



DIGITAL TRANSFORMATION AND STRATEGIC BUSINESS MANAGEMENT: EXAMINING INNOVATION CAPABILITY, AND SUSTAINABLE COMPETITIVE ADVANTAGE

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Article History

Received: 2026-07-10

Revised: 2026-09-26

Accepted: 2026-10-14

Published: 2026-10-26

Abstract

Digital transformation has become a critical strategic capability in contemporary business management, shaping how firms coordinate resources, strengthen innovation capability, and pursue sustainable competitive advantage in technology-intensive environments. This study examines the relationships among digital transformation, innovation capability, and sustainable competitive advantage from a strategic business management perspective, using firm performance as an empirical proxy for competitive outcomes. A quantitative cross-sectional design was applied to 2,000 firm-level observations. Innovation capability was operationalized through standardized R&D intensity and technology ratio, while firm performance combined standardized growth, return on assets, and Tobin's *Q*. Descriptive statistics, Pearson correlation analysis, one-way ANOVA, hierarchical ordinary least-squares regression with HC3 robust standard errors, and bootstrap indirect-effect analysis were employed. The findings show that digital transformation is positively and significantly associated with innovation capability and overall firm performance. Firms with higher levels of digital transformation also demonstrated significantly stronger growth and profitability outcomes. However, digital transformation was not significantly associated with Tobin's *Q*. Regression results confirmed that digital transformation remained a significant predictor of performance after controlling for firm age, size, leverage, ownership, and industry concentration. Innovation capability did not positively mediate the digital transformation-performance relationship. The study concludes that digital transformation strengthens innovation potential and strategic performance, while converting innovation capability into sustainable competitive advantage may require complementary managerial and organizational mechanisms. These findings position digital transformation as an important component of strategic business management.

Keywords: Digital Transformation; Strategic Business Management; Innovation Capability; Sustainable Competitive Advantage; Firm Performance

1. Introduction

Digital transformation is a key strategic focus for today's businesses and an increasingly important element of strategic business management, as it is changing the ways businesses coordinate resources, build capability, make decisions, and compete in technology-driven markets. Digital technologies integrated into financial and managerial systems can increase the accessibility of information, accelerate decision-making, and strengthen strategic responsiveness (Avira et al., 2023). As a result, digitalization is no longer limited to operational automation, but increasingly influences fundamental financial, technological, and strategic processes in companies (Bisht et al., 2022).

The strategic importance of data-driven decision-making is one of the key impacts of digital transformation. By utilizing big data for financial analysis, businesses can uncover patterns, assess performance, and gain insights that are hard to come by with traditional analytical methods (Adewale et al., 2023). Likewise, big data analytics in terms of organizational business intelligence facilitates the quality and timeliness of managerial decisions, which enables the transformation of large amounts of organizational data into knowledge. (Niu et al., 2021) Digitalized financial systems can also be used for more systematic financial planning and decision processes, which can enhance the organizational capacity for efficient resource allocation (Ren, 2022). The strategic value of digital transformation, however, relies on the complementary organizational capabilities. This is especially critical for innovation capability as firms need to translate technological assets into new processes, products, capabilities, and solutions.

Financial and digital skills can boost the decision-making power of individuals and enhance organizations' capacity to use technology (Kumar et al., 2023). Digital financial literacy evidence also reveals the need to comprehend and use digital information for financial decisions to ensure successful technology uptake (Mishra et al., 2024). Productively leveraging financial analytics can help enhance the quality of strategic choices made and help to deliver better results for the organization (Rangasamy et al., 2023). Digital transformation also exposes you to new strategic risks. With the growing interconnectedness of organizational systems, cybersecurity risks are becoming more strategic management issues than only information-technology issues (Mızrak, 2023). Therefore, for sustainable competitive advantage, companies need to integrate digital capability with the right governance, risk management and resource allocation processes. The key to sustainable business performance is organizational resilience and flexibility, especially in these uncertain times, since the capacity to make adaptations to decisions and reconfigure resources positively contributes to organizational resilience.

Another aspect of effective financial management is the relationship that can be established among organizational resources, decisions systems, and financial controls that enable it to optimize the results in the long term (Sitinjak et al., 2023). The strategic impact of digital transformation is also broadened using artificial intelligence, which can help develop predictive models that make complex business decisions. (Vudugula et al., 2023) These developments suggest that technology is not a source of competitive advantage by itself – technology needs to be accompanied by innovation capability to take advantage of opportunities created using technology. The connection between digital transformation and firm performance should therefore be analyzed in conjunction with the characteristics of innovation and taking into consideration firm size, firm age, leverage, ownership, and firm competitive environment.

The purpose of this study is to explore the link between digital transformation, innovation capability, and sustainable competitive advantage within the context of strategic business management, employing firm performance as an empirical indicator of competitive outcomes. Firm digital transformation, R&D intensity, technological capability, growth, profitability, market performance, and relevant organizational controls are covered. The goals are to

compare levels of digital transformation with innovation capability and strategic performance outcomes across low, moderate, and high digital-transformation firms,

examine how digital transformation directly relates to innovation capability and firm performance as a strategic business outcome, and

examine the statistical role of innovation capability in the relationship between digital transformation and competitive performance.

2. Methodology

2.1 Research Design, Sample, and Variable Operationalization

The study utilized a quantitative, cross-sectional research design to explore the relationships among digital transformation, innovation capability, and sustainable competitive advantage within a strategic business management framework. Firm performance was used as an empirical proxy for competitive outcomes. The final analytical sample comprised 2,000 firm-level observations and 25 variables (Colabsss, 2025). Data were checked for missing observations and duplicate records before statistical analysis. None of the variables used in the analysis contained missing values and there were no duplicate observations. Thus, no listwise deletion or statistical imputation was needed, and all 2,000 observations were used for all analyses. A continuous variable was used to assess digital transformation and was scaled from 0 to 1, with higher scores indicating higher levels of digital transformation. For comparative analysis, firms were divided into three groups: low digital transformation ($n = 192$, 9.6%), moderate digital transformation ($n = 1,434$, 71.7%), and high digital transformation ($n = 374$, 18.7%).

Innovation capability was operationalized through a composite Innovation Capability Index (ICI) constructed from two indicators. Each variable was first standardized using a z-score:

$$Z_X = \frac{X - \bar{X}}{s_X}$$

where X is the observed value, $\bar{X}$ is the sample mean, and s_X is the sample standard deviation calculated using the $N - 1$ denominator. The composite index was then calculated as:

$$ICI = \frac{Z_{\text{R\&D intensity}} + Z_{\text{technology ratio}}}{2}$$

Thus, both components contributed equally to the innovation capability measure, and the denominator of the composite was 2.

Sustainable competitive advantage was represented empirically through a Firm Performance Index (FPI), because the available data did not contain a direct longitudinal or multi-item measure of sustainable competitive advantage. Within the strategic business management framing of this study, the index serves as a performance-based indicator of firms' competitive outcomes. It was based on growth, ROA, and Tobin's Q, representing business growth, accounting performance, and market-based performance, respectively. The same z-score procedure was used for each indicator, and they were combined as follows:

$$FPI = \frac{Z_{\text{Growth}} + Z_{\text{ROA}} + Z_{\text{Tobin's Q}}}{3}$$

Each performance indicator was then given equal weight, making the denominator 3. The index was treated as a performance-based indicator relevant to strategic competitive advantage and did not measure the long-term sustainability of competitive advantage directly. Individual variables were also retained for additional analysis. The regression models included five control variables: firm age, logarithmic firm size, leverage, state ownership, and industry concentration.

2.2 Descriptive, Correlation, and Group-Comparison Procedures

Descriptive data was initially analyzed to give an overview of the nature and distribution of the main study variables. In the case of continuous variables, the mean, standard deviation, minimum, median, and maximum were reported. The distribution of the digital transformation index was also summarized by 10 intervals of the entire range 0 to 1. Pearson product-moment correlation coefficient was used to determine the bivariate relationships between digital transformation, innovation capability, firm performance, growth, ROA, and Tobin's Q. The coefficient work is as follows:

$$r = \frac{\sum_{i=1}^N (X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^N (X_i - \bar{X})^2 \sum_{i=1}^N (Y_i - \bar{Y})^2}}$$

Its denominator is the square root of the sum of squares of all the deviations of both variables. All correlation tests were two-tailed, and the significance was determined at $p < 0.05$, $p < 0.01$, and $p < 0.001$. A one-way analysis of variance (ANOVA) was used to compare differences between the three groups (low, moderate, and high) in digital transformation. The Innovation Capability Index, Firm Performance Index, R&D intensity, technology ratio, growth, ROA and Tobin's Q were analyzed using separate ANOVA models.

The omnibus F statistic was calculated as:

$$F = \frac{MS_{\text{between}}}{MS_{\text{within}}}$$

Effect size was evaluated using eta squared (η^2), calculated as:

$$\eta^2 = \frac{SS_{\text{between}}}{SS_{\text{total}}}$$

where SS_{between} is the between-group sum of squares and SS_{total} is the total sum of squares. Group means were reported separately for the low, moderate, and high categories.

2.3 Regression Models and Indirect-Effect Analysis

Hierarchical ordinary least-squares regression analysis was conducted to examine whether digital transformation predicted innovation capability and firm performance after adjustment for relevant firm-level characteristics. All regression models were estimated using the full analytical sample of $N = 2,000$.

Three regression models were specified.

Model 1 examined innovation capability as the dependent variable:

$$ICI_i = \beta_0 + \beta_1 DT_i + \beta_2 Age_i + \beta_3 Size_i + \beta_4 Lev_i + \beta_5 SOE_i + \beta_6 HHI_i + \varepsilon_i$$

where ICI represents the Innovation Capability Index, DT is the digital transformation index, Age is firm age, $Size$ is logarithmic firm size, Lev is leverage, SOE is state ownership, and HHI is industry concentration.

Model 2 examined firm performance as the dependent variable:

$$FPI_i = \beta_0 + \beta_1 DT_i + \beta_2 Age_i + \beta_3 Size_i + \beta_4 Lev_i + \beta_5 SOE_i + \beta_6 HHI_i + \varepsilon_i$$

where FPI represents the standardized Firm Performance Index.

Model 3 added innovation capability to the performance equation:

$$FPI_i = \beta_0 + \beta_1 DT_i + \beta_2 ICI_i + \beta_3 Age_i + \beta_4 Size_i + \beta_5 Lev_i + \beta_6 SOE_i + \beta_7 HHI_i + \varepsilon_i$$

Regression results were reported using standardized beta coefficients (β) together with HC3 heteroskedasticity-robust standard errors. Under the HC3 correction, squared residuals were adjusted as:

$$\frac{e_i^2}{(1 - h_{ii})^2}$$

where e_i is the residual for observation i and h_{ii} is the corresponding leverage value. Model fit was evaluated using R^2 and adjusted R^2 , while overall model significance and individual predictor p -values were also reported.

To examine whether innovation capability transmitted the relationship between digital transformation and firm performance, an indirect-effect analysis was performed using the coefficients linking digital transformation to innovation capability and innovation capability to firm performance. The indirect effect was calculated as:

$$\text{Indirect Effect} = a \times b$$

where a represents the digital-transformation-to-innovation coefficient and b represents the innovation-to-performance coefficient estimated while controlling for digital transformation and the firm-level covariates.

The digital-transformation-to-innovation coefficient, a , and the innovation-to-performance coefficient, b , were estimated while holding digital transformation and other firm-level covariates constant. An indirect effect estimate was obtained using a nonparametric bootstrap procedure with 2,000 resamples. A 95% bootstrap confidence interval was created, and the indirect effect was considered significant if the confidence interval did not contain zero. All statistical tests were conducted in both directions and a principal significance threshold of $p < 0.05$ was used. Where applicable, results at $p < 0.01$ and $p < 0.001$ were also found. Given the cross-sectional nature of the analyses, the indirect-effect procedure was not interpreted as a causal mediation analysis, but rather as an indicator of the consistency of statistics across the different analyses.

3. Results

The empirical analysis was based on 2,000 firm-level observations. Digital transformation was represented by a continuous index, innovation capability was measured using standardized R&D intensity and technology ratio, and firm performance was measured using standardized growth, ROA, and Tobin's Q. Consistent with the strategic business management framing, firm performance was interpreted as a performance-based indicator of competitive outcomes rather than a direct measure of the long-term sustainability of competitive advantage.

3.1 Descriptive Characteristics and Distribution of Digital Transformation

Table 1 shows the descriptive statistics for the major variables of the study. The mean digital transformation index was 0.526 (SD = 0.150) and ranged between 0 and 1, the full range of values. The mean R&D intensity was 0.129 and the mean technology ratio was 0.323. The average value of firm growth was 0.159, while the mean value for ROA and Tobin's Q was 0.104 and 2.805, respectively. The average score for infrastructure

was 0.595. The firms were of varying ages (1-39 years), and there was also significant variation in firm size and leverage.

Table 1. Descriptive statistics of key study variables

Variable	Mean	SD	Minimum	Median	Maximum
Digital transformation index	0.526	0.150	0.000	0.524	1.000
R&D intensity	0.129	0.069	0.010	0.128	0.250
Technology ratio	0.323	0.158	0.050	0.320	0.600
Growth	0.159	0.262	-0.300	0.169	0.600
Return on assets	0.104	0.085	-0.050	0.108	0.250
Tobin's Q	2.805	1.293	0.502	2.790	4.995
Infrastructure score	0.595	0.230	0.200	0.599	1.000
Firm age	20.052	11.112	1.000	20.000	39.000
Firm size (ln)	11.990	2.326	8.005	11.925	15.999
Leverage	0.507	0.232	0.101	0.506	0.900

Note: N = 2,000.

The distribution in Figure 1 suggests that the digital transformation was mostly focused in the middle part of the scale. The highest frequencies occurred between 0.40 and 0.60, with 449 firms in the 0.40-0.50 interval and 527 firms in the 0.50-0.60 interval. A small number of companies were at either end of the spectrum.

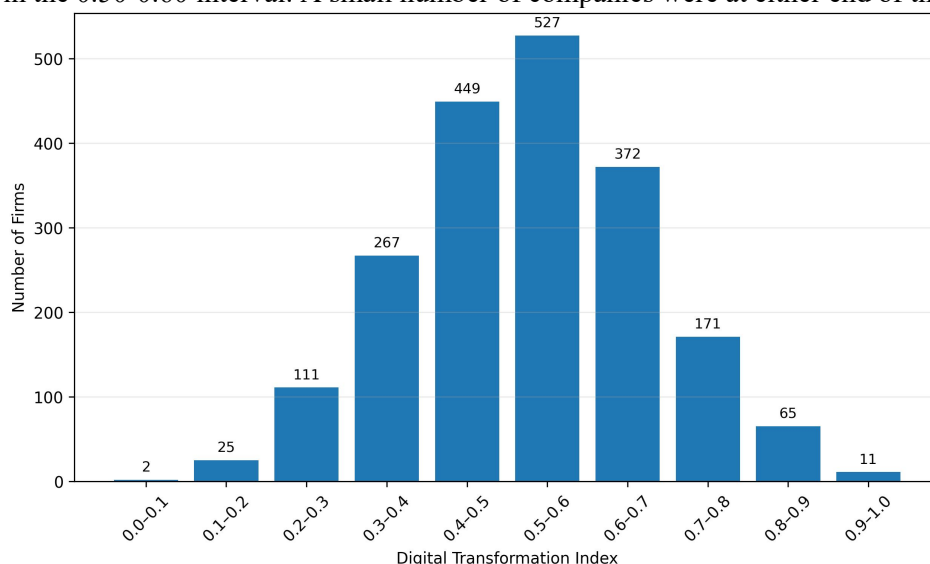


Figure 1. Distribution of the digital transformation index

3.2 Association and Group-Level Differences in Digital Transformation, Innovation Capability, and Strategic Performance

Table 2 shows the correlation analysis, which reveals that there is a statistically significant positive correlation between digital transformation and innovation capability ($r = 0.350$, $p < 0.001$). Digital transformation was also positively associated with the overall firm performance index ($r = 0.190$, $p < 0.001$),

firm growth ($r = 0.201$, $p < 0.001$), and ROA ($r = 0.118$, $p < 0.001$). Digital transformation, on the other hand, was not significantly related with Tobin's Q ($r = 0.014$, $p = 0.525$). There was weak relationship with overall firm performance and innovation capability ($r = 0.008$, $p = 0.706$) and it is not significant.

Table 2. Pearson correlations among principal study variables

Variable	1	2	3	4	5	6
1. Digital transformation	1.000					
2. Innovation capability	0.350***	1.000				
3. Firm performance index	0.190***	0.008	1.000			
4. Growth	0.201***	-0.016	0.590***	1.000		
5. ROA	0.118***	0.055*	0.580***	0.014	1.000	
6. Tobin's Q	0.014	-0.024	0.584***	0.021	0.003	1.000

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. Innovation capability is the mean standardized score of R&D intensity and technology ratio. Firm performance is the mean standardized score of growth, ROA, and Tobin's Q.

This is further corroborated by indicators derived from comparing companies in the low, moderate and high digital-transformation groups. The mean innovation capability index rose from -0.419 in low-transformation firms to -0.050 in moderate-transformation firms and 0.409 in high-transformation firms, according to the information presented in Table 3. The difference was statistically significant ($F = 108.983$, $p < 0.001$; $\eta^2 = 0.098$). Similarly, the performance index rose from -0.177 for the low transformation group to 0.157 for the high transformation group ($F = 23.430$, $p < 0.001$). The results showed that the R&D intensity, technology ratio and growth had significant differences while the Tobin's Q had no significant difference ($F = 0.399$, $p = 0.671$).

Table 3. Differences across digital-transformation groups

Outcome	Low DT Mean	Moderate DT Mean	High DT Mean	F	p-value	η^2
Innovation capability index	-0.419	-0.050	0.409	108.983	<0.001	0.098
Firm performance index	-0.177	-0.017	0.157	23.430	<0.001	0.023
R&D intensity	0.103	0.126	0.155	44.767	<0.001	0.043
Technology ratio	0.251	0.315	0.392	60.967	<0.001	0.058
Growth	0.070	0.153	0.230	25.779	<0.001	0.025
ROA	0.091	0.101	0.124	13.476	<0.001	0.013
Tobin's Q	2.757	2.821	2.768	0.399	0.671	<0.001

Note: Low DT, n = 192; Moderate DT, n = 1,434; High DT, n = 374. η^2 represents eta-squared effect size.

Figure 2 shows the remarkable disparity in innovation capability, which is evident and progressive within each category of digital transformation. The high digital-transformation firms had a score of around 0.83 standardized units higher for innovation capability than the low-transformation firms.

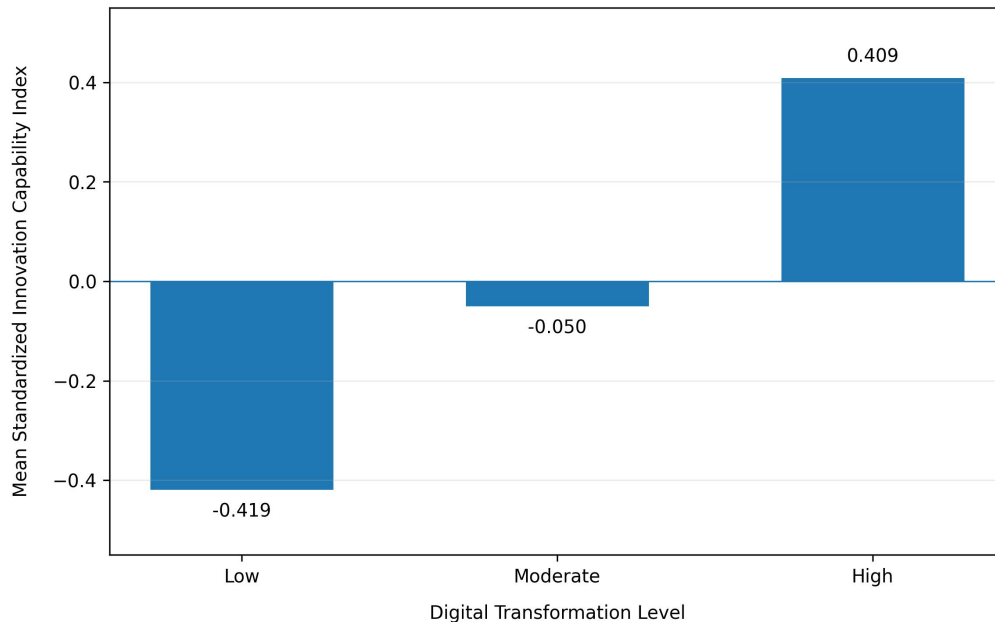


Figure 2. Innovation capability across digital-transformation groups

The same pattern is seen in Figure 3 about overall firm performance. This figure rose from -0.177 for low digital-transformation companies, to -0.017 for moderate, and 0.157 for high digital-transformation companies. This is further evidence of the positive relationship between higher digital transformation and overall firm performance.

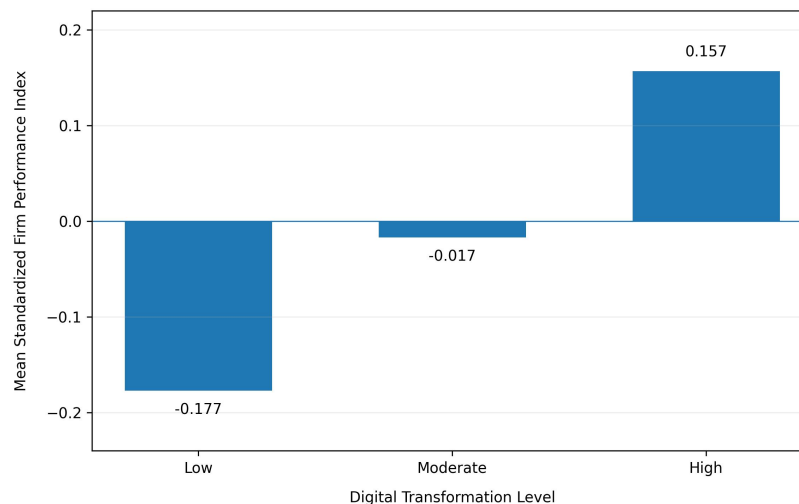


Figure 3. Firm performance across digital-transformation groups

3.3 Regression Results and the Role of Innovation Capability

A hierarchical regression analysis was conducted to test whether digital transformation contributes to innovation capability and strategic firm performance after controlling for firm age, firm size, leverage, state ownership, and industry concentration. The standardized coefficients with HC3 standard errors are shown in Table 4. The impact of digital transformation on innovation capability was strongly positive ($\beta = 0.358$, $p < 0.001$) in Model 1, accounting for around 12.5% of the variance in innovation capability. Model 2 showed that digital transformation remained statistically significant ($\beta = 0.191$, $p < 0.001$) and positively related to firm performance, $R^2 = 0.037$. In Model 3, digital transformation continued to have a positive and significant

conditional coefficient ($\beta = 0.214$, $p < 0.001$), while the coefficient of innovation capability was small and negative ($\beta = -0.066$, $p = 0.005$). The explanatory power improved modestly to $R^2 = 0.041$.

Table 4. Standardized regression estimates for innovation capability and firm performance

Predictor	Model 1: Innovation Capability β (Robust SE)	p	Model 2: Firm Performance β (Robust SE)	p	Model 3: Firm Performance β (Robust SE)	p
Digital transformation	0.358 (0.020)	<0.001	0.191 (0.022)	<0.001	0.214 (0.023)	<0.001
Innovation capability	—	—	—	—	-0.066 (0.024)	0.005
Firm age	-0.002 (0.021)	0.912	0.006 (0.022)	0.804	0.005 (0.022)	0.810
Firm size	0.016 (0.021)	0.461	-0.035 (0.022)	0.108	-0.034 (0.022)	0.118
Leverage	0.044 (0.021)	0.037	0.008 (0.022)	0.731	0.011 (0.022)	0.635
State ownership	-0.012 (0.021)	0.573	0.006 (0.022)	0.770	0.006 (0.022)	0.797
Industry concentration	0.024 (0.021)	0.251	<0.001 (0.022)	0.987	0.002 (0.022)	0.930
R ²	0.125		0.037		0.041	
Adjusted R ²	0.123		0.034		0.038	
Model significance	$p < 0.001$		$p < 0.001$		$p < 0.001$	

Note: N = 2,000. Coefficients are standardized. HC3 heteroskedasticity-robust standard errors are reported in parentheses. Model 1 dependent variable = innovation capability index; Models 2 and 3 dependent variables = firm performance index.

The indirect effect was about -0.024, with a 95% confidence interval of -0.040 to -0.008, using 2000 resample bootstrap analysis. Therefore, the role of innovation capability in the mediating process between digital transformation and firm performance is not supported by the results. The principal standardized coefficients of the digital transformation and innovation capability, direct relationship between digital transformation and firm performance, and small negative conditional relationship between innovation capability and firm performance are summarized in Figure 4.

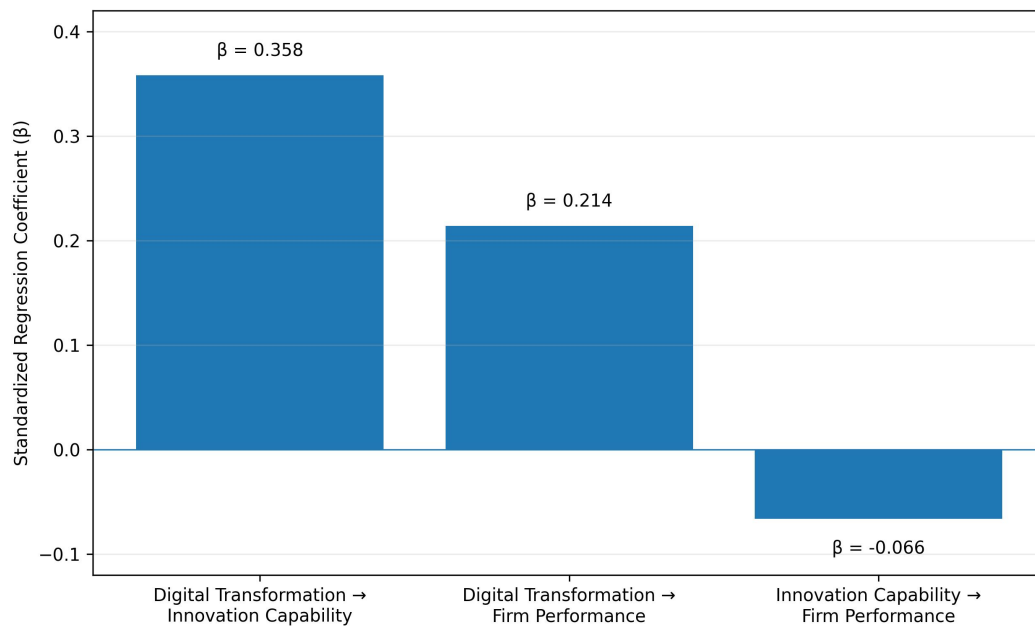


Figure 4. Standardized regression coefficients of the empirical model

Overall, the results suggest that digital transformation is associated with significant improvements in innovation capability and moderate improvements in strategic firm performance. The strongest patterns are evident for R&D intensity, technological capability, growth, and profitability, whereas no significant improvement is found for Tobin's Q. These findings support the strategic business management view that digital transformation can strengthen organizational capability and competitive performance, although innovation capability alone does not provide a positive indirect pathway to performance in this sample.

4. Discussion

The results show that digital transformation is positively related to innovation capability and firm performance, although the magnitude of these relationships varies. From a strategic business management perspective, the strongest association is between digital transformation and innovation capability, indicating that digitally advanced companies tend to display higher R&D intensity and technological capability (Settembre-Blundo et al., 2021).

The finding supports the broader strategic management argument that data analytics and decision-support systems enabled by digital technology can enhance organizations' ability to identify growth opportunities and optimize resource management (Ahmed Khan & Saha, 2024). The relationship between digital transformation and firm performance is also positive and significant, suggesting that digital transformation can strengthen strategic decision-making and organizational outcomes. Digitalization has been associated with improvements in forecasting precision, risk evaluation, and business choice, providing a logical pathway through which AI-driven financial analytics may support stronger operating performance (Celestin & Mishra, 2025). Predictive analytics also contributes to budgeting and strategic forecasting, as managers can anticipate future financial conditions more systematically (Diba, 2024). This positive impact of digital transformation persisted after controlling for firm age, size, leverage, ownership, and industry concentration. This is consistent with the view that financial analytics can play a standalone role in strategic planning and decision quality (Khan, 2025). Similar studies have highlighted the benefits of data analytics for risk management and business decision-making for growth (Khan & Saha, 2024).

The results also corroborate with the ability of financial analytics to help organizations assess investment opportunities while dealing with intricate financial risks (Ochuba et al., 2024). Nevertheless, one important finding is that there was no positive mediation between digital transformation and firm performance in terms of innovation capability. The conditional innovation-performance coefficient was small, and negative, although digital transformation was a strong predictor of innovation capability. These results indicate that increased R&D intensity and technological capability are not always followed by immediate financial gains (Victoria & Ali, 2025). The benefit brought by innovation could be contingent on supportive management systems, the quality of the implementation and its incorporation into the decision-making process within the

organization. Certain technologies, such as integrated predictive analytics and enterprise resource planning (ERP) systems, might be required to transform technological investments into tangible financial gains (Ogunnubi et al., 2025). Similarly, the value of predictive capability lies in the effective use of analytical insights in risk-management and managerial decision making (Olagoke, 2025).

The results also indicate that digital transformation was positively related to growth and ROA, but not significantly related to Tobin's Q. The difference suggests that digital transformation can have more immediate operational and accounting benefits than market-valuation benefits. Similarly, quantitative strategic financial planning frameworks highlight how an optimization process, risk assessment and the use of decision-support tools can enhance the efficiency of internal resources without necessarily being immediately reflected in the market (Raiyani, 2025). However, advanced AI-driven visualization and financial analytics could further enhance the managerial interpretation of financial information, but the business value will depend on how the decision makers use the analytical output to inform and guide strategic decision making (Sarna et al., 2025). This conclusion also aligns with the development of strategic financial intelligence, in which digital technologies help managers in business environments that are increasingly complex (Sugiarto, 2025). Thus, digital era strategic financial planning is expected to influence the performance of the corporation in several ways, not just by introducing innovation capability.

The overall findings suggest that digital transformation functions as an integrated strategic business management capability. It supports innovation development and firm-level performance, but the conversion of innovation investment into sustainable competitive advantage appears to depend on complementary organizational and managerial mechanisms that are not explicitly measured in the current study.

5. Conclusion

This research investigated digital transformation, innovation capability, and sustainable competitive advantage from a strategic business management perspective, using firm performance as an empirical proxy for competitive outcomes. The results show a positive relationship between digital transformation and both innovation capability and firm performance, with the strongest association observed between digital transformation and innovation capability. Significant relationships were also found between digital transformation and growth and profitability outcomes, with stronger results among firms at higher levels of digital transformation, while no significant relationship was found with Tobin's Q. Regression results indicated that digital transformation remained significant in predicting firm performance after accounting for firm age, firm size, leverage, ownership, and industry concentration. However, innovation capability did not provide a positive indirect pathway between digital transformation and performance; its conditional effect was small and negative, indicating that higher R&D intensity and technological competence alone do not necessarily translate into stronger financial performance. Overall, the findings position digital transformation as a strategic business management capability that can enhance innovation potential and competitive performance. Nevertheless, translating innovation capability into sustainable competitive advantage may require supportive managerial, organizational, and implementation mechanisms. Future studies should incorporate direct measures of organizational agility, dynamic capabilities, strategic management practices, and long-term sustainability outcomes.

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