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An Analysis of the Implementation of Green Building Technologies in Reducing Energy Consumption and Their Impact on Corporate Performance in Jakarta

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ABSTRACT

This study aims to analyze the effect of green building technology implementation on energy consumption reduction and its impact on company performance in Jakarta. A quantitative research design was employed using data from 150 respondents who are involved in building operations, facility management, and sustainability-related functions. Data were collected using a Likert-scale questionnaire and analyzed using Structural Equation Modeling–Partial Least Squares (SEM-PLS 3). The results indicate that green building technology has a significant positive effect on energy consumption reduction. In addition, energy consumption reduction significantly improves company performance through cost efficiency and operational effectiveness. The findings also show that green building technology has a direct positive effect on company performance. Furthermore, energy consumption reduction partially mediates the relationship between green building technology and company performance. The study concludes that the adoption of green building technologies plays a strategic role in improving both environmental efficiency and organizational performance in urban corporate settings.

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1. INTRODUCTION

The increasing urgency of environmental degradation and climate change has intensified global attention on sustainable development across industrial and commercial sectors. Among the sectors with the most significant environmental footprint, the building sector plays a critical role due to its high energy consumption, greenhouse gas emissions, and intensive resource utilization [1], [2]. In rapidly urbanizing cities such as Jakarta, where infrastructure expansion and commercial development continue to accelerate, the demand for energy-efficient and environmentally responsible building systems has become increasingly important [3], [4]. As a result, green building technologies are increasingly positioned as a strategic approach to reduce environmental impact while maintaining operational performance.

Green building technologies refer to integrated design, construction, and operational strategies aimed at minimizing the environmental impact of buildings throughout their life cycle. These technologies include energy-efficient HVAC and lighting systems, renewable energy integration, smart building management systems, water efficiency technologies, and the use of environmentally friendly materials [5], [6]. The implementation of these technologies is expected to significantly reduce energy consumption, improve operational efficiency, and support broader sustainability objectives at the organizational level.

From a corporate perspective, sustainability has shifted from a compliance-driven obligation to a strategic component of business performance. Firms that successfully implement green building technologies may benefit from reduced operational costs, improved energy efficiency, and enhanced long-term financial stability [7]–[9]. In addition, environmental performance can strengthen corporate reputation, increase stakeholder trust, and improve competitiveness in markets that are increasingly sensitive to sustainability issues [10]. However, the extent to which these benefits are realized depends on the level and consistency of adoption, which remains uneven in many developing economies.

In Jakarta, commercial and industrial buildings account for a substantial proportion of electricity demand, making the building sector a key target for energy efficiency interventions. The adoption of green building technologies in this context presents both significant opportunities and structural constraints [9], [11]. Rising energy costs and increasing environmental awareness encourage organizations to adopt sustainable building solutions, while high initial investment requirements, limited technical capacity, and inconsistent regulatory enforcement may hinder implementation. This creates a complex environment in which the effectiveness of green building technologies needs to be empirically examined.

Existing literature generally confirms that green building practices contribute positively to energy efficiency and environmental performance. However, there remains a limited understanding of how these technologies translate into measurable improvements in company performance, particularly in emerging market contexts such as Indonesia. Most prior studies emphasize technical and environmental outcomes, while the economic and organizational implications are less extensively explored. This gap highlights the need for more comprehensive empirical evidence linking green building technologies, energy consumption reduction, and firm performance.

Therefore, this study aims to analyze the implementation of green building technologies in reducing energy consumption and its impact on company performance in Jakarta. Specifically, it examines the effect of green building technology implementation on energy consumption reduction, the effect of energy consumption reduction on company performance, and the direct relationship between green building technologies and company performance. The results are expected to provide practical implications for policymakers, construction industry stakeholders, and corporate managers, while also contributing to the academic literature on sustainable building practices and organizational performance in urban environments.

2. LITERATURE REVIEW

2.1 Green Building Technology

Green building technology refers to an integrated approach in building design, construction, operation, and maintenance that aims to minimize environmental impact while optimizing resource efficiency. Based on sustainable development principles, it emphasizes energy efficiency, reduction of carbon emissions, the use of environmentally friendly materials, and improvements in indoor environmental quality [9], [12]. Key components typically include energy-efficient

HVAC systems, smart lighting systems, building automation systems, renewable energy integration such as solar panels, and the application of sustainable construction materials. In the context of corporate operations, green building technology is not merely a technical innovation but also a strategic investment that supports long-term organizational efficiency [10], [12]. Firms that adopt these technologies are expected to achieve cost reductions through lower electricity and maintenance expenses, while also improving overall operational performance. In addition, the implementation of green building practices reflects corporate environmental responsibility, which can enhance stakeholder legitimacy and strengthen corporate image in markets that are increasingly oriented toward sustainability.

2.2 *Energy Consumption Reduction*

Energy consumption in commercial buildings represents a critical component of operational costs and a significant contributor to environmental degradation. Consequently, reducing energy consumption has become a central objective in sustainable facility management, typically achieved through system optimization, behavioral adjustments, and technological innovation [13], [14]. Green building technologies contribute directly to energy consumption reduction by enhancing system efficiency and minimizing energy waste. For example, automated lighting systems regulate energy use based on occupancy levels, while smart HVAC systems optimize temperature control according to real-time environmental conditions. Prior studies indicate that the implementation of energy-efficient building systems can substantially reduce overall energy demand, leading to lower utility expenditures and a reduced environmental footprint [15], [16]. From an organizational standpoint, reduced energy consumption not only generates cost savings but also enhances operational stability by decreasing dependency on energy supply fluctuations and improving the predictability of long-term operational budgeting.

2.3 *Company Performance*

Company performance is a multidimensional construct encompassing financial performance, operational efficiency, and non-financial outcomes such as sustainability performance and corporate reputation. In contemporary environmental management contexts, performance evaluation is increasingly extended beyond profitability to include efficiency, innovation capacity, and environmental responsibility indicators [17], [18]. Sustainable operational practices, including the implementation of green building technologies, can enhance company performance through multiple mechanisms. First, improvements in energy efficiency lead to direct cost reductions, thereby increasing profitability. Second, stronger environmental performance contributes to enhanced corporate reputation, which can improve stakeholder trust and support [19], [20]. Third, sustainable building environments may increase employee productivity by providing healthier, safer, and more comfortable working conditions, thereby indirectly strengthening overall organizational effectiveness.

2.4 *Conceptual Framework*

Based on the theoretical review and hypotheses development, this study proposes a conceptual model in which green building technology influences energy consumption reduction, which in turn affects company performance. Additionally, green building technology is hypothesized to have a direct effect on company performance. Energy consumption reduction also functions as a key intervening mechanism linking technological adoption to organizational outcomes. This framework positions energy consumption reduction as a mediating variable that explains how technological implementation translates into improved organizational performance outcomes.

The relationship between green building technology and energy consumption has been widely discussed in the sustainability and environmental management literature. Green building systems are explicitly designed to optimize resource utilization, particularly through enhancing energy efficiency. Technologies such as building energy management systems, thermal insulation improvements, daylight optimization strategies, and renewable energy integration have been empirically shown to reduce energy consumption in both commercial and industrial buildings. Prior studies consistently indicate that organizations adopting green building technologies experience measurable reductions in energy usage through improved system efficiency, minimized energy losses, and optimized operational resource allocation. Therefore, the following relationship is proposed:

H1: Green building technology has a positive effect on reducing energy consumption.

H2: Energy consumption reduction has a positive effect on company performance.

H3: Green building technology has a positive effect on company performance.

3. METHODS

3.1 Research Design

This study employs a quantitative research design to examine the relationships among green building technology implementation, energy consumption reduction, and company performance in Jakarta. The quantitative approach is chosen for its ability to provide objective measurement of variables and to facilitate statistical hypothesis testing. Data are collected using a cross-sectional design, capturing respondents' perceptions at a single point in time regarding the variables of interest. For analysis, Structural Equation Modeling–Partial Least Squares (SEM-PLS 3) is employed, as it is well-suited for predictive modeling and for assessing complex relationships among latent constructs, particularly when the research framework includes multiple dependent variables and mediating effects.

3.2 Population and Sample

The population of this study comprises companies operating in Jakarta that have implemented or are in the process of adopting green building technologies, with respondents being individuals who possess sufficient knowledge of building operations, energy management, or corporate sustainability practices, including facility managers, operational staff, and sustainability officers. A total of 150 respondents were selected using a purposive sampling technique, a non-probability method applied to ensure that participants meet specific criteria relevant to the research objectives, particularly familiarity with green building practices and energy management systems.

3.3 Data Collection Method

Data for this study were collected using a structured questionnaire distributed directly to respondents, with items developed based on indicators from previous literature on green building technology, energy efficiency, and company performance. Each variable was measured using a 5-point Likert scale, where 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. The questionnaire consisted of three main sections: (1) green building technology implementation, (2) energy consumption reduction, and (3) company performance. The study includes three latent variables: Green Building Technology (GBT), which refers to the level of implementation of environmentally friendly building systems such as energy-efficient systems, smart building controls, and sustainable infrastructure; Energy Consumption Reduction (ECR), defined as the perceived decrease in energy usage resulting from green building technology adoption, including efficiency gains and cost savings; and Company Performance (CP), encompassing organizational outcomes such as operational efficiency, cost reduction, and improvements in sustainability-related performance.

3.4 Data Analysis Technique

The data analysis in this study was conducted using Structural Equation Modeling–Partial Least Squares (SEM-PLS) with SmartPLS 3 software, comprising two main stages. First, the measurement model (outer model) was evaluated to assess the validity and reliability of the constructs, including convergent validity through outer loadings (>0.70) and Average Variance Extracted (AVE >0.50), discriminant validity using the Fornell-Larcker criterion and cross-loading values, and reliability testing through Cronbach's Alpha (>0.70) and Composite Reliability (>0.70). Second, the structural model (inner model) was examined to test the hypothesized relationships between constructs, including the coefficient of determination (R^2) for explanatory power, effect size (f^2) to evaluate the impact of exogenous variables, predictive relevance (Q^2) using blindfolding procedures, and path coefficient significance testing through bootstrapping with t-statistics and p-values. Hypothesis testing was performed using the bootstrapping method in SmartPLS 3 at a 5% significance level ($\alpha = 0.05$), with a hypothesis considered supported if the t-statistic exceeded 1.96 and the p-value was below 0.05.

4. RESULTS AND DISCUSSION

4.1 Respondent Profile

The respondents in this study consisted of professionals involved in building operations, energy management, and sustainability-related roles in companies located in Jakarta.

Table 1. Respondent Characteristics

Category	Group	Frequency	Percentage
Gender	Male	86	57.3%
	Female	64	42.7%
Age	21–30 years	38	25.3%
	31–40 years	61	40.7%
	41–50 years	34	22.7%
	>50 years	17	11.3%

Position	Facility Manager	48	32.0%
	Operational Staff	57	38.0%
	Sustainability Officer	45	30.0%

The respondent profile shows a balanced representation across gender, age, and organizational roles. Male respondents slightly outnumbered females, comprising 57.3% of the sample, while females accounted for 42.7%. The largest age group was 31–40 years (40.7%), indicating that most participants were mid-career professionals, followed by 21–30 years (25.3%), 41–50 years (22.7%), and over 50 years (11.3%). In terms of organizational position, operational staff represented the largest group (38.0%), followed by facility managers (32.0%) and sustainability officers (30.0%), suggesting that the sample included respondents with both operational and sustainability oversight relevant to green building practices and energy management.

4.2 Measurement Model (Outer Model)

The measurement model evaluation confirms that all indicators meet validity and reliability standards.

Table 2. Validity and Reliability Results

Construct	Cronbach's Alpha	Composite Reliability	AVE
Green Building Technology (GBT)	0.912	0.935	0.742
Energy Consumption Reduction (ECR)	0.889	0.918	0.701
Company Performance (CP)	0.901	0.926	0.723

The validity and reliability analysis indicates that all constructs in the study demonstrate strong measurement properties. Cronbach's Alpha values ranged from 0.889 to 0.912, confirming high internal consistency for Green Building Technology (GBT), Energy Consumption Reduction (ECR), and Company Performance (CP). Composite Reliability values were also high, between 0.918 and 0.935, supporting the reliability of the constructs, while Average Variance Extracted (AVE) values exceeded the 0.50 threshold, ranging from 0.701 to 0.742, demonstrating satisfactory convergent validity for all variables.

4.3 Discriminant Validity

Discriminant validity is assessed using the Fornell-Larcker criterion.

Table 3. Fornell-Larcker Criterion

Construct	GBT	ECR	CP
GBT	0.861		
ECR	0.742	0.837	
CP	0.701	0.768	0.851

The Fornell-Larcker criterion results indicate that discriminant validity is adequately established for all constructs. Each construct's square root of AVE (diagonal values) is higher than its correlations with other constructs, with Green Building Technology (GBT) at 0.861, Energy Consumption Reduction (ECR) at 0.837, and Company Performance (CP) at 0.851, while the correlations between constructs remain lower, ranging from 0.701 to 0.768. These findings confirm that each construct is distinct and measures a unique concept within the research model.

4.4 Structural Model (Inner Model)

The R-square results indicate that the model explains 55.1% of the variance in Energy Consumption Reduction (ECR) and 67.3% of the variance in Company Performance (CP), demonstrating moderate to strong explanatory power. These values suggest that the implementation of green building technology and related factors account for a substantial portion of changes in energy consumption reduction and overall company performance, supporting the relevance of the proposed conceptual model in explaining organizational outcomes.

4.5 Hypothesis Testing Results

Bootstrapping analysis was conducted with 5,000 subsamples.

Table 4. Path Coefficients

Hypothesis	Relationship	Original Sample (O)	T-Statistic	P-Value	Decision
H1	GBT → ECR	0.742	11.842	0.000	Supported
H2	ECR → CP	0.516	6.317	0.000	Supported
H3	GBT → CP	0.321	3.984	0.000	Supported

The path coefficient analysis shows that all hypothesized relationships are supported. Green Building Technology (GBT) has a strong positive effect on Energy Consumption Reduction (ECR) with a coefficient of 0.742 ($t = 11.842$, $p < 0.001$), while ECR positively influences Company Performance (CP) with a coefficient of 0.516 ($t = 6.317$, $p < 0.001$). Additionally, GBT has a direct positive effect on CP with a coefficient of 0.321 ($t = 3.984$, $p < 0.001$), confirming that both direct and indirect pathways from green building technology to organizational performance are significant.

4.6 Indirect Effect (Mediation Test)

Table 5. Indirect Effect Results

Relationship	Indirect Effect	T-Statistic	P-Value
GBT → ECR → CP	0.383	5.721	0.000

The analysis of indirect effects indicates that Energy Consumption Reduction (ECR) significantly mediates the relationship between Green Building Technology (GBT) and Company Performance (CP). The indirect effect of GBT on CP through ECR is 0.383, with a t-statistic of 5.721 and a p-value of 0.000, demonstrating that the implementation of green building technologies enhances company performance not only directly but also indirectly by reducing energy consumption.

Discussion

The findings of this study confirm that green building technology has a strong and significant effect on reducing energy consumption, indicating that the implementation of energy-efficient systems, smart building technologies, and sustainable infrastructure effectively lowers energy usage in companies operating in Jakarta. This result aligns with sustainability theory, which emphasizes that technological innovation in buildings directly enhances resource efficiency and environmental performance [21], [22].

Furthermore, the reduction in energy consumption significantly improves company performance, suggesting that lower energy usage translates into operational cost savings, greater efficiency, and enhanced financial outcomes. Beyond cost benefits, organizations adopting green building practices also gain reputational advantages, strengthening stakeholder trust and competitive positioning in sustainability-conscious markets [23], [24].

The direct effect of green building technology on company performance demonstrates that its contribution extends beyond energy efficiency. Green building implementation can directly enhance organizational outcomes through improved working environments, advanced automation systems, and compliance with environmental standards, collectively increasing productivity and enhancing corporate image [7], [12], [25].

The mediation analysis confirms that energy consumption reduction partially explains the relationship between green building technology and company performance, indicating that the benefits of green building are both direct and indirect. These results reinforce the critical role of energy efficiency as a key mechanism in sustainable corporate performance improvement, highlighting that environmentally responsible building practices can simultaneously support operational effectiveness and strategic organizational goals in urban industrial contexts like Jakarta.

5. CONCLUSION

This study confirms that the implementation of green building technology significantly reduces energy consumption in companies operating in Jakarta, with energy-efficient systems, smart building management, and sustainable infrastructure effectively lowering operational energy usage and serving as a key mechanism for enhancing organizational efficiency. Energy consumption reduction also has a positive and significant impact on company performance, indicating that lower energy usage translates into cost savings, improved operational efficiency, and strengthened corporate sustainability outcomes, making energy efficiency a critical driver of both financial and non-financial results. In addition, green building technology exerts a direct positive effect on company performance, suggesting that its benefits extend beyond energy savings to include improved productivity, enhanced environmental reputation, and compliance with sustainability standards. The mediation analysis further demonstrates that energy consumption reduction partially mediates the relationship between green building technology and company performance, highlighting that the advantages of green building operate through both direct and indirect pathways, thereby underscoring its role as both an environmental initiative and a strategic business investment that supports sustainable and competitive organizational performance.

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