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EXPLORING THE FINANCIAL DYNAMICS OF GREEN BUILDING ADOPTION: INSIGHTS FROM INDONESIA

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ABSTRACT
This research purpose is to offer insights to property owners and developers whose focus tends to be solely on the initial costs of green buildings, and aligning with the requirements set forth by Minister of Public Works and Public Housing Regulation No. 21 of 2022, effective from 2022, which mandates green buildings to obtain Building Structure Approval (PBG) and Functional Worthiness Certificate (SLF). Drawing from the 2013-2018 Green Building Council Indonesia (GBCI) report, which indicates a mere 2% certification rate for buildings exceeding 12 floors, this study seizes the opportunity to delve into how green building considerations influence financial decisions. Surveying 102 experienced respondents in green building practices, this research employs green building factor analysis, value engineering, life cycle cost analysis, and Structural Equation Modeling (SEM)-PLS to scrutinize the factors influencing cost performance in green buildings. The findings spotlight 10 critical green building factors pivotal for securing certification, alongside unveiling correlations between initial costs, operational costs, and life cycle costs. Anticipated outcomes encompass facilitating compliance with Minister of Public Works and Public Housing Regulation No. 21 of 2021, and nurturing the development of green buildings in Indonesia. Implications span regulatory compliance, informed financial strategies, green building advancement, and knowledge dissemination. This study aims to simplify comprehension of the financial ramifications of green buildings, furnishing practical guidance for developers in navigating the intricacies of cost-sustainability equilibrium.
Keywords: *Green Building, Lifecycle Cost, SEM-PLS, Value Engineering*

1. Introduction

Heads of State, Government, and High Representatives convened at the UN Headquarters in New York from September 25 to 27, 2015, reaching a consensus on new global Sustainable Development Goals. Comprising 17 goals with 169 targets, these goals address diverse sustainable development issues, with Indonesia actively participating in their implementation. Under Minister of Public Works and Public Housing Regulation No. 21 of 2021, green buildings are required to obtain Building Structure 115Approval (PBG) and Functional Worthiness Certificate (SLF) (Menteri Pekerjaan Umum dan Perumahan Rakyat Republik Indonesia, 2021). The World Green Building Council summarizes the 17 criteria for achieving sustainable development goals into three main pillars: environmental (planet), social (human), and economic (profit). Green buildings, which adhere to principles of conservation, offer functionalities and benefits conducive to human well-being.

Historically, the swift rise of urbanization has led to unprecedented climate shifts and environmental degradation. Consequently, global warming has given rise to urban heat islands, where temperatures in many cities worldwide are 2 to 5 degrees Celsius higher compared to rural areas.(Alattyih et al., 2020).

The building industry remains highly energy-intensive regardless of location, with building energy consumption estimated to contribute around 32% of global energy usage and about 40% of energy-related carbon dioxide emissions. This stems from energy and resource depletion, inefficient utilization, and growing waste generation within the sector. Nonetheless, green buildings offer a solution by implementing efficient resource management practices during design, construction, and operation stages, resulting in energy savings(Aghili &

Amirkhani, 2021). Constructing green buildings by integrating diverse sustainable design parameters could potentially yield energy savings of 15%, water usage savings of 22.3%, and carbon reduction of 21% compared to conventional buildings. (Ebrahim & Wayal, 2019).

From 2013 to 2018, there were 20 GREENSHIP-certified buildings in Indonesia, which is relatively small compared to the total number of buildings, especially those with more than 12 floors, totaling 1,329 in Indonesia. This situation presents a significant challenge, especially in transforming conventional buildings into green ones and maintaining the sustainability of existing green buildings. According to Green Building Council Indonesia (GBCI) data until 2023, only 57 buildings have obtained GREENSHIP certification. A major hurdle for property developers lies in the misconception that initial capital expenditure outweighs the lifecycle costs of buildings. Many property owners and developers prioritize upfront costs without considering their close relationship with operational costs. (Utomo et al., 2022).

Previous research investigates rental premiums and costs of building green buildings. of 242 conventional and 121 green buildings carried out by 30 different companies were collected through a survey in Singapore. Results show that green building rental premiums range from 5% to 10% and cost performance is above budget, ranging from 4.5% to 7% (Hwang et al., 2017).

Optimizing the building envelope can significantly reduce the energy consumption of green buildings, value engineering (VE) technology can be used to optimize the green building envelope, which considers both energy savings and life cycle costs (Yuan et al., 2020).

The performance of Green MICE Investment Costs based on value engineering for a gold rating found that the additional costs for conventional MICE buildings to become green MICE buildings were 4.689% and the additional costs could be returned in 3 years and 10 months (Sutikno et al., 2022),(Husin et al., 2023).

Previous research seeks to examine empirical studies concerning the effects of environmentally friendly certifications on cash flow and property value, with a specific focus on professional property investors. Utilizing discounted cash flow (DCF), a commonly employed property valuation approach for income-producing properties, the research reveals that such certifications have the potential to enhance rental income while reducing operating expenses, vacancy rates, and property risks.(Leskinen et al., 2020).

Green buildings offer a promising solution to address the challenge of excessive energy consumption, particularly those subjected to validation by relevant institutions issuing green certificates. This paper aims to analyze and briefly discuss the trends associated with certifying office buildings in Poland. By the end of 2017, Poland had nearly 9.7 million square meters of modern office space, with 62% of it being certified. This marked a five percent increase in the proportion of certified office space compared to the total modern office space available in 2017. To evaluate the costs and advantages of certified buildings, simulations were conducted comparing the costs of a standard office building with those of a certified one. The comparison utilized the life cycle cost concept and calculated the Life Cycle Cost. The distinction between the standard building and the green one primarily revolved around achieving a higher Net Present Value with lower initial investment outlays for the green building. Additionally, there was a notable disparity in the commencement of investment profitability across different rent levels.(Plebankiewicz et al., 2019)

The construction industry plays a pivotal role in driving socio-economic advancement while heavily relying on energy and natural resources, underscoring its critical role in sustainability efforts. This study prioritizes investment allocation within Saudi Arabia's construction sector to align with sustainable development goals. The research offers a systematic approach to decision-making by identifying optimal alternatives. Through interviews with experts and decision-makers, key criteria and corresponding pairwise comparison matrices are defined, encompassing economic, environmental, and social (EES) factors with 8, 8, and 5 sub criteria, respectively. Smart-PLS, utilizing the partial least squares structural equation modeling (PLS-SEM) method, is employed to assess and rank construction sector investments in Saudi Arabia to advance sustainable development objectives.(Mansour et al., 2020).

The construction industry plays a crucial role in driving New Zealand's economic growth. However, projects often encounter cost overruns, transforming potentially successful ventures into financial losses with unforeseen negative consequences. This study aims to identify, categorize, and evaluate the factors impacting project costs in New Zealand. Using Smart-PLS, the research model was tested. Recognizing the absence of a systematic approach, the study identified 30 influencing factors from diverse sources and quantified their relative impacts. Data were collected through a questionnaire distributed across the New Zealand construction sector, yielding 283 responses with a 37% response rate.(Zhao et al., 2019)

Structural Equation Modeling (SEM) is based on covariance analysis, so it provides a more accurate covariance matrix than linear regression analysis. SEM can also be seen as a combination of regression analysis and factor analysis. SEM can be used to solve equation models with more than one dependent variable as well as recursive effects. SEM-Partial Least Squares (SEM-PLS) is a statistical tool for solving multilevel models simultaneously that cannot be solved with linear regression equations.

This research aims to determine the relationship and influence of the use and development of methods for analyzing factors that influence green cost performance based on Value Engineering and Life Cycle Cost Analysis in new buildings to meet the Green Building Council Indonesia (GBCI).

Through the concept of relationships between factors in new building objects, green concepts, value engineering, and life cycle cost analysis, the influence of increasing green cost performance in new buildings can be identified. Models and concepts of complex relationships like this can use the Least Square Partial for Structural Equations (SEM-PLS) analysis model. Models for SEM include structural models and measurement models.

2. Literature Review

2.1. Green Building

Green Building refers to a building that meets the technical standards for buildings and demonstrates significant performance in energy, water, and resource savings through the application of green building principles by its function and classification at each stage of its implementation.(Garzone, 2006). The life cycle of a building typically encompasses several phases: design and material production, transportation and construction, and operation and maintenance. Greenhouse gases and other emissions from buildings are not only generated during the operation and maintenance phase but also during earlier stages such as design, material production, and transportation and construction. These stages present opportunities to mitigate negative environmental impacts. Minimizing the adverse effects of building construction through green building practices has become a pivotal strategy for achieving sustainable infrastructure, influencing considerations for building operation and maintenance from the outset of the design process. Moreover, a thorough understanding of green building concepts simplifies the monitoring, control, and improvement of building lifecycle stages, particularly during construction, thereby streamlining the design process. Upon completing the planning phase, an initial assessment of the building plan is conducted using green building rating tools to ensure the sustainability of the construction phase.(Latief, Berawi, Van Basten, et al., 2017).

2.2. GREENSHIP

There are several GREENSHIP rating tools, new building, existing building, interior, home, and neighborhood. GREENSHIP New Building is a building certification system in Indonesia intended for new buildings related to design and construction. It is hoped that from the project team, there will be innovative and creative ideas from the design to the operational stage to create a comprehensive green building in obtaining the certification.(GBCI, 2013). Understanding green building concepts is essential for all individuals initiating green building projects. The evaluation of adherence to green building standards is conducted by a panel of experts in the field, leading to the acquisition of Design Recognition (DR) certification. Throughout the construction phase, strict compliance with this design recognition is paramount, necessitating seamless integration among building stakeholders, including owners, consultants, and contractors. Each step of the construction process is supervised by a professional associated with the GREENSHIP association. Upon the completion of the project, the Green Building

Council performs a final assessment based on the expert panel's evaluation, determining the building's alignment with green building rating tools and its preparedness for the operational and maintenance phase. This certification process is known as Final Assessment (FA) certification for New Buildings (NB). Monitoring of green buildings during the operational and maintenance phase is carried out by building management and subject to annual evaluation by the Green Building Council team. The findings from this monitoring serve as evidence for building certification during the operational and maintenance phase, referred to as Final Assessment (FA) certification for Existing Buildings (EB)(Latief, Berawi, Van Basten, et al., 2017)

2.3. Value Engineering

Value Engineering (VE) is a systematic review of projects, products, or processes to improve performance, quality, and/or life cycle costs by a team of independent multi-disciplinary specialists(Janani et al., 2018). Life Cycle Cost analysis in Value Engineering is based on value and is used to identify alternatives with the lowest cost. (Janani et al., 2018).

Value Engineering (VE) constitutes a systematic procedure directed at augmenting the worth of goods, products, or services. Its essence lies in the ratio of performance to cost, with the dual aim of enhancing performance or diminishing expenses. In today's construction landscape, the adoption of value engineering ensures the attainment of project objectives or the realization of cost-optimized endeavors. VE has been embraced across numerous countries globally for over fifty years, addressing diverse challenges encountered in the construction domain, all geared towards delivering projects of elevated value within predetermined timelines and financial constraints. Moreover, Value Engineering is perceived as an integrated management strategy, encompassing problem-solving implementation functions, alternative design considerations, cost-driven decision-making, and performance-centric project goals, all underpinned by structured and discerning selection criteria. Over time, both governmental bodies and private enterprises, particularly in the construction sector, have recognized VE's potential to boost efficiency and curtail project expenditures. According to certain accounts, VE has become commonplace among governments, private engineering entities, and contractors since its inception in the 1950s. Dell'isola contends that VE techniques can fulfill diverse objectives, including cost savings, time efficiency, and performance enhancement.(Usman et al., 2018).

2.4. Lifecycle Cost Analysis

Life Cycle Cost Analysis (LCCA) is an optimization method for choosing solutions that make the most money over their lifetime, or, in other words, have the lowest life cycle costs, which are the main objectives of technical and economic analysis.(Marrana et al., 2017), (Galle et al., 2017).

Lifecycle costs encapsulate the total estimated expenses incurred from the inception to the disposal of both equipment and projects, derived through analytical examination and evaluation of costs accrued throughout their lifespan. The principal aim of Life Cycle Cost (LCC) analysis is to select the most economically efficient approach from various alternatives, thereby achieving the lowest long-term cost of ownership. As defined by Kelly and Male (1993), Life Cycle Costing is a method of economic evaluation that encompasses all pertinent costs within the investor's time horizon, while considering the time value of money. The comprehensive life cycle cost of an item encompasses all expenditures associated with the item from its design phase to its eventual obsolescence(Imron & Husin, 2021). Based on these principles, the expression of Life Cycle Cost (LCC) is as follows:

LCC = Initial Cost + Cost of Usage + Cost of Care and Replacement.

If we consider the life cycle of a green building, the additional costs from conventional buildings to green buildings are very small or insignificant compared to other costs as shown in Figure 1.(J. S. Khan et al., 2019)

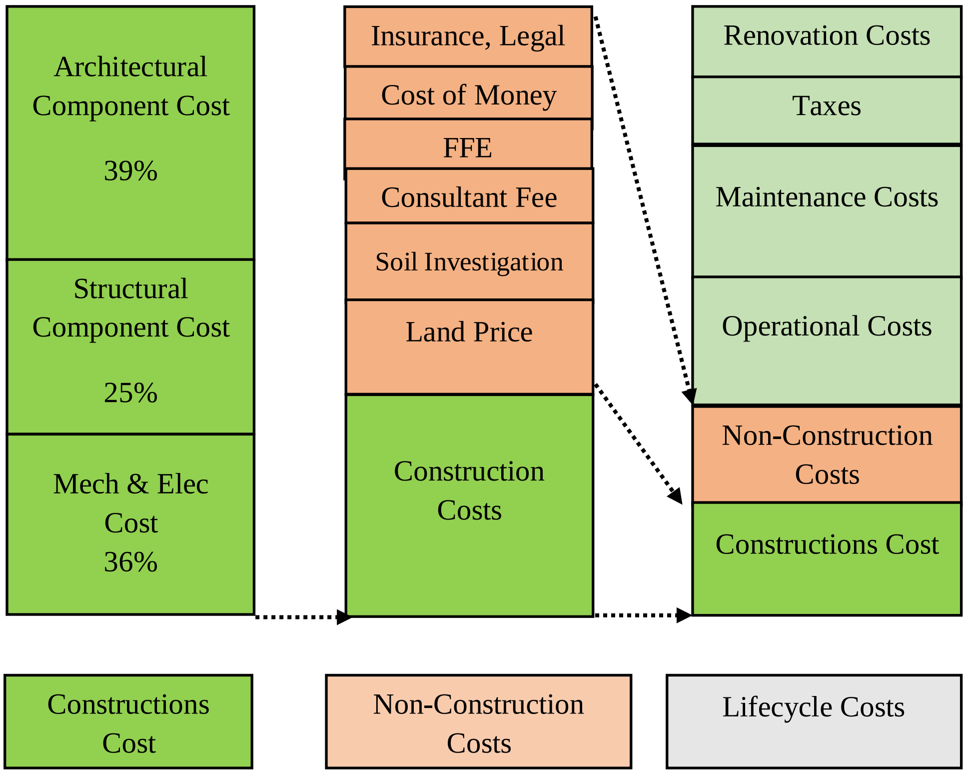


Fig. 1. Life cycle Building (Fungsi, 2019)

3. Research Methods

This research was conducted on the object of indicators of Green Building Council Indonesia, value engineering, lifecycle cost analysis, and cost performance of new buildings in Indonesia, using quantitative methods. The data obtained from the distribution of the questionnaire were processed using quantitative descriptive methods.

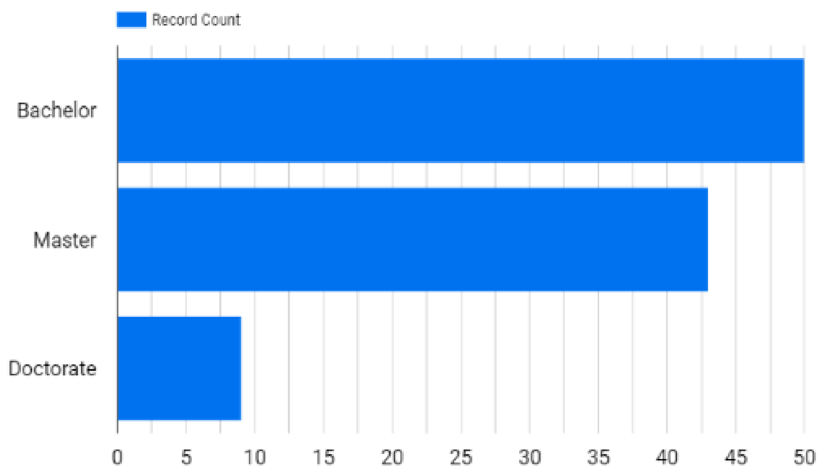
In analyzing researchers used SEM PLS software version 3.0, and to determine the sample size whether the data met the requirements of the SEM-PLS model. Some things that need to be considered are the characteristics of the model itself including sample size, data distribution shape, missing values, and measurement scale. The minimum sample size taken is based on the difference in levels in path coefficients (p Min) and a statistical strength test of 80% (Hair Jr et al., 2021).

In this research, respondents were selected using snowball sampling techniques. This snowball sampling technique is a technique for identifying, selecting, and taking samples in a continuous network or chain of relationships and this technique is very reliable for obtaining data from respondents to answer specific research problems in the field (Nurdiani, 2014).

The population used in this research are experts and actors who understand the concepts and practices of green buildings in Jakarta. Content Validity Index (CVI) is the most widely used and recommended approach in evaluating content validity in instrument development. The CVI instrument is used to assess each instrument item regarding its relevance to the existing construct to measure the degree of expert agreement on one item which can express the level of content validity.

This research model determines the minimum sample size based on a path coefficient value of 0.25 and an 80% statistical strength test at the 5% significance level, yielding 69 minimum samples. In this survey, questionnaires were distributed to 115 selected respondents. The selected respondents were experienced in green building with a range of 5 years to 30 years and had education from undergraduate to doctoral level. From the distribution of returned questionnaires from 102 respondents with a proportion of 88 men and 14 women, the percentage of returned questionnaires was 88.69%.

Respondent's Education Level



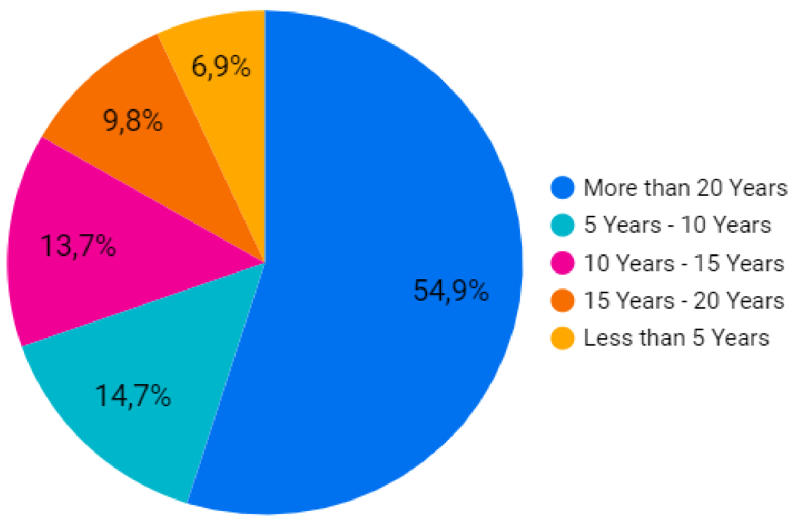


Fig. 2. Respondents Data

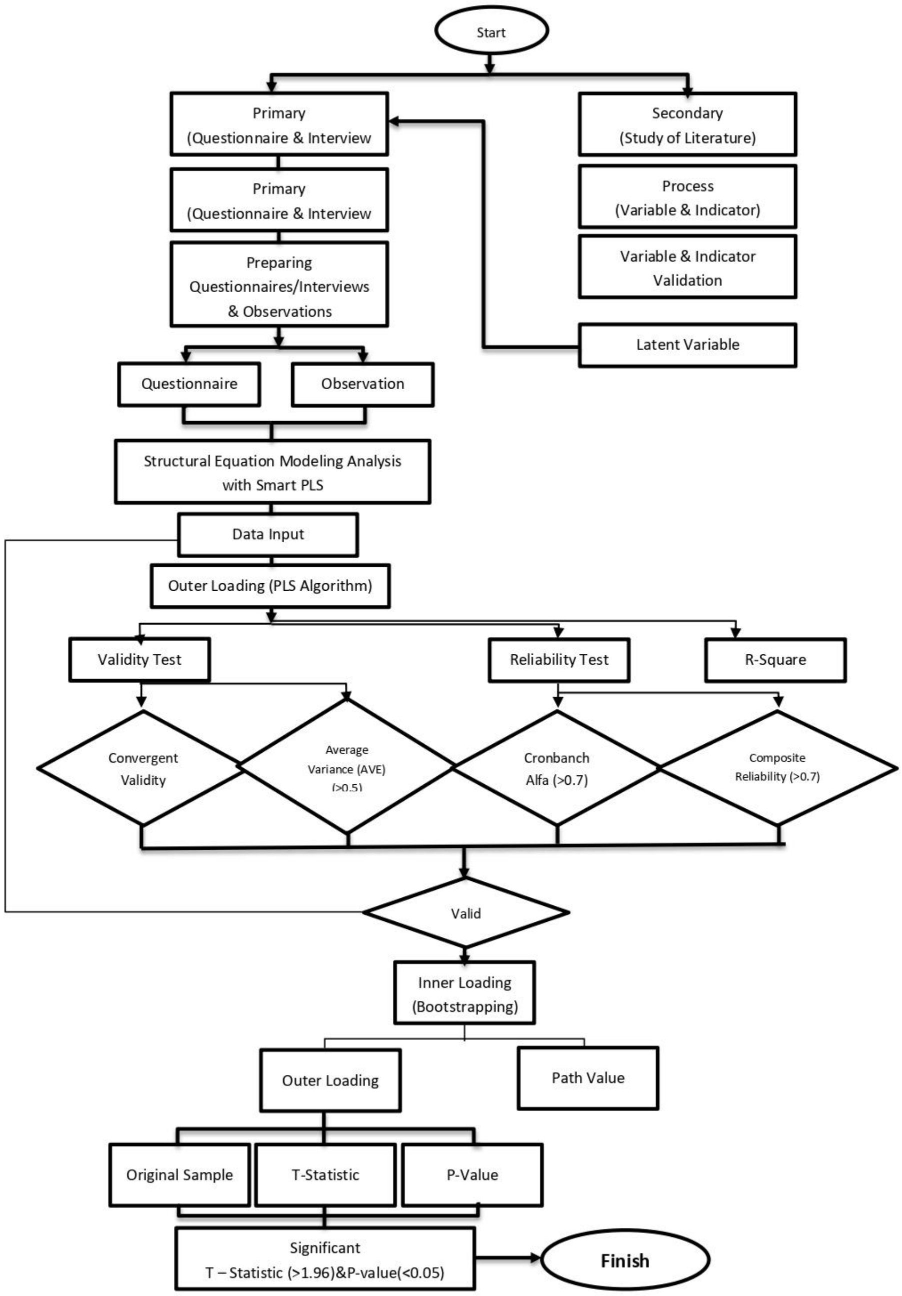


Fig. 3. Data Processing Diagram with SEM-PLS
Source: processed by Author

The data population was determined based on journal literacy and the experts' validity so that the population is appropriate. Data was examined and grouped by education, position, and experience. The primary data collection was conducted by instrument validation, pilot survey, respondent data collection, questionnaire distribution, questionnaire result validation, and data input process, as well as model simulation on SEM-PLS can be shown in Figure 3(Tran, 2021)

4. Results and Discussion

Questionnaire data obtained via Google Forms by researchers as part of this research will be processed and analyzed using structural equation modeling (SEM). This research consists of 5 variables, which are divided into 4 endogenous variables and 1 exogenous variable. The endogenous variables used consist of conventional buildings, green buildings, value engineering, and lifecycle cost analysis. The exogenous variable is effective cost performance. 25 Categories and 80 indicators.

Researchers used SEM SMART-PLS version 3.0 software. Research variables from this study are presented in Table 1.

Table 1 - Research variables, category, and indicators.

CODE	VARIABLE/CATEGORY/INDICATOR		REFERENCES
GK	**CONVENTIONAL BUILDING**		
KP	**1.1 Project Management**		
KP01	1	Project Organization	(Renault & Agumba, 2016), (Zhao et al., 2019),(Wu et al., 2019)
KP02	2	Risk Management	(Renault & Agumba, 2016), (Zhao et al., 2019),(Wu et al., 2019)
KP03	3	Monitoring & controlling	(Renault & Agumba, 2016), (Zhao et al., 2019),(Wu et al., 2019)
KP04	4	Project Manager Performance	(Renault & Agumba, 2016), (Zhao et al., 2019),(Wu et al., 2019)
KP05	5	Communication & Coordination	(Renault & Agumba, 2016), (Zhao et al., 2019),(Wu et al., 2019)
KC	**1.2 Contract Management**		
KC01	1	Bill of Quantity (BoQ)	(Renault & Agumba, 2016), (Alattyih et al., 2020), (Gunduz et al., 2022), (Gamage, 2023)
KC02	2	Technical Drawings	(Renault & Agumba, 2016), (Alattyih et al., 2020), (Gunduz et al., 2022), (Gamage, 2023)
KC03	3	Technical Specifications	(Renault & Agumba, 2016), (Alattyih et al., 2020), (Gunduz et al., 2022), (Gamage, 2023)
KC04	4	Work Schedule	(Renault & Agumba, 2016), (Alattyih et al., 2020), (Gunduz et al., 2022), (Gamage, 2023)
KC05	5	Requisition and Terms	(Renault & Agumba, 2016), (Alattyih et al., 2020), (Gunduz et al., 2022), (Gamage, 2023)
GB	**GREEN BUILDING**		
GS	**2.1 Green Building Certification**		
GS01	1	In applying for PBG, green building certification is required	(GBCI, 2013), (Aghili & Amirkhani, 2021), (Kussumardianadewi et al., 2024)
GS02	2	In applying for SLF green building certification is required	(GBCI, 2013); (Wu et al, 2016)' (Ghamdi et al. 2016); (Yusuf Latif et al., 2016); (Shen et al 2017) ;(Plebankiewicz et al, 2019); (Peraturan Menteri PUPR no 16, 2021 & no 21, 2021)
GS03	3	In applying for an SLF extension, green building certification is required	(GBCI, 2013); (Wu et al, 2016)' (Ghamdi et al. 2016); (Yusuf Latif et al., 2016); (Shen et al 2017);(Plebankiewicz et al, 2019); (Peraturan Menteri PUPR no 16, 2021 & no 21, 2021)
GC	**2.2 Green Building Construction Costs**		
GC01	1	Green building construction costs are more expensive than conventional costs	(GBCI, 2013); (Wu et al, 2016)' (Ghamdi et al. 2016); (Yusuf Latif et al., 2016); (Hwang, 2017), (Shen et al 2017); (Plebankiewicz et al, 2019)
GC02	2	The costs are smaller than the benefits of green building	(GBCI, 2013); (Wu et al, 2016)' (Ghamdi et al. 2016); (Yusuf Latif et al., 2016); (Hwang, 2017), (Shen et al 2017); (Plebankiewicz et al, 2019)
GM	**2.3 Green building operational and maintenance costs**		
GM01	1	Green building operational and maintenance costs are lower than conventional costs	(GBCI, 2013); (Wu et al, 2016)' (Ghamdi et al. 2016); (Yusuf Latif et al., 2016); (Shen et al 2017);(Plebankiewicz et al, 2019)
GT	**2.4 Appropriate Site Development**		
GT01	1	Basic Green Area	(GBCI, 2013), (M. A. Khan et al., 2021)
GT02	2	Site Selection	(GBCI, 2013), (M. A. Khan et al., 2021)
GT03	3	Community Accessibility	(GBCI, 2013), (M. A. Khan et al., 2021)
GT04	4	Public Transportation	(GBCI, 2013), (M. A. Khan et al., 2021)

GT05	5	Bicycle Facility	(GBCI, 2013), (M. A. Khan et al., 2021)
GT06	6	Site Landscaping	(GBCI, 2013), (M. A. Khan et al., 2021)
GT07	7	Microclimate	(GBCI, 2013), (M. A. Khan et al., 2021)
GT08	8	Stormwater Management	(GBCI, 2013), (M. A. Khan et al., 2021)
GE	**2.5 Energy Efficiency and Conversation**		
GE01	1	Electrical Sub Metering	(GBCI, 2013), (M. A. Khan et al., 2021)
GE02	2	OTTV Calculation	(GBCI, 2013), (M. A. Khan et al., 2021)
GE03	3	Energy Efficiency Measures	(GBCI, 2013), (M. A. Khan et al., 2021)
GE04	4	Natural Lighting	(GBCI, 2013), (M. A. Khan et al., 2021)
GE05	5	Ventilation	(GBCI, 2013), (M. A. Khan et al., 2021)
GE06	6	Climate Change Impact	(GBCI, 2013), (M. A. Khan et al., 2021)
GE07	7	On Site Renewable Energy	(GBCI, 2013), (M. A. Khan et al., 2021)
GA	**2.6 Water Conservation**		
GA01	1	Water Metering	(GBCI, 2013), (M. A. Khan et al., 2021)
GA02	2	Water Calculation	(GBCI, 2013), (M. A. Khan et al., 2021)
GA03	3	Water Use Reduction	(GBCI, 2013), (M. A. Khan et al., 2021)
GA04	4	Water Fixtures	(GBCI, 2013), (M. A. Khan et al., 2021)
GA05	5	Water Recycling	(GBCI, 2013), (M. A. Khan et al., 2021)
GA06	6	Alternative Water Resources	(GBCI, 2013), (M. A. Khan et al., 2021)
GA07	7	Rainwater Harvesting	(GBCI, 2013), (M. A. Khan et al., 2021)
GA08	8	Water Efficiency Landscaping	(GBCI, 2013), (M. A. Khan et al., 2021)
GS	**2.7 Material Resources and Cycle**		
GS01	1	Fundamental Refrigerant	(GBCI, 2013), (M. A. Khan et al., 2021)
GS02	2	Building and Material Reuse	(GBCI, 2013), (M. A. Khan et al., 2021)
GS03	3	Environmentally Friendly Material	(GBCI, 2013), (M. A. Khan et al., 2021)
GS04	4	Non-ODS Usage	(GBCI, 2013), (M. A. Khan et al., 2021)
GS05	5	Certified Wood	(GBCI, 2013), (M. A. Khan et al., 2021)
GS06	6	Prefab Material	(GBCI, 2013), (M. A. Khan et al., 2021)
GS07	7	Regional Material	(GBCI, 2013), (M. A. Khan et al., 2021)
GK	**2.8 Indoor Health and Comfort**		
GK01	1	Outdoor Air Introduction	(GBCI, 2013), (M. A. Khan et al., 2021)
GK02	2	CO_2 Monitoring	(GBCI, 2013), (M. A. Khan et al., 2021)
GK03	3	Environmental Tobacco Smoke Control	(GBCI, 2013), (M. A. Khan et al., 2021)
GK04	4	Chemical Pollutant	(GBCI, 2013), (M. A. Khan et al., 2021)
GK05	5	Outside View	(GBCI, 2013), (M. A. Khan et al., 2021)
GK06	6	Visual Comfort	(GBCI, 2013), (M. A. Khan et al., 2021)
GK07	7	Acoustic Level	(GBCI, 2013), (M. A. Khan et al., 2021)
GL	**2.9 Building Environment and Management**		
GL01	1	Basic Waste Management	(GBCI, 2013), (M. A. Khan et al., 2021)
GL02	2	GP as a Member of Project Team	(GBCI, 2013), (M. A. Khan et al., 2021)
GL03	3	Pollution of Construction Activity	(GBCI, 2013), (M. A. Khan et al., 2021)
GL04	4	Advanced Waste Management	(GBCI, 2013), (M. A. Khan et al., 2021)
GL05	5	Proper Commissioning	(GBCI, 2013), (M. A. Khan et al., 2021)
GL06	6	Green Building Submission Data	(GBCI, 2013), (M. A. Khan et al., 2021)
GL07	7	Fit Out Agreement	(GBCI, 2013), (M. A. Khan et al., 2021)
GL08	8	Occupant Survey	(GBCI, 2013), (M. A. Khan et al., 2021)
VE	**VALUE ENGINEERING**		
VI	**3.1 Information Phase**		
VI01	1	Top Management Commitment Attitude	(Janani et al., 2018), (Abdel-Raheem et al., 2018), (Araszkiewicz, 2020), (Alattyih et al., 2022)
VI02	2	Data analysis	(Janani et al., 2018), (Abdel-Raheem et al., 2018), (Araszkiewicz, 2020), (Alattyih et al., 2022)

VI03	3	Information and communication	(Janani et al., 2018), (Abdel-Raheem et al., 2018), (Araszkiewicz, 2020), (Alattyih et al., 2022)
VI04	4	Policies and regulations	(Janani et al., 2018), (Abdel-Raheem et al., 2018), (Araszkiewicz, 2020), (Alattyih et al., 2022)
VF	**3.2 Function Analysis Phase**		
VF01	1	Improved project quality	(Janani et al., 2018), (Abdel-Raheem et al., 2018), (Araszkiewicz, 2020), (Alattyih et al., 2022)
VF02	2	Function analysis	(Janani et al., 2018), (Abdel-Raheem et al., 2018), (Araszkiewicz, 2020), (Alattyih et al., 2022)
VK	**3.3 Creativity Phase**		
VK01	1	Selection of work methods	(Janani et al., 2018), (Abdel-Raheem et al., 2018), (Araszkiewicz, 2020), (Alattyih et al., 2022)
VK02	2	Material selection	(Janani et al., 2018), (Abdel-Raheem et al., 2018), (Araszkiewicz, 2020), (Alattyih et al., 2022)
VE	**3.4 Evaluation Phase**		
VE01	1	Analyzing Value Engineering	(Janani et al., 2018), (Abdel-Raheem et al., 2018), (Araszkiewicz, 2020), (Alattyih et al., 2022)
VE02	2	Results from ideas and evaluations for alternatives	(Janani et al., 2018), (Abdel-Raheem et al., 2018), (Araszkiewicz, 2020), (Alattyih et al., 2022)
VD	**3.5 Development Phase**		
VD01	1	Reduction of material costs	(Janani et al., 2018), (Abdel-Raheem et al., 2018), (Araszkiewicz, 2020), (Alattyih et al., 2022)
VD02	2	Looking for alternative materials	(Janani et al., 2018), (Abdel-Raheem et al., 2018), (Araszkiewicz, 2020), (Alattyih et al., 2022)
VP	**3.6 Presentation Phase**		
VP01	1	Implementation of the settlement	(Janani et al., 2018), (Abdel-Raheem et al., 2018), (Araszkiewicz, 2020), (Alattyih et al., 2022)
VP02	2	Resource	(Janani et al., 2018), (Abdel-Raheem et al., 2018), (Araszkiewicz, 2020), (Alattyih et al., 2022)
VM01	**3.7 Implementation Phase**		
VM01	1	Improved project quality	(Janani et al., 2018), (Abdel-Raheem et al., 2018), (Araszkiewicz, 2020), (Alattyih et al., 2022)
VM02	2	Function analysis	(Janani et al., 2018), (Abdel-Raheem et al., 2018), (Araszkiewicz, 2020), (Alattyih et al., 2022)
VN	**3.8 Value Engineering Practice**		
VN01	1	*Value engineering has a positive effect on cost performance*	(Janani et al., 2018), (Abdel-Raheem et al., 2018), (Araszkiewicz, 2020), (Alattyih et al., 2022)
VN02	2	Value engineering is often used in building construction	(Janani et al., 2018), (Abdel-Raheem et al., 2018), (Araszkiewicz, 2020), (Alattyih et al., 2022)
LA	**LIFECYCLE COST ANALYSIS**		
LC	4.1 Cost Breakdown Structure		
LC01	1	Initial Costs	(Latief, Berawi, Basten, et al., 2017),(J. S. Khan et al., 2019), (Kussumardianadewi et al., 2024)
LC02	2	Operational & Maintenance Costs	(Latief, Berawi, Basten, et al., 2017),(J. S. Khan et al., 2019), (Kussumardianadewi et al., 2024)

LC03	3	Final score	(Latief, Berawi, Basten, et al., 2017),(J. S. Khan et al., 2019), (Kusumardianadewi et al., 2024)
LL	**4.2 LCCA**		
LL01	1	Payback Period Analysis	(Latief, Berawi, Basten, et al., 2017),(J. S. Khan et al., 2019), (Kusumardianadewi et al., 2024)
LL02	2	Payback Period Percentage	(Latief, Berawi, Basten, et al., 2017),(J. S. Khan et al., 2019), (Kusumardianadewi et al., 2024)
LK	**4.3 Appropriateness**		
LK01	1	Sensitivity Analysis	(Latief, Berawi, Basten, et al., 2017),(J. S. Khan et al., 2019), (Kusumardianadewi et al., 2024)
LK02	2	*Internal Rate of Return* (IRR)	(Latief, Berawi, Basten, et al., 2017),(J. S. Khan et al., 2019), (Kusumardianadewi et al., 2024)
LK03	3	Net Present Value (NPV)	(Latief, Berawi, Basten, et al., 2017),(J. S. Khan et al., 2019), (Kussumardianadewi et al., 2024)
LR	**4.4 Risks**		
LR01	1	Exchange rate	(Ajeng, Nur Fatwa, 2022)
LR02	2	Inflation	(Ajeng, Nur Fatwa, 2022)
LR03	3	Interest rate	(Ajeng, Nur Fatwa, 2022)
LP	**4.5 Decision**		
LP01	1	LCCA plays a big role in making green building investment decisions	(Wei TC, 2022)
KB	**COST PERFORMANCE**		
KY	5.1 Internal dan External Factors		
KY01	1	Material Costs	(Latief, Berawi, Basten, et al., 2017), (Plebankiewicz et al., 2019)
KY02	2	Labor Costs	(Latief, Berawi, Basten, et al., 2017), (Plebankiewicz et al., 2019)
KY03	3	Equipment Cost	(Latief, Berawi, Basten, et al., 2017), (Plebankiewicz et al., 2019)
KY04	4	Shipping Costs	(Latief, Berawi, Basten, et al., 2017), (Plebankiewicz et al., 2019)
KY05	5	Material Price Fluctuation Costs	(Latief, Berawi, Basten, et al., 2017), (Plebankiewicz et al., 2019)
KY06	6	Environment Costs	(Latief, Berawi, Basten, et al., 2017), (Plebankiewicz et al., 2019)

4.1. Evaluation of the Measurement Model (Outer Loading – PLS algorithm)

Measurement of the indicator (Outer Model) is carried out by looking at Convergent validity, Average variance Extracted-AVE, Construct Reliability, and Cronbach's Alpha. The model between latent variables and indicators and median variables of the study uses a reflective model.

In SEM, there are 3 (three) activities carried out simultaneously, namely: validating and assessing the reliability of data (confirmatory factor analysis); developing a model suitable for forecasting (path analysis); and obtaining models (structural models and regression analysis). Each model has a connection to a measurement model, a structural model, or a causal model. In contrast to structural models, which are models that describe hub-and-spoke relationships that are being hypothesized, model measurements are used to generate conclusions about the validity and validity of discriminants.

Based on Figure 3 the measurement model in this research is 2 stages where there are latent variables as well as manifest or indicator variables. For example, the Information Stage and Function Stage are latent variables, each of which has an indicator. However, they are also indicators of the latent variable X3, as well as X1, and so on.

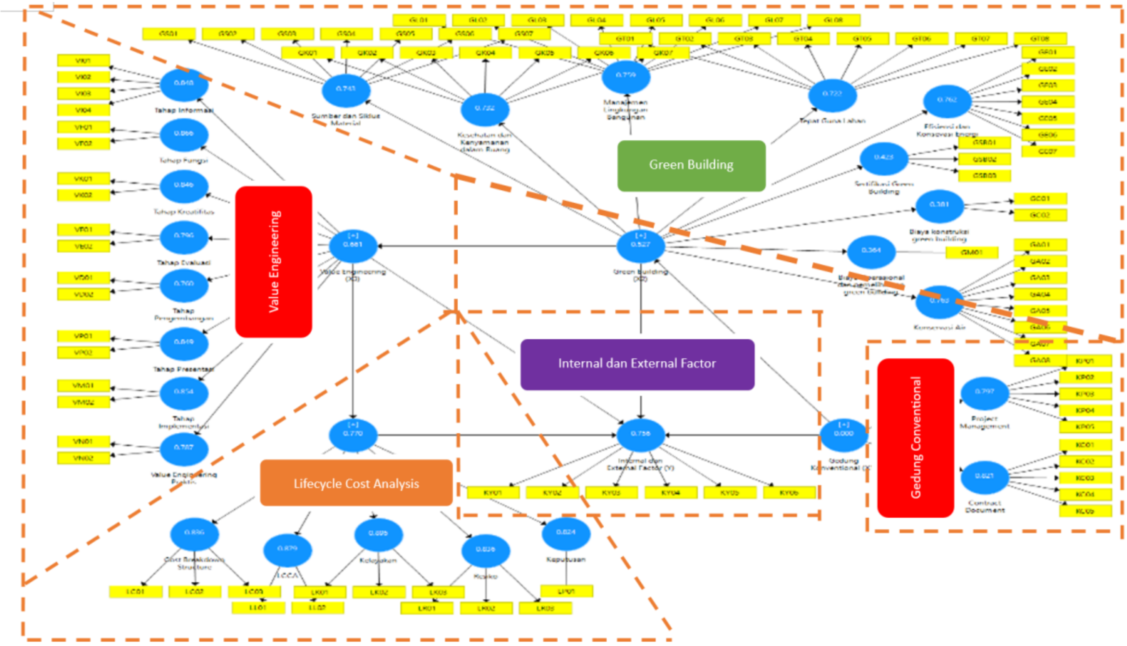


Fig. 4. Model with SEM_PLS

Figure 4 shows that the blue ones are the latent variables, and the yellow ones are the indicators. From the figure, all indicators reflect their respective variables with the following details:

1. Conventional Building (X1)
2. Green Building (X2)
3. Value Engineering (X3)
4. Lifecycle cost Analysis (X4)
5. Cost Performance (Y)

4.1.1. Discriminate Validity

Discriminant validity testing is carried out to prove whether the indicators in a construct will have the largest loading factor on the construct it forms compared to the loading factor with other constructs. You can see cross-loading in Table 2 below.

Table 2. Cross-Loading

Indicator	Conventional Building (X1)	Green Building (X2)	Internal & External Factor (Y)	Lifecycle Cost Analysis (X4)	Value Engineering (X3)
GA01	0.783	**0.875**	0.740	0.770	0.776
GA02	0.796	**0.883**	0.790	0.790	0.784
GA03	0.667	**0.836**	0.780	0.748	0.755
GA04	0.763	**0.910**	0.823	0.828	0.831
GA05	0.752	**0.863**	0.754	0.742	0.787
GA06	0.767	**0.904**	0.799	0.804	0.791
GA07	0.797	**0.874**	0.742	0.763	0.791
GA08	0.808	**0.901**	0.792	0.813	0.825
GC01	0.635	**0.624**	0.582	0.581	0.548
GC02	0.517	**0.629**	0.574	0.573	0.565
GE01	0.765	**0.907**	0.793	0.807	0.830
GE02	0.763	**0.899**	0.812	0.809	0.801
GE03	0.818	**0.887**	0.786	0.783	0.825
GE04	0.802	**0.876**	0.762	0.756	0.782

GE05	0.829	**0.887**	0.787	0.789	0.801
GE06	0.743	**0.860**	0.737	0.722	0.741
GE07	0.783	**0.847**	0.745	0.771	0.774
GK01	0.750	**0.916**	0.825	0.813	0.821
GK02	0.800	**0.899**	0.783	0.793	0.808
GK03	0.784	**0.878**	0.766	0.795	0.822
GK04	0.677	**0.760**	0.620	0.644	0.680
GK05	0.789	**0.888**	0.752	0.780	0.807
GK06	0.805	**0.893**	0.776	0.800	0.826
GK07	0.672	**0.784**	0.628	0.661	0.664
GL01	0.755	**0.867**	0.761	0.779	0.814
GL02	0.680	**0.843**	0.770	0.761	0.755
GL03	0.684	**0.856**	0.743	0.747	0.741
GL04	0.721	**0.878**	0.775	0.760	0.791
GL05	0.749	**0.903**	0.789	0.802	0.805
GL06	0.764	**0.914**	0.832	0.849	0.841
GL07	0.746	**0.889**	0.813	0.849	0.839
GL08	0.755	**0.859**	0.815	0.830	0.831
GM01	0.508	**0.615**	0.499	0.503	0.506
GS01	0.767	**0.896**	0.799	0.770	0.770
GS02	0.649	**0.787**	0.711	0.647	0.674
GS03	0.808	**0.906**	0.791	0.775	0.811
GS04	0.735	**0.884**	0.787	0.808	0.801
GS05	0.690	**0.849**	0.745	0.764	0.752
GS06	0.711	**0.871**	0.786	0.778	0.771
GS07	0.678	**0.880**	0.774	0.768	0.748
GSB01	0.641	**0.679**	0.674	0.660	0.668
GSB02	0.634	**0.684**	0.688	0.673	0.649
GSB03	0.596	**0.611**	0.610	0.579	0.566
GT01	0.767	**0.892**	0.774	0.788	0.789
GT02	0.740	**0.853**	0.779	0.773	0.767
GT03	0.776	**0.857**	0.802	0.776	0.768
GT04	0.750	**0.791**	0.756	0.726	0.733
GT05	0.701	**0.837**	0.731	0.730	0.724
GT06	0.834	**0.911**	0.772	0.761	0.773
GT07	0.734	**0.815**	0.708	0.685	0.701
GT08	0.804	**0.885**	0.782	0.789	0.802
KC01	**0.922**	0.812	0.733	0.764	0.794
KC02	**0.949**	0.829	0.748	0.751	0.762
KC03	**0.933**	0.839	0.763	0.769	0.771
KC04	**0.920**	0.833	0.767	0.763	0.763
KC05	**0.854**	0.805	0.750	0.738	0.720
KP01	**0.909**	0.742	0.715	0.719	0.750
KP02	**0.828**	0.672	0.681	0.710	0.690
KP03	**0.929**	0.788	0.724	0.755	0.798
KP04	**0.893**	0.765	0.707	0.679	0.686

KP05	**0.921**	0.792	0.775	0.783	0.801
KY01	**0.742**	0.851	0.932	0.878	0.874
KY02	0.740	0.782	**0.906**	0.866	0.854
KY03	0.768	0.834	**0.916**	0.869	0.837
KY04	0.780	0.826	**0.932**	0.888	0.831
KY05	0.753	0.814	**0.916**	0.864	0.849
KY06	0.705	0.798	**0.922**	0.869	0.842
LC01	0.783	0.822	0.851	**0.907**	0.871
LC02	0.804	0.857	0.900	**0.916**	0.866
LC03	0.766	0.845	0.908	**0.936**	0.894
LK01	0.778	0.830	0.876	**0.942**	0.895
LK02	0.783	0.847	0.913	**0.952**	0.916
LK03	0.755	0.826	0.886	**0.956**	0.906
LL01	0.770	0.848	0.895	**0.949**	0.914
LL02	0.753	0.826	0.864	**0.934**	0.908
LP01	0.777	0.839	0.877	**0.916**	0.875
LR01	0.753	0.817	0.874	**0.925**	0.870
LR02	0.740	0.806	0.880	**0.933**	0.874
LR03	0.691	0.769	0.855	**0.897**	0.833
VD01	0.700	0.770	0.817	0.827	**0.852**
VD02	0.720	0.771	0.850	0.855	**0.899**
VE01	0.739	0.808	0.837	0.856	**0.917**
VE02	0.727	0.789	0.811	0.815	**0.875**
VF01	0.790	0.824	0.853	0.856	**0.926**
VF02	0.783	0.841	0.847	0.868	**0.940**
VI01	0.777	0.871	0.845	0.905	**0.912**
VI02	0.797	0.879	0.863	0.901	**0.933**
VI03	0.813	0.872	0.881	0.893	**0.933**
VI04	0.791	0.847	0.851	0.881	**0.9243**
VK01	0.764	0.813	0.781	0.840	**0.914**
VK02	0.751	0.808	0.838	0.859	**0.931**
VM01	0.747	0.821	0.874	0.914	**0.936**
VM02	0.762	0.814	0.825	0.884	**0.919**
VN01	0.746	0.817	0.812	0.870	**0.928**
VN02	0.701	0.745	0.806	0.847	**0.853**
VP01	0.794	0.849	0.875	0.882	**0.919**
VP02	0.772	0.837	0.876	0.897	**0.931**

Based on Table 2. above, the cross-loading value also shows good discriminate validity because the correlation value of the indicator with the construct is higher than the correlation value of the indicator with other constructs.

4.1.2. Acceptedity and Reliability Test

The Acceptedity test is used to measure the Acceptedity or not of a research instrument by providing information from the variables tested correctly. The Acceptedity test can be accepted or said to be Accepted if the Convergence Acceptedity value is greater than 0.5 and the Average Variance Extracted (AVE) value is greater than 0.5.

The reliability test is carried out by looking at the value of Composite reliability obtained from the indicator block that corroborates the construct. Composite reliability and Cronbach's aplha results show satisfactory values if above 0.7. Composite reliability values at output are presented in Table 3.

Table 3 - Composite Reliability, Cronbach's Alpha and AVE Values

Construct / Variable	Average Variance Extracted (AVE) (>0.5)	Composite Reliability (> 0.7)	Cronbach Alpha (>0.7)
Conventional Building (X1)	0.979	0.976	0.979
Green Building (X2)	0.971	0.992	0.992
Value Engineering (X3)	0.979	0.989	0.988
Lifecycle Cost Analysis (X4)	0.992	0.986	0.987
Internal dan External Factor (Y)	0.987	0.971	0.964

4.1.3. R-Square & Q-Square

R-Square and Q-Square testing are tools for adjusting the Goodness of Fit threshold for each structural model. The value of R-Square (R2) is used to measure how much influence a particular independent latent variable has on the dependent latent variable. The coefficient of determination (R2) is estimated to have a value between 0 and 1. Strong, medium, and weak models, are indicated by R2 values of 0.75, 0.50, and 0.25. (Khan et al., 2019). Chin classifies the R2 criteria as strong, medium, and weak with values of 0.67, 0.33, and 0.19 (Ghozali & Laten 2015, 2018).

Table 4. R-Square & Q-Square Values

Variable	R Square	Q Square
Green Building (X2)	0.757	0.527
Internal dan External Factor (Y)	0.908	0.756
Lifecycle Cost Analysis (X4)	0.906	0.770
Value Engineering (X3)	0.807	0.661

The R-Square value is a value that expresses how much an independent variable can explain the variance of the dependent variable. It is known that the result of R-square against Y = cost of 0.908 is all latent variables and the median can explain the dependent variable or affect the cost by 90.8%.

Besides looking at the R-square value, the PLS model was also evaluated by looking at the predictive Q-square relevance by model as well as parameter estimates. A q-square value > 0 indicates the model has predictive relevance, otherwise if a Q-square value ≤ 0 indicates the model lacks predictive relevance. (Ghozali & Laten 2015, 2018). Q-square calculation done by the formula:

$$Q^2 = 1 - (1 - R_1^2)\,(1 - R_1^2)\,(1 - R_3^2)\,\ldots.\,(1 - R_p^2)$$

$$Q^2 = 1 - (1 - 0.\,757^2)\,(1 - 0.906^2)\,(1 - 0.807^2)\,\ldots.\,(1 - R_p^2)$$

Where: R_1^2, R_2^2, R_3^2,…. Rp^2 is the endogen variable Interprets same with coefficient determination in path analysis. (R2 in regression).

4.2. Evaluation of the Measurement Model (Inner Loading – Bootstrapping)

Determination of the significance and strength of the relationships between constructs as well as to test hypotheses, the path coefficients between constructs are also measured. The value of the path coefficient ranges from -1 to +1. The relationship between the two constructs is stronger when the value is close to +1. Relationships less than -1 indicate negative relationships (Khan et al., 2019). To test the value of structural models (inner loading) or models that connect between constructs (latent variables) is further analyzed using the Bootstrapping procedure (Hair et al., 2014).

Coefficient path interpretation results are results taken from bootstrapping procedures, path analysis results, or structural models that have a significant effect if the statistical T value is more than 1.96 and the p-value is less than 0.05 (Ghozali & Latent 2015, 2018).

Table 5 - Path Coefficient Values

Correlations	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
Conventional Building(X1) -> Green Building (X2)	0.870	0.865	0.041	21.187	0.000
Conventional Building (X1) -> Internal and External Factor (Y)	0.756	0.751	0.066	11.383	0.000
Conventional Building (X1) -> Lifecycle Cost Analysis (X4)	0.744	0.738	0.066	11.239	0.000
Conventional Building (X1) -> Value Engineering (X3)	0.782	0.776	0.061	12.818	0.000
Green Building (X2) -> Internal and External Factor (Y)	0.850	0.845	0.078	10.904	0.000
Green Building (X2) -> Lifecycle Cost Analysis (X4)	0.855	0.851	0.042	20.139	0.000
Green Building (X2) -> Value Engineering (X3)	0.899	0.896	0.035	25.556	0.000
Lifecycle Cost Analysis (X4) -> Internal and External Factor (Y)	0.683	0.692	0.105	6.489	0.000
Value Engineering (X3) -> Internal and External Factor (Y)	0.743	0.747	0.098	7.611	0.000
Value Engineering (X3) -> Lifecycle Cost Analysis (X4)	0.952	0.949	0.016	59.212	0.000

Table 5 above it is known that the results of the analysis have a significant influence because they have a T statistic value greater than 1.96 (T statistic > 1.96) with a P value less than 0.05 (P value <0.05).

From the results of the discussion and analysis, the factors taken by the top 10 influenced the improvement of green cost performance based on Value Engineering and Life Cycle Cost Analysis applied to the Green Building are as follows:

a) Submission of green building data,
b) Introduction of outside air,
c) Water features,
d) Alternative water sources,
e) Installation of Sub Meters,
f) Energy saving measures,
g) Water Use Efficiency,
h) OTTV Calculation,
i) Monitoring CO2 levels and
j) Refrigerant Fundamentals

4.3. Result Interpretation (PLS Model)

To assess the significance of the prediction model in testing the structural model, it can be seen from the t-statistic value between the independent variable and the dependent variable in the Path Coefficient table in the Smart- PLS output below:

Tabel 6 - Reflective Loading of Variables Based on Category

Indicator	Original Sample Estimate	Mean of Subsamples	Standard Deviation	T-Statistic
Conventional Building (X1) -> Contract Document	0.974	0.974	0.009	113.194
Conventional Building (X1) -> Green Building (X2)	0.870	0.865	0.041	21.187
Conventional Building (X1) -> Internal and External Factor (Y)	0.016	0.019	0.080	0.202
Gedung Conventional (X1) -> Project Management	0.971	0.971	0.011	85.362
Green Building (X2) -> Operational and maintenance cost of green building	0.615	0.612	0.096	6.409
Green Building (X2) -> Green building	0.735	0.737	0.060	12.198

construction cost				
Green Building (X2) -> Efficiency and conservation Energy	0.970	0.969	0.009	105.701
Green Building (X2) -> Internal and External Factor (Y)	0.182	0.174	0.118	1.551
Green Building (X2) -> Internal health and comfort in the room	0.957	0.956	0.012	76.934
Green Building (X2) -> water conservation	0.971	0.971	0.009	114.090
Green Building (X2) -> Building Environment Management	0.960	0.959	0.013	75.913
Green Building (X2) -> Green Building certification	0.688	0.686	0.098	7.018
Green Building (X2) -> Material Resources and Cycle	0.962	0.962	0.011	89.934
Green Building (X2) -> Appropriate Site Development	0.961	0.961	0.013	76.465
Green Building (X2) -> Value Engineering (X3)	0.899	0.896	0.035	25.556
Lifecycle Cost Analysis (X4) -> Cost Breakdown Structure	0.959	0.958	0.015	65.519
Lifecycle Cost Analysis (X4) -> Internal and External Factor (Y)	0.683	0.692	0.105	6.489
Lifecycle Cost Analysis (X4) -> Appropriate	0.986	0.985	0.005	218.415
Lifecycle Cost Analysis (X4) -> Decision	0.916	0.914	0.026	35.082
Lifecycle Cost Analysis (X4) -> LCCA	0.964	0.963	0.011	83.794
Lifecycle Cost Analysis (X4) -> Riks	0.951	0.951	0.014	68.150
Value Engineering (X3) -> Internal and External Factor (Y)	0.093	0.090	0.136	0.689
Value Engineering (X3) -> Lifecycle Cost Analysis (X4)	0.952	0.949	0.016	59.212
Value Engineering (X3) -> Evaluation Phase	0.924	0.921	0.023	40.320
Value Engineering (X3) -> Functional Phase	0.952	0.950	0.015	64.000
Value Engineering (X3) -> Implementation Phase	0.952	0.950	0.014	66.852
Value Engineering (X3) -> Information Phase	0.961	0.960	0.012	82.219
Value Engineering (X3) -> Creativity Phase	0.952	0.950	0.014	66.310
Value Engineering (X3) -> Development Phase	0.905	0.901	0.028	32.590
Value Engineering (X3) -> Presentation Phase	0.947	0.945	0.016	57.687
Value Engineering (X3) -> Value Engineering Practice	0.936	0.934	0.018	52.176

Obtained model equation Y = 0.016 X1 + 0.182 X2 + 0.093 X3 + 0.683 X4

From this equation, it appears that life cycle costs (0,683) is the most dominant influence on cost performance. to prove that property owners and developers in calculating green building costs do not only calculate initial costs but need to take into account life cycle costs because initial costs only have a small influence on life-cycle costs.

4.4. Model Fit

Fit Summary

	Saturated Model	Estimated Model
SRMR	0.045	0.050
d_ULS	35.859	45.164

RMS Theta

RMS Theta	0,147

The model is Fit based on the SRMR value of 0.050, less than 0.08. Meanwhile, it does not fit based on the RMS Theta or Root Mean Square Theta value of 0.147 > 0.10. So based on the model assessment, one of the models meets the model fit criteria so it can be concluded that the model fits the data.

Discussion

The Ministry of Public Works and Housing Main Building attained Platinum-level status. Table 7 presents the contract costs for building management spanning from 2012 to 2019, totaling IDR 53,983,767,691. Additionally, Table 8 outlines contract costs amounting to IDR 3,748,418,591.58, culminating in a total of IDR 57,732,186,283 for operating and maintenance costs over 8 years (Leskinen et al., 2020).

Referring to Table 9, the collective electricity expenses from 2012 to 2019 sum up to IDR 22,769,234,524. Furthermore, Table 10 illustrates that the electricity utilized for water requirements amounted to IDR 1,466,252,260, resulting in a total electricity cost of IDR 24,235,486,784 over 8 years.

Table 7 - Building Management Contracts

Num	Year	Contract Cost IDR	Contract Period
1	2012	2,802,705,000.00	5 Months
2	2013	5,497,045,076.00	1 year
3	2014	6,706,812,827.00	1 year
4	2015	7,729,882,600.00	1 year
5	2016	7,989,000,000.00	1 year
6	2017	7,507,000,000.00	1 year
7	2018	7,606,973,711.00	1 year
8	2019	633,914,477.00	4 Months
		7,510,434,000.00	8 Months

Table 8. Maintenance Contracts

Year	Type of Work	Contract Cost IDR/year
2017	Workspace improvements	97,807,800.00
	1st 2nd and 3rd floor improvement	197,061,000.00
	Hall and 9th floor improvement	150,833,000.00
	Indoor building information network maintenance	169,125,000.00
	Sewage treatment plant maintenance	63,415,000.00
	Lift maintenance and repair	188,815,000.00
	Sub Total	867,056,800.00
2018	Changes in the elevator operational system by adding a BSO (Bank Separate Operation) program	116,600,000.00
	Fitness room and basement hall maintenance	190,597,000.00
	Pantry and interior wall maintenance	150,284,000.00
	Rooftop improvements	152,449,000.00
	Maintenance of the southern backyard area	155,809,291.22
	Improvement of workspace and changing room for Security Officer	195,145,000.00
	Mechanical and Electrical maintenance	112,670,800.35
	CCTV maintenance and improvement	65,227,470.00
	Storing cabinet repairs	118,556,000.00
	Repainting of stairway walls and hallways	154,407,000.00
	Wallpaper replacement	180,931,000.00
	Roof leakage repairs	147,704,000.00
	Sub Total	1,740,380,561.58
	Roof leakage repairs	147,704,000.00
2019	Interior maintenance of Inspectorate General Workspace	124,976,000.00
	Toilet Maintenance	94,188,240.00
	2nd and 3rd-floor interior wall maintenance	126,896,000.00
	Interior partition improvement and furniture maintenance	127,080,000.00
	5th floor roof garden maintenance	109,005,000.00
	Main building and basement parking building maintenance	156,336,000.00
	Minister workspace area 2nd floor improvements	183,865,000.00
	3rd floor workspace maintenance	70,930,990.00
	Sub Total	1,140,981,230.00
	TOTAL (IDR / 8 years)	**3,748,418,591.58**

Table 9. Electricity Cost

Num	Year	Total Electricity Consumption kWh	Energy Use Intensity kWh/M^2/year	Annual Cost IDR/year
1	2012	1,260,840	118.25	1,023,931,559
2	2013	3,276,636	128.04	2,990,756,389
3	2014	2,844,586	111.16	2,883,603,890
4	2015	3,026,500	118.27	3,323,930,737
5	2016	3,143,684	122.85	2,731,246,307
6	2017	3,385,022	132.28	3,091,599,935
7	2018	3,520,452	137.57	3,239,343,425
	2019	3,794,145	148.27	3,484,822,283
		TOTAL (IDR / 8 years)		**22,769,234,524**

Table 10 - Water Usage Cost

Num	Year	Total Water Usage M^3	Water Usage Liter/employee/day	Annual Cost IDR//year
1	2012	8,190	34.87	81,429,861
2	2013	20,052	35.56	196,175,171
3	2014	25,857	45.85	254,674,440
4	2015	19,486	34.55	191,494,890
5	2016	18,408	32.64	180,380,136
6	2017	19,942	35.36	196,813,616
7	2018	17,249	30.59	170,278,915
8	2019	19,821	35.15	195,005,231
		TOTAL (IDR/ 8 years)		**1,466,252,260**

Based on figure 1, shows that life cycle costs are proven to be the main element in cost performance, where the additional costs of green building investment are completely insignificant compared to other costs.(Ke et al., 2017).

Lifecycle Cost Analysis:

Incorporating the Initial Costs, Operation & Maintenance Costs, and Energy Costs data, an assessment of the Life Cycle Cost Structure of the Ministry of Public Works and Public Housing Main Building for an 8-year duration (2012-2019) can be conducted. The anticipated lifespan of this government edifice is estimated at 50 years, aligning with the criteria outlined in Minister Public Work no 45/PRT/M/2007, ensuring continued functionality and reliability.

To derive the 8-year life cycle costs, the Initial Cost necessitates reassessment, considering the building's service life. The ensuing calculations yield the following outcomes:

Tabel 11 - Lifecycle cost structure

No	Category	Cost	LCC	Percentage
		IDR	IDR / 8 year	%
1	Initial Cost	401,616,833,582.00	64,258,693,371.12	43.94%
2	O & M Cost	57,732,186,283.00	57,732,186,283.00	39.48%
3	Electrical Cost	24,235,486,784.00	24,235,486,784.00	16.57%
	Total		146,226,366,438.12	100.00%

Development of research conducted on the green building where the analysis uses SEM-PLS and obtains the results of the factors that influence the performance of green costs using the GBCI, namely Submission of green building data, Introduction of outside air, Water features, Alternative water sources, Installation of Sub Meters, Energy saving measures, Water Use Efficiency, OTTV Calculation, Monitoring CO2 levels and Refrigerant Fundamentals

5. Conclusion

Based on the research results, it shows that in the Validity Test the Outer Loading and AVE values are above 0.5, and in the Reliability Test the Composite reliability and Cronbach's alpha values show satisfactory values, namely above 0.7. The application of the GREENSHIP concept to green buildings using the Value Engineering and Lifecycle Cost Analysis methods, has a significant influence on increasing green cost performance with a fit structural model, and the 10 most influential factors are obtained, namely; Submission of green building data, introduction of outside air, water features, alternative water sources, installation of sub meters, energy saving measures, water use efficiency, OTTV calculations, monitoring CO2 levels and refrigerant fundamentals. Developers and property owners when building green buildings do not only consider initial costs but also life cycle costs because costs are very small or increasingly smaller after the green building is operational.

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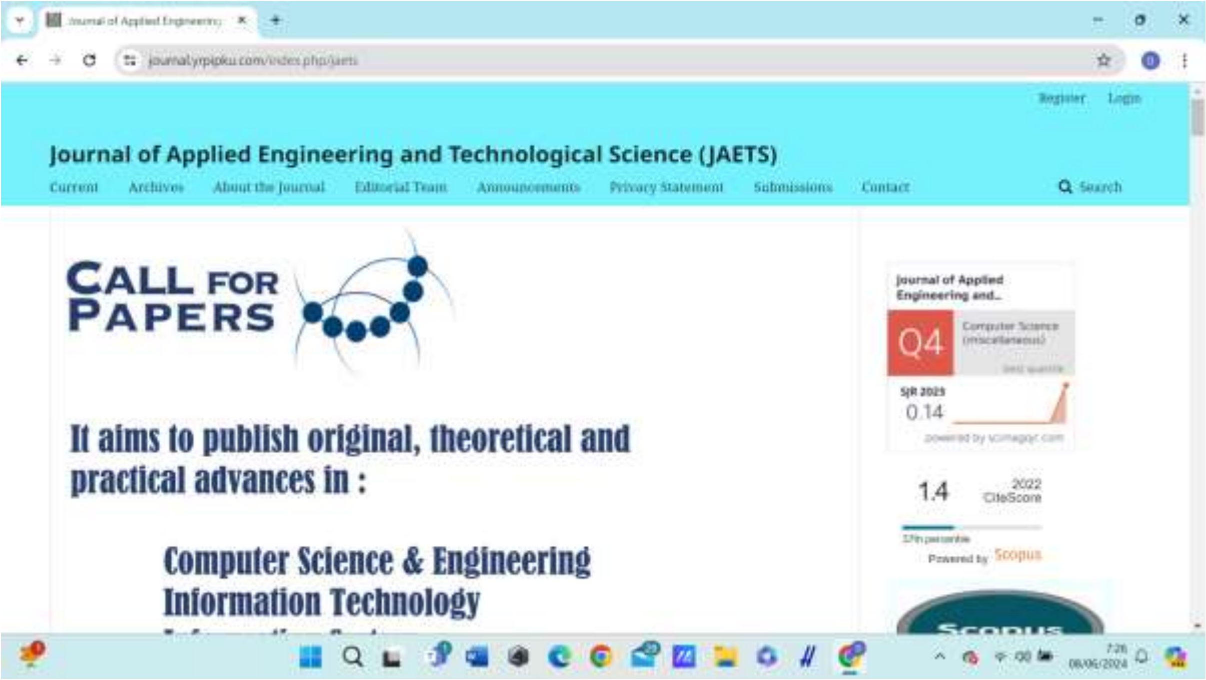
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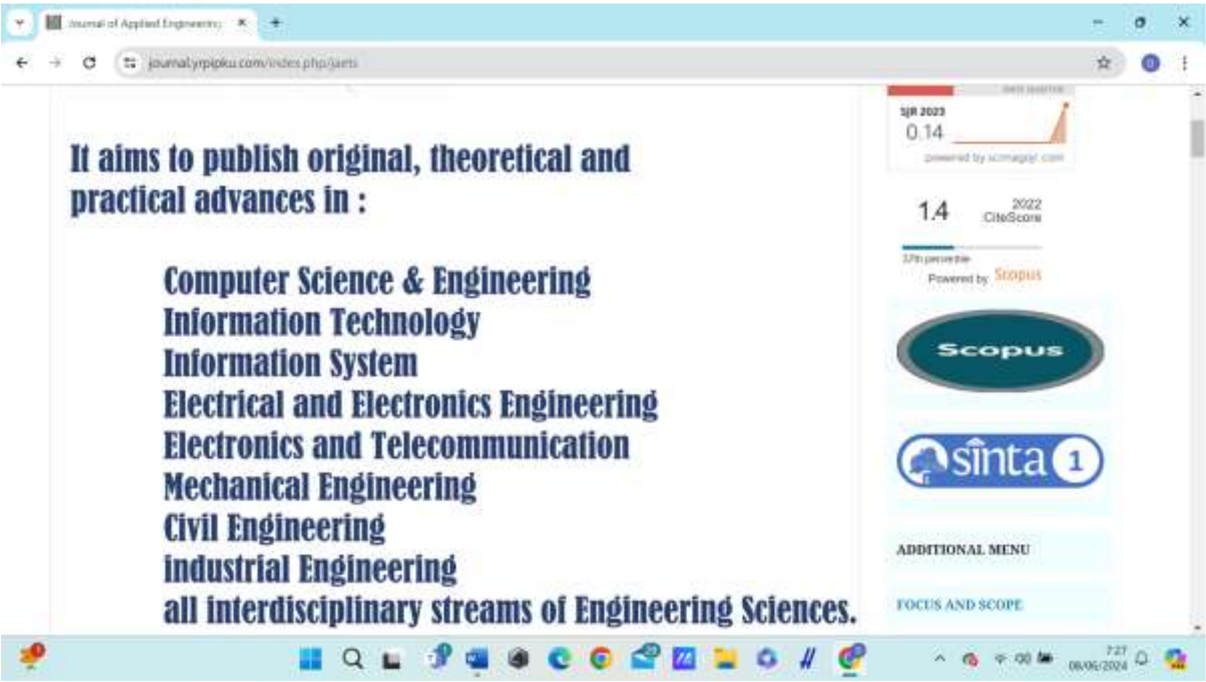
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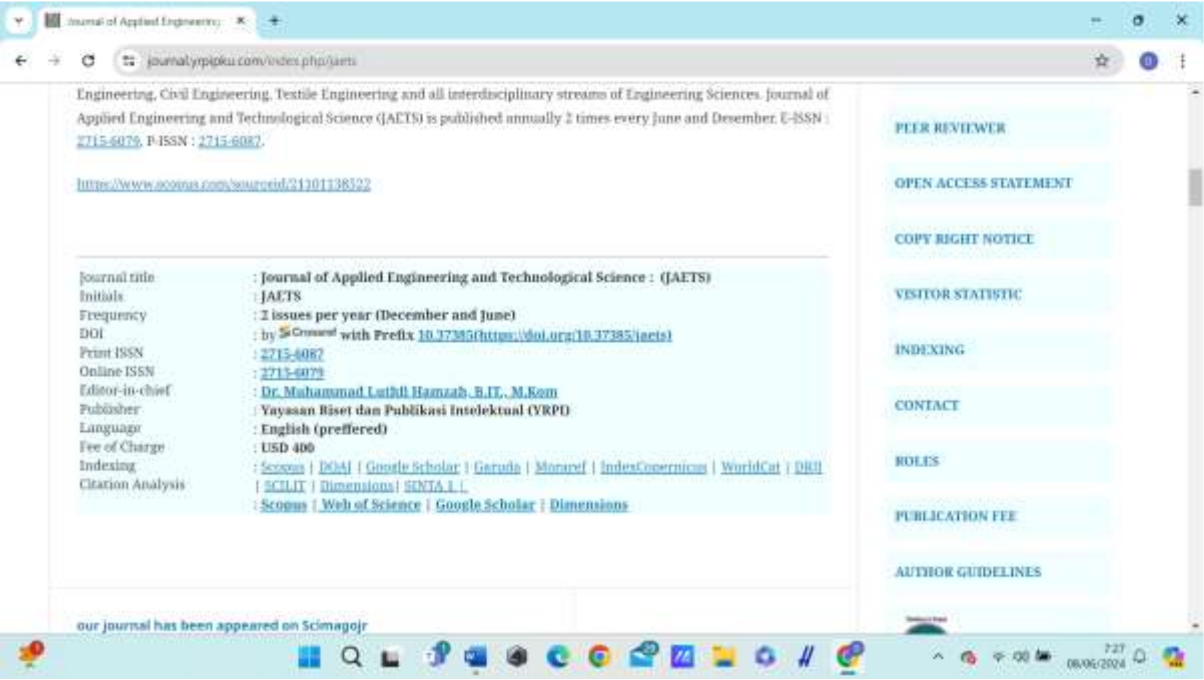

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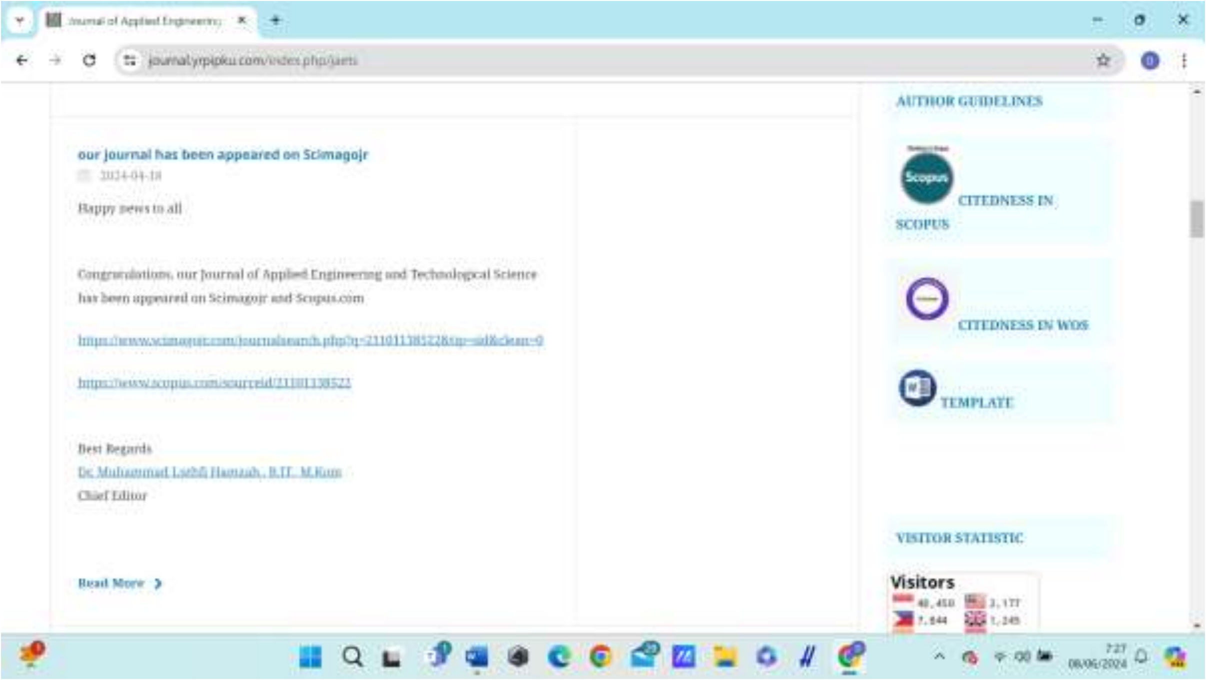

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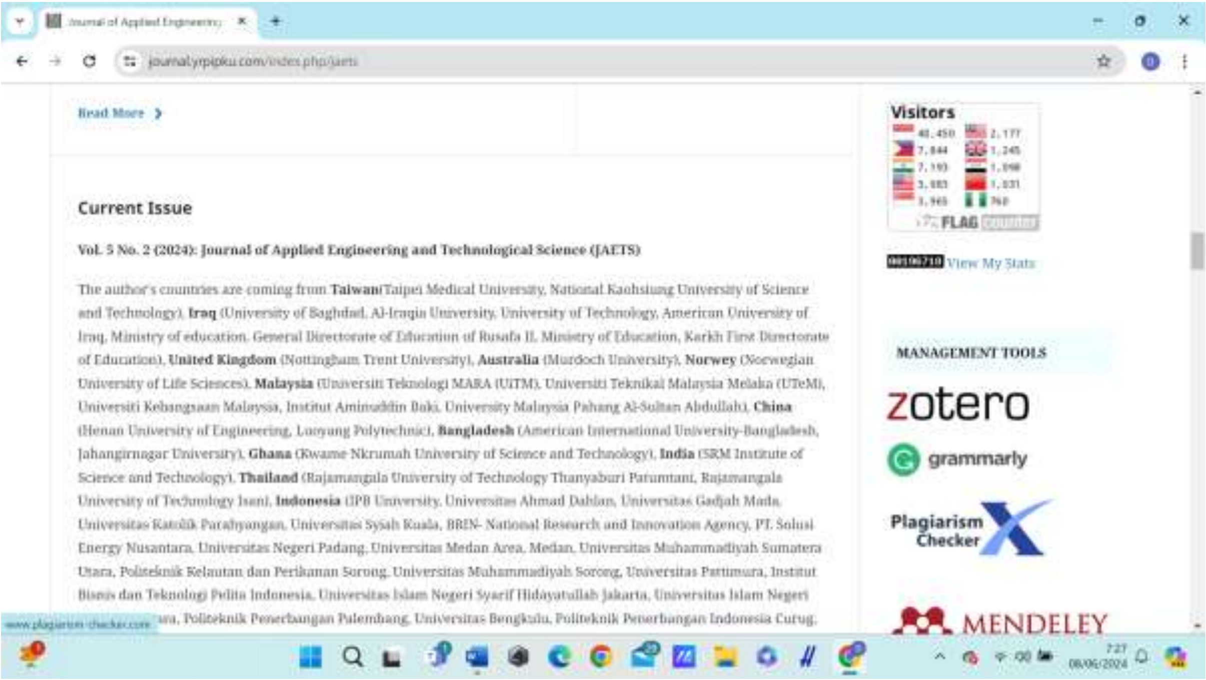

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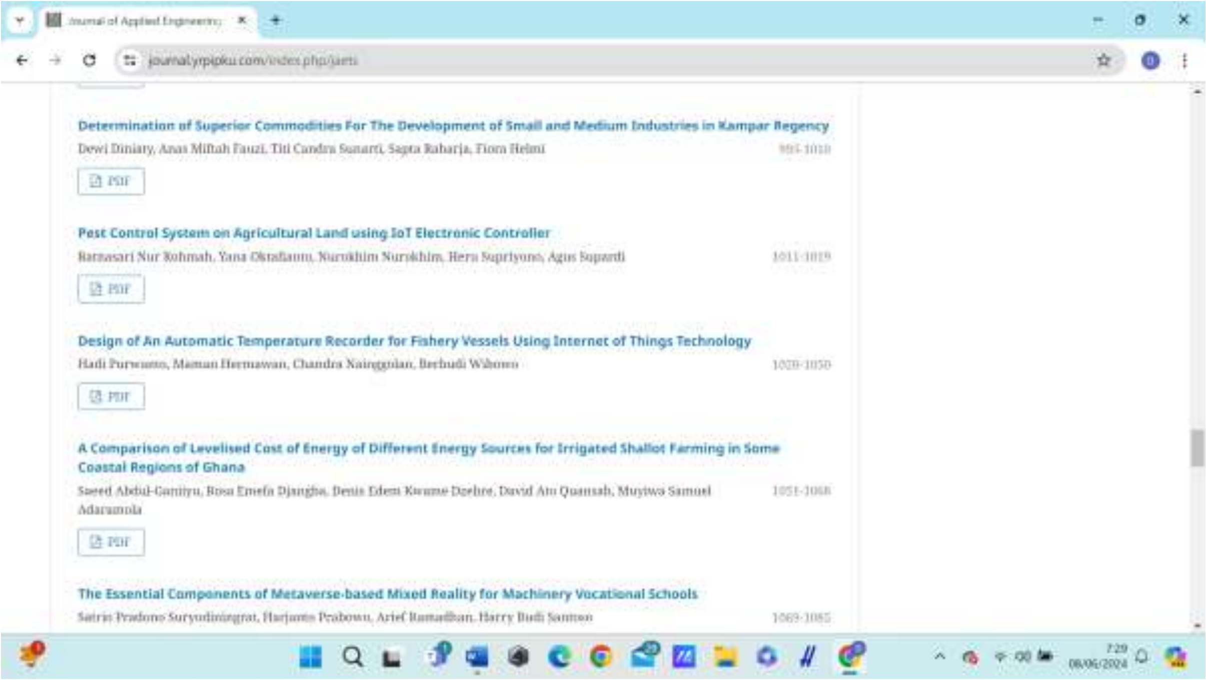

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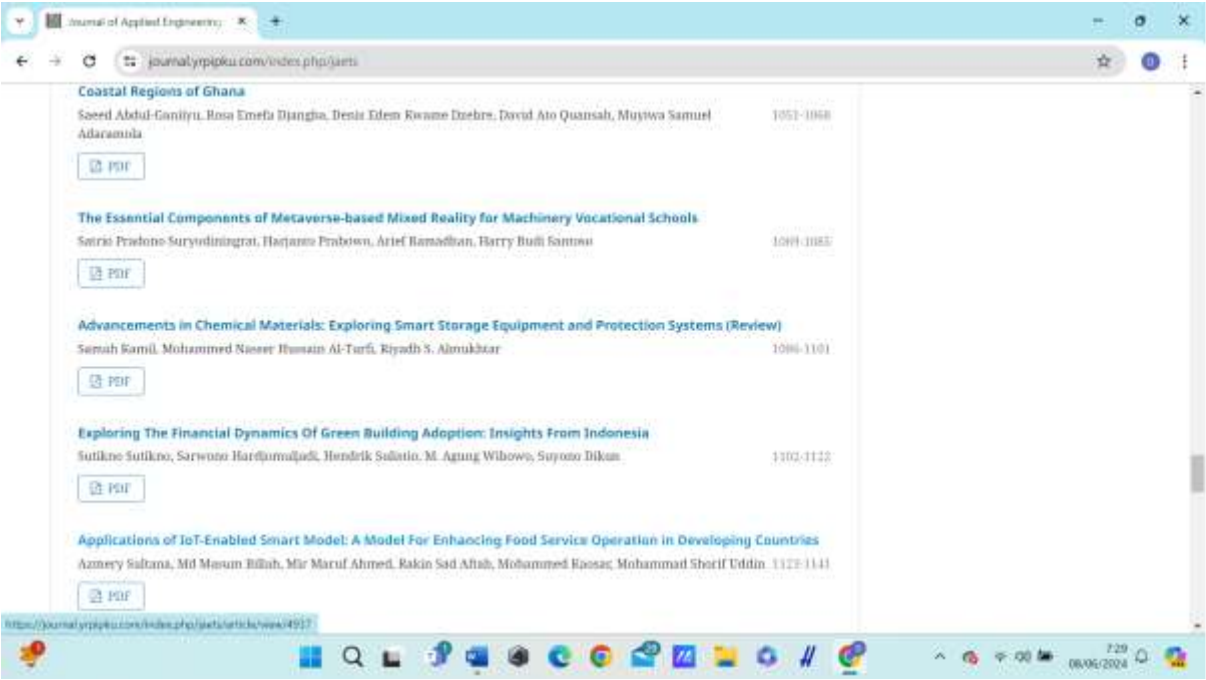

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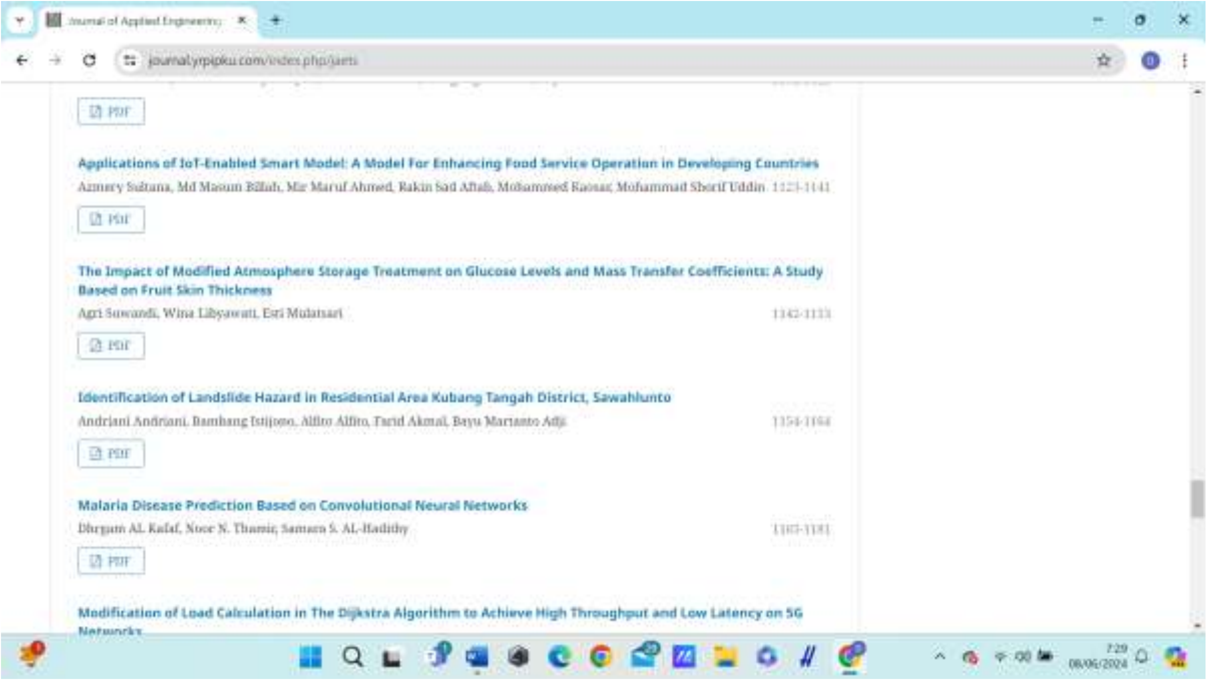

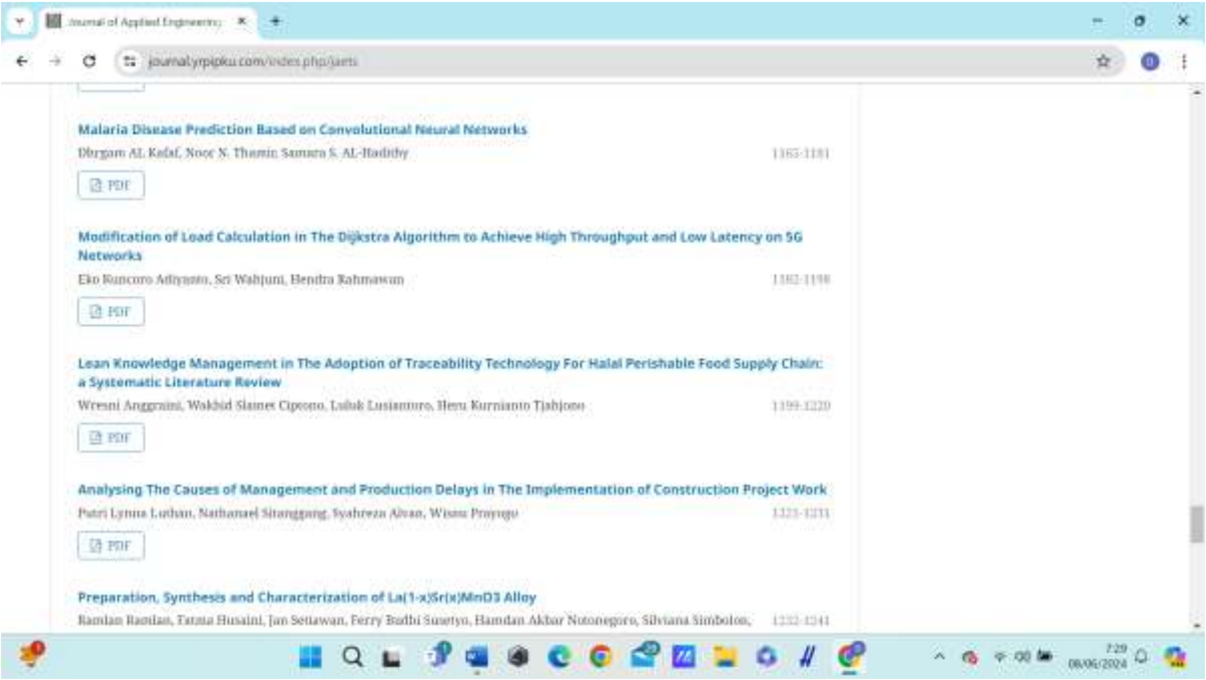

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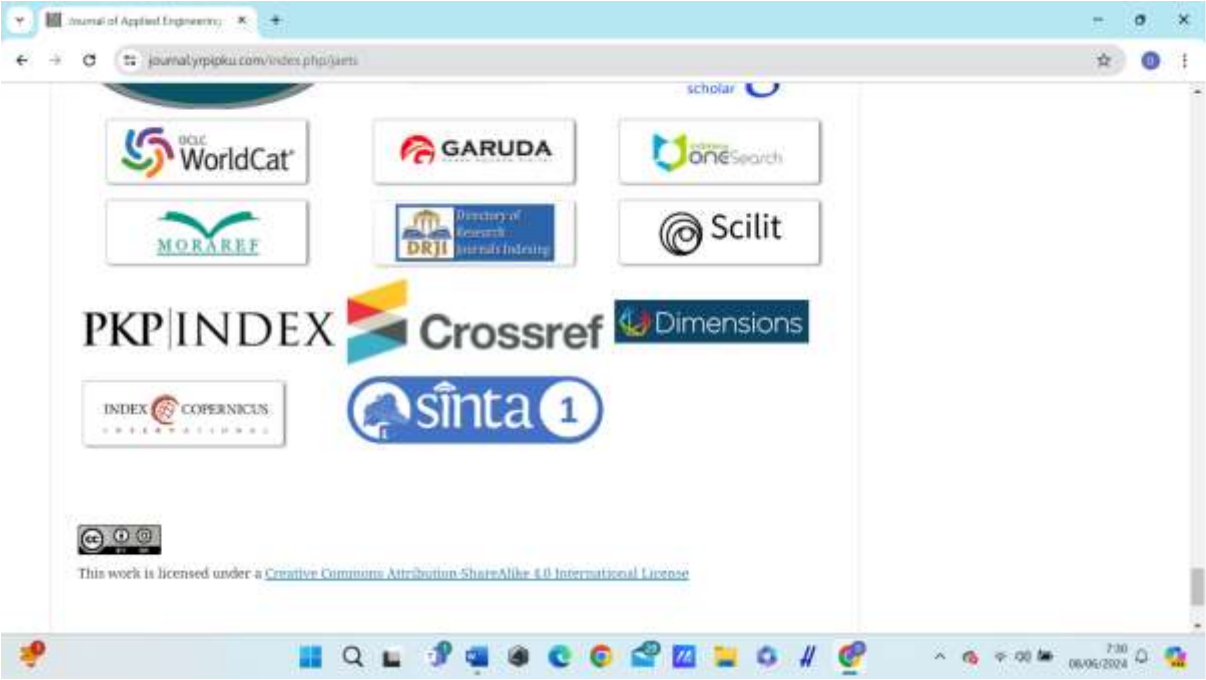
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