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The Moderating Effect of Technological Innovation of Intellectual Capital to Firm Performance

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Abstract

The role of technological innovation in shaping the relationship between intellectual capital (IC) and firm performance in the industrial sector has garnered increasing attention, particularly within the context of Indonesia, where research in this area has been limited. This study explores the influence of the IC on firm performance, with a specific focus on the moderating impact of technological innovation. The research focuses on industrial firms listed on the Indonesian Stock Exchange (IDX). Data is collected using the purposive sampling technique and examined using the OLS estimation process employing multiple regression analysis. The findings reveal that Structural Capital Efficiency and Capital Employed Efficiency demonstrate a significant positive influence on firm performance. Additionally, Technological Innovation and Human Capital Efficiency do not show a significant influence. Concerning the moderating variable, Interestingly, this study has established that there is a weakening effect of TI on the relationship between SCE and firm performance while CEE remains unaffected. This study, while insightful, is limited by its sector-specific focus and the short duration of the data from 2018 to 2022. The adjusted R-squared value of 55.6% suggests the presence of unexplored variables. Future research could benefit from a wider sectoral scope, an extended data timeline, and the inclusion of additional variables.

Keywords: Intellectual Capital, Technological Innovation, Firm Performance

Introduction

Intellectual capital (IC) is a key element in generating value for businesses, offering them a competitive edge and enhanced performance in the knowledge-based economy. In addition to physical and financial resources, IC is viewed as an extra value (Xu et al., 2019). The escalating significance of innovation in various academic and industrial domains is largely perceived as a result of effective management of intellectual capital (Yüksel et al., 2022).

According to Nadeem et al. (2018), The resource-based view (RBV) theory focuses on physical and intangible assets that are stable, transcendent, and diverse within the organization.

Previous studies conducted by Campos et al. (2022), Truong et al. (2024), and Farooq and Ahmad (2023) have focused on IC and its impact on firm performance. Some scholars suggest that an organization's investment in R&D can lead to ongoing revenue and growth in the future, which in turn can enhance its market value and financial performance (He & Estébanez, 2023). Businesses that invest in research and development activities can accelerate the introduction of innovative products to the market, which in turn boosts their productivity. Moreover, the cost of production can be reduced for the business. As a result, business performance has a potential to enhance firm performance (Insee & Suttipun, 2023). Technological Innovation by utilizing IC will improve their competitive advantage and firm performance (Xu et al., 2019).

Most IC and TI research that is conducted by Palazzi et al. (2020), Insee and Suttipun (2023), and Wang et al. (2021) applied survey questionnaire as measurement of those variables. This research aims to employ secondary data measurement as the model's metric. For instance, TI can be quantified using expenditures for Research and Development (R&D) (Xu et al., 2019). VAIC (Value-Added Intellectual Capital) is a measure that assesses the impact of IC on firm performance and is believed to capture the combined effect of both technological and non-technological innovation (Gallegos & Miralles, 2023).

Indonesia industrial companies face a range of challenges in maintaining their performance and competitiveness in different factors, including the need to innovate and adapt to technological changes. Today's business landscape presents growing challenges and complexities, exacerbated by the impact of COVID, which has led to a slowdown in the corporate sector, rising labor costs due to a shortage of workers, and constantly shifting customer behavior (Insee & Suttipun, 2023). According to the Engineering Indicators by the National Science Foundation (2020) in Indonesia, the gross domestic expenditures on R&D are a mere USD 2.5 Billion. This is significantly low when compared to developed countries like the US, which spent USD 730.3 Billion in 2020. Given this context, it becomes interesting for us to take on the moderation effect of technological innovation proxy by R&D expenditure in Indonesia.

The impact of Intellectual Capital (IC) on the performance of a firm varies based on its unique corporate attributes (Palazzi et al., 2020). The impact of IC on firm performance will be examined in this article, with a specific focus on the moderating effect of technological innovation. This study will examine existing literature, empirical studies, and theoretical frameworks to shed light on the complex relationship between IC, technological innovation, and firm performance. By implementing this approach, it aims to contribute to the understanding of the factors that drive firm performance in today's dynamic business environment.

Literature Review

Resource-based view (RBV)

Resource-Based View is a firm's sustained competitive advantage is based on its valuable, rare, inimitable, and nonsubstitutable resources (Barney et al., 2011). The capability of firms

to create or acquire these resources affects their performance and competitiveness over their competitors.

Firm Performance

Firm performance refers to how well a company is achieving its strategic objectives, typically evaluated through indicators such as profitability, market share, sales growth, and shareholder value (Tawse & Tabesh, 2023). Thriving enterprises play a vital role in the progress of developing nations, often likened to an engine driving economic, social, and political development by many economists. To endure and prosper within a competitive business environment, each firm must function under conditions that promote optimal performance (Taouab & Issor, 2019). Return on Assets (ROA) is a key indicator of a firm's financial performance. It measures the efficiency of a company in using its assets to generate profit. A higher ROA indicates a higher financial performance.

Intellectual Capital and Firm Performance

VAIC is a measure of an organization's asset efficiency. Thus, it follows that VAIC helps to enhance businesses' performance (Sohel Rana & Hossain, 2023). According to Nhon et al. (2020), the results of research conducted on 370 samples in Vietnam show significant positive results due to significant impacts of IC on firm performance. The research conducted by Xu et al. (2019) also says that intellectual capital can improve the performance of industrial listed companies in China, thus concludes that intellectual capital is significantly positive to firm performance, this finding is also similar as what Sohel Rana and Hossain (2023) said in their finding that revealed intellectual and tangible capital positively enhances the company's performance. Results by Hoang et al. (2020) said that intellectual capital dimensions have significant impacts on firm performance, also echoes a positive result between intellectual capital and performance. Further studies by Andreeva and Garanina (2016) implies the same. From this literature this study assumed that VAIC positively influenced Firm Performance.

H_1: Intellectual capital influences significantly to firm performance.

Human Capital Efficiency and Firm Performance

Human Capital Efficiency (HCE) represents the ratio of value added to employee costs. It is about getting the most value from the people within a company. HCE affects companies' performance in a significant positive way (Sohel Rana & Hossain, 2023). Research conducted in Italy by Palazzi et al. (2020) also shows that HCE positively affects the corporate performance of tech-industrial Italian SMEs, in the Middle East, study by Abdel et al. (2023) mentioned Jordanian companies, spanning both the service and industrial sectors, require an elevated level of HC to facilitate the creation of superior products and services to improve firm performance. Based on the description above this study assumed that HCE positively influenced firm performance.

H_2: HCE influences significantly to firm performance.

Structural Capital Efficiency and Firm Performance

Structural Capital Efficiency (SCE) refers to the effectiveness with which an organization utilizes its structural capital. In Indonesia, Halim (2023) mentioned that SCE have a positive influence on ROA. Kasoga (2020) found that SCE has positive impact on firm performance in

Africa. Research by Xu and Li (2022) also found the same result in China. Xu et al. (2019) also confirms that SCE has a positive relationship with firm performance. This study can draw the conclusion that SCE (Structural Capital Efficiency) has a positive impact on firm performance.

H_3: SCE influences significantly to firm performance.

Capital Employed Efficiency and Firm Performance
Capital Employed Efficiency (CEE) is a financial metric that assesses how effectively a company utilizes its capital to generate profits. Based on few past research results, results shown by Abdel et al. (2023), Kasoga (2020), and Halim (2023) show that CEE had a substantial impact which means CEE affects firm performance positively, Xu and Li (2022) also said that in China, it is the most influential contributor to the performance of industrial companies, from this, we can draw conclusion that CEE positively influence firm performance.

H_4: CEE influences significantly to firm performance.

Technological Innovation and Firm Performance
According to Yaw Obeng and Mkhize (2019) technological innovation is well aligned with the firm performance; a similar result is also obtained by Uwizeyemungu et al. (2018). Xu et al. (2019) mentioned that technological innovation can enhance the performance of industrial listed companies in China, meanwhile in Thailand, Insee and Suttipun (2023) says that there is a positive influence between R&D expenditure and firm performance. In Europe Palazzi et al. (2020) mentioned that the higher the technological intensity, the higher the positive impact on corporate performance. This justifies technological innovation proxy by R&D expenditure to firm performance.

H_5: A positive influence exists between Technological innovation and firm performance.

Technological Innovation moderates Intellectual Capital on Firm Performance
Most research articles on this topic uses mediation as their topic, Wang et al. (2021) uses mediation and found significant results, same results are obtained by Zhang et al. (2018), and lastly by Gallegos and Miralles (2023). While it is interesting because mediation has many significances in many research, this study will use moderation as the type of test to know whether Technological Innovation moderates Intellectual Capital on Firm Performance.

H_6: Technological innovation moderates intellectual capital on firm performance.
H_7: Technological innovation moderates human capital efficiency on firm performance.
H_8: Technological innovation moderates structural capital efficiency on firm performance.
H_9: Technological innovation moderates capital employed efficiency on firm performance.

Research Methodology
The study focuses on industrial companies listed on the IDX exchange during the reporting period from 2018 to 2022. A quantitative method is applied, and a purposive sampling technique is applied. The sample selection employs a purposive sampling methodology, necessitating specific criteria to ensure the appropriateness of the sample. These prerequisites include: (1) the availability of a comprehensive annual financial report, (2) the company's report being published by the 31st of December, (3) the utilization of Rupiah in

the report, and (4) the report's accessibility on the company's official website. In the industrial sector, there are a total of 45 companies listed. Out of these, 18 companies meet our specified criteria. VAIC is used to measure intellectual capital, VAIC's strength lies in its ease of calculation with readily available financial report data, making it a popular choice for measuring intellectual capital. This method of IC also provides a standardized measure (Xu et al., 2019). Multiple Regression Analysis using the OLS estimation procedure was employed for analysis, so that for each observation in the set, a forecast is made for the dependent variable. The estimation process adjusts the weights of the regression variable to reduce the residuals to a minimum. (Hair et al., 2017) (e.g., minimizing the differences between predicted and actual values of the dependent variable).

Table 1
Variable Measurement

Variable	Formula	Source
ROA	$\frac{Net\ Income}{Total\ Assets}$	(Sohel Rana & Hossa 2023)
TI	The logarithm of R&D Expenditures	(He & Estébanez, 2023)
VAIC	$HCE + SCE + CEE$	(Smriti & Das, 2021)
HCE	$\frac{Value\ Added}{Human\ Capital}$ Value Added: Total Revenue – Total Expenses Human Capital: Salary + Training Expenses	(Sohel Rana & Hossa 2023)
SCE	$\frac{Structural\ Capital}{Value\ added}$ Structural Capital: Value Added – Human Capital	(Sohel Rana & Hossa 2023)
CEE	$\frac{Value\ Added}{Capital\ Employed}$ Capital Employed: Total Asset – Intangible Asset	(Sohel Rana & Hossa 2023)

Conceptual Model

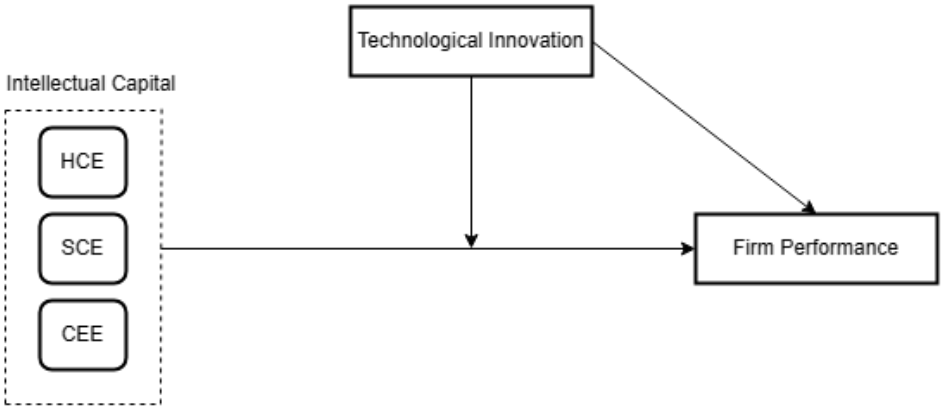

Figure 1. Conceptual Model

Results and Discussions

Table 2
Descriptive Statistics

Variable	Minimum	Maximum	Mean	Std. Deviation
ROA	0.008	0.364	0.105	0.072
TI	0.000	844.861.000,000	39.501.330,253	133.055.872,765
VAIC	-119.600	200.030	10.930	40.419
HCE	-4.296	198.868	15.027	37.098
SCE	-10.800	1.233	0.1236	1.902
CEE	0.003	0.364	0.0953	0.066

Source: Stata17 output (2024)

During the period spanning 2018 to 2022, the typical company within the industrial sector demonstrated a ROA averaging 10.5%, ranging from 0.01% to 36.4%. Descriptive findings indicate that industrial sector entities primarily accrue firm value from the HCE factor, averaging 14,364, compared to SCE at -0,268, and CEE at 0,089. This outcome aligns with earlier research such as Soetanto and Liem (2019) and Barak (2023), underscoring the significance of HCE in intellectual capital. Nonetheless, this study reveals instances where both HCE and SCE exhibit negative values, attributed to HCE investment surpassing the generated Value Added. Furthermore, when discussing Research and Development (R&D) Expenditures, nearly all industrial sector companies lack reported figures, resulting in an average of only Rp39,501,330.253; It is important to note that the variability in data is influenced by the exclusion of R&D expenditures in financial reporting by many companies.

Table 3
Correlation Test

	ROA	TI	VAIC	HCE	SCE	CEE
ROA	1.0000					
TI	0.1822	1.0000				
VAIC	0.0311	-0.0588	1.0000			
HCE	0.0517	-0.0972	0.9034	1.0000		
SCE	0.3550	0.0797	0.1647	0.1744	1.0000	
CEE	0.7579	0.2510	0.0720	0.0578	0.3441	1.0000

Source: Stata17 output (2024)

According to the correlation matrix presented in Table 3, this study can infer that all variables such as VAIC, HCE, SCE, CEE, and TI exhibit a positive association with ROA. This observed relationship aligns with the research hypotheses, suggesting that these variables have the potential to enhance a company's ROA. Consequently, it becomes evident that

allocating a greater budget to Research and Development (R&D) will likely lead to an increase in ROA.

Table 4
Regression Result

	(1) ROA	(2) ROA	(3) ROA	(4) ROA	(5) ROA
TI	0.0000*	0.0000*	0.0000*	0.0000	-0.0000
	(1.66)	(1.67)	(1.70)	(1.45)	(-0.39)
VAIC		0.0001			
		(0.71)			
HCE			0.0001	0.0000	-0.0000
			(1.06)	(0.11)	(-0.31)
SCE				0.0131***	0.0042**
				(4.94)	(2.08)
CEE					0.7944***
					(7.30)
Constant	0.1019***	0.1011***	0.0997***	0.1007***	0.0303**
	(12.61)	(11.93)	(11.29)	(12.01)	(2.03)
Adj. R-squared	0.0222	0.0128	0.0159	0.1202	0.5651
Obs.	90	90	90	90	90
="* p<0.10	** p<0.05	*** p<0.01"			

Source: Stata17 output (2024)

In the context of regression analysis given in Table 4, statistical significance is typically determined by the probability value (often denoted as *p*) being below 0.05. The findings reveal the following relationships, SCE is significant positive to ROA which means H_3 is supported. CEE is also significant positive to ROA. H_4 is supported. TI (Technological Innovation) the adoption and development of recent technologies directly influence financial results. Companies embracing technological advancements tend to have higher profitability. H_5 is supported. HCE and VAIC, while important, these variables do not significantly impact ROA. Thus, their direct relationship with financial performance remains inconclusive. H_1 and H_2 are rejected.

Table 5
Moderated Regression Result

	(1) ROA	(2) ROA	(3) ROA	(4) ROA	(5) ROA	(6) ROA	(7) ROA	(8) ROA
TI	0.0000*							
	(1.66)							
VAIC_TI		0.0000***						
		(8.62)						
HCE_TI			0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000
			(5.72)	(5.79)	(6.34)	(7.64)	(5.85)	(1.50)
HCE				0.0001	0.0001	0.0000	0.0000	-0.0000
				(1.15)	(1.05)	(0.11)	(0.13)	(-0.30)
SCE_TI					-0.0000***	-0.0000***	-0.0000***	-0.0000**
					(-3.85)	(-4.68)	(-3.44)	(-2.07)
SCE						0.0128***	0.0128***	0.0043**
						(4.96)	(4.91)	(2.06)
CEE_TI							-0.0000	0.0000
							(-1.59)	(0.83)
CEE								0.7789***
								(6.48)
Constant	0.1019***	0.1010***	0.1005***	0.0982***	0.0993***	0.1003***	0.1000***	0.0316**
	(12.61)	(13.01)	(12.71)	(11.42)	(11.31)	(12.02)	(11.80)	(2.00)
Adj. R-squared	0.0222	0.0739	0.0658	0.0607	0.0626	0.1642	0.1554	0.5568
Obs.	90	90	90	90	90	90	90	90
="*	**							
p<0.10	p<0.05	*** p<0.01"						

Meanwhile in the moderated regression analysis, TI exhibits a significant positive moderating effect on IC to ROA, thereby supporting H_6. Additionally, TI also plays a significant moderating role in the relationship between SCE and ROA, providing support for H_8. However, it is crucial to note that TI moderates SCE in a negative direction, challenging the initial expectations. Furthermore, TI does not demonstrate a moderating effect on HCE and CEE, TI only partially moderate HCE, leading to the non-support of H_7 and H_9. The adjusted R-squared value, derived through moderated regression, indicates a percentage of 55.6%.

Using Table 4's test, the negative impact of the VAIC and ROA is noticeable, this result is similar to what Aybars and Oners (2022) found in Turkey. Thus, H_1 is rejected. This negative impact is primarily because lower SCE in industrial companies is causing ROA to fall instead of improving ROA itself.

Given the observed negative correlation between HCE and ROA, H_2 is unsupported. This negative correlation is attributed to suboptimal human capital management practices in Indonesian industrial companies, where HCE utilization remains limited, the same result is also obtained by Kasoga (2020) where HCE does not affect firm performance in Tanzania.

The OLS regression analysis also revealed that H_3 is supported. Specifically, for Indonesia's industrial companies, effective utilization of intangible assets (such as patents, trademarks, databases, and knowledge management systems) can lead to enhanced productivity and innovation, ultimately resulting in improved ROA. This finding aligns with a previous study conducted in Indonesia by Halim (2023), reinforcing the notion that Indonesia's industrial firms are indeed proficient in leveraging their intangible assets.

Our empirical analysis robustly confirms H_4, which asserts that strategic capital allocation both in terms of equity and debt exerts a favorable impact on a company's ROA. This affirmation resonates strongly within the context of industrial company as Xu and Li (2022) claims that it has the greatest impact on the performance of Chinese industrial enterprises, it is also the same in Turkey by Aybars and Oners (2022) that firm performance is found to be driven by CEE. When these firms judiciously allocate their capital resources, they unlock a cascade of benefits, with ROA standing out as the most crucial metric.

TI is also significant positive to ROA, this finding aligns with H_5, suggesting that companies embracing technological advancements tend to have higher profitability, while results in Thailand by Insee and Suttipun (2023) show that TI is significant to ROA but only when mediated by competitive advantage. This implies that Indonesian industrial companies should prioritize research and development (R&D) investments and projects. Technological innovation plays a crucial role in improving operational efficiency, product quality, and customer experiences, leading to enhanced financial performance.

In the context of moderated regression analysis, this study observed that TI effectively moderates the relationship between VAIC and firm performance, Technological innovation often leads to more efficient utilization of resources within a firm. This optimization can positively impact VAIC, which considers intellectual capital components such as human capital, structural capital, and relational capital. When these resources are effectively harnessed through innovation, it contributes to improved firm performance. This finding supports H_6. However, TI only exhibits a partial moderating effect on HCE, rendering H_7 unsupported. Additionally, when SCE is moderated, it leads to a significant negative impact, therefore H_8 is rejected. Lastly, this research reveals that TI does not moderate CEE, resulting in H_9 being unsupported.

The limited number of companies in our study context shows only three firms that include research and development fees in their annual reports contribute to these outcomes. Descriptive statistics indicate that the mean research and development expenditure is approximately 39 million Rupiah, which is notably low. Consequently, most of our moderated regression results do not demonstrate successful moderation by Technological Innovation.

Conclusions

The objective of this research is to provide light on the complex relationship between intellectual capital and firm performance, with the moderating effect of Technological Innovation. The results indicate that SCE and CEE demonstrate a significant positive association. Concerning the moderating variable, TI strengthens the effect of HCE on Firm Performance and weakens the effect of SCE on Firm Performance. This study gives insight for industrial companies listed in IDX to develop their structural capital policy. Companies should train their employees on leveraging technological innovation to boost the firm's performance. However, they should be aware that such investment in technological innovation could potentially weaken the company's firm performance due to increased costs.

The limitations of this study are primarily due to its sector-specific focus, which means the findings are not based on a broad range of sectors. Furthermore, the data utilized in this research spans only a five-year period from 2018 to 2022. The adjusted R-squared value obtained is 55.6 percent, suggesting that there are additional variables that could be explored for a more comprehensive understanding.

This study proposes that subsequent research should encompass a broader range of sectors and extend the duration of the reporting period to yield more comprehensive results. Additionally, it would be beneficial to investigate other variables, such as Return on Equity (ROE), to enhance the quality of the outcomes.

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