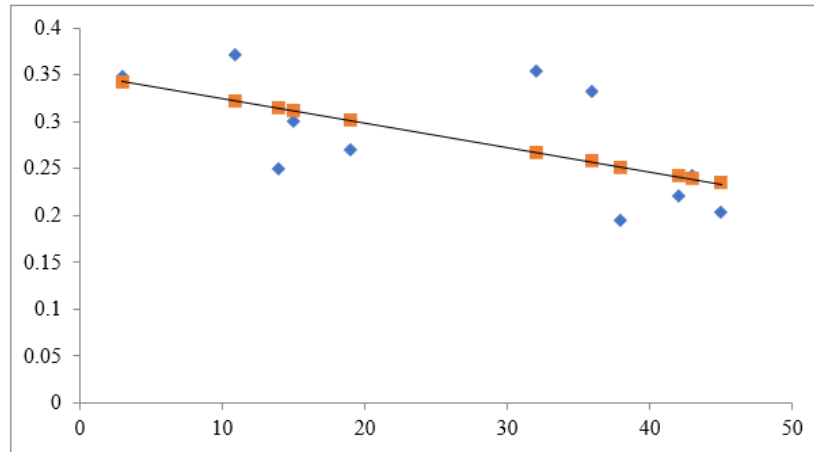


Fig 2. Regression equation between the degree of digital transformation and ROE (2013-2023). (Picture credit: Original)

According to Table 2 and Figure 2, the significant F-value is 0.0458, which is lower than 0.05, indicating that the regression equation is statistically significant overall—i.e. there is a significant linear relationship between digital transformation-related indicators and ROE. At the same time, the p-value of the digital transformation process is also 0.0458, which is less than 0.05, further indicating that its impact on ROE is statistically significant. However, due to the regression coefficient of -0.00259, this means that under the current data context, as the degree of digital transformation deepens, ROE shows a downward trend, reflecting a certain negative impact. This result may reflect that enterprises face greater investment pressure or "transformation pains" in the short term during the promotion of digital transformation, leading to a phased decline in profitability indicators.

3.2. Case Analysis of Digital Transformation

The core of Gree Electric Appliances' digital transformation lies in the integration of technology and in-depth business integration. Through technologies such as 5G + industrial internet and AI quality inspection, it has achieved a 30% improvement in production efficiency and a 50% reduction in defect rates. The key lies in embedding technology into practical scenarios rather than simply pursuing technology accumulation [6].

At the same time, Gree has built a unified data middle platform. Through measures such as "one item, one code," LBS marketing, and supply chain big data analysis, it has connected the real-time linkage of production, logistics, and customer demand, forming a closed-loop feedback. In supply chain management, Gree has reduced supply chain costs by more than 100 million yuan through centralized procurement, a customized pricing system, and an intelligent settlement module, and increased the inventory turnover rate from 6.8 times per year to 8.2 times per year.

In addition, Gree focuses on user needs to promote the optimization of online channels, such as live-streaming e-commerce, predictive maintenance services, and smart community services. In terms of organizational transformation, Dong Mingzhu led the establishment of a digital technology center, promoted the "product + service" model, and broke the traditional hierarchical structure through performance appraisal and the strategy of "team renewal + mindset renewal."

4. Conclusion

This study takes Gree Electric Appliances—a typical enterprise in the digital transformation of the home appliance manufacturing industry—as the research object. It systematically sorts out its digital transformation process from 2013 to 2023, dividing it into three stages: the initial phase of informatization construction, the improvement of production intelligence, and the construction of a digital ecosystem. By using a multi-dimensional analysis framework combining financial and non-financial indicators, and supplemented by quantitative methods such as linear regression, it explores

the correlation between transformation and enterprise performance. The research finds that Gree Electric Appliances has achieved remarkable results in digital transformation: at the operational level, the application of intelligent equipment and industrial internet technology has improved production efficiency, reduced product defect rates, and significantly increased inventory turnover; at the financial performance level, there is a significant positive linear correlation between the degree of digital transformation and total operating revenue, which confirms the driving role of digitalization in the expansion of enterprise business scale. However, it is also found that in the short term, there is a significant negative correlation between the degree of digital transformation and ROE, which reflects the "transformation pains" caused by large-scale investment in the early stage of enterprise transformation, leading to a phased decline in profitability indicators.

For the future digital transformation of Gree Electric Appliances and similar home appliance manufacturing enterprises, the following suggestions can be put forward: on the one hand, enterprises need to pay attention to the balance between short-term investment and long-term benefits, optimize the rhythm of transformation investment, and reduce the pressure of "transformation pains" on enterprise profitability by formulating phased investment plans and strengthening the benefit evaluation of each transformation link; on the other hand, enterprises should further deepen the integration of digital technology and core business, not only staying at the application of single-point technology but also focusing on the in-depth excavation of data value—for example, using big data and AI technology to accurately predict market demand and optimize product R&D.

Looking to the future, with the continuous iteration of technologies such as AI and industrial internet, the digital transformation of the home appliance manufacturing industry will move toward a more intelligent and integrated direction. Enterprises that can realize full-chain digital integration of product R&D, production, sales, and services will have stronger competitiveness in the global market, thereby promoting the high-quality development of the entire manufacturing industry.

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