



Impact of digital transformation on business performance: Empirical evidence from Vietnam listed food manufacturing enterprises

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Abstract

This research examines the relationship between digital transformation and the performance of food manufacturing enterprises in Vietnam using a sample of 20 food manufacturing enterprises listed on the Vietnamese stock market from 2013 to 2023. A composite digital transformation index, capturing three key dimensions—digitization, digitalization, and comprehensive digital transformation—is constructed through content analysis of annual reports and quantified using Python-based text mining techniques to measure the extent of digital engagement. Firm performance is proxied by ROA and ROE, and regression analyses are conducted using OLS, FEM, and REM, with several financial and operational control variables included. The empirical results indicate that digital transformation exerts a positive and statistically significant effect on both ROA and ROE. However, the magnitude of this effect is moderated by firm size; larger enterprises tend to experience reduced short-term gains, likely due to higher implementation costs and greater organizational complexity. The study provides empirical evidence in the context of Vietnam and highlights the role of digital transformation, not only as a supporting tool but also as a strategic lever to enhance business performance. The research results are the basis for proposing solutions and recommendations to strengthen digital capabilities and improve the business performance of food manufacturing enterprises in Vietnam.

Keywords: Business performance, Digital transformation, Digitalization, Digitization.

DOI: 10.53894/ijirss.v8i3.7171

Funding: This study received no specific financial support.

History: Received: 2 April 2025 / Revised: 6 May 2025 / Accepted: 8 May 2025 / Published: 19 May 2025

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Competing Interests: The authors declare that they have no competing interests.

Publisher: Innovative Research Publishing

Authors' Contributions: Both authors contributed equally to the conception and design of the study. Both authors have read and agreed to the published version of the manuscript.

Transparency: The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

Acknowledgement: The author sincerely appreciates the financial assistance provided by the Banking Academy of Vietnam.

1. Introduction

Digital technologies, such as the Internet of Things (IoT), cloud computing, artificial intelligence (AI), and big data analysis, are driving fundamental changes across sectors. To leverage this trend and remain competitive in the digital era, companies are increasingly accelerating their digital transformation processes.

Digital transformation refers to the integration of digital technologies into all areas of the business, reshaping how organizations operate and creating value for customers [1]. This transformation includes two core dimensions: external business digitalization (EBD) and internal business digitalization (IBD). While EBD focuses on enhancing customer experience through digital platforms and interactive technologies, IBD emphasizes the optimization of internal operations and organizational efficiency using technologies such as AI, IoT, and big data [2]. Therefore, digital transformation is a shift driven by the potential to improve business models, products, and organizational structures through digital technologies Hess et al. [3]. Nadkarni and Prügl [4] defined digital transformation as an organizational change process enacted by technology. According to Siebel [5], the ultimate goal of digital transformation is to improve the organization's performance.

Therefore, digital transformation in enterprises can be defined as the application of digital technologies and solutions to enhance business performance and operational efficiency. It involves changing business models, management models, and organizational structures to maximize a firm's performance. This process also includes efforts to improve customer relationships, internal workflows, and business models through the use of digital technologies.

The benefits of digital transformation include enhancing a firm's competitiveness and optimizing productivity. Specifically, it reduces costs, increases productivity, and improves the quality of products and services. By adopting digital technologies, businesses can digitize processes related to production, management, and sales, thereby improving competitiveness and supporting both short- and long-term profit-increasing objectives [6].

The Vietnamese government has issued various policies to support enterprises in their digital transformation efforts, aiming to foster rapid and sustainable socio-economic development. However, this process faces significant challenges. The overall readiness to adopt Industry 4.0 technologies remains low. Common barriers include a lack of digital skills, underdeveloped IT infrastructure, limited digital awareness, and constrained financial resources.

In the food manufacturing industry, effective management of production lines, product quality, and inventory is critical to business performance. Rising market demand and rapid technological advancements among competitors are forcing firms to innovate or risk falling behind. Digital transformation is, therefore, vital for food manufacturing companies to enhance operational efficiency and maintain competitiveness.

This study evaluates the impact of digital transformation on the performance of food manufacturing companies listed on the Vietnamese stock market. Performance is measured using key financial indicators—ROA and ROE—while market value indicators are not considered. The research aims to shed light on how digital transformation influences business performance within this sector.

2. Literature Review and Hypothesis Testing

Previous studies have examined whether and how digital transformation enhances the performance of firms. The impacts are observed as follows: (i) positive impact, (ii) negative impact, and (iii) mixed or ambiguous impact.

Firstly, many studies have concluded the positive effects of digital transformation on firms' performance. From an operational perspective, digital technologies not only accelerate business processes and improve efficiency but also enhance the flexibility of market capitalization and adaptive capacity, thereby improving overall business performance [7]. In terms of sales, the adoption of systems such as Product Lifecycle Management (PLM) and Enterprise Resource Planning (ERP) helps reduce unnecessary costs in the sales process [8] thus increased firm value. Zhao et al. [9] indicated that digital transformation can significantly improve corporate performance, with more significant effects in small and medium-sized enterprises (SMEs) compared to larger firms, and among labor-intensive companies. Zhai et al. [10] examined the impact of digital transformation on the performance of Chinese firms. Their findings showed that digital transformation leads to lower costs and higher performance. The study also differentiated between conventional digital transformation and overtransformation. While conventional digital transformation enhances long-term performance, over-transformation fosters firms' performance primarily in the first two years. Ferreira et al. [11] found that digitalization boosts competitiveness, promotes innovation, and has a positive impact on firm performance. Similarly, Chen et al. [12] argued that the more advanced the digital technology, the higher the profitability manufacturers can derive from it. The necessary conditions (policies and innovation environments) for improving performance can be more effectively leveraged through digital transformation. Additionally, digital technologies can indirectly improve financial performance by fostering green technological innovation Ren and Li [13] and Xie et al. [14]. Ren and Li [13] also showed that digital transformation has a positive impact on the performance of state-owned enterprises. Xu et al. [15] found that digital transformation can improve both strategic effectiveness and internal control, thereby enhancing overall performance.

In Vietnam, several studies have also explored the relationship between digital transformation and business performance. Thi et al. [16] evaluated the impact of digital transformation on the performance of manufacturing firms in Vietnam, emphasizing the mediating role of supply chain agility. The results showed that both internal and external digital transformation positively influence supply chain agility, which in turn enhances business performance. Thi et al. [16] examined the effect of digital transformation on the performance of industrial manufacturing firms in Can Tho. Using survey data from 198 firms collected between 2021 and 2023, the study provided empirical evidence that digital transformation significantly improves business performance.

While the majority of studies highlight the benefits of digital transformation, some have identified potential negative effects. When big data systems are unsuitable for a firm's core structure, digital technologies may fail to generate value [17].

Companies may face the "digitization paradox," where despite investments in digital technologies, revenue gains do not match expectations Gebauer et al. [18]. Xu et al. [15], while noting the positive impacts of digital transformation, also warned against blindly increasing investment in digital technologies due to potential risks related to this paradox. Guo et al. [19] found that although digital transformation can significantly boost total factor productivity, it may reduce performance due to increased operating costs, decreased asset turnover, and higher administrative expenses. Managerial myopia may exacerbate these negative effects. Their findings suggest that low or excessive digital transformation is not beneficial to firm performance, while moderate levels of digital transformation yield optimal results. Moreover, in labor-intensive firms, digital transformation may have even more significant negative impacts.

Some studies report both positive and negative effects, depending on specific contexts. Jardak and Ben Hamad [20], in a study of Swedish publicly listed firms from 2015 to 2018, found that digital transformation had a negative impact on ROA and ROE but a positive effect on Tobin's Q. The negative performance outcomes may reflect the time lag between investment in digital technologies and the realization of financial benefits, suggesting that in the long run, firms may still achieve performance gains. The positive impact on Tobin's Q may be attributed to the market's expectations of long-term value creation. Similarly, Vo et al. [21] showed that while digital transformation negatively affects corporate performance, performance improves when it is implemented with enterprise restructuring among listed companies in Vietnam.

In summary, findings on the impact of digital transformation on firm performance are mixed. Variations in measurement approaches and sample periods may contribute to these inconsistencies. Based on the above analysis, this study proposes the following hypothesis:

Hypothesis 1: Digital transformation improves the firm's performance.

3. Data and Methodology

The research data were collected from listed food enterprises in Vietnam for the period from 2014 to 2023. Important financial variables, such as ROA (Return on Assets), ROE (Return on Equity), financial leverage (LEV), cash ratio, asset turnover (turn), and revenue growth rate (growth), were collected from Vietstock, a financial data provider operating in Vietnam.

In addition, the digital transformation variable (d) was measured through content analysis of annual reports from food enterprises in Vietnam during the period from 2013 to 2023, which was conducted using Python software to scan and quantify the extent of digital technology application within business operations. The authors calculated the values of variables d₁, d₂, d₃ for enterprises over the years, representing the components of the total variable d, used to measure the level of digital transformation. Specifically, d₁ corresponds to "digitization," including keywords related to data conversion and digital information such as "digitization," "digital technology," "software," and "information technology"; variable d₂ represents "digitalization," evaluating the application of digital technology in process automation, data management, and digital transformation," including technology upgrades and in-depth digital innovation like "artificial intelligence," "big data," "blockchain," "Internet of Things (IoT)," and "virtual reality." These indicators are aggregated into the general digital transformation variable d to comprehensively measure the level of digital transformation among enterprises in the study. The use of a composite digital transformation index generally provides a more objective and comprehensive reflection of an enterprise's level of digital transformation compared to individual indicators [22] while measuring digital transformation through individual metrics often fails to fully capture the comprehensive nature of digital transformation within the organization [6].



Figure 1 reflects the trend of digital transformation of enterprises in the period 2013–2023 through both the general index (d) and the component dimensions, including d1, d2, and d3. In general, the level of digital transformation tends to increase

markedly over time, especially after 2017. In the 2013–2016 period, the composite index (d) remained low and stable around 0.12, indicating modest digital transformation efforts. However, from 2017 onwards, especially during 2018–2022, enterprises began intensifying their technology adoption, as reflected by the sharp rise in the component indexes, particularly d_1 (red line) and d_2 (green line). Notably, the digital transformation index reached its peak in 2022 (~0.32), coinciding with the COVID-19 pandemic as a strong push for digital adoption in enterprises. However, by 2023, the chart indicates a slight slowdown, with all indexes seeing a minor decrease, suggesting that the digital transformation process may be stalling, or enterprises require more time to adapt and optimize. Among the dimensions, d_3 ("comprehensive digital transformation") always retains the lowest value during the observation period, though it also increased gradually, implying that integrating digital technology into the core activities remains a challenge for many firms. The d_1 and d_2 indices rose evenly and almost parallel after 2017, indicating simultaneous investment in technological infrastructure and digital management. Overall, the chart shows substantial positive progress but highlights a lack of uniformity and comprehensive adoption – this is an important basis for future policy support and enterprise digital strategies.

To investigate the effect of digital transformation on the business performance of food manufacturing enterprises, this study employs Equation 1 as the main empirical model for analysis. ROA and ROE were selected as proxies for business performance, serving as key indicators widely used in numerous studies investigating the impact of digital transformation on corporate financial outcomes [15, 20, 23]. In addition, control variables such as financial leverage (LEV), cash ratio, asset turnover (turn), and revenue growth rate (growth) are incorporated to account for essential financial factors, thereby isolating the true effect of digital transformation [24-26]. Specifically, LEV reflects financial risk and is generally found to negatively impact financial performance [23, 26]. The cash ratio measures short-term liquidity, ensuring financial stability in the event of market shocks. Asset turnover indicates the efficiency of asset utilization in generating revenue and improving profitability, and it has been identified as a crucial factor in previous research [24, 25]. Finally, the growth variable captures a firm's ability to expand operations and increase revenue, representing a direct determinant of business performance [27].

Table 1.

Computation	of	control	variables.

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Name	Meaning	Calculations
ROA	Return on assets	Net income / Total assets
ROE	Return on equity	Net income / Shareholder's equity
LEV	Financial leverage	Total liabilities / Total assets
Cash ratio	Short-term liquidity	Cash and cash equivalents / Current liabilities
Turn	Asset turnover	Revenue / Total assets
Growth	Revenue growth rate	(Current revenue – Previous revenue) / Previous revenue

The research model to analyze the impact of digital transformation on business performance, specifically ROA or ROE, is constructed as follows:

 $Y_{i,t} = \beta_0 + \beta_1 \text{LEV}_{i,t} + \beta_2 \text{cashratio}_{i,t} + \beta_3 \text{turn}_{i,t} + \beta_4 \text{growth}_{i,t} + \beta_5 d_{i,t} + \beta_6 \text{size}_{i,t} + \beta_7 (d_{i,t} \times \text{size}_{i,t}) + \epsilon_{i,t} \quad (1)$

Where:

- $Y_{i,t}$: Dependent variable, the business performance of firm i at time t, measured by ROA (Return on Assets) or ROE.
- LEV_{*i*,*t*}, cashratio_{*i*,*t*}, turn_{*i*,*t*}, growth_{*i*,*t*}, $d_{i,t}$, size_{*i*,*t*}, $d_{i,t}$ ×size_{*i*,*t*}? Corresponding independent variables of firm i at time t.
- β_0 : Constant
- $\beta_1, \beta_2, \dots, \beta_7$: Regression coefficients of independent variables
- $\epsilon_{i,t}$: Random error of firm i at time t

The Ordinary Least Squares (OLS), Fixed Effects Model (FEM), and Random Effects Model (REM) were used to measure the impact of digitalization on performance. The choice of the FEM model was determined by statistical tests (not shown here) and the need to account for unobserved characteristics that vary across firms or over time. Additionally, robust standard errors were used to address potential issues such as heteroskedasticity and serial correlation. In this regression model, the coefficient β_5 reflects the isolated impact of digital transformation on business performance (measured by ROA or ROE), while β_7 represents the difference in the effect of digital transformation between groups of firms of different sizes, thus permitting an assessment of the moderating effect of firm size.

4. Results and Analysis

4.1. Descriptive Statistics

Table 2 presents the descriptive statistics of the variables utilized in this study, based on a sample of 221 observations collected over the period from 2014 to 2023. The dependent variables indicate that food enterprises have a high average profitability, with ROA at 10.4% and ROE at 15%, although there is significant variation, with ROA ranging from -13.8% to 37.7% and ROE from -60.2% to 72.6%. Higher ROE than ROA reflects the role of financial leverage (LEV average 0.444, ranging from 0.046 to 0.978). The digital transformation variable d, measured by the composite index from content analysis, has a mean value of 0.218 (ranging from 0 to 1.161), showing that the level of digital transformation is still low and there is a significant difference across enterprises. Additionally, other variables such as cash ratio (with an average of 8.9%), turnover (1.124), growth (11.4%), and size (logarithm of total assets, with an average of 29.054) also reflect the diverse scale and financial characteristics within the industry.

Descriptive Statistics.					
Variable	Obs	Mean	Std. Dev.	Min	Max
ROA	221	0.104	0.103	-0.138	0.377
ROE	221	0.15	0.178	-0.602	0.726
LEV	221	0.444	0.2	0.046	0.978
cashratio	221	0.089	0.081	0.003	0.398
turn	218	1.124	0.615	0.09	3.121
growth	216	0.114	0.323	-0.477	1.437
d	212	0.218	0.232	0	1.161
size	221	29.054	1.748	25.69	32.468

Table 2.

4.2. Regression Results

Table 3.

Pairwise Correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) ROA	1.000							
(2) ROE	0.813	1.000						
(3) LEV	-0.536	-0.345	1.000					
(4) cashratio	0.187	0.149	-0.323	1.000				
(5) turn	0.153	0.100	0.039	0.015	1.000			
(6) growth	0.072	0.149	0.155	-0.022	0.006	1.000		
(7) d	-0.036	0.014	0.086	-0.038	-0.005	-0.023	1.000	
(8) size	-0.093	-0.009	0.308	-0.122	-0.415	0.174	0.348	1.000

The correlation matrix indicates that there is no high multicollinearity among the independent variables in the model, as all correlation coefficients are below the 0.8 threshold, thereby ensuring the reliability and stability of the regression estimates. Specifically, the digital transformation variable (d) has a mild positive correlation with ROE (0.014) and a minor negative correlation with ROA (-0.036). LEV has a negative correlation with ROA, reflecting financial pressure from high leverage. In contrast, turnover and growth are positively correlated with performance, consistent with the theoretical expectations regarding the roles of efficiency and revenue growth. The size variable has a low correlation with others, reducing concerns about multicollinearity. Overall, the results from Table 2 indicate that the established regression model is statistically appropriate, without the risk of bias caused by high correlation among the explanatory variables.

Table 4.

Regression Table.

	(1)	(2)	
	ROA	ROE	
LEV	-0.182***	-0.355**	
	(0.061)	(0.138)	
cashratio	0.172*	0.363	
	(0.098)	(0.212)	
turn	0.077**	0.171***	
	(0.033)	(0.039)	
growth	0.034	0.071	
	(0.022)	(0.043)	
d	10.109*	20.312***	
	(0.62)	(0.659)	
size	0.018	0.021	
	(0.018)	(0.027)	
interaction	-0.038*	-0.079***	
	(0.021)	(0.022)	
_cons	-0.439	-0.536	
	(0.519)	(0.755)	
Observations	207	207	
R-squared	0.295	0.275	
Robust standard arrors are in parenthe	140		

Robust standard errors are in parentheses

Note: *** p<0.01, ** p<0.05, * p<0.1.

This regression model tests the direct impact of digital transformation (d) on performance (ROA, ROE) and its interaction with firm size to examine effect variations by size. The regression results for both dependent variables indicate that digital transformation (d) has a positive and statistically significant effect at the 10% level for ROA and the 1% level for ROE. This

finding confirms the positive contribution of digital transformation activities to enhancing operational efficiency and profitability among food enterprises in Vietnam. This is consistent with the study hypothesis and with modern governance theories, which posit that digital transformation optimizes costs, improves supply chains, and enhances data-driven decision-making. This finding is also consistent with the results of Wang, et al. [28] when studying manufacturing firms in China, as well as the studies of Jardak and Ben Hamad [20], Guo and Xu [25] and Vo et al. [29].

The regression results show that LEV (leverage ratio) has a statistically significant negative impact on both ROA and ROE, indicating that increasing the use of debt raises financial costs and reduces profitability, which can be attributed to the high levels of debt among food manufacturing enterprises and the relatively high prevailing average loan interest rates in the Vietnamese market. This finding is consistent with Modigliani and Miller's capital structure theory Modigliani and Miller [30] and studies by Guo and Xu [25], Wang et al. [28] and Hung and Chen [26]. The cash ratio has a weak positive impact on ROA (0.172, p<0.1) and is not significant for ROE, indicates that cash reserves do not significantly impact short-term financial performance in the context of food industry enterprises, which often prioritize investments in inventory and fixed assets rather than holding much cash. This is consistent with Opler et al. [31] study on cash policy and operational efficiency. Turnover has a positive and significant coefficient in both models, confirming that the efficiency of asset utilization to generate revenue is a key determinant of financial performance, consistent with studies by Chen and Zhang [24] and Guo and Xu [25]. Growth (revenue growth) has a positive impact but does not have statistical significance for the financial performance of food industry enterprises in Vietnam, differing from the study by Hossain and Sultana [27] where the growth variable shows a positive and statistically significant impact on business performance. Similarly, firm size has a positive impact but lacks clear statistical significance, reflecting the reality that food industry enterprises, especially small and medium enterprises, have not yet optimally leveraged size to improve efficiency. This contrasts with some studies in developed markets where larger firms sometimes have lower ROAs due to management and process complexity [28] whereas the study by Guo and Xu [25] indicates a significantly positive impact of size on financial performance.

4.4. Moderating Role of Firm Size (Interaction Effect)

The interaction variable ($d \times size$) is calculated as the product of digital transformation and firm size, reflecting how firm size adjusts the impact of digital transformation on performance. Including this interaction variable in the model aims to test whether firm size plays a moderating effect on the impact of digital transformation on performance, thus providing a better understanding of the causes of the non-uniform effects of digital transformation among different groups of firms. The model results show that the coefficient of the interaction variable is negative, meaning that for larger firms, the positive impact of digital transformation on business performance diminishes and may even become slightly negative. This can be explained by the fact that larger firms often face higher digital transformation costs, causing a moderating effect or reducing the initial positive impact of digital transformation, or even partially eliminating these benefits. Therefore, while digital transformation brings overall benefits, for large firms, high costs and implementation complexity may reduce the short-term improvement in business performance. This is consistent with the study by Zhao et al. [9], which found that the impact of digital transformation on business performance is stronger in small and medium-sized enterprises (SMEs) compared to larger firms, since larger firms face greater challenges in digital transformation, including higher costs, causing factor, also pointed to the complex relationship between size and performance, as size may negatively correlate with the digital transformation index, representing the organizational complexity and inertia of larger firms.

5. Conclusion

This study provides empirical evidence on the relationship between digital transformation and business performance among listed food manufacturing enterprises in Vietnam from 2014 to 2023. By employing ROA and ROE as proxies for operational efficiency and profitability, the findings indicate that digital transformation exerts a positive and statistically significant impact on both measures. The results also demonstrate the moderating effect of firm size, whereby larger enterprises may encounter higher digital transformation costs and greater managerial complexity, thus attenuating the short-term benefits. Financial leverage is found to negatively affect business performance, while efficient asset utilization makes a significant contribution to improved financial outcomes. These findings are consistent with international literature and highlight digital transformation as a critical strategic lever to enhance corporate competitiveness, particularly within the food manufacturing sector. Nevertheless, the level of digital adoption among Vietnamese enterprises remains uneven and relatively low, underscoring the necessity for supportive policies and investments to foster digital capabilities. Future research should further explore the long-term impacts of digital transformation and clarify the moderating roles of organizational factors, such as technological readiness, human resource capacity, and corporate culture. In addition, analyses should be expanded across different industry sectors and consider external environmental factors, including policy frameworks and digital infrastructure, to develop more comprehensive recommendations for strengthening digital capabilities and improving business performance.

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