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Capital Intensity, Liquidity, and Leverage on Profitability with Operational Efficiency as a Mediating Variable in Manufacturing Firms

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Abstract: Manufacturing is the largest contributor to Indonesia's gross domestic product, yet the average return on assets of listed manufacturers declined from 0.0667 in 2021 to 0.0335 in 2024. The research gap addressed here is that prior studies test the direct effects of asset structure and financing decisions on profitability without explaining the internal mechanism through which those effects travel. This study examines whether operational efficiency mediates the effects of capital intensity, liquidity, and leverage on profitability. The sample consists of 45 manufacturing firms listed on the Indonesia Stock Exchange during 2020 to 2024, producing 222 firm-year observations. Panel regression was estimated in EViews 13 and the mediation test was run in Stata 15 using a cluster bootstrap with 5,000 replications. Model selection used the Chow, Hausman, Lagrange Multiplier, and Mundlak tests, and inference relied on cluster-robust standard errors. Capital intensity lowers operational efficiency, operational efficiency raises profitability, and operational efficiency fully mediates the effect of capital intensity on profitability. Liquidity and leverage affect neither variable. The novelty of this study is evidence that asset turnover is the single channel linking asset structure to profitability, while financing decisions do not determine profitability during crisis and recovery.

Keyword: Capital Intensity, Liquidity, Leverage, Operational Efficiency, Profitability.

INTRODUCTION

The manufacturing sector is the largest single contributor to Indonesia's gross domestic product. Statistics Indonesia records a contribution of 19.87 percent of total gross domestic product in 2020, 18.67 percent in 2023, and a recovery to 18.98 percent in 2024 (Badan Pusat Statistik, 2024). The sector also absorbs about 16 percent of formal employment and remains the largest source of national tax revenue (Kementerian Perindustrian, 2024). Its financial performance therefore carries consequences well beyond the firms themselves.

Performance in this sector came under severe pressure during 2020 and 2021. Disruption of global supply chains, mobility restrictions, and weaker domestic demand

simultaneously reduced production capacity and earnings. Evidence from listed manufacturers shows that average return on assets fell from 0.049 before the pandemic to 0.035 during it (Wahyuni et al., 2024). Observation of the 45 sample firms used in this study reveals a similar but longer pattern. Average return on assets stood at 0.0389 in 2020, rose to 0.0667 in 2021 as demand recovered, then declined in each subsequent year to 0.0335 in 2024, a level below the trough of the pandemic itself. Profitability has not returned to its pre-crisis path.

The other variables did not move in step with profitability. Average total asset turnover fell to 0.8847 in 2020, peaked at 1.1233 in 2022, and eased to 1.0650 in 2024. Average capital intensity followed a U-shaped path, falling from 0.3908 in 2020 to 0.3563 in 2022 before rising to 0.3708 in 2024. Average debt to equity ratio rose from 0.9796 in 2020 to 1.0659 in 2023 and then fell to 0.9950. Average current ratio dropped to 2.1622 in 2021, jumped to 2.9241 in 2022, and settled at 2.6407 in 2024. Between 2023 and 2024 profitability and asset turnover declined together while capital intensity rose and leverage fell. Divergence of this kind cannot be resolved by descriptive observation alone, since firm heterogeneity and time dynamics operate at once.

Return on assets is the most fundamental measure of financial performance in corporate finance because it captures the ability of management to generate earnings from the entire asset base (Brigham & Houston, 2019). In capital-intensive manufacturing, where physical assets dominate the balance sheet, the capacity to earn from a large asset base is a direct indicator of operating quality.

Capital intensity is the first structural determinant examined here. It is defined as the proportion of net fixed assets to total assets and reflects the degree to which production depends on physical capital (Brigham & Houston, 2019). Empirical findings are inconsistent. A study of insurance and banking firms listed in Indonesia over 2011 to 2015 reports a significant negative effect on return on assets (Aldy, 2018), while a study of consumer non-cyclical manufacturers over 2021 to 2024 finds no partial effect at all (Waruwu, 2026). Other Indonesian evidence reports a significant effect without testing any transmission mechanism (Noor, 2024).

Liquidity, measured by the current ratio, is the second determinant. Its relationship with profitability is not linear. Adequate liquidity secures the ability to meet short-term obligations, but an excessive current ratio may signal idle current assets that are not deployed productively (Brigham & Houston, 2019). Studies of Indonesian manufacturers report significant effects whose direction varies with industry context and macroeconomic conditions (Anggraini, 2023; Zarkasyi et al., 2021; Sayyidah & Riyanti, 2026).

Leverage, measured by the debt to equity ratio, is the third. Debt raises returns to shareholders through financial leverage and the interest tax shield, yet excessive borrowing increases default risk and interest expense, which erodes operating earnings (Modigliani & Miller, 1963; Ross et al., 2019). Indonesian evidence suggests a negative effect once borrowing exceeds a firm's optimal capacity (Kurniawan et al., 2023), while cross-country evidence links capital structure to performance through ownership and efficiency channels (Margaritis & Psillaki, 2010).

This study positions operational efficiency, proxied by total asset turnover, as the mechanism that translates these financial characteristics into profitability. The reasoning draws on several theories rather than one. Working Capital Management Theory holds that efficient management of current assets accelerates the operating cycle and improves asset utilisation. Trade-off Theory holds that financing structure shapes operational flexibility and therefore the productive use of assets. Agency Theory explains how conflicts among managers, shareholders, and creditors influence the discipline with which assets are deployed (Jensen & Meckling, 1976), while Pecking Order Theory explains the financing hierarchy that governs how asset expansion is funded (Myers & Majluf, 1984). DuPont decomposition supplies the arithmetic link, since return on assets is the product of net profit margin and total asset turnover (Ross et al., 2019). An Indonesian study has already shown that total asset turnover mediates the effect

of the current ratio on return on equity (Pratiwi, 2022), which supports treating asset turnover as an operational transmission mechanism. The three independent variables were selected because they represent the three fundamental decisions of financial management, namely the investment decision through asset structure, the working capital decision through liquidity, and the financing decision through capital structure.

Four gaps emerge from this literature. The conceptual gap is that earlier work tests direct effects without specifying the internal mechanism that bridges financial structure and earnings. The empirical gap is that findings on capital intensity, liquidity, and leverage remain inconsistent in both significance and direction. The contextual gap is that most observation windows either predate the pandemic or exclude the recovery phase. The methodological gap is that mediation is usually assessed through simple path analysis or the Sobel test without accommodating firm heterogeneity or violations of classical assumptions.

The state of the art of this study lies in an integrative model that explains profitability formation through the operational efficiency channel, built on Trade-off Theory, Agency Theory, Working Capital Management Theory, Pecking Order Theory, and DuPont decomposition together. The observation period spans both the pandemic shock and the recovery, which produces extreme variation across all variables. Estimation combines a formal panel model selection procedure, cluster-robust standard errors, and a cluster bootstrap with 5,000 replications for the indirect effect. This combination has seen limited application in Indonesian profitability research.

Based on the description above, the research questions are formulated as follows:

1. Does capital intensity affect the profitability of manufacturing firms listed on the Indonesia Stock Exchange?
2. Does liquidity affect profitability?
3. Does leverage affect profitability?
4. Does capital intensity affect operational efficiency?
5. Does liquidity affect operational efficiency?
6. Does leverage affect operational efficiency?
7. Does operational efficiency affect profitability?
8. Does operational efficiency mediate the effect of capital intensity on profitability?
9. Does operational efficiency mediate the effect of liquidity on profitability?
10. Does operational efficiency mediate the effect of leverage on profitability?

METHOD

This study applies a quantitative approach with an explanatory design intended to test causal relationships among variables, both directly and indirectly through a mediating variable. The data are panel data combining a cross-section of firms with a time series of annual observations. Panel regression was chosen because the phenomenon demands it rather than for technical convenience. Movements in capital intensity, liquidity, leverage, operational efficiency, and profitability between 2020 and 2024 show no consistent pattern across firms or over time, which indicates the presence of unobserved firm characteristics that remain constant through the observation window (Baltagi, 2021).

The population consists of firms whose principal activity is the production of physical goods, distributed across the Basic Materials, Consumer Non-Cyclicals production, and Consumer Cyclicals production sectors of the IDX Industrial Classification, totalling 166 firms. Purposive sampling applied five criteria: listing before 1 January 2020; complete audited annual reports throughout the observation period; no delisting or trading suspension; financial statements presented in rupiah; and availability of all components required to compute the research variables. Forty-five firms met every criterion, comprising 20 firms in Basic Materials, 13 in Consumer Non-Cyclicals production, and 12 in Consumer Cyclicals production, yielding 225 firm-year observations. Data were collected by documentation from audited annual reports published through the Indonesia Stock Exchange.

Three firm-year observations, namely Alumindo Light Metal Industry in 2020, Sepatu Bata in 2024, and Pan Brothers in 2024, recorded negative total equity and therefore a negative debt to equity ratio. Because the natural logarithm is undefined for negative values, these

observations could not enter estimations requiring Ln(DER). The three firms remain within the sample and only the affected firm-years were dropped, which leaves 222 observations in an unbalanced panel with 42 firms observed for five years and three firms for four years. Fixed effect and random effect estimators remain consistent on unbalanced panels provided the mechanism generating missing observations is uncorrelated with the model error (Wansbeek & Kapteyn, 1989; Baltagi & Song, 2006), a condition satisfied here because the mechanism is deterministic and mathematical.

Two distributional problems were addressed before estimation. The debt to equity ratio and total asset turnover were sharply right-skewed, with skewness of 2.66 and 3.09 respectively. Natural logarithm transformation is a standard procedure for right-skewed financial ratios because it compresses large values proportionally without discarding observations (Gujarati & Porter, 2009). After transformation, skewness fell to -0.014 for Ln(DER) and 0.461 for Ln(TATO). Capital intensity and the current ratio were left untransformed because capital intensity was already close to symmetric, with skewness of 0.383 , and applying a logarithm produced skewness of -0.737 in the opposite direction. Return on assets could not be log-transformed because 31 observations were negative, representing loss-making firms whose information is relevant to the pandemic context. Winsorizing at the fifth and ninety-fifth percentiles was applied instead, following the argument that the cutoff should match the frequency of influential observations in the sample (Leone et al., 2019). Skewness of return on assets fell from -1.119 to 0.368 after winsorizing, and no observation was removed. These transformations are mathematical operations at the estimation stage and do not alter the conceptual constructs, so the hypotheses continue to refer to DER and TATO while the estimated equations use Ln(DER) and Ln(TATO).

The operationalisation of each variable is presented in Table 1. Capital intensity is defined as net fixed assets divided by total assets and is not the inverse of total asset turnover, an explicit distinction that prevents conceptual overlap with the mediating variable. Three measurement conventions were applied uniformly: net income attributable to owners of the parent entity was used for return on assets; consolidated total equity including non-controlling interests was used for the debt to equity ratio; and statements presented in United States dollars were converted using the Bank Indonesia middle rate at the reporting date.

Table 1. Operationalisation of Research Variables

Variable	Symbol	Measurement	Scale	Reference
Capital Intensity	CIR (X_1)	Net fixed assets / Total assets	Ratio	Brigham & Houston (2019)
Liquidity	CR (X_2)	Current assets / Current liabilities	Ratio	Brigham & Houston (2019)
Leverage	DER (X_3)	Total liabilities / Total equity	Ratio	Ross et al. (2019)
Operational Efficiency	TATO (Z)	Net sales / Total assets	Ratio	Ross et al. (2019)
Profitability	ROA (Y)	Net income / Total assets	Ratio	Brigham & Houston (2019)
Firm Size	SIZE (K_1)	Ln (Total assets)	Ratio	Wooldridge (2010)

Source: Processed by the authors (2026)

Two structural equations were estimated. Model 1 explains operational efficiency, and Model 2 explains profitability with the mediator included:

$$Z_{it} = \alpha_0 + \alpha_1 X_{1it} + \alpha_2 X_{2it} + \alpha_3 X_{3it} + \alpha_4 K_{1it} + \varepsilon_{it} \quad (1)$$

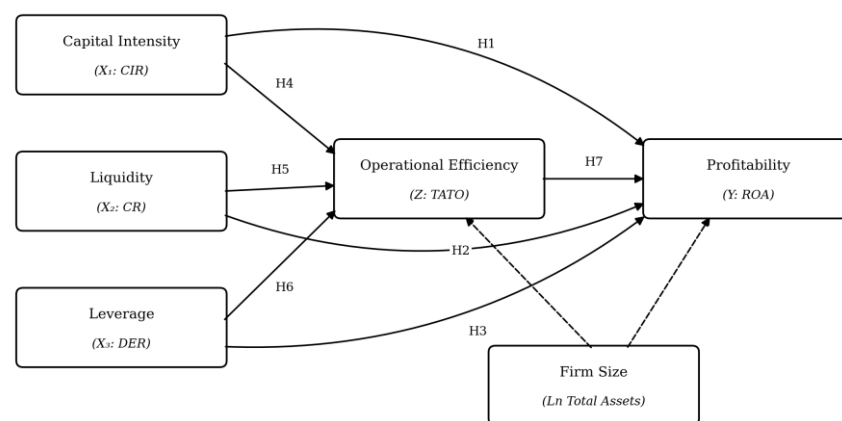
$$Y_{it} = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 Z_{it} + \beta_5 K_{1it} + \mu_{it} \quad (2)$$

Y denotes profitability, Z denotes operational efficiency, X_1 to X_3 denote capital intensity, liquidity, and leverage, and K_1 denotes firm size as a control variable, with i indexing

firms and t indexing years. Equation (1) tests H4, H5, and H6, while equation (2) tests H1, H2, H3, and H7. The indirect effect of each independent variable is the product of its coefficient in equation (1) and the coefficient of the mediator in equation (2), written as $IE_k = \alpha_k \times \beta_4$, which tests H8, H9, and H10.

Model selection followed the Chow test, the Hausman test, and the Breusch-Pagan Lagrange Multiplier test. A robust Mundlak specification test was added for Model 1 because the classical Hausman test is invalid when errors are autocorrelated; the procedure adds group means of all regressors to the random effect equation and tests their joint significance using cluster-robust standard errors (Mundlak, 1978). Classical assumption testing covered normality, multicollinearity, heteroskedasticity, and autocorrelation. Remaining violations were addressed through firm-level cluster-robust standard errors, which yield valid inference in the presence of heteroskedasticity and within-cluster serial correlation (Cameron & Miller, 2015).

The mediation test used bootstrapping rather than the Sobel test, because the sampling distribution of a product of two coefficients is generally non-normal and the normality assumption produces inaccurate inference at moderate sample sizes (Preacher & Hayes, 2008). The procedure ran 5,000 replications under a cluster bootstrap scheme that resamples at the firm level with replacement, preserving the within-firm dependence inherent in panel data. The decision criterion is the 95 percent percentile confidence interval, and mediation is significant when the interval excludes zero. Percentile intervals were preferred to bias-corrected intervals because they balance statistical power against type I error control more reliably (Hayes & Scharkow, 2013; Tibbe & Montoya, 2022). Panel estimation and specification testing were carried out in EViews 13, while the cluster bootstrap was run in Stata 15, since EViews does not provide cluster-based bootstrapping of indirect effects by default. Results from both packages were reconciled to ensure consistency. The conceptual framework of the study is presented in Figure 1



H8-H10: Indirect effects of X₁, X₂, and X₃ on Y through Z

Source: Developed by the authors (2026)

Figure 1. Conceptual Framework

RESULTS AND DISCUSSION

Result

Descriptive Statistics

Descriptive statistics for all variables after transformation and winsorizing are reported in Table 2.

Table 2. Descriptive Statistics of Research Variables

Variable	Mean	Median	Std. Dev.	Minimum	Maximum
CIR	0.3713	0.3312	0.1957	0.0496	0.8144
CR	2.6145	1.7400	2.7199	0.2897	16.2821
Ln(DER)	-0.3152	-0.2937	0.8876	-2.4478	1.9124
Ln(TATO)	-0.1588	-0.1248	0.6007	-1.4844	1.7516
ROA	0.0557	0.0519	0.0912	-0.5410	0.3489
ROA (winsorized)	0.0577	0.0519	0.0619	-0.0500	0.1937
SIZE	29.8262	29.4341	1.7431	26.8323	33.7900

Source: Processed data (2026); n = 222

Mean capital intensity of 0.3713 indicates that about 37 percent of sample firms' assets are net fixed assets. The range from 0.0496 to 0.8144 is wide and economically meaningful, since firms with a large fixed asset base carry depreciation charges that cannot be reduced when demand falls. Mean current ratio of 2.6145 with a standard deviation of 2.7199, larger than the mean itself, points to sharply different working capital strategies: some firms hold large liquidity buffers while others operate on tight liquidity. Mean winsorized return on assets of 0.0577 with a standard deviation of 0.0619 confirms that the pandemic and the recovery were not experienced uniformly. Firm size ranges from 26.8323 to 33.7900 in natural logarithm, equivalent to total assets of roughly IDR 0.4 trillion to IDR 475 trillion, which justifies controlling for scale.

Panel Model Selection

Results of the panel model selection procedure are summarised in Table 3.

Table 3. Panel Model Selection Test Results

Test	Statistic	Prob.	Conclusion
Model 1: Chow test	F = 52.5753 (44; 173)	0.0000	Fixed Effect preferred to Common Effect
Model 1: Breusch-Pagan LM test	LM = 349.3100	0.0000	Random Effect preferred to Common Effect
Model 1: Classical Hausman test	$\chi^2 = 16.6155$ (df = 4)	0.0023	Points to Fixed Effect
Model 1: Mundlak (robust) test	$\chi^2 = 9.2856$ (df = 4)	0.0543	Random Effect consistent
Model 2: Chow test	F = 21.0875 (44; 172)	0.0000	Fixed Effect preferred to Common Effect
Model 2: Hausman test	$\chi^2 = 21.9487$ (df = 5)	0.0005	Fixed Effect preferred to Random Effect

Source: Processed data (2026)

For Model 2 every test points to the same conclusion, so the model was estimated as a fixed effect model with cluster-robust standard errors. For Model 1 the classical Hausman test and the robust Mundlak test disagree, which follows from their differing assumptions rather than from any anomaly. The classical Hausman test requires the random effect estimator to be efficient under the null hypothesis, a condition that holds only when errors are homoskedastic and free of autocorrelation. Testing found significant first-order autocorrelation in the residuals of Model 1, with rho of 0.4709 and a probability of 0.0000, so the efficiency precondition fails and the classical statistic becomes inconsistent. The Mundlak test with cluster-robust standard errors imposes no such requirement, and its result shows that the group-mean coefficients are

jointly insignificant at the 5 percent level. Model 1 was therefore estimated as a random effect model with cluster-robust standard errors.

Classical assumption testing produced mixed results that were handled consistently. Residuals of Model 1 are normally distributed with a Jarque-Bera probability of 0.1242, a result that follows directly from the logarithmic transformation of total asset turnover; without it, residual kurtosis reached 16.854. Residuals of Model 2 do not meet formal normality, with a Jarque-Bera probability of 0.0015, although the shape is close to normal with skewness of 0.033. This does not invalidate inference, because with 222 observations the central limit theorem ensures asymptotic normality of the sampling distribution (Wooldridge, 2010), and all inference uses cluster-robust standard errors that do not assume normal errors. Every variance inflation factor lies well below 10, with a maximum of 2.0567, so multicollinearity is not a concern. The Breusch-Pagan test indicates homoskedasticity in Model 1 with a probability of 0.3600 and heteroskedasticity in Model 2 with a probability of 0.0056, while autocorrelation shows the reverse pattern, significant in Model 1 and absent in Model 2 with a probability of 0.2462. Autocorrelation in Model 1 is expected because asset turnover is persistent within firms over time. Both violations were addressed through firm-level cluster-robust standard errors (Cameron & Miller, 2015).

Regression Results

Estimation results for both structural equations are presented in Table 4.

Table 4. Regression Estimation Results of Model 1 and Model 2

Variable	Model 1: Ln(TATO) — Random Effect	Model 2: ROA — Fixed Effect	Decision		
	Coef.	Prob.	Coef.	Prob.	
Constant	3.1459	0.0281	−0.4422	0.2992	
CIR (X ₁)	−0.9233	0.0047**	−0.1104	0.1815	H4 supported; H1 not supported
CR (X ₂)	−0.0146	0.2705	−0.0011	0.3323	H5 and H2 not supported
Ln(DER) (X ₃)	−0.0311	0.7026	−0.0003	0.9740	H6 and H3 not supported
Ln(TATO) (Z)	—	—	0.0879	0.0000**	H7 supported
SIZE (K ₁)	−0.0984	0.0364*	0.0187	0.1752	Control variable
F-statistic	2.6839	0.0324*	9.0524	0.0000**	
R ²	0.2462 (overall)		0.3049 (within)		
Observations	222		222		

Source: Processed data (2026). ** significant at 1 percent; * significant at 5 percent. Both models use firm-level cluster-robust standard errors. The dependent variable of Model 2 is winsorized return on assets.

Model 1 yields an overall coefficient of determination of 0.2462, with a between value of 0.2558 and a within value of 0.0177, meaning that explanatory power comes mainly from differences between firms rather than from variation within a firm over time. Model 2 yields a within coefficient of determination of 0.3049, which is adequate for a firm fixed effect panel model on heterogeneous financial data. Both models are jointly significant, with F statistics of 2.6839 at a probability of 0.0324 for Model 1 and 9.0524 at a probability of 0.0000 for Model 2.

Mediation Test

Indirect effects were computed as the product of the path a coefficient from Model 1 and the path b coefficient from Model 2, with significance assessed through a cluster bootstrap of 5,000 replications using 95 percent percentile confidence intervals. Results appear in Table 5

Table 5. Mediation Test Results Using Cluster Bootstrap with 5,000 Replications

Mediation path	Indirect effect	Lower 95% CI	Upper 95% CI	Result
CIR → Ln(TATO) → ROA	−0.08113	−0.13881	−0.02603	Significant
CR → Ln(TATO) → ROA	−0.00128	−0.00543	0.00076	Not significant
Ln(DER) → Ln(TATO) → ROA	−0.00273	−0.01823	0.01131	Not significant

Source: Processed data (2026); 45 clusters, 222 observations, percentile confidence intervals

Table 6. Summary of Hypothesis Testing

No.	Hypothesis	Coefficient	Significance	Decision
H1	Capital intensity → profitability	−0.1104	p = 0.1815	Not supported
H2	Liquidity → profitability	−0.0011	p = 0.3323	Not supported
H3	Leverage → profitability	−0.0003	p = 0.9740	Not supported
H4	Capital intensity → operational efficiency	−0.9233	p = 0.0047	Supported
H5	Liquidity → operational efficiency	−0.0146	p = 0.2705	Not supported
H6	Leverage → operational efficiency	−0.0311	p = 0.7026	Not supported
H7	Operational efficiency → profitability	0.0879	p = 0.0000	Supported
H8	Mediation of capital intensity	−0.0811	CI [−0.1388; −0.0260]	Supported
H9	Mediation of liquidity	−0.0013	CI [−0.0054; 0.0008]	Not supported
H10	Mediation of leverage	−0.0027	CI [−0.0182; 0.0113]	Not supported

Source: Processed data (2026)

Of the ten hypotheses, three are supported, namely H4, H7, and H8, while seven are not. The three supported hypotheses form a single coherent causal chain rather than three unrelated findings.

Discussion

The Effect of Capital Intensity on Operational Efficiency (H4)

Capital intensity has a negative and significant effect on operational efficiency, with a coefficient of −0.9233 and a probability of 0.0047, so H4 is supported. Because the dependent variable is in logarithmic form while the independent variable is in level form, the coefficient reads as a semi-elasticity: a rise of 0.1 point in the capital intensity ratio lowers total asset turnover by roughly 9.23 percent, holding other variables constant.

The theoretical basis is firm within the DuPont framework. Total asset turnover measures the capacity of the whole asset base to generate sales. Fixed assets such as machinery, buildings, and production installations convert into sales more slowly than current assets such as inventory and trade receivables. The larger the share of fixed assets in the asset structure, the larger the slow-turning base, and the lower the total asset turnover ratio becomes. Operating leverage completes the explanation. Capital-intensive firms carry a high proportion of fixed costs and require large sales volumes to reach efficient capacity utilisation. The demand shock of the pandemic left many such firms operating below optimal capacity throughout 2020 to 2024, so

installed fixed assets went underused and turnover was suppressed. This link between capital intensity and asset turnover is what makes the mediation test in H8 possible.

The Effect of Operational Efficiency on Profitability (H7)

Operational efficiency has a positive and significant effect on profitability, with a coefficient of 0.0879 and a probability of 0.0000, so H7 is supported. Read as a semi-elasticity, a 10 percent rise in total asset turnover raises return on assets by about 0.88 percentage points. The finding confirms the core proposition of DuPont decomposition, under which return on assets is the product of net profit margin and total asset turnover (Ross et al., 2019). Within a fixed effect model that controls for time-invariant firm characteristics, including each firm's relatively stable margin structure, an improvement in asset turnover translates directly into higher profitability. The strength of this relationship is what qualifies operational efficiency to serve as a mediator, since a variable can act as a transmission mechanism only when its link to the dependent variable is strong.

The Mediating Role of Operational Efficiency (H8, H9, H10)

Operational efficiency fully mediates the effect of capital intensity on profitability, with an indirect effect of -0.0811 and a 95 percent percentile confidence interval from -0.1388 to -0.0260 that excludes zero, so H8 is supported. The direct effect of capital intensity on profitability in Model 2 is not significant at a probability of 0.1815, while the indirect effect is significant, which is the pattern of full mediation as formulated by Baron and Kenny (1986).

Full mediation carries a stronger theoretical meaning than partial mediation, since it indicates that operational efficiency is the only channel connecting asset structure to profitability within the sample. The practical implication follows directly: raising profitability in capital-intensive firms requires raising utilisation of assets already owned, and changing the composition of assets alone will not achieve it.

The mediation paths of liquidity and leverage are not significant, so H9 and H10 are rejected. The reason is that the precondition for mediation is unmet rather than that the mediator fails. Mediation requires a significant effect of the independent variable on the mediator along path a (Baron & Kenny, 1986), and neither the current ratio nor $\text{Ln}(\text{DER})$ significantly affects $\text{Ln}(\text{TATO})$ in Model 1. Where no path exists, nothing can be mediated.

Non-Significant Direct Effects on Profitability (H1, H2, H3)

H1 is rejected with a coefficient of -0.1104 at a probability of 0.1815, although the sign remains negative as predicted. Rather than contradicting the framework, this strengthens it: under DuPont decomposition, asset structure does not influence profitability directly, because its influence runs through the capacity of assets to generate sales. The combination of an insignificant direct effect with a significant indirect effect is precisely the full mediation pattern discussed above, and it extends earlier Indonesian evidence that reports a significant capital intensity effect without testing any mechanism (Noor, 2024).

H2 is rejected with a coefficient of -0.0011 at a probability of 0.3323. This matches the trade-off proposition of Working Capital Management Theory (Brigham & Houston, 2019). High liquidity provides security in meeting short-term obligations, yet it simultaneously reflects idle current assets. The two opposing forces offset each other, leaving a net effect that is not significant. Period context reinforces the result, since firms held large liquidity buffers against uncertainty during the pandemic, and this precautionary motive is defensive rather than profit-oriented. Inconsistency in the direction of liquidity effects in earlier work (Anggraini, 2023; Sayyidah & Riyanti, 2026) is consistent with this reading.

H3 is rejected with a coefficient of -0.0003 at a probability of 0.9740. A coefficient this close to zero indicates no systematic relationship within the sample. Trade-off Theory holds that an optimal capital structure balances the interest tax shield against financial distress costs

(Modigliani & Miller, 1963). If sample firms operate near their respective optima, the marginal benefit and marginal cost of debt offset one another and the net effect is insignificant. A median debt to equity ratio of 0.7455 indicates that most sample firms carry moderate leverage. The divergence from Kurniawan et al. (2023), who report a significant negative effect, is explained by model specification, since the present model includes operational efficiency in the same equation and part of the effect is absorbed by that variable.

Non-Significant Paths to Operational Efficiency (H5, H6)

H5 is rejected with a coefficient of -0.0146 at a probability of 0.2705. Working Capital Management Theory predicts that efficient working capital management smooths the operating cycle and raises the capacity of assets to generate sales, but the theory concerns the quality of that management while the current ratio measures only its magnitude. The current ratio is a static measure at a single point in time and does not distinguish productive liquidity, such as fast-moving inventory, from unproductive liquidity, such as idle cash or uncollectible receivables. The insignificance of H5 therefore reflects a limitation of the proxy rather than a failure of the theory, and the cash conversion cycle would capture the proposition more accurately.

H6 is rejected with a coefficient of -0.0311 at a probability of 0.7026. Of all hypotheses proposed, H6 rests on the weakest theoretical foundation. Trade-off Theory addresses the relationship between capital structure and firm value, while the relationship between capital structure and asset turnover falls outside its scope. Agency Theory explains conflicts of interest among management, shareholders, and creditors (Jensen & Meckling, 1976) without addressing asset productivity directly. The proposed path rested on the authors' own synthesis, namely that high interest expense constrains operational flexibility. Its insignificance confirms that theoretical weakness, and future work testing this path would be better served by a framework such as the resource-based view.

The Control Variable

Firm size has a negative and significant effect on operational efficiency in Model 1, with a coefficient of -0.0984 at a probability of 0.0364, but no significant effect on profitability in Model 2 at a probability of 0.1752. The negative effect on efficiency indicates diseconomies of scale in asset utilisation, since larger firms tend to hold larger asset bases without proportionate growth in sales. This pattern fits capital-intensive manufacturing, where capacity expansion often precedes demand growth.

Novelty of the Study

The novelty of this study is the empirical demonstration that operational efficiency is the single transmission channel through which asset structure reaches profitability in Indonesian manufacturing during the crisis and recovery period, while financing decisions expressed through liquidity and leverage reach neither efficiency nor profitability. Earlier studies position total asset turnover as one determinant among several, or test direct effects without specifying any mechanism. Placing it as a mediator within a DuPont-based framework and confirming full mediation for the capital intensity path shows that the investment decision on asset structure, rather than financing decisions, governs profitability formation, and that its influence is entirely indirect. A direct-effect model alone would have reported capital intensity as unrelated to profitability and missed this channel.

CONCLUSION

Conclusion

This study tested the effects of capital intensity, liquidity, and leverage on profitability with operational efficiency as a mediating variable, using 222 firm-year observations from 45

manufacturing firms listed on the Indonesia Stock Exchange between 2020 and 2024. Capital intensity does not affect profitability directly but reduces operational efficiency significantly, so firms with a larger share of fixed assets record lower asset turnover. Liquidity affects neither profitability nor operational efficiency, since the current ratio as a static measure does not capture the quality of working capital management proposed by Working Capital Management Theory. Leverage likewise affects neither, a result consistent with Trade-off Theory under conditions approaching an optimal capital structure and one that confirms the weak theoretical basis for a path running from leverage to asset productivity. Operational efficiency raises profitability with strong significance, in line with the core proposition of DuPont decomposition, and it fully mediates the effect of capital intensity on profitability while mediating neither liquidity nor leverage.

Three of the ten hypotheses are supported, and they form one coherent causal chain: capital intensity lowers operational efficiency, operational efficiency raises profitability, and capital intensity therefore lowers profitability entirely through the efficiency channel. The contribution to management science is a shift of attention from what affects profitability to how it is affected. For the manufacturing firms studied, financing decisions did not determine profitability during the crisis and recovery period. The investment decision embodied in asset structure did, and it operated through a single channel, namely the efficiency with which existing assets are used.

Limitations

This study carries several limitations. First, the observation period spans the COVID-19 shock, so the findings are contextual to conditions of crisis and recovery and generalisation to normal economic periods requires caution. Second, the year 2025 was excluded because audited annual reports were not yet uniformly available for all sample firms when the research design was fixed, so the most recent dynamics are not captured. Third, the model uses only internal financial variables and a single control variable, and therefore does not account for macroeconomic conditions that affect all firms simultaneously. Fourth, the current ratio proved a limited proxy for the quality of working capital management, which restricts what can be concluded about the liquidity path. Fifth, one sample firm-year displayed extreme ratios associated with a debt restructuring process, and although winsorizing limited its influence, its presence reflects the heterogeneity of the period.

Recommendations

Future research should extend the observation period beyond the crisis and recovery window, widen the range of sectors, and incorporate macroeconomic variables such as inflation, exchange rates, or economic growth, which have been shown to affect firm performance in comparable settings (Ibrahimov et al., 2025; Mitra et al., 2023; Isibor & Esechie, 2026; Jaysa et al., 2026; Putri et al., 2025). Replacing the current ratio with the cash conversion cycle would test the working capital proposition more directly, and grounding the leverage-to-efficiency path in the resource-based view would give it a firmer theoretical footing. Alternative approaches such as structural equation modelling, dynamic panel estimation, or moderated mediation could also deepen understanding of the mechanism.

For company management, capital-intensive firms should treat improvement of asset turnover as the priority in any strategy aimed at profitability, since it is the only channel linking asset structure to earnings. Concrete steps include optimising capacity utilisation, reviewing unproductive fixed assets, and aligning expansion plans with demand projections. Total asset turnover deserves a place among primary performance indicators in management control systems, alongside the profitability measures already in common use. Adding liquidity or adjusting debt structure did not affect profitability significantly in the period studied, so performance improvement should not rest on those instruments.

For investors, assessment of manufacturing firms should give greater weight to activity ratios, particularly total asset turnover, which showed stronger explanatory power than financial structure ratios in this context. Firms with high capital intensity warrant scrutiny of their utilisation levels, because a heavy asset structure without adequate turnover tends to depress profitability. For policymakers, programmes to strengthen manufacturing would be better directed at raising utilisation of installed capacity than at encouraging additions to fixed assets, since higher capital intensity was found to reduce asset turnover. Fiscal incentives tied to fixed asset acquisition merit review of their effectiveness, as incentives that expand assets without assurance of market absorption risk lowering efficiency. Given that manufacturing is the largest contributor to national tax revenue, tax policy design should also account for the operational efficiency conditions of firms so that the tax burden does not undermine the capacity to sustain profitability during recovery.

Author Contributions

The first author took primary responsibility for research conceptualisation, data collection, data analysis, and preparation of the manuscript. The second author contributed to development of the theoretical framework, interpretation of results, and critical review and revision of the manuscript. Both authors have read and approved the final version submitted for publication.

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