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# Research on the Impact of Digital Transformation on the Performance of Manufacturing Enterprises

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**Abstract:** To address the challenges faced by manufacturing enterprises in digital transformation, this paper analyzes the relationship between digital transformation and enterprise performance. Using panel data from domestic A-share-listed manufacturing enterprises from 2012 to 2022, two hypotheses were proposed. The analysis and verification revealed that digital transformation in manufacturing enterprises can enhance performance and reduce costs. Based on the impact of digital transformation on manufacturing enterprise performance, optimization suggestions are proposed to guide future digital transformation and performance improvement efforts in these enterprises.

**Keywords:** Digital transformation; Manufacturing enterprise; Performance; Costs

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## 1. Introduction

With the advent of the digital era, both manufacturing production and enterprise management have increasingly adopted technologies such as big data and cloud computing, using modern information technology to drive digital transformation in manufacturing. This transformation is a crucial pathway for achieving growth momentum and high-quality development across industries. The manufacturing industry, as a fundamental component of China's real economy, significantly influences the national economy and is a key element of the national strategic layout. Manufacturing enterprises play a leading role in the digital economy, leveraging digital transformation to enhance efficiency and innovation.

From a micro perspective, digital transformation in manufacturing enterprises involves detailed processes in research, development, and production, where digital innovation is applied to eliminate data silos within the organization. Through data integration, new resources can be created, enabling lean management and improving overall performance. Thus, digital transformation has a direct impact on the performance of manufacturing enterprises. This article proposes hypotheses to explore this relationship and verifies the effects of digital transformation on corporate performance.

## 2. Theory and hypothesis

### 2.1. Background of digital transformation in the manufacturing industry

Starting from 2023, China has actively implemented the "Overall Layout Plan for Digital China Construction." The government work report also highlights the need to "vigorously develop the digital economy" and "accelerate the digital transformation of traditional industries and small and medium-sized enterprises." These directives underscore the potential of the digital economy within the manufacturing sector and outline the industry's development direction in this digital era. Manufacturing enterprises must actively engage in digital transformation to achieve high-quality development goals. They should strategically apply digital technologies to accelerate this transformation, leveraging their considerable potential. It is essential to analyze the impact of digital transformation on performance in manufacturing enterprises from a strategic perspective [1].

### 2.2. Proposing hypotheses

#### 2.2.1. The overall impact of digital transformation on manufacturing enterprises

In the era of the Internet of Things (IoT), traditional industrial production and manufacturing are rapidly undergoing transformation and upgrading. Digital transformation has become a strategic choice for many manufacturing enterprises to adapt to the changing environment. By extensively applying digital technologies, these enterprises can integrate resources that were previously managed independently, innovate in product and service production, and enhance their adaptability in the digital marketplace.

Manufacturing enterprises that embrace digital transformation can explore new market opportunities, introduce new businesses and services, and innovate their business models, all of which contribute to increased operating revenue. The adoption of digital and intelligent production models enables comprehensive tracking of the manufacturing process, enhances transparency in product quality control, and reduces unnecessary costs. Therefore, digital transformation is positively correlated with improved performance in manufacturing enterprises [2].

Based on this, **Hypothesis 1** is proposed: Practicing digital transformation in manufacturing enterprises can improve their performance.

#### 2.2.2. The mechanism of the impact of digital transformation on the performance of manufacturing enterprises

While the positive impact of digital transformation on corporate performance is acknowledged, the specific channels through which it affects performance warrant further discussion. From the experience of manufacturing enterprises, reducing costs and increasing efficiency are critical pathways to enhancing performance. Particularly in the manufacturing sector, production is a vital component, and cost savings in this area directly contribute to profitability. The extensive application of digital technologies in manufacturing has significantly improved production efficiency, shortened product cycles, and reduced product loss rates, thereby minimizing resource and energy waste [3].

Additionally, digital transformation can lead to cost savings in other areas such as management. By collecting data and information from various departments and production processes, management can achieve precise control and enable on-demand production. Consequently, digital transformation helps manufacturing enterprises save on production and operational costs, increase profits, and enhance overall performance.

Based on this, **Hypothesis 2** is proposed: Digital transformation of manufacturing enterprises can save costs and improve performance.

## 3. Hypothesis analysis of the impact of digital transformation on the performance of manufacturing enterprises

### 3.1. Selection of variables

This analysis examines the impact of digital transformation on the performance of manufacturing enterprises. Panel data from domestic A-share-listed manufacturing enterprises from 2012 to 2022 were selected as the initial research sample, with data sourced from the Hugedata information website. During this period, influenced by the external environment, many manufacturing enterprises restructured their development strategies and actively promoted digital transformation, marking a critical phase in this process. The initial data samples were filtered as follows: (1) exclusion of ST, *ST, PT samples; (2) exclusion of samples with missing key variables; (3) removal of data where the explanatory variable remains 0 after cleaning. All data were observed, with continuous variables as the target, and a bilateral trimming at a ratio of 1% was applied to minimize the impact of abnormal and extreme data on the final analysis results [4].

### 3.2. Variable settings

#### 3.2.1. Dependent variable

Based on existing research methods, the Data Envelopment Analysis (DEA) method was chosen to measure the performance level of manufacturing enterprises. This method uses input-output data to create an envelope, compares various decision-making units with optimal decisions, highlights the differences, and evaluates efficiency, providing a more intuitive understanding of relative efficiency [5]. In this study, enterprise performance, impacted by the digital transformation of manufacturing enterprises, is set as the dependent variable. Two main types of indicators are used to measure it: financial indicators (return on equity, return on total assets, Tobin Q value) and non-financial indicators. The Tobin Q value, chosen for this analysis, reflects both the enterprise's value and market investors' confidence in the enterprise's future value, making it a more objective measure compared to other financial indicators which are based on historical data and may not accurately reflect real-time market changes [6].

#### 3.2.2. Explanatory variables

The determination of explanatory variables aims to measure the final outcome of the digital transformation practices of listed manufacturing enterprises. Digital technology is used to assess the effectiveness and level of digital transformation, with a characteristic vocabulary spectrum developed to capture digital attributes. Vocabulary related to corporate strategy is extracted from the annual reports of manufacturing enterprises. Given the differences between enterprises, the methodology was refined by adding English expressions and abbreviations of terms to the feature word lists, making them more comprehensive.

#### 3.2.3. Control variables

Based on existing relevant research, the selected control variables include the listing time of manufacturing enterprises, the operating scale of enterprises, the revenue growth rate, and the structure of the manufacturing industry.

#### 3.2.4. Mediating variables

Based on the hypotheses proposed in this article, the operating cost rate of manufacturing enterprises is selected as the mediating variable.

### 3.3. Modeling

To validate **Hypothesis 1**, **Model 1** was constructed:

$$TobinQ=\alpha_1+\alpha_2 DCG+\alpha_3 Size+\alpha_4 Age+\alpha_5 Growth+\alpha_6 Structure+\varepsilon \quad (1)$$

For validating **Hypothesis 2**, using **Model 1** as a reference, **Models 2** and **3** were constructed using the stepwise regression method:

$$Ofee=\beta_1+\beta_2 DCG+\beta_3 Size+\beta_4 Age+\beta_5 Growth+\beta_6 Structure+\varepsilon \quad (2)$$

$$TobinQ=\delta_1+\delta_2 DCG+\delta_3 Size+\delta_4 Age+\delta_5 Growth+\delta_6 Structure+\varepsilon \quad (3)$$

## 4. Empirical analysis

### 4.1. Descriptive statistics

Based on the validation and construction of the model, descriptive statistical results were obtained, as shown in **Table 1**. According to the analysis of the data in **Table 1**, the results are as follows:

(1) The minimum value of the dependent variable (Tobin's Q) is 0.803, and the maximum value is 16.11, indicating significant differences in the performance of the sample companies [7].

(2) The data show that the average performance of the sample companies is 2.081, which indicates a lower performance value and suggests a greater potential for improvement in company performance.

(3) The minimum value of the explanatory variable for the sample enterprises is 0.0072, the maximum value is 5.841, and the average value is 1.722.

This analysis indicates that although manufacturing enterprises have already invested in digital transformation, the results have not been very significant. They are still in a stage of development and exploration. Although enterprises have embraced the concept of digital transformation, there are still obstacles in practice, resulting in unclear effects [8].

**Table 1.** Descriptive statistical results

| Variable | Symbolic representation | Average value | Standard deviation | Maximum value | Minimum value |
|---|---|---|---|---|---|
| Enterprise performance | Tobin Q | 2.081 | 1.257 | 16.11 | 0.803 |
| Digital transformation | DCG | 1.722 | 0.266 | 5.841 | 0.0072 |
| Enterprise operation scale | Scale | 22.41 | 1.220 | 26.38 | 19.54 |
| Time of listing | Age | 8.5 | 1.25 | 9.12 | 7.63 |
| Revenue growth rate | Growth | 0.145 | 0.328 | -0.661 | 4.134 |
| Industrial structure of the manufacturing industry | Structure | 0.38 | 0.12 | 0.73 | 0.14 |

### 4.2. Regression analysis

To avoid multicollinearity in the analysis, a collinearity diagnosis was performed on all the variables selected above, using the variance inflation factor (VIF) to verify the hypothesis. See **Table 2** for the relevant regression analysis data. According to the data in **Table 2**, the VIF values of all variables are less than 10, so it can be determined that multicollinearity will not interfere with subsequent regression. In addition, the regression model was more accurately constructed using the Hausman test method, with the test result $P = 0$ and $P < 0.01$, which allows us to reject the null hypothesis and build a fixed-effects model [9].

In the process of benchmark regression analysis, a fixed-effects model is constructed, and the regression results are shown in the column labeled "Model 1" in **Table 2**. Based on the regression coefficient of the

explanatory variable (DCG), a significant positive value is determined at the 1% level, indicating that manufacturing enterprises can positively improve performance through digital transformation. This verifies **Hypothesis 1**.

In the mediation effect test, the stepwise regression method is used to verify the specific channels through which the operating cost rate influences the relationship between the digital transformation of manufacturing enterprises and enterprise performance.

**Table 2.** Benchmark regression and mediation regression

| Variable | | Model 1 | Model 2 | Model 3 |
|---|---|---|---|---|
| Digital transformation | DCG | 0.075*** | -0.003*** | 0.077*** |
| | Standard deviation | 0.014 | -0.002 | 0.012 |
| Enterprise operation scale | Scale | -0.328*** | -0.033*** | -0.294*** |
| | Standard deviation | 0.024 | 0.002 | 0.024 |
| Time of listing | Age | -0.011*** | -0.011*** | -0.008*** |
| | Standard deviation | -5.10 | -2.99 | -4.59 |
| Revenue growth rate | Growth | 0.156*** | 0.028*** | 0.193*** |
| | Standard deviation | 0.027 | -0.003 | 0.027 |
| Industrial structure | Structure | -0.372*** | -0.288 | -0.353** |
| | Standard deviation | -2.55 | -1.52 | -2.43 |
| Constant | _cons | 9.322*** | 2.533*** | 8.211*** |
| | Standard deviation | 0.457 | 3.44 | 0.491 |
| $R^2$ | | 0.025 | 0.137 | 0.02 |

Note: *** indicates a 1% significance level, ** indicates a 5% significance level, and * indicates a 10% significance level.

According to **Table 2**, there are some mediating effects between the digital transformation of manufacturing enterprises and their operating costs. This means that during the practice of digital transformation, manufacturing enterprises can improve performance by reducing operating costs, which verifies **Hypothesis 2**.

## 4.3. Robustness test

**Hypotheses 1** and **2** proposed in this analysis have been verified. To ensure the reliability of the results, a robustness test was carried out focusing on the main effect regression. By using the method of substitution variables, the management in the annual reports of manufacturing enterprises was analyzed statistically by the frequency of vocabulary to understand the general views of managers and leaders on digital transformation. The Digital Index is calculated using the formula "total frequency ÷ segment length × 100," verifying the process and degree of digital transformation practice from a more micro perspective. Subsequently, the reduced sample method was applied to eliminate cyclical industries from the manufacturing sector, such as the computer, communication, coal, and steel industries.

Tobin's Q coefficient of digital transformation and manufacturing enterprise performance is significantly positive, indicating the robustness of the analysis results. This further verifies the hypothesis proposed in this paper that the implementation of digital transformation in manufacturing enterprises is conducive to improving enterprise performance.

# 5. Conclusions and suggestions

## 5.1. Research conclusion

Based on the hypotheses and verification analysis presented in this paper, the following conclusions can be drawn:

(1) Positive impact on enterprise performance: The digital transformation of manufacturing enterprises can significantly improve enterprise performance. As manufacturing enterprises advance in their digital transformation efforts, there is a notable positive impact on performance. This conclusion remains valid after robustness testing.

(2) Cost savings and performance improvement: For manufacturing enterprises, digital transformation can enhance performance by reducing production costs. Implementing a digital management system within the enterprise allows for the integration of various processes, such as manufacturing, production, warehousing, and management. This comprehensive improvement in the efficiency of the entire manufacturing process leads to reduced operating costs, which, in turn, boosts enterprise performance.

## 5.2. Countermeasures and suggestions

(1) Optimize cost control: Analyzing the production practices and management of manufacturing enterprises reveals that digital transformation significantly enhances enterprise performance. However, there are still areas in need of optimization. Despite the high operating income of manufacturing enterprises compared to others in the industry, there is still ample room for improvement in cost control. Enterprises should focus on reducing the costs of digital products and related technologies. By maintaining costs below the industry average, enterprises can improve their debt repayment and operational capabilities, thereby supporting comprehensive digital transformation and enhancing performance.

(2) Develop human resources: In the digital economy era, human resources play a crucial role in the transformation of manufacturing enterprises. It is recommended to establish a talent training system within the enterprise. In the process of digital transformation, enterprises should continuously pay attention to user needs, leverage digital technology advantages, and capitalize on market diversity. Additionally, manufacturing enterprises need to enhance innovation and creativity, build digital talent teams, increase research and development investment, and meet users' digital requirements for manufacturing products. This approach will improve the competitiveness of manufacturing enterprises. By establishing a digital talent team, enterprises can implement digital R&D at each stage, further promoting digital innovation and accelerating the digital transformation process.

(3) Build a sharing system: Manufacturing enterprises should develop a sharing system tailored to the realities of traditional manufacturing. After clarifying the goals of digital transformation and learning from the industry's successful transformation experiences, enterprises can collect and share digital transformation data within the system. This approach facilitates the integration of high-quality resources across major manufacturing enterprises, thereby enhancing the efficiency of digital transformation.

(4) Enhance internal cost control: In the context of digital transformation, internal cost control is paramount for manufacturing enterprises. Continuously improving cost control capabilities can boost performance in the digital transformation process. Therefore, it is advised that manufacturing enterprises allocate resources efficiently to reduce production and operating costs during digital transformation. By doing so, they can improve enterprise performance and support the digital transformation journey.

## Disclosure statement

The author declares no conflict of interest.

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