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Impact of Digital Transformation and Big Data Analytic Capabilities of The Indonesian Bank Profitability

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A B S T R A C T

This study analyzed the impact of digital transformation (DT) and big data analytic capabilities (BDAC) on bank profitability, which is proxied by ROA and ROE. This study also examined the moderation effect of institutional ownership on digital transformation (DT) relationships on bank profitability. This research uses a quantitative approach with a panel data model. The sample of this study was 34 banks listed on the Indonesian Stock Exchange from 2018 to 2021, with a total observation of 136 firm years. This research uses secondary data derived from annual reports and company financial reports. This study shows that big data analytic capabilities have no significant effect on bank profitability, which means that the impact of the application of technology is not immediately visible. This study shows that digital transformation decreased the company's profitability. Institutional ownership failed to moderate the relationship between digital transformation on bank profitability. This finding implies the importance of companies being careful in investing in digital transformation and big data analytics because the costs outweigh the benefits in the short term.

A B S T R A K

Penelitian ini mengkaji dan menganalisis dampak digital transformation (DT) dan big data analytic capabilities (BDAC) terhadap kinerja perusahaan, yang diproksi oleh ROA dan ROE. Penelitian ini juga menguji efek moderasi dari kepemilikan institusional terhadap hubungan Digital transformation (DT) terhadap kinerja perusahaan. Penelitian ini menggunakan pendekatan kuantitatif dengan model data panel. Sampel penelitian ini adalah 34 bank yang terdaftar di Bursa Efek Indonesia dari 2018 hingga 2021, dengan total pengamatan 136 firm-years. Penelitian menggunakan data sekunder yang berasal dari annual report dan finan-cial report perusahaan. Penelitian ini menunjukkan bahwa big data analytic capabilities tidak berpengaruh signifikan terhadap profitabilitas bank, yaitu dampak penerapan teknologi tidak langsung terlihat. Studi ini menunjukkan bahwa transformasi digital menurunkan profitabilitas perusahaan. Kepemilikan institusional gagal memoderasi hubungan antara transformasi digital terhadap profitabilitas bank. Temuan ini menyiratkan pentingnya perusahaan untuk berhati-hati dalam berinvestasi dalam transformasi digital dan analitik data besar karena biayanya lebih besar daripada manfaatnya dalam jangka pendek.

1. INTRODUCTION

Pervasive digital technologies (such as artificial intelligence, the internet of things, big data analytics, and cloud computing) are causing profound social and industrial transformations (Bharadwaj et al., 2013; Vial, 2019). Digital Transformation (DT) is the use of new digital technologies to enable the enhancement of big business (Fitzgerald et al., 2013). Fitzgerald et al. (2013) report a paradoxical phenomenon of digital technology in which managers believe in the benefits of DT adoption but are frustrated with the advancement of DT and are getting results from it in their companies. Conceptually, DT benefits the firm, such as lower costs, better operating efficiency, or increased innovation success.

Several studies have been conducted to test the relationship of DT to performance firms, such as research by Sousa-Zomer et al. (2020), which proves that a company's ability to transform digitally

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contributes to maintaining its performance over time. Guo & Xu (2021) found a U-shaped relationship between DT and firm performance. Singh et al. (2021) conducted a study on Indian manufacturing companies that found that DT benefits the company's performance.

Zhai et al. (2022) also found a positive relationship between DT and firm performance. Jardak & ben Hamad (2022) found a negative relationship between digital maturity and financial performance. During the digital transformation process, companies' investment in IT will increase, which essentially increases their assets; as a result, ROA will be negatively impacted because the increase in IT investments is not amortized. At the same time, the second cause is ineffective digital transition management.

According to Zhai et al. (2022), institutional investors have the resources and motivation to monitor the companies they invest in. Therefore, they are expected to pay attention to the company's DT, apply appropriate pressure, and monitor their DT. When a company has high institutional investor ownership, the company will be monitored more closely than a low institutional investor-owned company in the DT process. Thus, DT firms perform better with high institutional investor ownership.

According to a survey conducted by Accenture and General Electric (Columbus, 2014), 87 percent of organizations anticipate that big data analytics will change the competitive landscape of their sector in the next three years. Eighty-nine percent feel businesses that do not use big data analytic strategy next year risk losing market share and momentum. However, the low relationship between analytical capabilities and company performance makes investing in big data still face some obstacles.

Some academics assert that investing in big data analytic capabilities (BDAC) is a mirage, arguing that it must demonstrate productivity by demonstrating innovative capabilities and improving firm performance (Blackburn et al., 2017; Ghasemaghaei & Calic, 2019; Yang et al., 2017). However, productivity is not the same as profitability, and the former does not always lead to the latter. Productivity is the increase in output for a given amount of inputs. Profitability evaluates a company's capacity to achieve a competitive advantage and earn greater earnings than expected.

Several studies have examined the influence of big data on firm performance, resulting that big data can improve firm performance (e.g., Collymore et al., 2017; Ferraris et al., 2019; Raguseo et al., 2020; Suoniemi et al., 2020). In this research, firm performance will be measured by a strategic management approach, namely profitability proxied with ROA and ROE.

On October 28, 2018, the National Information and Communication Technology Council of the Republic of Indonesia issued a roadmap for the direction of Indonesia 4.0, which indicates that Indonesia has begun to declare to implement the technology of the industrial revolution 4.0 (Habibie, 2018). Based on this, this research was conducted over four years, starting in 2018-2021.

This study adds to the limited literature regarding the role of digital transformation and big data analytics in influencing company performance. Especially in Indonesia, this research is the first to examine the effect of these two variables on company profitability. Another novelty contribution from this research is the investigation of the role of institutional ownership in moderating the influence of big data analytics on company profitability.

2. THEORETICAL FRAMEWORK AND HYPOTHESES

Resource-Based View Theory

Resources-Based View Theory explains why some companies perform better than others and how they can improve their performance. Resource-Based View Theory has two main assumptions; the first is that the company has a combination of different resources, even if they belong to the same industry (Shan et al., 2019). Secondly, this resource disparity is triggered by the difficulty of resource exchange between companies. This assumption indicates the immobility of resources and emphasizes that the synergy of various resources is maintained in the long term (Barney & Hesterly, 2020).

Based on these differences, this research was conducted to prove previous research in a more specific industry: banking companies that went public on the Indonesia Stock Exchange. It was decided because, due to digital transformation, change and diversification of business activities are occurring rapidly in the banking sector (Do et al., 2022). In addition, researchers, policymakers, and businesses pay great attention to digital transformation in commercial banks' business operations (Lee & Shin, 2018).

Big Data

The literature defines big data as a large amount of structured and unstructured data that can be accessed in real-time (Einav & Levin, 2013; O'Leary, 2013). According to Ferraris et al. (2019), big data can be a strategy for managing, processing, and analyzing five data dimensions known as 5V: volume, variety, velocity, veracity, and value.

1. Volume. The daily data created is growing exponentially with the never-ending advancement of technology. The amount of data generated every second on the internet exceeds the storage capacity of the entire internet twenty years ago.
2. Variety. Big data sources are numerous and relatively new. Various digital platforms generate data. Consumers provide information about their habits, needs, and wants through their inputs across multiple digital devices. For example, big data can take the form of messages, updates, and images posted on social networks, as well as sensor readings and GPS signals from mobile devices.
3. Velocity. The speed with which data is generated is more important than its volume as the global economy becomes increasingly competitive. The ability to make faster decisions is a critical success factor. Today, data can be accessed in real-time or near real-time, allowing businesses to be much more agile and faster in their decision-making.
4. Veracity. The data collected must be of high quality, and the source must be credible. "truth" refers to the possibility that the data may contain noise or be insufficient and outdated.
5. Value. The importance of extracting economic benefits from available big data is enormous. This value is often associated with the organization's capacity to make better decisions. Some practitioners and researchers consider big data to come from various sources, including photo data, videos, social media, sensors, satellites, and cell phone data (Wamba et al., 2015).

There are three key dimensions, namely organization (BDA Management), physical (IT Infrastructure), and human (analytic skill or knowledge). In addition to the three key dimensions, there are also 11 sub-dimensions, namely BDA planning, investment, coordination, control, connectivity, compatibility, modularity, technical knowledge, technology management knowledge, business knowledge, and relational knowledge (Akter et al., 2016).

Digital Transformation

Digital Transformation (DT) is the use of new digital technologies to enable the enhancement of big business (Fitzgerald et al., 2013; Piccinini et al., 2015). Agarwal et al. (2010) illustrated the meaning of DT by focusing on DT in a healthcare setting. Specifically, they consider three aspects: (1) information technology (IT) design, (2) measurement and quantification of IT payoff and impact, and (3) extending the traditional realm of IT.

According to Verhoef et al. (2021), the DT of a firm has three aspects: digital technology application, business model innovation, and digital strategy. The last element is built on the first two. There are ten specific digital technology applications and business model innovations (artificial intelligence, business intelligence, digital technology, robots, Internet of Things, blockchain, robotic process automation, digitalization, cloud computing, and Hadoop) (Zhai et al., 2022). Hence, this research follows Gal et al. (2019) to focus on digital technology applications and business model innovation to quantify a firm's level of DT.

Bank Transformation

The rate of technological advancement in banking is so rapid that banks that rely on branches are transforming into banks without branches and, eventually, digital banks. Today, it is still known as a 4.0 bank. King (2018) described the transformation of the bank such as:

1. Bank 1.0: Based on the history and tradition of the bank branch as the main access point. In the 12th century, it was founded by the Medici family.
2. Bank 2.0: the emergence of banks that offer self-service to provide banking access outside working hours. It started with Automated Teller Machines (ATMs) and accelerated in 1995 with the advent of the internet.
3. Bank 3.0: banking services for customers anytime and anywhere they follow the emergence and popularity of smartphones of 2007. It was later accelerated by switching to mobile payments, peer-to-peer transactions, and Challenger Bank over mobile: channel-agnostic.
4. Bank 4.0: Embedded, ubiquitous banking served in real-time through layer technology. It is dominated by real-time, contextual, experiential, frictionless engagement factors and an AI-powered intelligent suggestion layer. With no need for physical distribution, omnichannel distribution is mainly digital.

Big Data Analytic Capability and Firm Performance

Resources-Based View Theory explains why some companies perform better than others and how they can improve their performance. According to Behl (2022) and Collymore et al. (2017), companies that implement big will have a better competitive advantage and performance than companies that do not use big data. Cao et al. (2022) stated that big data increase firm marketing capabilities. Furthermore, Suoniemi et al. (2020) showed that big data resources could improve firm performance through market-directed capabilities. Moreover, firms pursuing a differentiation strategy rather than a cost-leadership strategy benefit the most from big data resource investments, accounting for 13% of the variance in firms seeking a differentiation strategy.

Ferraris et al. (2019) demonstrated that big data analytics positively impacts firm performance. Furthermore, it shows the growing importance of these IT-related capabilities to the overall competitiveness of modern and increasingly "digital" businesses (Janssen et al., 2017; Wamba et al., 2017). Based on this, the following hypotheses can be formulated:

H$_1$: Big data analytic capabilities positively affect firm performance

Digital Transformation and Firm Performance Relationship

Fitzgerald et al. (2013) defined digital transformation as the application of new digital technologies such as social media, mobile, analytics, or embedded devices to enable significant business improvements (streamlining operations, improving customer experience, creating new business models, and many others). Using digital transformation, management, shareholders, employees, and other stakeholders communicate more effectively. Digital transformation drives organizational innovation and, in turn, corporate performance (AlMulhim, 2021; Tsou & Chen, 2021). Previous studies show that digital transformation positively affects firm performance (Avirutha, 2018; Sousa-Zomer et al., 2020; Zhai et al., 2022). Based on this, the following hypotheses can be formulated:

H$_2$: Digital transformation has a positive impact on improving firm performance

Institutional Ownership and Firm Performance Relationship

According to Panda & Leepsa (2019), institutional investors have the resources and motivation to monitor the companies they invest in. Therefore, they are expected to pay attention to the company's DT, apply appropriate pressure, and monitor their DT. When a company has high institutional investor ownership, the company will be monitored more closely than a low institutional investor-owned company in the DT process (Daryaei & Fattahi, 2020). Thus, DT firms perform better with high institutional investor ownership. In addition, it found that the impact of DT on the performance of companies proxied by ROA and ROE is more pronounced when a company is in a mature stage or has a high percentage of institutional investors (Zhai et al., 2022). Based on this, the following hypotheses are formulated:

H$_3$: Institutional ownership can moderate the relationship of digital transformation with firm performance

Based on the discussion, the research model is presented in Figure 1.

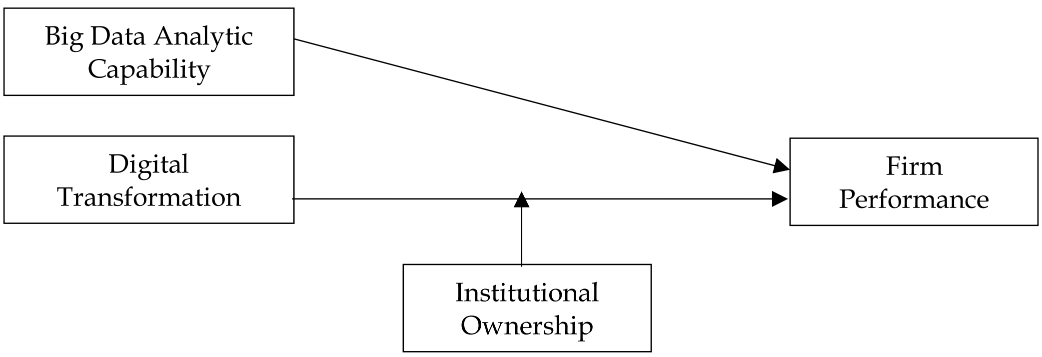

Figure 1. Research model

3. RESEARCH METHOD

Population and Sample

The sampling method in this study was carried out using purposive sampling. According to Zikmund et al. (2013), purposive sampling is a non-probability sampling technique in which an experienced person selects a sample based on assessing some appropriate characteristics required for the sample members. The samples in this study will be selected based on the following criteria:

1. Banking companies listed from 2018 to 2021 on the IDX;
2. Have annual report from the period 2018 to 2021;
3. Financial statements do not use foreign currency;

Banking companies were chosen as samples in this study because they experience such rapid technological development, so it is expected that the samples taken can describe the existing population.

Variable Measurement

Table 1 presents the measurement of research variables. Profitability is measured using return on asset and return on equity. Big data analytic capabili-ties reflect the firm's software investment relative to its assets. Digital transformation is measured using dummy variables (coded 1) when the company car-ries out digital transformation. Firm size takes a role as a control variable, measured using the lognormal of its assets.

Table 1. Operational definition

Variable	Definition
ROA	Net Profit / Total Assets
ROE	Net Profit / Total Equity
BDAC	Big Data Analytic Capabilities are measured by the ratio of software investment / to total assets.
DT	Digital Transformation, where digital transformation is measured by dummy variables, namely the value of 1 if the company carries out digital transformation, otherwise 0
Institutional	Ownership of shares by institutions / total shares outstanding
DT*Institutional	Coefficient of interaction between Digital Transformation and Institutional Ownership
SIZE	Ln of Total Assets

Panel Data Regression

The analysis technique used in this study was panel data regression. Panel data combines time series and cross-section data types (Gujarati et al., 2019). According to Wooldridge (2015), the main advantage of the panel data regression method is that it is robust against violations of Gauss-Markov assumptions, such as heteroskedasticity and normality. In addition, Gujarati et al. (2019) also identified the benefits of using panel data, such as explicitly describing individual heterogeneity, providing more information and variety, less collinearity between variables, a higher degree of freedom, and increased efficiency. Panel data is also suitable for checking the dynamics of changes, can measure effects that cannot be seen from pure cross-section and time-series data, can be used to learn sophisticated behavioral models, and may reduce the bias effect of the individual- and group-level data collected at scale.

Panel data models do not need to be tested for classical assumptions because of these benefits (Gujarati et al., 2019; Ajija et al., 2020). In this study, a regression analysis of **model 1** is carried out as follows:

$$\mathrm{ROA_{it}}, \mathrm{ROE_{it}} = \beta_0 + \beta_1 \mathrm{BDAC_{it}} + \beta_2 \mathrm{SIZE_{it}} + \varepsilon_{it} \quad (1)$$

The equation above estimates the influence of big data analytic capability on the company's ROA and ROE. Meanwhile, to estimate the impact of digital transformation on ROA and ROE as well as the effect of institutional ownership moderation using the regression equation **model 2** as follows:

$$\mathrm{ROA_{it}}, \mathrm{ROE_{it}} = \beta_0 + \beta_1 \mathrm{DT_{it}} + \beta_2 \mathrm{Institutional_{it}} + \beta_3 \mathrm{SIZE_{it}} + \beta_4 \mathrm{DT_{it}} * \mathrm{Institutional_{it}} + \varepsilon_{it} \quad (2)$$

Data Analysis Methods

The method used to analyze the data in this study was the panel data regression with a weighted method (cross-section weights) to avoid the presence of heteroskedasticity. This method uses an Estimator Generalized Least Square (EGLS), a Best Linear Unbiased Estimator (BLUE) (Gujarati et al., 2019).

4. DATA ANALYSIS AND DISCUSSION

Descriptive Statistical Test Results

The sample period starts from 2018-2021, and the sample used is 136 firm years. Table 2 reveals that, on average, companies invest about 16 percent of their assets in developing big data analytics. However, on a median basis, this investment is less than three percent of their assets, a relatively small value of the investment. Furthermore, about 80 percent of sample companies carry out digital transformation.

Table 2. Descriptive statistics

	BDAC	DT	SIZE	INSTIT	ROA	ROE
Mean	0.1585	0.8014	20.6462	0.7542	0.0045	0.0256
Median	0.0260	1.0000	19.0590	0.7984	0.0063	0.0364
Maximum	0.4493	1.0000	32.5205	0.9991	0.0910	0.2595
Minimum	0.0000	0.0000	13.4071	0.0000	-0.1806	-1.2393
Std. Dev.	0.3564	0.4004	4.8338	0.1913	0.0290	0.1557

Source: Processed secondary data (2022)

Based on the results in Table 3, the Prob F-Chow in model 1 shows a smaller result than the value of the α (Prob F-Chow < α), so the temporary model chosen is the fixed effect. Furthermore, re-testing will be carried out using the Hausman test to determine the last model suitable for use in this study.

Table 3. Model 1 Chow and Hausman test

	ROA				ROE			
	Statistic	d.f.	Prob.	Sig	Statistic	d.f.	Prob.	Sig
Cross-section F	16.6179	(33,99)	0.0000	***	34.8303	(33,99)	0.0000	***
Cross-section random	14.3265	3	0.0025	***	9.8288	3	0.0201	***

Source: Processed secondary data (2022)

Based on the results in Table 4, the Prob Cross-section random in model 2 shows a smaller result than the value of α (Prob Cross-section random < α), so the model chosen for models 1 and 2 is a fixed effect model.

Table 4. Model 2 F Chow and Hausman test

	ROA				ROE			
	Statistic	d.f.	Prob.	Sig	Statistic	d.f.	Prob.	Sig
Cross-section F	11.3799	(33,98)	0.0000	***	34.2169	(33,98)	0.0000	***
Cross-section random	22.4022	4	0.0002	***	11.0029	4	0.0265	***

Source: Processed secondary data (2022)

Results and Discussion

Table 5 present the test results of Model 1. Based on ROA and ROE estimation results, the coefficient of determination (R2) is 0.8759 and 0.9292, respectively. It means that all independent variables (big data analytic capability and digital transformation) and control variables (size) have the ability of 88% and 93% to describe variations of the de-pendent variables in the regression model, and other variables outside the model explain the rest.

The p-value F result in model 1 above shows a value of 0.0000, so H0 is rejected. All independent variables (big data analytic capability and digital transformation) and control variables (size) significantly affect ROA and ROE.

Table 5. ROA and ROE Model 1 estimation results

Variable	ROA				ROE			
	Coefficient	t-Statistic	Prob.	Sig	Coefficient	t-Statistic	Prob.	Sig
C	-0.2116	-3.6420	0.0004		-1.7554	-5.7300	0.0000	
BDAC	-0.0004	-0.1233	0.9022		-0.0062	-0.5204	0.6039	
DT	-0.0066	-7.9090	0.0000	***	-0.0259	-3.5724	0.0005	***
SIZE	0.0107	3.7969	0.0003	***	0.0873	5.8094	0.0000	***
R-squared		0.8759				0.9292		
F		19.4015	0.0000	***		36.0991	0.0000	***

Source: Processed secondary data (2022)

Notes: *,**,***p-value is significance at α=10%, 5%, 1%

Based on Model 1 estimation, the DT and size p-value is 0.000. It means that digital transformation and control variables (size) significantly affect ROA and ROE. Meanwhile, the BDAC p-values against ROA and ROE are 0.9022 and 0.6039, where the ROA and ROE values are both > 0.05, so it can be said that big data analytic capability has no significant effect on ROA and ROE. The results of this study differ from those conducted by Collymore et al. (2017), that explained that companies that implement big data would show better competitive advantage and performance compared to companies that do not use big data.

Table 5 reveals that big data analytics has no significant impact on the firm's profitability. Table 2 of the descriptive statistics show that the median investment in big data analytics is less than three percent of the firm's total asset. This small investment may lead to the insignificant impact of this variable on the firm profitability. In addition, Ghasemaghaei & Calic (2019) state that the data velocity, not the investment size, plays more important in enhancing the firm performance.

The table also shows that digital transformation significantly affects ROA and ROE. A negative coefficient means that companies that transform digitally will experience a decline in performance. Investment in digital transformation requires large funds. When this investment is recognized as a periodic expense, it incurs an expense that exceeds the benefits generated in the short term. As a result, digital transformation is detrimental to the company's performance.

Furthermore, Guo & Xu (2021) found a U-shaped relationship between DT and firm performance. After one year since the company's digital transformation, operating performance has improved significantly, but its profitability has decreased. If a company expects the benefit of data transformation, then it is necessary to wait two to four years. This result is also in line with Lee et al. (2016) stating the IT investment paradox concept. The IT investment spent by a company has a short-term negative impact on business performance, while the positive impact is still not visible.

Table 6. ROA and ROE Model 2 estimation results

Variable	ROA				ROE			
	Coefficient	t-Stat.	Prob.	Sig	Coefficient	t-Stat.	Prob.	Sig
C	-0.2423	-3.2614	0.0015		-1.1196	-4.4436	0.0000	
DT	-0.0134	-1.8000	0.0749	*	-0.0450	-1.6793	0.0963	*
SIZE	0.0118	3.2956	0.0014	***	0.0537	4.4162	0.0000	***
INSTITUTIONAL	0.0095	0.7320	0.4659		0.0696	1.6703	0.0980	*
DT * INSTITUTIONAL	0.0121	1.2236	0.2241		0.0338	0.9639	0.3375	
R-squared		0.8239				0.9275		

Source: Processed secondary data (2022)
Notes: *,**,***p-value is significance at α=10%, 5%, 1%

Based on the estimation results of ROA and ROE Model 2 presented in Table 6, the coefficient of determination (R^2) is 0.823919 and 0.927478, respectively. It means that all free variables (big data analytic capability and digital transformation) and control variables (Size) have the ability of 88% and 93% to explain variations of firms' profitability in regression models. At the same time, other variables outside the model explain the remaining. The p-value F result in model 2 above shows a value of 0.0000, so H_0 is rejected. All independent variables (big data analytic capability and digital transformation) and control variables (size) significantly affect ROA and ROE.

Based on the estimation carried out in Table 5 and Table 6, it can be seen that digital transformation and institutional ownership significantly affect ROA and ROE at 10%. Meanwhile, size has a significant effect, and institutional ownership has a significant effect only on ROA. This finding supports Lin et al. (2020), stating that internal and external governance is important in driving innovation that improves firm performance. Institutional ownership, as part of corporate governance, can increase supervision of company management which has an impact on increasing profits.

Furthermore, institutional ownership has not succeeded in moderating the relationship between digital transformation on ROA and ROE. It is in contrast to the findings of Zhai et al. (2022), proving that the impact of DT on the performance of companies proxied with ROA and ROE is more pronounced when the company is in a maturity stage or when it has a high percentage of institutional investors.

5. CONCLUSION, IMPLICATION, SUGGESTION, AND LIMITATIONS

Based on data analysis and discussions previously submitted, big data analytic capabilities have no significant effect on firm performance. It shows that the impact of applying technology is not immediately visible results. Digital transformation has a significant effect on firm performance. This study also shows that digital transformation harms the company's profitability. Institutional ownership does not affect the relationship between digital transformation and firm performance. It proves that institutional ownership marginally affects the company's performance.

This research is expected to contribute to the literature on the influence between big data analytic capabilities, digital transformation, institutional ownership of firm performance, and the moderation effect of institutional ownership on the relationship between digital transformation and firm performance. The results of this study provide evidence that the influence of the application of it does not always have a positive impact but rather negative; it can even have no effect.

The findings imply that the firms' managers need to consider their cash flow of investment decisions in big data analytics or digital transformation because it cannot provide instant results. However, it takes a long time for the company to reap the fruits.

This study has several limitations, including that the measurement used in this study may not capture the effects of digital transformation in the long run. It also does not cover other variables that may play an important role in implementing digital transformation. Future research may consider examining the long-term impact of digital transformation on firm performance. In addition, researchers may include mediator variables, such as dynamic and operational capabilities, or moderator variables, such as organizational innovation and organizational culture.

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