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Factors Influencing Cost Performance Improvement on the Concept of Green Retrofitting High-Rise Offices Using Structural Equationg Modelling-Part Least Square (SEM-PLS)

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ABSTRACT

The increase in energy consumption in the operation of the building construction industry globally has increased by a percentage of 35%, so that this increase can lead to an increase in carbon emissions which was originally at a percentage of 28% to 38%. The concepts of Green Retrofitting, Dynamic Systems and Value Engineering can be researched based on the influence on improving the cost performance of Green Retrofitting in high-rise (existing) office buildings and connected with the Structural Equation Modelling-Partial Least Square (SEM-PLS) analysis model. PLS-SEM is very appropriate to be used in research aimed at developing theories. The results of this study show that in the application of the Green Retrofitting concept in high-rise office buildings using Dynamic Systems and Value Engineering has a significant effect on improving the cost performance of Green Retrofitting and get the most influential factors are Top Management Support, Energy Efficiency, Water Efficiency, Indoor Air Quality, Retrofitting Planning, Retrofitting Initial Costs, Bill Of Quantity, Dynamic System Model Generation, Alternative Material Selection, and Material Cost Reduction.

Key word: highrise building; office; green retrofitting; system dynamics; value engineering; SEM-PLS

INTRODUCTION

The increase in energy consumption of the operation of the building construction industry globally increased by a percentage of 35%, (UN Environment Programme, 2020). The increase has led to increased carbon emissions, from 28% to 38%. (Robati et al., 2021).

Sustainable development parameters, Green Retrofitting is a parameter that can be used to control an increase in the number of existing buildings in buildings in developing countries with a percentage of 1.5%-2% (Rahmawati et al., 2018), so that the application of Green Retrofitting produces cost savings in terms of economic, environmental and social aspects up to a percentage of 10%-20%. (Ronald et al., 2020).

The process of implementing Green Retrofitting is an application system used in increasing the cost of building construction (Retrofitting Cost) to reduce the amount of energy consumption used up to a percentage of 10.77%. (Kim et al., 2017).

The energy crisis has an impact on increasing carbon emissions to the environment, so that the application of the green building concept can be significantly optimized. Dynamic System is a scenario system used in determining the rating (level) of cost increase control towards the optimization and efficiency of energy savings with the green building concept (Lee et al., 2015) and Value Engineering is a method used in calculating the optimization of energy savings and life cycle costs against the feasibility of the green building concept. (Yuan et al., 2020).

Seeing that there is a relationship between the concept and the factors above, the concepts of Green Retrofitting, Dynamic Systems and Value Engineering can be examined based on the influence on improving the cost performance of Green Retrofitting in high-rise (existing) office buildings. The complex relationship model and concept can use the Structural Equation Modelling-Partial Least Square (SEM-PLS) analysis model.

RESEARCH METHODS

Some characteristics that need to be considered include sample size, data distribution shape, missing values and measurement scale. The minimumasample sizeataken is based on the difference in levels in path coefficients (p Min) andastatistical strength test ofa80% (Hair Jr et al., 2021).

Table 1.1 Table Minimum Sample Size For Level Difference with Minimum Path Coefficient and 80% Strength Test

Pmin	**Significance Level**		
	1%	**5%**	**10%**
0.05-0.1	1004	619	451
0.11-0.2	251	155	113
0.21-0.3	112	69	51
0.31-0.4	63	39	29
0.41-0.5	41	25	19

(Source: Hair Jr et al., 2021)

This research model determines theaminimum sample size taken basedaon the path coefficientavalue of 0.25 and a statisticalastrength test of 80% at a significant level of 5% so that a minimum sampleaofa69 isaobtained. Data information of 80 samples obtained.

Figure 1. Respondent Data (Source:author)

According to Sugiyono (2010: 62), data collection technique is the most strategic step in research, data collection is carried out with the Observation stage. (Nawawi and Martini, 1992:74), interviews (Sugiyono, 2010:194), and documentation (Hamidi, 2004:72), while primary data collection was carried out with the instrument validation stage, pilot survey, respondent data collection, questionnaire dissemination, validation of questionnaire results and data input process and model simulation on SEM-PLS.

The questionnaire data collected by the researcher in this research and will be processed and analyzed using "Structural Equation Modeling" (SEM). This method seems to dominate the use of multiple path and regression analysis that has been used frequently so far. This is because this analysis is more comprehensive because each value in each question of each latent variable or factor or in this method is referred to as an observed variable or sub-factor of a latent variable can be analyzed comprehensively. Researchers used SEM SMART-PLS software version 3.0.

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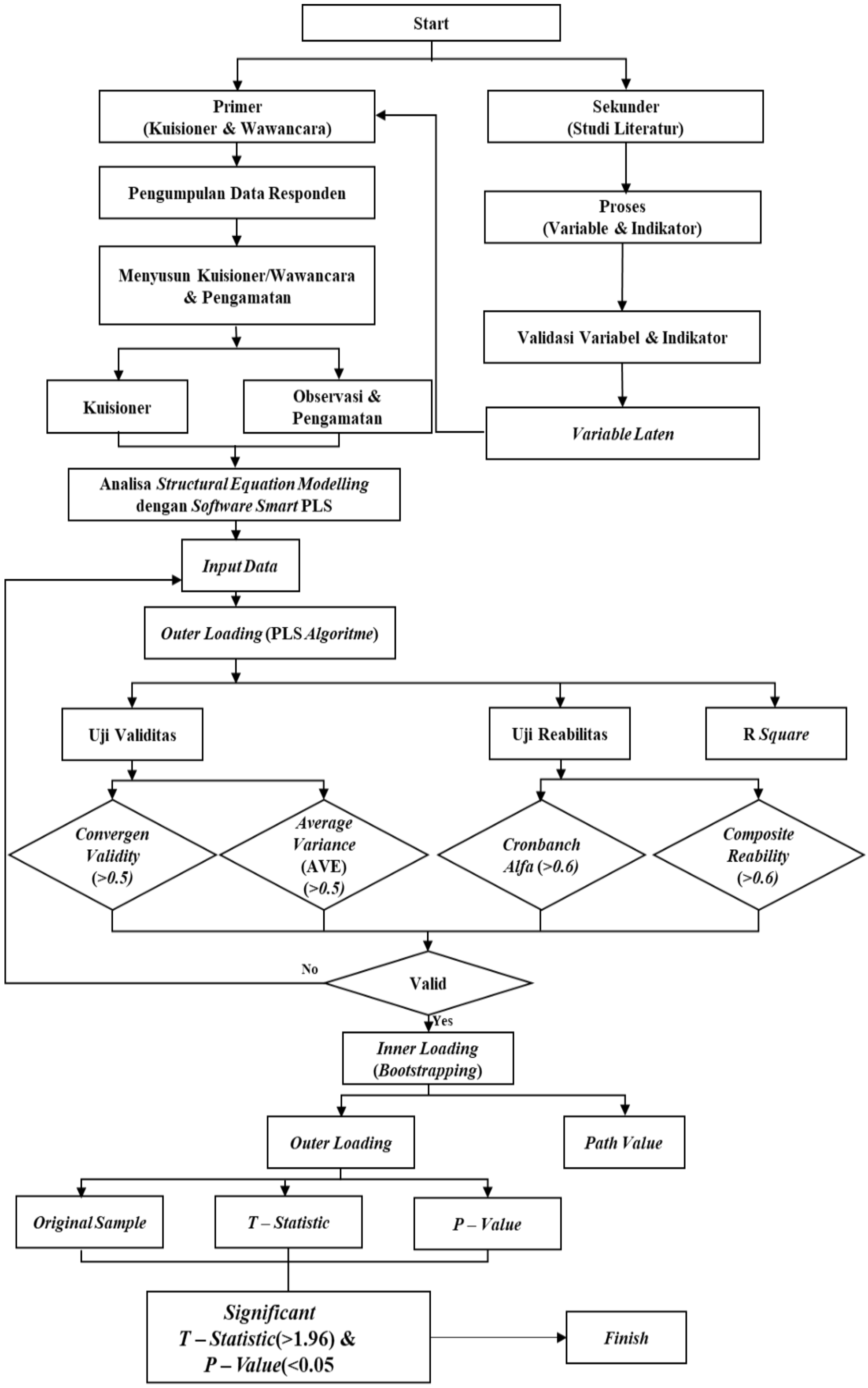

Figure 2. Structural Equatian Modeling (SEM) Factor Diagrams (Source:author)

RESULT

Evaluation Model Outer Loading

Measurement of the indicator (Outer Model) is carried out by looking at Convergent validity, Average variance Extracted, Construct Realibility 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); develop models suitable for forecasting (path analysis); and obtaining models (structural models and regression analysis). Each modeling has a connection to a measurement model, a structural model, or a causal model. In contrast to structural models, which are modeling that describes hub-and-spoke relationships that are being hypothesized, model measurements are used to generate inferences about the validity and validity of discriminants.

Validity Test

The validity test serves to measure the validity or not of a research instrument can provide information from the variables tested correctly (Nur & Husin, 2022). The validity test can be accepted or said to be valid if the Convergence Validity value is greater than 0.5 and the Average Variance Extracted (AVE) value is greater than 0.5.

Table 2.2 Outer Loading (Factor Loading)

Indicator	Outer Loading	Indicator	Outer Loading
X1	0.954	X50	0.967
X2	0.863	X36	0.976
X3	0.969	X37	0.937
X4	0.969	X38	0.985
X5	0.952	X39	0.969
X6	0.953	X40	0.983
X7	0.962	X41	0.948
X8	0.920	X42	0.942
X9	0.793	X43	0.607
X10	0.906	X44	0.929
X11	0.569	X51	0.963
X12	0.922	X52	0.941
X13	0.719	X53	0.948
X14	0.943	X54	0.959
X15	0.924	X55	0.959
X16	0.821	X56	0.953
X17	0.942	X57	0.912
X18	0.723	X58	0.941

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Indicator	Outer Loading	Indicator	Outer Loading
X19	0.800	X59	0.946
X20	0.919	X60	0.951
X21	0.953	X61	0.954
X22	0.896	X62	0.952
X23	0.936	X63	0.967
X24	0.912	X64	0.985
X25	0.908	X65	0.943
X26	0.764	X66	0.950
X27	0.933	X67	0.958
X28	0.917	X68	0.929
X29	0.873	X69	0.990
X30	0.912	X70	0.990
X31	0.963	X71	0.995
X32	0.950	X72	0.995
X33	0.919	X73	0.971
X34	0.942	X74	0.970
X35	0.981	Y1	0.918
X45	0.941	Y2	0.896
X46	0.950	Y3	0.938
X47	0.966	Y4	0.889
X48	0.735	Y5	0.694
X49	0.855	Y6	0.640

(Source:author)

Reability Test

The reliability test is carried out by looking at the composite reliability value of the indicator block that measures the construct. Composite Reliability and Cronbach's Alpha results will show satisfactory values if above 0.7. The composite reliability value at the output is presented in the following table:

Table 3. 3 Composite Reliability & Cronbanch's Alpha

Variable	Cronbach's Alpha (>0,7)	Composite Reliability (>0,7)
Cost (Y)	0.911	0.932
Planning Document (DP)	0.956	0.968
Green Retrofitting (X2)	0.977	0.978
HighRise Building (X1)	0.957	0.962
Building Organization and Governance (OTKB)	0.950	0.961
Planning (PRN)	0.960	0.966
Making a Stock Flow Diagram (PSFD)	0.911	0.957
Maintenance of BGH Performance Utilization Period (PKBGHMP)	0.967	0.973
Environmental Tread Recovery (PTL)	0.881	0.944
Model Usage (PMOD)	0.777	0.874
The Role of Occupants and Uses (PPP)	0.962	0.976
Implementation (PLK)	0.962	0.972
Disassembly Process (PP)	0.978	0.986
Retrofitting Adjustment Modifier Process (PPSR)	0.861	0.935
Retrofitting Cost (RC)	0.936	0.953
System Dynamic (X3)	0.906	0.923
Evaluation Stages (TE)	0.960	0.971
Function Stages (TF)	0.899	0.952
Implementation Stages (TIMP)	0.938	0.970
Stages of Information (IT)	0.980	0.983
Creative Stages (TK)	0.966	0.978
Stages of Development (TP)	0.980	0.990
Presentation Stages (TPERES)	0.990	0.995
Value Engineering (X4)	0.987	0.988

(Source: author)

R Square

R-squared (R2) testing is a test carried out to measure the Goodness of Fit level of a structural model. The value of R-squared (R2) is used to measure how much influence a particular independent latent variable has on the dependent latent variable. According to Chin (1998) in Ghozali (2012: 27),

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an R2 result of 0.67 indicates that the model is categorized as good. R2 results between 0.33 and 0.67 indicate that the model is categorized as moderate

Table 4. 4 R Square

Variable	R Square
Evaluation Stages (TE)	0.835
Value Engineering (X4)	0.578
Making a Stock Flow Diagram (PSFD)	0.449
Model Usage (PMOD)	0.841
Building Organization and Governance (OTKB)	0.914
Environmental Tread Recovery (PTL)	0.547
Function Stages (TF)	0.774
Disassembly Process (PP)	0.641
Retrofitting Adjustment Modifier Process (PPSR)	0.753
Cost (Y)	0.810
Green Retrofitting (X2)	0.438
The Role of Occupants and Uses (PPP)	0.650
Stages of Development (TP)	0.837
Creative Stages (TK)	0.730
Implementation Stages (TIMP)	0.679
Implementation (PLK)	0.922
Maintenance of BGH Performance Utilization Period (PKBGHMP)	0.877
Planning (PRN)	0.812
Presentation Stages (TPERES)	0.832
Retrofitting Cost (RC)	0.907
Stages of Information (IT)	0.698
Planning Document (DP)	0.916
System Dynamic (X3)	0.642

(Source: author)

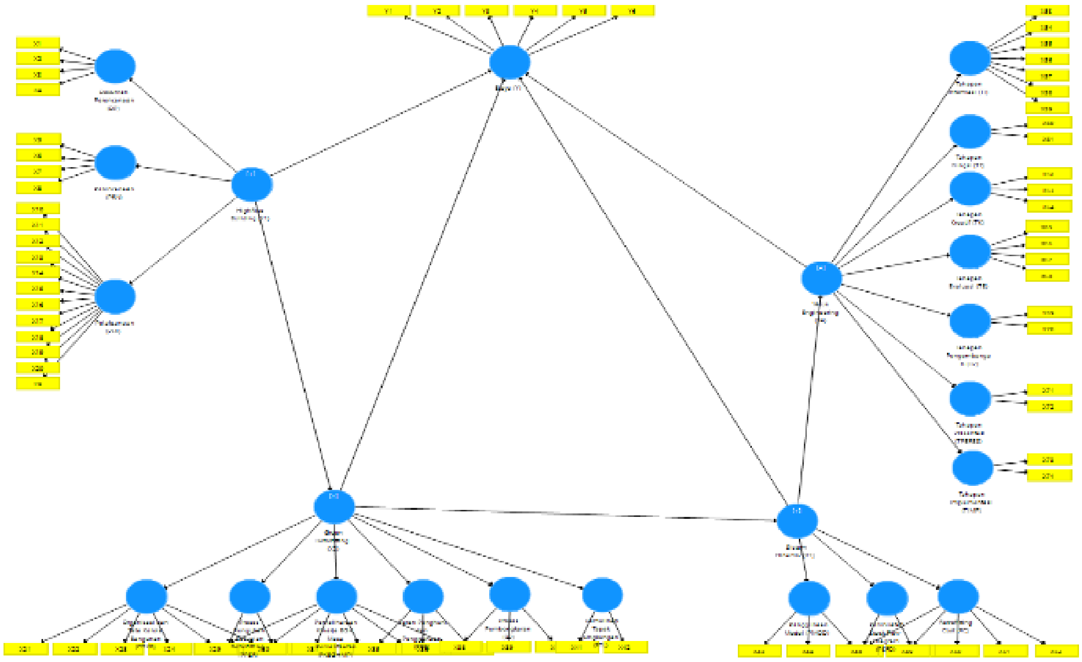

Figure 3.1 Research Model with SMART PLS (Source:author)

Evaluation of the Inner Loading Model

To test the value of structural models (inner loading) or models that connect between constructs (latent variables) are then analyzed using the Bootsrapping procedure (Hair et al., 2014). To determine 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 that are less than -1 indicate negative relationships (Sarstedt, 2019). The result of interpretation of path coefiicient according to table 7 path coefficient is the result taken from the bootstrapping procedure, the results of path analysis or structural models have a significant effect if the statistical T value is more than 1.96 and the p value is less than 0.05 (Ghozali & Latan, 2015)

The discussion and analysis obtained the factors taken by the top 10 influenced the improvement of the cost performance of Green Retrofitting based on System Dinamik and Value Engineering applied to High-Rise Office Buildings are as follows:

Table 5.5 Influencing Factors

No.	Sub Factor	Original Sample Value	Mean	R Square
1.	Top Management Support	0.995	5.263	0.922
2.	Energy Efficiency	0.995	5.350	
3.	Water Efficiency	0.990	4.425	0.916
4.	Indoor Air Quality	0.990	5.438	
5.	Retrofitting Planning	0.985	4.563	0.914
6.	Initial Cost of Retrofitting	0.985	4.438	0.907

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No.	Sub Factor	Original Sample Value	Mean	R Square
7.	Bill Of Quantity	0.983	4.425	0.877
8.	Dynamic System Model Creation	0.981	5.313	0.841
9.	Selection of Alternative Materials	0.976	4.463	0.837
10.	Reduction of Material Costs	0.971	4.475	

(Source:author)

CONCLUSION

The results of the research are in the application of the concept of green areas in residential areas based on value engineering and lifecycle cost analysis has a significant effect on improving the cost performance of new green areas and obtaining the most influential factors, namely: Project Management, Infrastructure and Facilities Burden, Infrastructure and Facilities Service Functions, Microclimate and Ecosystem Preservation, Environmentally Friendly Materials, Development, Cost Breakdown Structure, LCC Analysis, Evaluation, Value Engineering. By using SEM-PLS analysis, it is more effective in obtaining correlation of theoretical relationships in research.

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The results of this study show that in the application of the Green Retrofitting concept in high-rise office buildings using Dynamic Systems and Value Engineering has a significant effect on improving the cost performance of Green Retrofitting and get the most influential factors are Top Management Support, Energy Efficiency, Water Efficiency, Indoor Air Quality, Retrofitting Planning, Initial CostaRetrofitting, Bill Of Quantity, Dynamic System Model Manufacturing, Alternative Material Selection, and Material Cost Reduction.

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