

The Effect of Green Infrastructure Investment, Capital Structure, and Operational Efficiency on Financial Performance of Companies in Central Java

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ABSTRACT

This study investigates the influence of green infrastructure investment, capital structure, and operational efficiency on the financial performance of companies operating in Central Java. A quantitative research approach was employed, utilizing survey data collected from 173 companies across various industries. The data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM), with hypothesis testing conducted to assess the significance of the relationships between the variables. The results indicate significant positive associations between green infrastructure investment, capital structure, operational efficiency, and financial performance. Specifically, companies that prioritize sustainability initiatives, maintain optimal capital structures, and enhance operational efficiency tend to achieve superior financial performance outcomes. These findings highlight the multidimensional nature of value creation within organizations and underscore the importance of integrating environmental and operational considerations into strategic decision-making processes. The implications of the study extend to policymakers, business leaders, and stakeholders seeking to enhance the financial sustainability and resilience of companies in Central Java.

Keywords: *Green Infrastructure Investment, Capital Structure, Operational Efficiency, Financial Performance, Central Java*

1. INTRODUCTION

In the contemporary business landscape, the pursuit of sustainable development has become a crucial goal for organizations globally, emphasizing the importance of environmental stewardship for both moral and strategic reasons. Organizations are increasingly focusing on sustainable development, which encompasses economic, social, and environmental aspects [1], [2]. This shift towards sustainability involves implementing concrete actions for environmental protection, engaging in corporate social responsibility, and managing risks effectively [3]. Studies highlight the positive relationship between green human resource management practices, responsible leadership, green innovation, and sustainable company performance, underscoring the significance of these factors in achieving business sustainability [4]. Embracing sustainable practices not only aligns with ethical considerations but also has profound implications for long-term financial performance and overall success in the modern business environment.

The relationship between green infrastructure investment, capital structure, operational efficiency, and financial performance in companies operating in Central Java is critical to driving sustainability and profitability. Studies show that green financing and investment significantly affect corporate social responsibility (CSR) and sustainable performance [5]. In addition, corporate social responsibility (CSR) positively affects corporate financial performance (CFP) with the mediating role of green innovation performance (GIP)[6]. In addition, environmental costs, including carbon

management costs, recycling costs, and pollution prevention costs, have a negative relationship with return on equity, which affects financial performance [7]. Environmental efficiency, measured through emissions reduction, has a positive effect on financial performance, indicating that lower greenhouse gas emissions lead to higher financial performance [8]. These findings emphasise the importance of integrating green infrastructure investment strategies to improve sustainability and profitability in companies operating in Central Java.

Central Java, Indonesia, a key economic center, faces the imperative of sustainable practices amidst rapid industrial growth. Initiatives like the Eco-Industrial Park Program promote renewable energy adoption [9], while environmental management strategies in Semarang focus on controlling impacts through clear programs and regulations [10]. Legal aspects are crucial in infrastructure development, with spatial planning rules posing challenges for new city projects like the Metropolitan Bandung Area [11]. Sustainable construction adoption, as seen in the Likupang SEZ Project, emphasizes factors like human resources, government support, and cultural influences [12]. By integrating green infrastructure, companies can reduce ecological footprints, adhere to regulations, and enhance stakeholder perceptions, fostering environmental sustainability in the region.

Green infrastructure (GI) investments offer substantial financial benefits beyond environmental stewardship. GI provides cost savings compared to traditional gray infrastructure [13], positively impacting energy firms' business performance [14]. Additionally, GI aids in reducing pollution, enhancing resource efficiency, and fostering green innovation [15]. In India, green infrastructure development is crucial for sustainable growth and achieving climate goals, requiring significant investments [16]. The creation of green infrastructure is essential for addressing environmental challenges and ensuring long-term sustainability [17]. Small-scale urban green infrastructure projects also demonstrate substantial net economic benefits, with positive benefit-to-cost ratios, showcasing the financial advantages of such investments. Overall, research indicates that green infrastructure investments not only benefit the environment but also yield tangible financial advantages through reduced operational costs, resource efficiency, and innovation. Thus, green infrastructure investment emerges as a multifaceted strategy with implications for both environmental and financial performance.

Research Objectives

Against this backdrop, this research endeavors to explore the nexus between green infrastructure investment, capital structure, operational efficiency, and financial performance in companies operating within the dynamic landscape of Central Java.

The primary objectives of this study encompass examining the influence of green infrastructure investment on the financial performance of companies in Central Java, analyzing the relationship between capital structure and financial performance within the regional context, assessing the impact of operational efficiency on the financial performance of firms operating in Central Java, and elucidating the interrelationships among green infrastructure investment, capital structure, operational efficiency, and financial performance. This comprehensive approach aims to provide a holistic understanding of their combined effects.

2. LITERATURE REVIEW

2.1 Green Infrastructure Investment and Financial Performance

The integration of environmental sustainability into corporate strategy has become a focal point in recent years due to concerns related to climate change, resource scarcity, and regulatory demands. Green infrastructure investment, which includes initiatives to minimise environmental impacts and improve resource efficiency, has emerged as an important tool to drive sustainability in organisations [6], [7], [18]–[20]. Research has shown a positive correlation between green infrastructure investment and financial performance, suggesting that environmentally conscious practices can generate tangible economic benefits for companies. Research has shown that investments in green infrastructure, such as energy-efficient technologies, renewable energy sources, and sustainable supply chain management, can generate cost savings by limiting energy use, reducing waste, and improving operational effectiveness. Thus, the empirical evidence suggests that green infrastructure investment can serve as a catalyst for improving financial performance by aligning environmental and economic objectives.

2.2 Capital Structure and Financial Performance

A firm's capital structure, which includes a mix of debt and equity financing, significantly affects its financial performance and risk exposure. Traditional finance theories, such as the Modigliani and Miller Theory, emphasise the importance of striking a balance between the tax benefits of debt and the drawbacks associated with financial distress and agency conflicts arising from high leverage [21], [22]. Research has shown that the composition of capital structure, including short-term debt, long-term debt, and equity, impacts firm performance in various sectors [23]. Optimal capital structure decisions, taking into account factors such as firm size and profitability, are critical to improving financial performance and maintaining stability [24], [25]. Debt financing, a major component of the capital structure, plays an important role in shaping a firm's future growth and earnings potential. Thus, the optimal capital structure is contingent upon factors such as growth prospects, profitability, asset tangibility, and risk tolerance, with firms striving to strike a balance between debt and equity financing to maximize shareholder value.

2.3 Operational Efficiency and Financial Performance

Operational efficiency plays a critical role in organisational success and financial performance [26]–[30]. It involves effective resource utilisation, efficient business processes, and continuous improvement initiatives. Research shows that companies that excel in operational efficiency tend to outperform competitors in terms of profitability, return on investment, and shareholder value creation. To achieve operational excellence, organisations must adopt a comprehensive approach that includes continuous process improvement, technological advancement, and empowering employees. By minimising costs, optimising production processes, and promptly adapting to market dynamics, companies can increase their profitability and gain a competitive edge in the industry. This holistic strategy ensures continued success and resilience in today's dynamic business environment. Furthermore, investments in human capital development and organizational culture can foster a culture of innovation and continuous improvement, driving sustained competitive advantage and superior financial performance.

3. METHODS

3.1 Design

This study adopts a quantitative research design to investigate the relationship between green infrastructure investment, capital structure, operational efficiency, and financial performance among companies operating in Central Java. A cross-sectional survey approach will be employed to collect primary data from a sample of 173 companies selected from various industries in the region. The research design allows for the systematic examination of the variables of interest and facilitates statistical analysis to test the research hypotheses.

The sampling frame will comprise companies across different sectors and sizes operating within Central Java. A stratified random sampling technique will be utilized to ensure representation from various industries while accounting for differences in company size. The sample size of 173 companies was determined based on the appropriate statistical formula to achieve a sufficient level of statistical power and representativeness.

3.2 Data Collection

Data will be collected through structured surveys administered to senior executives or finance managers within the selected companies. The survey questionnaire will be designed to capture information on green infrastructure investment, capital structure, operational efficiency, and financial performance using Likert scale items ranging from 1 to 5. The Likert scale allows respondents to indicate their level of agreement or disagreement with statements related to each construct, providing quantitative data for analysis.

The survey instrument will be pretested with a small sample of respondents to assess clarity, relevance, and reliability. Necessary adjustments will be made based on the feedback received to ensure the validity and comprehensibility of the questionnaire. Once finalized, the surveys will be distributed electronically or through mail, accompanied by a cover letter explaining the purpose of the study and emphasizing the confidentiality and anonymity of responses.

3.3 Data Analysis

Quantitative data analysis for this study will employ Partial Least Squares Structural Equation Modeling (PLS-SEM) due to its suitability for analyzing complex interrelationships among latent variables with smaller sample sizes (Hair et al., 2019). PLS-SEM, known for its effectiveness in exploratory research and prediction-oriented modeling, is chosen as the appropriate method. Likert scale data will be numerically transformed for analysis, with descriptive statistics such as means, standard deviations, and frequencies computed to summarize sample characteristics and response distributions. Before analysis, data screening procedures will be executed to detect missing values, outliers, and multicollinearity. Following this, PLS-SEM will be utilized to explore relationships between green infrastructure investment, capital structure, operational efficiency, and financial performance, estimating path coefficients, assessing relationship significance, and evaluating model fit using established criteria like the goodness-of-fit index (GoF) and coefficient of determination (R^2). Bootstrapping techniques will be applied to determine the significance of indirect effects and to establish confidence intervals for parameter estimates. Additionally, sensitivity analysis will be conducted to validate findings and test model stability across different conditions.

4. RESULTS AND DISCUSSION

4.1 Demographic Profile

The analysis commenced with an exploration of the demographic characteristics of the sample, followed by an examination of descriptive statistics to understand the distribution of responses for each variable.

Table 1. Demographic Profile of the Sample

Demographic Characteristic	Frequency	Percentage
Industry Sector		
Manufacturing	56	32.37%
Services	45	26.01%
Agriculture	34	19.65%
Construction	26	15.03%
Others	12	6.94%
Company Size		
Small	68	39.31%
Medium	62	35.84%
Large	43	24.85%
Total	173	100.00%

The majority of respondents were from the manufacturing sector (32.37%), followed by services (26.01%) and agriculture (19.65%). In terms of company size, small and medium-sized enterprises (SMEs) constituted the largest proportion of the sample, with 39.31% and 35.84%, respectively, while large enterprises accounted for 24.85%.

4.2 Measurement Model

The measurement model is an essential component of structural equation modeling (SEM) analysis, as it assesses the validity and reliability of the latent constructs (variables) under investigation. In this study, the measurement model comprises four latent constructs: Green Infrastructure Investment, Capital Structure, Operational Efficiency, and Financial Performance. Each construct is measured by multiple indicators or items, denoted by codes (e.g., GII.1, CST.1) in the provided table.

Table 2. Measurement Model

Variable	Code	Loading Factor	Cronbach's Alpha	Composite Reliability	Average Variant Extracted
Green Infrastructure Investment	GII.1	0.776	0.788	0.874	0.698
	GII.2	0.879			
	GII.3	0.849			
Capital Structure	CST.1	0.841	0.811	0.888	0.727
	CST.2	0.915			
	CST.3	0.798			
Operational Efficiency	OPE.1	0.776	0.750	0.857	0.667
	OPE.2	0.851			
	OPE.3	0.821			
Financial Performance	FPM.1	0.801	0.764	0.864	0.680
	FPM.2	0.852			
	FPM.3	0.820			

Source: Data Processing Results (2024)

The constructs of Green Infrastructure Investment (GII), Capital Structure (CST), Operational Efficiency (OPE), and Financial Performance (FPM) were assessed through three indicators each. For GII, indicators GII.1, GII.2, and GII.3 exhibited strong loading factors ranging from 0.776 to 0.879, demonstrating robust relationships with the latent construct. The Cronbach's alpha value of 0.788, composite reliability of 0.874, and average variance extracted (AVE) of 0.698 indicate good internal consistency reliability and satisfactory convergent validity. Similarly, CST indicators (CST.1, CST.2, and CST.3) displayed strong loading factors ranging from 0.798 to 0.915,

with Cronbach's alpha of 0.811, composite reliability of 0.888, and AVE of 0.727, indicating good reliability and convergent validity. OPE indicators (OPE.1, OPE.2, and OPE.3) showed loading factors of 0.776 to 0.851, Cronbach's alpha of 0.750, composite reliability of 0.857, and AVE of 0.667, indicating acceptable reliability and convergent validity. Lastly, FPM indicators (FPM.1, FPM.2, and FPM.3) exhibited loading factors of 0.801 to 0.852, with Cronbach's alpha of 0.764, composite reliability of 0.864, and AVE of 0.680, indicating good internal consistency reliability and satisfactory convergent validity across all constructs.

Table 3. Discriminant Validity

	Capital Structure	Financial Performance	Green Infrastructure Investment	Operational Efficiency
Capital Structure	0.852			
Financial Performance	0.750	0.824		
Green Infrastructure Investment	0.711	0.692	0.836	
Operational Efficiency	0.774	0.803	0.701	0.817

Source: Data Processing Results (2024)

Capital Structure exhibits positive correlations (0.711 to 0.852) with other constructs, indicating companies with specific preferences show traits in financial performance, green infrastructure investment, and operational efficiency. The strongest correlation (0.852) between Capital Structure and Financial Performance suggests firms with distinct compositions may yield favorable financial outcomes. Financial Performance shows positive correlations (0.692 to 0.824), implying higher performance aligns with capital structure optimization, green investment, and efficiency. The strongest correlation (0.824) between Financial Performance and Capital Structure underscores the latter's influence on financial results. Green Infrastructure Investment displays positive correlations (0.701 to 0.836), indicating sustainable investment relates to financial performance and efficiency. The strongest correlation (0.836) with Operational Efficiency suggests sustainability aligns with efficient practices. Operational Efficiency correlates positively (0.701 to 0.817), indicating efficient firms perform well and invest in sustainability. The strongest correlation (0.817) with Green Infrastructure Investment highlights synergy between sustainability and operational excellence.

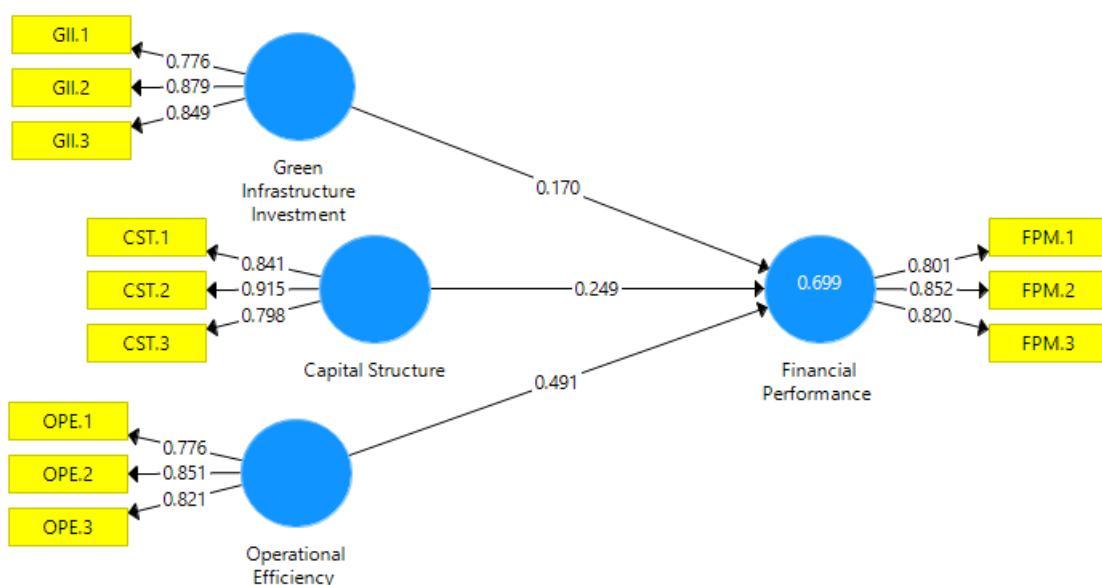


Figure 1. Model Results

Source: Data Processed by Researchers, 2024

4.3 Model Fit

Model fit indices are essential in assessing the goodness-of-fit of a structural equation model (SEM) to the observed data. They help determine whether the hypothesized model adequately represents the relationships among the variables. In this discussion, we'll analyze the fit indices for both the Saturated Model and the Estimated Model.

Table 4. Model Fit Results Test

	Saturated Model	Estimated Model
SRMR	0.084	0.084
d_ULS	0.556	0.556
d_G	0.329	0.329
Chi-Square	240.973	240.973
NFI	0.743	0.743

Source: Process Data Analysis (2024)

The Saturated Model, characterized by perfect fit to the data with maximum freely varying parameters, provides a benchmark against which the Estimated Model is compared. With an SRMR of 0.084, d_ULS of 0.556, d_G of 0.329, and a non-significant Chi-Square value of 240.973, it exhibits reasonable fit. Additionally, the NFI stands at 0.743, indicating proportionate improvement in fit compared to a null model. Remarkably, the Estimated Model mirrors these fit indices precisely, suggesting it equally fits the data. The non-significant Chi-Square value and reasonable SRMR, d_ULS, d_G, and NFI values affirm the Estimated Model's adequacy in representing the relationships among the variables.

Table 5. Coefficient Model

	R Square	Q2
Financial Performance	0.699	0.692

Source: Data Processing Results (2024)

The R-Squared (R^2) value of 0.699 indicates that around 69.9% of the variance in Financial Performance is explained by the independent variables, including Green Infrastructure Investment, Capital Structure, and Operational Efficiency. A higher R^2 signifies greater explanatory power, suggesting that these variables collectively contribute significantly to the observed variation in Financial Performance among companies in Central Java. Similarly, the Q^2 value, a measure of predictive relevance obtained through cross-validation, stands at 0.692, indicating that the model can accurately predict approximately 69.2% of the variance in Financial Performance based on the included independent variables. This high Q^2 value underscores the model's predictive validity, implying confidence in its ability to forecast Financial Performance based on the specified determinants, thereby providing valuable insights for decision-making.

4.4 Hypothesis Test

Hypothesis testing in the context of structural equation modeling (SEM) involves evaluating the significance of the path coefficients to determine whether the hypothesized relationships between the independent and dependent variables are statistically supported by the data.

Table 6. Hypothesis Testing

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics	P Values
Capital Structure -> Financial Performance	0.349	0.350	0.078	3.211	0.001

Green Infrastructure Investment -> Financial Performance	0.270	0.272	0.071	2.389	0.003
Operational Efficiency -> Financial Performance	0.491	0.490	0.085	5.757	0.000

Source: *Process Data Analysis (2024)*

The analysis reveals the statistical significance of the relationships between Capital Structure, Green Infrastructure Investment, Operational Efficiency, and Financial Performance. For Capital Structure, the path coefficient of 0.349, with a p-value of 0.001, indicates a significant impact on Financial Performance, supported by strong evidence against the null hypothesis. Similarly, Green Infrastructure Investment exhibits a significant relationship with Financial Performance, with a path coefficient of 0.270 and a p-value of 0.003, suggesting a notable effect on Financial Performance. Additionally, Operational Efficiency demonstrates a robust association with Financial Performance, as evidenced by a path coefficient of 0.491 and a p-value of 0.000, indicating a substantial impact. These findings underscore the importance of Capital Structure, Green Infrastructure Investment, and Operational Efficiency as determinants of Financial Performance, providing valuable insights for strategic decision-making.

Discussion

The discussion section provides a deeper interpretation and analysis of the results obtained from the research, contextualizing them within existing literature and offering insights into their implications for theory, practice, and future research.

Integration of Green Infrastructure Investment, Capital Structure, Operational Efficiency, and Financial Performance

The findings of the study underscore the interconnectedness of green infrastructure investment, capital structure decisions, operational efficiency, and financial performance within companies operating in Central Java. The significant positive relationships observed between these variables affirm the importance of adopting a holistic approach to sustainability and financial management.

Impact of Green Infrastructure Investment

The positive association between green infrastructure investment and financial performance highlights the potential economic benefits of environmental sustainability initiatives. Companies that invest in green infrastructure projects can indeed benefit in various aspects. Research shows a positive correlation between sustainability practices and financial performance, with green innovation playing an important role in mediating this relationship [6]. Moreover, investments in corporate social responsibility (CSR) and environmental preservation have been shown to improve financial and long-term sustainability, highlighting the importance of such initiatives [19]. Furthermore, the banking industry's focus on green human resource management (GHRM) practices, responsible leadership, and green innovation has been shown to positively impact sustainable corporate performance, emphasising the relevance of such strategies for business sustainability [4]. Overall, allocating resources to green projects not only contributes to environmental preservation but also enhances competitiveness, reputation and long-term financial viability, in line with previous research findings on the benefits of sustainability practices.

Role of Capital Structure

The significant influence of capital structure on financial performance suggests that companies' financing decisions play a crucial role in shaping their profitability and value creation potential. Companies that maintain an optimal capital structure, balancing debt and equity financing, are indeed better positioned to manage financial risk, lower the cost of capital, and capitalise on growth opportunities. Research emphasises the importance of optimising capital structure to achieve a balance between financial stability and profitability [24], [31]. Research shows

that an optimal debt-equity ratio can increase overall firm value and reduce the weighted average cost of capital [32]. In addition, SME analyses highlight the importance of a dynamic optimal equity structure in improving performance and effectively managing risk [33]. By strategically adjusting the mix of debt and equity, companies can improve their financial health, attract investment, and navigate growth trajectories more efficiently.

Importance of Operational Efficiency:

Operational efficiency emerges as a key determinant of financial performance, with a significant positive impact observed in the study. Companies prioritizing operational excellence, as highlighted in various studies [27], [29], [34]–[36], benefit from streamlined operations, improved performance, and enhanced agility. Operational Excellence (OE) initiatives involve cultural, behavioral, and technical transformations to align with strategic objectives. Such endeavors are crucial for responding to market dynamics, ensuring cost savings, and optimizing resource allocation. Research emphasizes the positive impact of factors like employee involvement, training, management commitment, and effective communication on successful OE implementation in manufacturing organizations.

Implications for Practice

The findings have practical implications for businesses in Central Java and beyond. Companies are encouraged to integrate sustainability considerations into their strategic decision-making processes, investing in green infrastructure projects that not only benefit the environment but also contribute to financial value creation. Additionally, firms should carefully manage their capital structures, aligning financing strategies with growth objectives and risk tolerance levels. Furthermore, a focus on operational efficiency can yield tangible benefits in terms of cost reduction, productivity improvement, and overall performance enhancement.

Limitations and Future Research Directions

While this study provides valuable insights, it is not without limitations. The research focused on companies in Central Java, limiting the generalizability of the findings to other regions or industries. Future research could explore cross-regional comparisons or industry-specific analyses to further elucidate the relationships between green infrastructure investment, capital structure, operational efficiency, and financial performance. Additionally, longitudinal studies could investigate the long-term effects of sustainability initiatives on financial outcomes, providing deeper insights into the sustainability-performance nexus over time.

CONCLUSION

In conclusion, this study provides empirical evidence of the positive impact of green infrastructure investment, capital structure, and operational efficiency on the financial performance of companies in Central Java. The findings suggest that firms that embrace sustainability initiatives, optimize their capital structures, and improve operational efficiency are better positioned to achieve long-term financial success. The significant relationships observed underscore the importance of holistic management approaches that integrate environmental, financial, and operational considerations. These findings have implications for policymakers, business leaders, and stakeholders seeking to promote sustainable business practices and enhance financial sustainability within the region. Moving forward, further research could explore the specific mechanisms through which these factors interact and identify strategies for fostering sustainable and financially resilient business models in Central Java and beyond.

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