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INTELLECTUAL CAPITAL EFFECTS ON EMPLOYEE PRODUCTIVITY: MODERATING INFLUENCE OF TANGIBLE ASSETS IN INDONESIA'S NON-CYCLICAL MANUFACTURING

Sevi Rachmawati[1] Bima Cinintya Pratama[2] Sri Wahyuni[3] Tiara Pandansari[4]

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Abstract

Increasing employee productivity in the manufacturing sector is crucial for driving the accumulation of industrial value-added and national gross domestic product growth. This study aims to examine the effect of intellectual capital on employee productivity, with tangible assets as a moderator. The research sample consists of non-cyclical manufacturing sector companies listed on the Indonesia Stock Exchange during the 2021–2024 period. A total of 117 observation data met the research criteria, selected through purposive sampling. The results of panel data regression show that value added intellectual coefficient, human capital efficiency, physical capital efficiency, and tangible assets have a positive and significant effect on employee productivity, while structural capital efficiency has a significant negative effect. Tangible assets are proven to significantly strengthen positive effects of value added intellectual coefficient, human capital efficiency, and physical capital efficiency, but fail to mitigate the negative effect of structural capital efficiency on employee productivity in the Indonesian non-cyclical manufacturing firms.

Kata Kunci:

Aset Berwujud;
Modal Intelektual;
Produktivitas Karyawan;

Abstrak

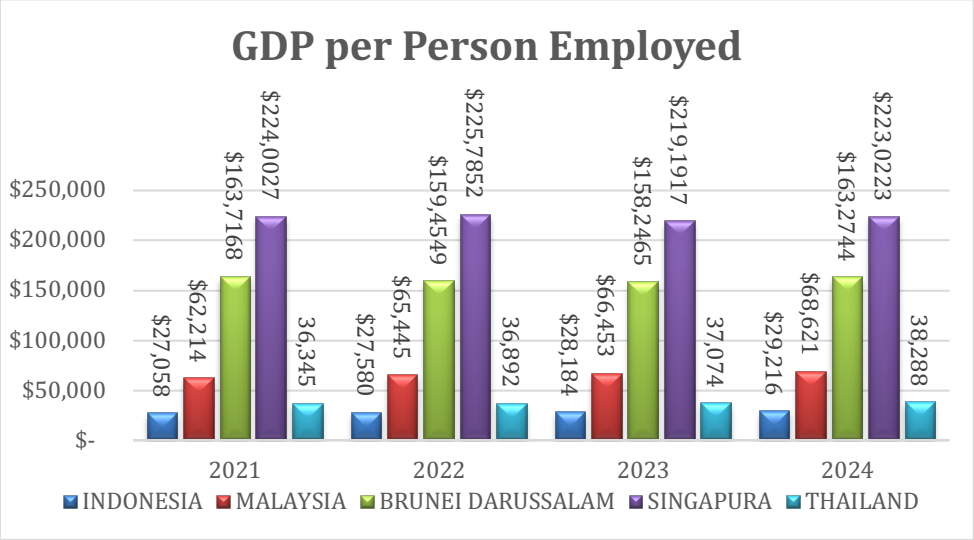
Peningkatan produktivitas karyawan di sektor manufaktur merupakan faktor penting dalam mendorong akumulasi nilai tambah industri dan pertumbuhan produk domestik bruto (PDB) nasional. Penelitian ini bertujuan untuk menguji pengaruh modal intelektual terhadap produktivitas karyawan dengan aset berwujud sebagai variabel moderasi. Sampel penelitian terdiri atas perusahaan manufaktur sektor non-siklikal yang terdaftar di Bursa Efek Indonesia selama periode 2021–2024. Sebanyak 117 data observasi memenuhi kriteria penelitian dan dipilih menggunakan teknik purposive sampling. Hasil regresi data panel menunjukkan bahwa *value added intellectual coefficient* (VAIC), efisiensi modal manusia (*human capital efficiency*), efisiensi modal fisik (*physical capital efficiency*), dan aset berwujud berpengaruh positif dan signifikan terhadap produktivitas karyawan, sedangkan efisiensi modal struktural (*structural capital efficiency*) berpengaruh negatif dan signifikan. Selain itu, aset berwujud terbukti secara signifikan memperkuat pengaruh positif *value added intellectual coefficient* (VAIC), efisiensi modal manusia, dan efisiensi modal fisik terhadap produktivitas karyawan. Namun, aset berwujud tidak mampu memoderasi atau mengurangi pengaruh negatif efisiensi modal struktural terhadap produktivitas karyawan pada perusahaan manufaktur sektor non-siklikal di Indonesia.

Corresponding:
Faculty of Economics and Business, Universitas Muhammadiyah Purwokerto, Banyumas, Indonesia
Email:
bimacinintyapratama@ump.ac.id

Faculty of Economics and Business, Universitas Muhammadiyah Purwokerto, Banyumas, Indonesia[1,3,4]
Email: sevirachmawati123@gmail.com[1]
Email: yuni_7067@yahoo.co.id[3]
Email: tiarapandansari@gmail.com[4]

INTRODUCTION

Transformation toward a knowledge-based economy and technological advancements in the Industry 4.0 era have transformed the sources of a company's competitive advantage. A company's competitive advantage was previously largely determined by its ownership of physical assets, but nowadays, a company's ability to manage knowledge, the competencies of its human resources, and its organizational systems have become increasingly critical factors in business success. In this context, employee productivity is a key outcome indicator because it reflects a company's ability to optimize its human resources to generate sustainable value added. Employee productivity not only reflects a company's operational efficiency but also indicates the effectiveness of human capital utilization in generating output that supports both corporate growth and the broader economy (Yusuf et al., 2026). Improving employee productivity has become a strategic issue for companies seeking to maintain their competitiveness amid an increasingly dynamic business environment (Xu et al., 2022). The International Labor Organization (ILO) identifies employee productivity as one of the key indicators of the efficient use of human resources that contributes to a country's economic growth (ILO, 2025). One of the indicators used to measure productivity is Gross Domestic Product (GDP) per employed person, which is the value of economic output generated by each worker (Rosales-córdova, 2025). The higher the GDP per worker, the greater a country's ability to convert its labor force into economic output.



Source: World Bank (2024)

Figure 1. Graph of GDP per Worker (Employee productivity) in ASEAN Countries, 2021–2024

Based on Figure 1, Indonesia's employee productivity still lags behind several ASEAN countries. In 2024, Indonesia's GDP per person employed reached only around US$29.217, far below that of Singapore (US$223.203), Brunei Darussalam (US$168.621), Malaysia (US$68.621), and Thailand (US$38.288). Although it showed an upward trend during the 2021–2024 period, the growth rate of Indonesia's employee productivity was relatively slower compared to those countries. This situation indicates that companies in Indonesia still face challenges in improving the efficiency of labor utilization, meaning their ability to create added value remains suboptimal. Thus, increasing employee productivity is not only a macroeconomic issue but also a real challenge at the company level the primary unit of economic value creation. This issue is particularly relevant for non-cyclical manufacturing firms, as this sector is characterized by being capital-intensive and process-intensive; consequently, a company's productivity heavily depends on its ability to integrate human resources,

organizational systems, and physical assets into its operational activities (Situmorang & Setyawan, 2023).

Among the resources a company must integrate to sustain competitive productivity, Intellectual Capital (IC)—which encompasses Human Capital Efficiency (HCE), Structural Capital Efficiency (SCE), and Physical Capital Efficiency (PCE)—serves as the primary driver of innovation and the optimization of the workforce (Ahmed et al., 2023). Stewart (1997: 58), in his book "Intellectual Capital: The New Wealth of Organizations", first popularized the concept of intellectual capital. Intellectual capital refers to information and an organization's ability to create and implement knowledge. Knowledge management through intellectual capital enables companies to accelerate learning, improve work processes, and enhance the quality of work output, as human capital efficiency provides individual capacity, structural capital efficiency provides systems and procedures, and physical capital efficiency supports work facilities (Ahmed et al., 2023). Research by Ognjanovic et al. (2023) demonstrates that the effectiveness of intellectual capital significantly contributes to improving employee performance as part of a company's internal work system, underscoring the importance of intellectual capital management in enhancing employee productivity. Research by Wany (2010) further supports this by showing a similar contribution of intellectual capital effectiveness to internal operational productivity. Conversely, other research by Xu et al. (2022) indicates that intellectual capital does not always significantly affect employee productivity, highlighting a research gap that warrants further investigation.

Improvements in labor unit productivity within a company are strongly influenced by the quality of human capital efficiency, as it reflects employees' skills, experience, and creativity in generating added value (Suhardi et al., 2026). Conceptually, human capital efficiency has a positive effect on employee productivity because individual capacity is a key determinant of work quality and productivity (Kamath, 2015). The role of human capital efficiency in enhancing employee productivity is becoming increasingly important because the quality of human resources determines the effectiveness of a company's resource utilization. Other studies show that human capital efficiency makes a dominant contribution to increases in individual work output (Buallay et al., 2021). In contrast, other research finds that human capital efficiency does not have a significant effect, particularly in companies with high levels of automation that tend to reduce the role of the human workforce (Wanigasekara & Deshika, 2020). This inconsistency highlights a research gap that requires further investigation.

Structural capital efficiency encompasses the systems, procedures, technologies, and workflows that support operations; when managed effectively, it can reduce information barriers and improve the speed and accuracy of employee productivity. Hasibuan et al. (2025) find that the integration of workforce competence and manufacturing technology significantly improves production speed, reduces error rates, and strengthens quality stability, provided it is supported by adequate human resource skills. Moedjahedy & Paoki (2026) and Halim et al. (2025) further show that both standard operating procedures and employee competence individually have a positive and significant effect on work productivity. However, other research emphasizes that the effectiveness of structural capital efficiency is contingent, as it is influenced by the alignment between system structure and human resource competencies Ari & Kurniasari (2025) and Setyaningrum et al. (2025), for instance, find that structural capital has no significant direct effect on firm performance once other intellectual capital components are accounted for. Nevertheless, the effect of structural capital efficiency on employee productivity remains inconsistent, thus requiring further testing

Companies require physical assets to ensure that work processes run optimally. Physical capital efficiency encompasses machinery, production technology, and operational facilities, and measures the extent to which these assets are capable of generating added value. Theoretically, adequate physical capital efficiency can increase employee productivity by providing efficient, safe, and productive working conditions, particularly in the manufacturing industry, where the quality of machinery and technology is directly related to the speed and quality of output. Setyaningrum et al. (2025) find that

physical capital has a positive and significant effect on financial performance, an effect that is further strengthened by competitive advantage. Research by Sari & Zubaidi (2026) further supports this, showing that physical capital efficiency serves as the primary foundation for human and structural capital to function at their full potential. In contrast, Ognjanovic et al. (2023) find that tangible capital efficiency negatively moderates the relationship between intellectual capital and performance, such that as physical capital efficiency increases, the positive contribution of other intellectual capital components actually weakens. This research gap indicates that the utilization of physical capital efficiency does not always consistently result in increased employee productivity; the possibility that physical capital efficiency instead functions as a moderating condition for the relationship between other intellectual capital components and productivity remains underexplored and requires further testing.

According to International Accounting Standard (IAS) 16, tangible assets are physical assets used in a company's operations with a useful life of more than one year. Although intellectual capital is a strategic resource, tangible assets remain crucial in supporting value creation. Research by Sumiati & Isnaini (2024); Febriana & Triyono (2024); Halim (2024) indicates that intellectual capital and the efficiency of tangible assets can enhance employee output efficiency. However, Ognjanovic et al. (2023) found that tangible assets can act as a negative moderator if they are not aligned with intellectual capital strategy. This suggests that the role of tangible assets in work productivity depends on their alignment with other strategic resource. Therefore, further testing is needed regarding the role of tangible assets in supporting the utilization of intellectual capital to enhance employee productivity. Taken together, these inconsistent findings suggest that the mixed effects of IC on employee productivity reported across prior studies may not be attributable to measurement or contextual differences alone, but rather to the varying extent to which tangible assets are present and aligned with a firm's intellectual capital strategy — positioning tangible assets as a plausible moderating variable rather than merely another parallel predictor.

The significance of this study lies in the urgency of reconstructing value propositions through an optimal configuration of intellectual capital and tangible assets to enhance employee productivity. Lar & Taguchi (2022) emphasize that the threat of premature deindustrialization necessitates strengthening the quality of human resources to ensure the resilience of the national industry. This situation indicates that improving employee productivity is not merely an operational issue but also a structural strategy for maintaining Indonesia's manufacturing competitiveness. Theoretically, previous research by Ognjanovic et al. (2023) has been dominated by the service sector, thereby overlooking the dynamics of capital-intensive manufacturing, which relies on the synchronization of machine technology and workforce expertise. Previous research has also been dominated by the use of purely financial corporate performance proxies, such as profitability or market value, while studies that explicitly position employee productivity as a reflection of a company's economic contribution—in line with the macroeconomic logic of GDP per person employed—remain relatively rare. The novelty of this study lies in the integration of tangible assets as a moderating variable in the VAIC model to analyze how the support of tangible assets can strengthen the influence of intellectual capital on employee productivity. This research is not merely a contribution to the literature, but rather a strategic tool for identifying the critical prerequisites for Indonesian manufacturing companies to remain competitive, innovative, and capable of competing on the global stage.

The Resource-Based View (RBV), introduced by Wernerfelt (1984) and developed by Barney (1991), asserts that a company's internal operational effectiveness can be enhanced through the management of internal resources that are valuable, rare, inimitable, and non-substitutable (VRIN). These resources can take the form of tangible assets such as factories, machinery, and technology, as well as intangible assets (intellectual capital) such as knowledge, skills, and organizational reputation. Within this framework, intellectual capital—comprising human capital efficiency, structural capital efficiency, and physical capital efficiency—is viewed as a strategic asset that is difficult for competitors to imitate, whereas tangible assets represent physical assets that, although valuable, are relatively easier

for other companies to acquire (Barney, 1991). RBV emphasizes that sustainable competitive advantage is achieved through the synergistic integration of tangible and intangible resources to create added value, increase productivity, and strengthen long-term competitiveness (Gueler & Schneider, 2021; Ariska et al., 2026).

The Value-Added Intellectual Coefficient (VAIC) is an analytical framework for measuring the efficiency of value creation through the integration of intellectual capital and tangible assets. Based on the Resource-Based View (RBV), competitive advantage and productive capacity stem from a company's ability to manage intangible strategic assets (Barney, 1991). In a company, VAIC reflects the effectiveness of optimizing human capital, structural capital, and physical capital as a combination of strategic resources. Conceptually, the higher the VAIC efficiency, the more optimally a company utilizes its assets to increase employee productivity. Empirical findings from Wany (2010) ; Ognjanovic et al. (2023); Ahmed et al. (2023) indicate that intellectual capital efficiency, as measured by VAIC, has a positive effect on employee work efficiency. For non-cyclical manufacturing firms in Indonesia—whose employee productivity still lags behind that of Singapore, Brunei Darussalam, and Malaysia—VAIC optimization can serve as a lever to boost aggregate productivity. Based on this evidence, the first hypothesis to be tested is as follows:

H_1: VAIC has a significant positive effect on employee productivity.

Human Capital Efficiency (HCE) represents the knowledge, skills, and competencies of individuals within a company. From the perspective of the Resource-Based View (RBV), human capital efficiency is considered a strategic resource that is intangible and firm-specific, making it difficult for competitors to replicate and serving as a source of sustainable competitive advantage in driving labor efficiency. Theoretically, individuals with high competencies possess stronger problem-solving abilities and greater adaptability to technological changes in the Industry 4.0 era (Ali et al., 2021). Empirical findings by Suhardi et al. (2026) indicate that differences in the quality of human resources lead to variations in the level of work output efficiency, even when companies manage the same assets. Research by Buallay et al. (2021) also found a strong positive relationship between human capital efficiency and employee productivity. Given that the productivity gap remains wide at the national level, strengthening human capital efficiency in manufacturing firms has the potential to gradually accelerate employee productivity growth, starting from the smallest unit—the firm itself. Based on this evidence, the second hypothesis to be tested is as follows:

H_2: Human capital efficiency has a significant positive effect on employee productivity.

Structural Capital Efficiency (SCE) is a component of intellectual capital that encompasses work procedures, information systems, organizational culture, innovation, and technological infrastructure that support employee productivity (Pratama & Innayah, 2023; Hasibuan et al., 2025). From the Resource-Based View (RBV) perspective, structural capital efficiency is viewed as firm-specific non-human assets that are difficult to imitate, thereby enhancing the efficiency and consistency of employee work (Barney, 1991). In addition to providing a systematic framework, structural capital efficiency strengthens employees' ability to learn and innovate, thereby directly impacting increased employee productivity. Empirical findings by Moedjahedy & Paoki (2026) and Halim et al. (2025) indicate that information systems, an innovative culture, and standardized SOPs have a positive effect on employee productivity. Given that national productivity in Indonesia still lags behind other ASEAN countries, the effectiveness of structural capital efficiency warrants testing as a structural factor with the potential to support firm productivity. Based on this evidence, the third hypothesis to be tested is as follows:

H_3: Structural capital efficiency has a significant positive effect on employee productivity.

Physical Capital Efficiency (PCE) is a measure of a company's efficiency in utilizing physical capital to create added value. Physical capital includes work facilities, production tools, technology, and equipment that support the company's productivity. Within the Resource-Based View (RBV) framework, physical assets can serve as a source of competitive advantage if managed efficiently and combined with other resources (Barney, 1991). The more optimally a company utilizes its physical

capital, the higher its efficiency and the value generated, thereby increasing employee productivity. Empirical findings by Sari & Zubaidi (2026) indicate that physical capital efficiency has a positive effect on employee productivity. Given that Indonesia's employee productivity remains below that of Malaysia and Thailand, optimizing physical capital efficiency can serve as a strategic effort for non-cyclical manufacturing firms to close this gap. Based on this evidence, the fourth hypothesis to be tested is as follows:

H_4: Physical capital efficiency has a significant positive effect on employee productivity.

Tangible assets are physical assets that companies use to support their operations, such as work equipment, production technology, office facilities, and other supporting infrastructure. Within the Resource-Based View (RBV) framework, efficient management of physical assets can be a source of competitive advantage for companies because it supports the productivity and effectiveness of employee activities (Barney, 1991). Empirical findings indicate that the efficient utilization of tangible assets is one of the fundamental factors that directly contribute to improving employee productivity and overall company performance (Sumiati & Isnaini, 2024; Febriana & Triyono, 2024; Halim, 2024). The stagnant growth in Indonesia's employee productivity throughout 2021–2024 compared to other ASEAN countries further underscores the importance of testing whether the optimal utilization of tangible assets can drive productivity at the firm level. Based on this evidence, the fifth hypothesis to be tested is as follows:

H_5: Tangible assets has a significant positive effect on employee productivity.

From the perspective of the Resource-Based View (RBV), competitive advantage is determined not by a single resource, but by the synergy among mutually supportive resources (Barney, 1991). VAIC reflects a company's ability to optimize intellectual capital to create value added, while tangible assets serve as supporting infrastructure that enhances the effectiveness of its utilization. Pulic (2000) also emphasizes that measuring VAIC is inseparable from the efficiency of capital employed in reflecting the utilization of a company's physical assets. Research by by Sumiati & Isnaini (2024); Febriana & Triyono (2024) found that the utilization of intellectual capital supported by tangible assets contributes to increased employee productivity. The synergy between VAIC and tangible assets warrants further examination, given that, according to World Bank (2024) data, Indonesia's productivity gap relative to other ASEAN countries cannot be closed by relying on just one type of resource alone. Based on this evidence, the sixth hypothesis to be tested is as follows:

H_6: Tangible assets moderates the positive relationship between VAIC and employee productivity.

The synergy between intangible and tangible resources forms the basis of the Resource-Based View (RBV) theory; the strategic value of a resource does not stand alone but is determined by its configuration and complementarity with other resources within the company. Human capital efficiency, as an intangible resource, requires adequate physical support to realize the full potential of employee productivity (Dhammawan et al., 2024). Thus, the synergy between human capital efficiency and tangible assets is key to achieving high productivity and work quality. Research by Gunadi & Utama (2025); Sie et al. (2026); Dhammawan et al. (2024) shows that the quality of tangible assets plays a crucial role in supporting the effectiveness of a company's resource management, thereby potentially boosting work productivity. No matter how high an employee's competencies may be, it will be difficult for them to have an optimal effect on productivity if not supported by the availability of adequate tangible assets—a relevant consideration given the current challenges facing Indonesia's employee productivity (World Bank, 2024). Based on this evidence, the seventh hypothesis to be tested is as follows:

H_7: Tangible assets moderates the positive relationship between human capital efficiency and employee productivity.

Structural Capital Efficiency (SCE), which encompasses systems, procedures, knowledge bases, and organizational culture, requires the support of tangible assets to be implemented optimally Setyaningrum et al. (2025). From the perspective of Barney (1991), Resource-Based View (RBV), the

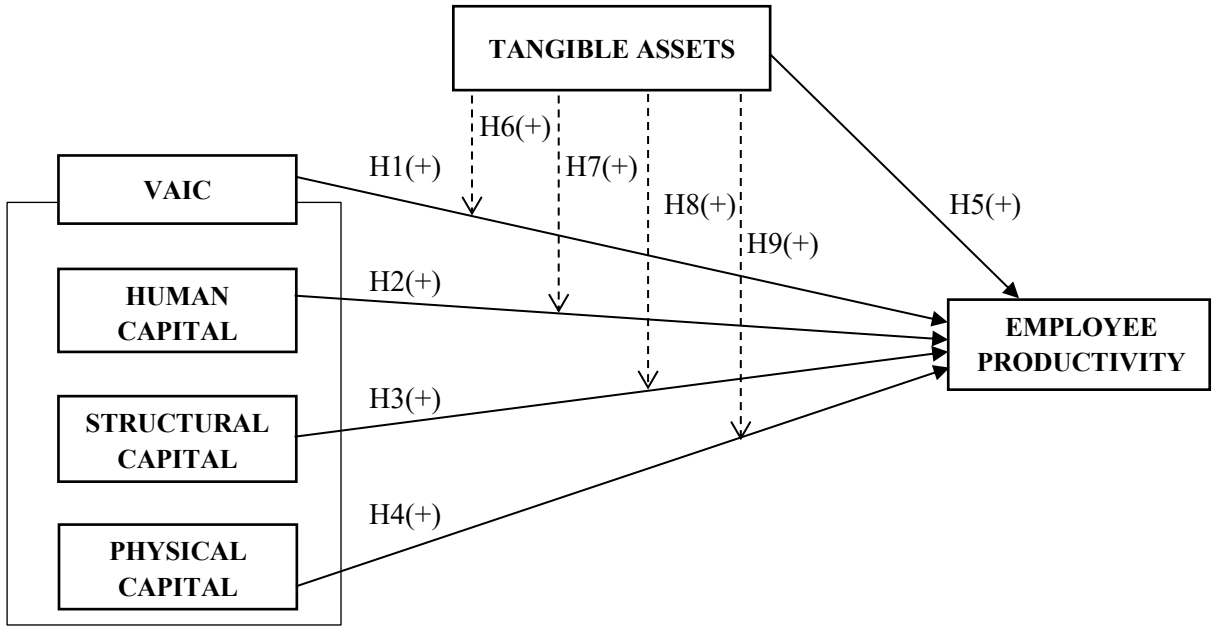
strategic value of a resource increases when it is complementarily combined with other resources within the organization. Without adequate tangible assets, the implementation of structural capital efficiency struggles to boost employee productivity and effectiveness. The integration of structural capital efficiency and tangible assets is a critical factor in consistently improving individual performance. Moedjahedy & Paoki (2026) and Halim et al. (2025)research found that the effectiveness of structural capital efficiency in enhancing employee productivity is highly dependent on the availability and quality of tangible assets. These findings suggest that the effectiveness of structural capital efficiency, supported by tangible assets, still requires further testing—particularly in the context of Indonesian employee productivity, as indicated by World Bank (2024) data, which still lags behind that of other ASEAN countries. Based on this evidence, the eighth hypothesis to be tested is as follows:

H_8: Tangible assets moderates the positive relationship between structural capital efficiency and employee productivity.

Physical Capital Efficiency (PCE)—the efficiency of physical capital in creating value—is highly dependent on the quality of tangible assets in supporting employee productivity Setyaningrum et al. (2025). Adequate physical infrastructure enables more effective use of assets, thereby enhancing efficiency, productivity, and the quality of employee output. Within the Resource-Based View (RBV) framework, the interrelationships among resources generate organizational capabilities of strategic value (Barney, 1991). The synergy between tangible assets and physical capital efficiency is a critical factor in strengthening improvements in employee productivity. Empirical evidence from the study by Abireza & Faris (2022) and Gunadi & Utama (2025) indicates that tangible assets amplify the effect of physical capital efficiency on employee productivity. It is important to test this synergy between physical capital efficiency and tangible assets as a concrete means of boosting employee productivity, which, in aggregate, contributes directly to an increase in corporate value added and national GDP growth. Based on this evidence, the ninth hypothesis to be tested is as follows:

H_9: Tangible assets moderates the positive relationship between physical capital efficiency and employee productivity.

These nine hypotheses (H1–H9) collectively structure the research framework detailing the direct and moderated interactions. This conceptual model is visually in the following figure.



Source: Research Data, 2026

Figure 2. Research Model

RESEARCH METHOD

Table 1.
Research Criteria

Research Criteria	Total
• Observation of major non-cyclical manufacturing companies listed on the Indonesia Stock Exchange (IDX) from 2021 to 2024. (43x4).	172
• Companies published annual reports for the 2021–2024 period. (10x4)	(40)
• The annual reports contain relevant information regarding the research variables and have undergone a data trimming process to eliminate incomplete observations, outliers, or data that do not meet the criteria for regression analysis.	(15)
Total	**117**

Source: Research Data, 2026

Referring to the criteria presented in Table 1, this study limits the scope of analysis to manufacturing firms in the non-cyclical sector. The selection of this sector is based on the relatively inelastic nature of demand and its resilience to macroeconomic shocks, meaning that variations in firm performance tend to reflect internal factors rather than external market fluctuations. These conditions provide a more suitable empirical context for testing the effects of intellectual capital and tangible assets on employee productivity. Furthermore, the observation period of 2021–2024 was chosen to represent the post-pandemic economic recovery phase, when companies adjusted their operational strategies and resource allocation in an effort to maintain efficiency and employee productivity.

To ensure the reliability of this analysis, this study relies entirely on secondary data, which possesses a high degree of objectivity, is verifiable, and reflects real-world conditions without researcher intervention (Yalni & Mulyani, 2026). The sampling technique used is purposive sampling, which involves selecting a sample based on specific criteria relevant to the research objectives (Nyimbili & Nyimbili, 2024). Based on these criteria, 33 non-cyclical manufacturing companies that met the requirements over the four-year observation period were identified, resulting in 117 observations.

This section presents the operational definitions of the variables used in this study, along with the formulas applied to measure each variable.

Employee Productivity (EP) is a measure of employee productivity that reflects each employee's average financial contribution to the company's profits. EP emphasizes the efficient use of human resources in creating value for the company (Rasheed, 2025). EP is calculated by dividing Net Income by Number of Employees, where Net Income refers to the company's net income at the end of the period and Number of Employees refers to the number of employees on the payroll at the end of the period.

$$EP = \frac{\text{Net Income}}{\text{Number Of Employee}} \quad (1)$$

Intellectual Capital (IC) is an intangible asset that reflects a company's ability to create added value through the efficient use of intellectual resources. IC is measured using the method Value-Added Intellectual Coefficient (VAIC) (Pulic, 2000; Pulic, 2004; Ulum, 2013; Pratama & Innayah, 2023).

$$VAIC = HCE + SCE + CEE \quad (2)$$

Human Capital Efficiency (HCE) measures the workforce's contribution to a company's value added through the ratio of Value Added (VA) to labor costs or Human Capital (HC) (Pulic, 2000). This ratio indicates how much value added is generated from each monetary unit invested in employees, where Value Added (VA) is obtained from Net Profit plus Employee Costs, Depreciation, and Amortization, while Human Capital (HC) is obtained from Salaries, General and Administrative Salary Expenses, Pension Costs, and Other Employee Costs.

$$HCE = \frac{VA}{HC} \quad (3)$$

Structural Capital Efficiency (SCE) measures the efficiency of an organization's structure, internal processes, and information systems in supporting the company's performance (Pulic, 2000).

SCE measures how much Structural Capital (SC) is required to generate one unit of Value Added (VA), where Structural Capital (SC) is obtained by subtracting Human Capital (HC) from Value Added (VA).

$$\text{SCE} = \frac{\text{SC}}{\text{VA}} \quad (4)$$

Physical Capital Efficiency (PCE) indicates the extent to which physical and financial capital are utilized efficiently in creating value added (Pulic, 2000; Vo & Tran, 2021). PCE is measured using Capital Employed Efficiency (CEE) to assess the contribution of each unit of working capital (funds invested in fixed and current assets) to the creation of corporate value, where Capital Employed (CE) refers to the company's total equity at the end of the period.

$$\text{CEE} = \frac{\text{VA}}{\text{CE}} \quad (5)$$

Tangible assets refer to property, machinery, and equipment used in a company's operations. Their efficiency is measured using Tangible Capital Efficiency (TCE) (Pulic, 2004). TCE reflects the amount of value added a company is able to generate from each unit of tangible assets it owns, where Tangible Assets (TA) refer to the company's total assets at the end of the period.

$$\text{TCE} = \frac{\text{VA}}{\text{TA}} \quad (6)$$

Firm size (SIZE) is a control variable representing the scale of a company's operations, measured as the natural logarithm of total assets at the end of the period. This transformation is applied to reduce the skewness of the raw asset value and to mitigate heteroscedasticity arising from large disparities in firm scale (Gujarati & Porter, 2009).

$$\text{SIZE} = \text{Ln}(\text{Total Assets}) \quad (7)$$

Leverage (LEV) is included as a control variable to capture a firm's capital structure and is measured as the debt-to-equity ratio, calculated by dividing total liabilities by total equity (Brigham & Houston, 2022).

$$\text{LEV} = \frac{\text{Total Liabilities}}{\text{Equity}} \quad (8)$$

A panel data regression model was used in this study to analyze the effect of Intellectual Capital (IC) and the moderating role of Tangible Assets (TCE) on Employee Productivity (EP) in non-cyclical manufacturing firms in Indonesia. The analysis began with descriptive statistics to characterize the data, followed by a panel data model specification test using the Hausman test to determine the best estimation method between the Fixed Effects Model (FEM) and the Random Effects Model (REM) (Gujarati & Porter, 2009). To ensure the model's validity and efficiency, the analysis continued with an evaluation of heteroscedasticity and autocorrelation, as well as the application of Driscoll-Kraay adjustments to standard errors to produce consistent estimators.

Based on this conceptual framework, the panel data regression model in this study is formulated into the following four equations:

Model (1): The direct effects of VAIC and Tangible Assets on Employee Productivity

$$EP_{\{it\}} = a_0 + \beta_1 VAIC_{\{it\}} + \beta_2 TCE_{\{it\}} + \beta_3 SIZE_{\{it\}} + \beta_4 LEV_{\{it\}} + \mu_i + e_{\{it\}} \quad (9)$$

Model (2): The Direct Effect of Intellectual Capital on Employee Productivity

$$EP_{\{it\}} = a_0 + \beta_1 HCE_{\{it\}} + \beta_2 SCE_{\{it\}} + \beta_3 CEE_{\{it\}} + \beta_4 LEV_{\{it\}} + \beta_5 SIZE_{\{it\}} + \mu_i + e_{\{it\}} \quad (10)$$

Model (3): The Moderating Effect of Tangible Assets on the Relationship Between VAIC and Employee Productivity

$$EP_{\{it\}} = a_0 + \beta_1 VAIC_{\{it\}} + \beta_2 TCE_{\{it\}} + \beta_3 VAIC * TCE_{\{it\}} + \beta_4 LEV_{\{it\}} + \beta_5 SIZE_{\{it\}} + \mu_i + e_{\{it\}} \quad (11)$$

Model (4): The Moderating Effect of Tangible Assets on the Relationship Between Intellectual Capital and Employee Productivity

$$EP_{\{it\}} = a_0 + \beta_1 HCE_{\{it\}} + \beta_2 SCE_{\{it\}} + \beta_3 CEE_{\{it\}} + \beta_4 TCE_{\{it\}} + \beta_5 HCE * TCE_{\{it\}} + \beta_6 SCE * TCE_{\{it\}} + \beta_7 CEE * TCE_{\{it\}} + \beta_8 LEV_{\{it\}} + \beta_9 SIZE_{\{it\}} + \mu_i + e_{\{it\}} \quad (12)$$

Variable description:

$EP_{\{it\}}$ = Employee Productivity company i in year t
a_0 = Constanta
β_1–β_9 = Regression coefficients for each variable
$VAIC_{\{it\}}$ = Value Added Intellectual Coefficient company i in year t
$HCE_{\{it\}}$ = Human Capital Efficiency company i in year t
$SCE_{\{it\}}$ = Structural Capital Efficiency company i in year t
$CEE_{\{it\}}$ = Capital Employed Efficiency company i in year t
$TCE_{\{it\}}$ = Tangible Capital Efficiency company i in year t
$LEV_{\{it\}}$ = Leverage company i in year t
$SIZE_{\{it\}}$ = Size company i in year t
μ_i = Fixed Effect company specific
e = Error term

RESULT AND DISCUSSION

Table 2.
Descriptive Statistic of Variable

Variable	Observation	Mean	Std. Deviation	Minimum	Maximum
EP (Rp million)	117	320.000	540.000	6.819	3,310.000
VAIC (ratio)	117	8.368	3.993	2.439	21.400
HCE (ratio)	117	6.774	3.809	1.601	19.726
SCE (ratio)	117	0.797	0.121	0.375	0.949
CEE (ratio)	117	0.796	0.532	0.221	3.115
TCE (ratio)	117	0.406	0.180	0.133	0.915
SIZE (Ln Total Aset)	117	29.874	1.318	27.596	32.937
LEV (ratio)	117	0.973	0.916	0.071	6.465

Source: Research Data, 2026

Based on Table 2, the results of the descriptive statistical analysis of 117 observations show a mean Employee Productivity (EP) value of Rp320.000 thousand (approximately Rp320 million) per employee. This positive value indicates that, in general, the companies in the sample are able to utilize their human resources productively to generate net profit. The intellectual capital (IC) variable recorded a mean value added intellectual coefficient (VAIC) of 8.368. Referring to Ulum, (2013), classification of IC efficiency—namely, high (VAIC ≥ 4,0), moderate (2.5 ≤ VAIC < 4,0), and low (VAIC < 2,5)—the mean VAIC value in this study falls into the high jcategory. This finding confirms the company's ability to optimally manage intellectual resources as a source of value creation and competitive advantage (Pulic, 2004).

In terms of its constituent components, human capital efficiency (HCE) makes the largest contribution, with a mean of 6.774, placing it in the "very good" category contributing approximately 80.9 percent of total VAIC. This finding reflects the high efficiency of human resources in creating added value. Meanwhile, structural capital efficiency (SCE) and capital employed efficiency (CEE) recorded means of 0.797 and 0.796 (approximately 9.5 percent each of total VAIC), respectively, indicating that the organizational structure and the utilization of physical and financial capital have been managed relatively efficiently (Pulic, 2000). In contrast, tangible capital efficiency (TCE) has a mean of 0.406, indicating that the role of tangible assets in creating value added remains relatively low and is primarily supportive (Pulic, 2004). On the control variables, firm size (SIZE) recorded a mean of 29.874 with a concentrated data distribution, while leverage (LEV) had a mean of 0.973 with wide variability, reflecting the heterogeneity of financing structures across firms.

Table 3.
Hausman Test

Hausman Test	Chi2	Prob > Chi2	Result
Model 1	14.81	0.051	FE
Model 2	16.25	0.062	FE
Model 3	14.46	0.013	FE
Model 4	23.88	0.045	FE

Source: Research Data, 2026

Gujarati & Porter, 2009 state that the Hausman test is a crucial statistical procedure used to determine the most appropriate specification for a panel data regression model, namely by evaluating whether the Fixed Effects Model (FEM) or the Random Effects Model (REM) better represents the data. The test results presented in Table 3 show that Model 1 has a chi-square value of 14.81 with a p-value of 0.051, Model 2 has a chi-square value of 16,25 with a p-value of 0.062, Model 3 yields a chi-square value of 14.46 with a p-value of 0.0130, and Model 4 records a chi-square value of 23.88 with a p-value of 0.045. All four p-values are <0.05; therefore, the Fixed Effects Model (FEM) is deemed more appropriate and relevant for use than the Random Effects Model (REM).

Table 4.
Heterocedasticity and Autokorelasi Result

	Model 1	Model 2	Model 3	Model 4
Full Sample	117	117	117	117
Heterocedasticity Chi2	2.99	1.71	7.94	5.30
Prob > Chi2	0.000	0.000	0.000	0.000
Serial Correlation F	19.815	9.471	20.705	10.087
Prob > F	0.001	0.049	0.001	0.038

Source: Research Data, 2026

Based on Table 4, all models using the Fixed Effects Model (FEM) approach show signs of heteroscedasticity (Prob > Chi^2 = 0.000) and autocorrelation (Prob > F < 0.05). These conditions indicate that the error variances are not constant and the residuals are correlated with one another, making standard Fixed Effects Model estimates no longer efficient. To address these two issues, clustered standard errors were used; according to Mackinnon et al. (2023) this method can simultaneously correct for heteroscedasticity and autocorrelation in panel data. The estimates were further strengthened using Driscoll-Kraay standard errors to ensure the consistency of the estimators in the presence of heteroscedasticity, autocorrelation, and cross-sectional dependence (Petersen, 2021). Through the adjustment of this model, the estimation results are ensured to be more stable for the subsequent analysis stages.

Table 5.
Hipotesis Test Model 1

Discroll-Kraay Standard Errors					
Hypothesis	**Path**	**Coefficient**	**T value**	**P>|t|**	**Result**
H1	VAIC→ EP	2.995	2.49	0.018**	Accepted
H5	TCE→ EP	566.000	6.32	0.000***	Accepted
	SIZE	387.000	18.40	0.000	
	LEV	-45.200	-2.17	0.037	
R-Squared		0.250			
F		3,123.44			
Prob>F		0.000			

*10% Sign; **5% Sign; ***1% Sign

Source: Research Data, 2026

Table 6.
Hipotesis Test Model 2

Discroll-Kraay Standard Errors					
Hypothesis	**Path**	**Coefficient**	**T value**	**P>|t|**	**Result**
H2	HCE → EP	8.967	2.29	0.029**	Accepted
H3	SCE → EP	-215.000	-2.09	0.044**	Rejected
H4	CEE → EP	321.000	3.00	0.005***	Accepted
	SIZE	412.00	13.30	0.000	
	LEV	-144.000	-18.96	0.000	
R-Squared		0.244			
F		682.64			
Prob>F		0.000			
*10% Sign; **5% Sign; ***1% Sign					

Source: Research Data, 2026

Table 7.
Hipotesis Test Model 3

Discroll-Kraay Standard Errors					
Hypothesis	**Path**	**Coefficient**	**T value**	**P>|t|**	**Result**
	VAIC	-9.363	-1.68	0.103	
	TCE	2.570	1.93	0.063	
H6	VAIC*TCE → EP	36.900	2.20	0.035**	Accepted
	SIZE	379.000	18.82	0.000	
	LEV	-46.600	-2.05	0.048	
R-Squared		0.259			
F		1,144.51			
Prob>F		0.000			
*10% Sign; **5% Sign; ***1% Sign					

Source: Research Data, 2026

Table 8.
Hipotesis Test Model 4

Discroll-Kraay Standard Errors					
Hypothesis	**Path**	**Coefficient**	**T value**	**P>|t|**	**Result**
	HCE	-1.087	-0.07	0.948	
	SCE	4.790	1.77	0.087	
	CEE	-6.950	-3.18	0.003	
	TCE	-3.360	-0.02	0.981	
H7	HCE*TCE → EP	29.100	3.27	0.003***	Accepted
H8	SCE*TCE → EP	-1.350	-1.29	0.207	Rejected
H9	CEE*TCE → EP	1.660	2.14	0.040**	Accepted
	SIZE	395.000	6.61	0.000	
	LEV	14.200	0.26	0.797	
R-Squared		0.365			
F		1,944.49			
Prob>F		0.000			
*10% Sign; **5% Sign; ***1% Sign					

Source: Research Data, 2026

The results of the model validity test (F-test) show that all four regression models are statistically significant at the 1 percent level (Prob > F = 0.000), confirming that all independent variables simultaneously have a significant effect on employee productivity. The coefficient of determination (R^2) values varied, with Model 1 at 25.0 percent and Model 2 at 24.4 percent. The models' explanatory power increased when the moderating interaction effect of tangible assets was included, as evidenced by the

rise in R^2 values (Model 3 = 25.9 percent) and (Model 4 = 36.5 percent). The remaining percentage in these four models is influenced by factors outside the scope of this study's variables.

The results of the H_1 test in Table 5 show that the Value Added Intellectual Coefficient (VAIC) has a significant positive effect on Employee Productivity (EP) in non-cyclical manufacturing. This effect is indicated by a coefficient value of 2.995 and a significance level of 0.018 < 5 percent. In practical terms, high intellectual capital efficiency serves as the primary driver for optimizing employee performance. These results validate the resource-based view theory, in which a company's strategic assets serve as a source of competitive advantage (Barney, 1991). This evidence is further supported by the mean VAIC of 8.368 in Table 2, which underscores a company's ability to manage intangible assets to generate added value. These results are consistent with previous studies by Wany (2010) ; Ognjanovic et al. (2023); Yasman et al. (2025) which state that IC efficiency has a significant effect on EP, as well as Ahmed et al. (2023), who emphasize the importance of comprehensive optimization of internal resources. In the Indonesian context, these findings indicate that optimal intellectual capital management at the firm level can serve as a concrete strategy to narrow the productivity gap with other ASEAN countries (World Bank, 2024). Thus, VAIC in the non-cyclical manufacturing sector has been empirically proven to optimize its contribution to EP, thereby supporting Hypothesis 1.

The results of the H_2 test in Table 6 show that Human Capital Efficiency (HCE) has a positive and significant effect on Employee Productivity (EP) in non-cyclical manufacturing companies. This effect is indicated by a coefficient value of 8.967 with a significance level of 0.029 < 5 percent. The descriptive statistics in Table 2 further support these findings, where the mean HCE of 6.774 contributes 80.9 percent to the company's total intellectual capital efficiency. This indicates that employees' knowledge, skills, and experience are strategic assets that play a crucial role in enhancing the company's productivity. From the Resource-Based View (RBV) perspective, human capital is viewed as a strategic resource that is difficult to imitate because it is inherent to individual capabilities, thereby enabling the creation of sustainable competitive advantage (Barney, 1991). This is consistent with the research by Buallay et al. (2021) which shows that HCE efficiency influences EP. These results indicate that enhancing human resource competencies is an effective strategy for non-cyclical manufacturing companies to increase employee productivity, while also potentially supporting an increase in national employee productivity, which still lags behind that of other ASEAN countries (World Bank, 2024). Thus, HCE in non-cyclical manufacturing has been empirically proven to optimize its contribution to EP, and therefore the second hypothesis is accepted.

The results of the H_3 test in Table 6 show that Structural Capital Efficiency (SCE) has a negative and significant effect on Employee Productivity (EP), with a coefficient value of -215.000 and a significance level of 0.044 < 5 percent. The descriptive statistics in Table 2 also support these findings, where the mean SCE of 0.797 contributes only about 9.5 percent to total intellectual capital efficiency (VAIC). This indicates that the contribution of structural capital to creating value added remains relatively limited compared to other components of intellectual capital. From the perspective of the Resource-Based View (RBV), an organization's resources will only create a competitive advantage if they can be managed and utilized effectively (Barney, 1991). Thus, organizational systems, procedures, or structures that lack adaptability have the potential to hinder employee productivity even if the company possesses structural capital. The findings of this study are consistent with the results of research by Ari & Kurniasari (2025) and Setyaningrum et al. (2025) which show that the influence of Structural Capital Efficiency (SCE) on performance is highly dependent on the quality and suitability of the organizational system relative to the company's operational needs. These results indicate that the presence of structural capital alone is not sufficient to improve employee productivity; it must be supported by an organizational system that is flexible, adaptive, and capable of effectively facilitating work activities. This finding also suggests that improving the productivity of Indonesia's workforce depends not only on increasing organizational resources but also on enhancing the quality of corporate

governance and operational systems (World Bank, 2024). Thus, SCE in non-cyclical manufacturing has not been empirically proven to optimize its contribution to EP; therefore, the third hypothesis is rejected.

The results of the H_4 test in Table 6 show that Capital Employed Efficiency (CEE)—used as a proxy for Physical Capital Efficiency (PCE)—has a positive and significant effect on Employee Productivity (EP), with a coefficient of 321.000 and a significance level of 0.005 < 1 percent. The descriptive statistics in Table 2 further support these findings, where the mean CEE of 0.796 contributes approximately 9.5 percent to total intellectual capital efficiency (VAIC). From a Resource-Based View (RBV) perspective, the efficient utilization of physical assets supports the creation of more effective work processes, thereby enhancing employee productivity and the quality of their output (Barney, 1991). The findings of this study are consistent with the results of research by Sari & Zubaidi (2026) which show that Physical Capital Efficiency (PCE) has a positive effect on performance because it reflects a company's ability to optimize the use of capital to create added value. These results indicate that the efficient utilization of physical capital is a key factor in improving employee productivity in non-cyclical manufacturing firms. These findings also suggest that the optimization of physical assets at the firm level has the potential to support broader improvements in employee productivity, even though Indonesia's productivity remains below that of Malaysia and Thailand (World Bank, 2024). Thus, the PCE in non-cyclical manufacturing has been empirically shown to optimize its contribution to EP, and therefore the fourth hypothesis is accepted.

The results of the H_5 test in Table 5 show that Tangible Capital Efficiency (TCE) has a positive and significant effect on Employee Productivity (EP), with a coefficient of 566.000 and a significance level of 0.000 < 1 percent. These results indicate that the optimization of tangible assets directly drives an increase in employee productivity. From a resource-based view perspective, tangible assets can contribute to improved performance when effectively utilized to support a company's operational activities (Barney, 1991). The use of technology and work infrastructure in this non-cyclical manufacturing sector can accelerate work processes, improve production efficiency, and help employees produce more optimal output. This aligns with the research by Sumiati & Isnaini (2024); Febriana & Triyono (2024); Halim (2024) which shows that efficient utilization of tangible assets can increase employee productivity. These results indicate that the stagnation in Indonesian employee productivity throughout 2021–2024 can indeed be overcome—at least at the firm level—through more optimal utilization of tangible assets (World Bank, 2024). Thus, TCE in non-cyclical manufacturing has been empirically proven to optimize its contribution to EP, and therefore the fifth hypothesis is accepted.

The results of the H_6 test in Table 7 show that Tangible Capital Efficiency (TCE) plays a significant positive role in strengthening the relationship between VAIC and Employee Productivity (EP), with a coefficient of 36.900 and a significance level of 0.035 < 5 percent. The data in Table 2 reinforce the findings of this study, where the average VAIC value of 8.368 indicates that the sample companies have generally utilized intellectual capital relatively efficiently. Empirically, this finding suggests that in the non-cyclical manufacturing sector, employees' intellectual potential requires the support of physical capital—such as machinery and facilities—to be optimally channeled into strategic tasks. From a resource-based view perspective, this demonstrates that tangible assets function as complementary assets that minimize operational friction, thereby enabling optimal work outcomes. This aligns with the research by Sumiati & Isnaini (2024); Febriana & Triyono (2024) which emphasizes the importance of integrating tangible assets. In other words, relying on intellectual capital alone is insufficient; synergy with tangible assets has proven to be a more effective combination for boosting productivity—a relevant lesson for efforts to close Indonesia's productivity gap with ASEAN (World Bank, 2024). Thus, TCE in non-cyclical manufacturing has been empirically shown to optimize VAIC's contribution to EP, and therefore the sixth hypothesis is accepted.

The results of the H7 test in Table 8 show that Tangible Capital Efficiency (TCE) significantly strengthens the positive effect of Human Capital Efficiency (HCE) on Employee Productivity (EP), with a coefficient of 29.100 and a significance level of 0.003 < 5 percent. This finding confirms that although

human capital is the primary driver in the non-cyclical manufacturing sector—with HCE contributing a dominant 80.9 percent—the presence of tangible assets remains an absolute prerequisite for optimal work execution. From a resource-based view perspective, this finding confirms that human capital functions as a strategic resource only when supported by adequate complementary assets to minimize operational barriers. This is consistent with the research by Gunadi & Utama (2025); Sie et al. (2026); Dhammawan et al. (2024) which indicates that human capital efficiency—as an intangible resource—requires an adequate physical platform to realize its full potential. These findings underscore that no matter how advanced employees' competencies may be, their effect on productivity will be limited without adequate support from tangible assets—an important lesson for companies seeking to help boost national employee productivity (World Bank, 2024). Thus, TCE in non-cyclical manufacturing has been empirically proven to optimize HCE's contribution to EP, thereby supporting the seventh hypothesis.

The results of the H8 test in Table 8 show that the interaction between Tangible Capital Efficiency (TCE) and Structural Capital Efficiency (SCE) does not have a significant effect on Employee Productivity (EP), with a coefficient value of -1.350 and a significance level of 0.207. This finding provides an important insight that the efficiency of physical assets is unable to mitigate the negative effect of structural capital efficiency rigidity, which had previously been identified. From a resource-based view perspective, this finding demonstrates that adequate physical facilities cannot serve to improve an internal system that lacks adaptability. Consistent with the research by Putra et al. (2025), he quality and flexibility of organizational systems are considered to have a greater influence on performance than physical support alone. These results are also supported by the research of Ognjanovic et al. (2023), which shows that TCE is unable to strengthen the relationship with intellectual capital. This indicates that the problem of a rigid organizational system cannot be resolved simply by adding physical assets but requires direct structural reforms to narrow the productivity gap among the Indonesian workforce (World Bank, 2024). Thus, the role of TCE has not been empirically proven, and the eighth hypothesis is rejected.

The results of the H9 test in Table 8 show that the interaction between Capital Employed Efficiency (CEE) and Tangible Capital Efficiency (TCE) has a positive and significant effect on Employee Productivity (EP), with a coefficient value of 1.660 and a significance level of 0.040 < 5 percent. As shown in Table 2, CEE = 0.796 will reach its optimal level when supported by TCE = 0.406, which acts as a catalyst that transforms funding allocation into tangible working capital. From a resource-based view perspective, a company's operational success heavily depends on the synchronization of its various resources (Barney, 1991). These test results align with the research by Abireza & Faris (2022) and Gunadi & Utama (2025) which demonstrated that tangible assets are highly effective as complementary assets. These findings reinforce the argument that the combination of physical capital efficiency and tangible assets can serve as a concrete strategy for non-cyclical manufacturing firms to help accelerate the productivity of Indonesia's workforce, thereby increasing corporate value added and national GDP growth. Thus, TCE in non-cyclical manufacturing has been empirically proven to optimize PCE's contribution to EP, and consequently, the ninth hypothesis is accepted.

CONCLUSION AND RECOMMENDATION

This study concludes that intellectual capital and tangible assets have varying effects on employee productivity in non-cyclical manufacturing firms in Indonesia, thereby reinforcing the Resource-Based View. Partially, VAIC has a significant positive effect on work productivity, driven primarily by the contributions of human capital efficiency (HCE) and physical capital efficiency (PCE). Conversely, structural capital efficiency (SCE) has a significant negative effect, proving that bureaucracy and rigid systems actually become operational burdens that hinder employee efficiency, while tangible assets

(TCE) are shown to have a significant positive effect in directly accelerating production output. In the moderation test, tangible assets act as complementary assets that reinforce the positive effects of VAIC, HCE, and PCE in eliminating idle capacity. However, this physical support fails to mitigate the negative effect of structural capital efficiency (SCE), indicating that limitations in internal governance cannot be resolved simply through mechanization or the addition of physical facilities.

Based on these findings, future research is encouraged to further examine whether reductions in rigid bureaucratic structures can help offset the negative influence of structural capital on employee efficiency, and whether aligning tangible asset investment with the development of human resource competencies allows firms to better translate workforce capability into productive output. At a broader level, the synergy between intellectual capital and tangible assets identified in this study offers a theoretically relevant, though empirically untested, link to corporate value added and, in turn, to macro-level indicators such as GDP per person employed — a relationship future studies could investigate directly. However, this study has several limitations; first, corporate conditions are influenced by external dynamics such as economic changes, market demand fluctuations, and the acceleration of digital transformation—factors beyond the researcher's control; and second, varying levels of information transparency in annual reports may result in differences in data quality. Future research is expected to expand the scope of analysis by applying mixed-methods approaches with more specific and contextually relevant HR operational indicators, such as individual KPI achievements, turnover rates, or revenue-per-hour-worked ratios, to more comprehensively capture the mechanisms linking intellectual capital, tangible assets, and employee productivity.

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