International Journal of Research and Review
DOI: https://doi.org/10.52403/ijrr.20211159
Vol.8; Issue: 11; November 2021
Website: www.ijrrjournal.com
Research Paper *E-ISSN: 2349-9788; P-ISSN: 2454-2237*

Key Success Factors: Application 6D BIM to Reduce Initial Cost, Operational Cost & Maintenance Cost in Project Facade High-rise Office using RII Method

Paulus Praja Credana[1], Budi Susetyo[2]

[1]Postgraduate Student of Master Civil Engineering, Mercu Buana University, Jakarta, Indonesia,
[2]Lecturer of Master Civil Engineering, Mercu Buana University, Jakarta, Indonesia.

Corresponding Author: Paulus Praja Credana

ABSTRACT

The application of 6D BIM and value engineering in a project is still very rarely studied because BIM is still a new discussion in the project planners' field. The key to the success of implementing BIM 6D is influenced by several factors which will be explained in this study. The purpose of this study was to determine the success factors for applying BIM 6D value engineering to the Façade project of high-rise office buildings in terms of reducing design costs, operating costs, and maintenance costs. Office Building. This factor will be a focus for stakeholders, especially the Office Building Façade project in Indonesia.

Keywords: BIM 6D, building facade, Office building, RII.

INTRODUCTION

Buildings have a considerable impact on the environment, so it is necessary to pay more attention to environmental performance in building design. In addition, the largest energy consumption on earth is found can be in buildings, especially office buildings.

Therefore, issues related to energy and future survival are the main focus that cannot be separated from the discussion of the world, energy sustainability for the future, or what is known (Sustainable development) which can be realized by the application of green building concept.

Green building design applied to the building envelope is considered more effective in controlling energy consumption in the building because the building envelope is the outermost part that is exposed to direct exposure to solar radiation which causes heat inside the building thereby increasing energy consumption. So that the design of the building envelope is an important object in a green building design, the alternative of choosing a building envelope is very influential on energy consumption.

The chosen alternative of the building envelope can be analyzed for energy consumption using BIM 6D analysis, BIM 6D software that analyzes energy consumption, the analysis is carried out by first modeling the proposed alternative design then setting the design location, material, and type of shading and getting the value results in energy consumption according to alternative building envelopes.

Energy consumption in buildings significantly affects the direct costs of building operations, which will become routine costs incurred every year that will be taken into consideration for investors to calculate their Life Cycle Costs.

According to Saleem 2016, LCC especially on façade is estimated based on the materials used during the pre-use phase (design planning), used phase (use), and post-use phase (after use) or the calculated

costs and those are design costs, operational costs & maintenance costs.

LITERATURE REVIEW

Identification and Categorization of Key Success Factors application BIM 6D

From the results of literature review and justification from experts there are 29 sub-factors, 7 main factors and 3 variables as follows.

Design Fee

The study of the effect of design costs on project performance is summarized below. Design changes in construction projects often lead to cost overruns or schedule growth. To clarify the causes of change orders for construction projects, and also to analyze their effects, Wu et al. (2004) There are 7 sub-factors that affect changes in Design Costs, among others; Types of Materials (Jalaei, F., & Jrade, A. (2014), Functional analysis (Zhou, C et al. (2014), Life Cycle Cost (Bertolini, V. (2016)), Product Costs (Bertolini, V. (2016), Development Costs (Bertolini, V. (2016), Implementation Costs (Bertolini, V. (2016), Change Costs (Bertolini, V. (2016). Maintenance costs.

According to Liu, (2005) each maintenance intervention is associated with a determined amount of monetary expenditure which includes direct and indirect costs. The effect of application time on cost estimates can be accounted for by a discount rate that converts future costs to values at a predetermined reference time.) 3 sub-factors affect changes in Maintenance Costs, among others; Routine costs (Kim, J., Han, S., & Hyun, C. (2016), Repair Costs Kim, J., Han, S., & Hyun, C. (2016) and Rejuvenation Costs Kim, J., Han, S., & Hyun, C. (2016).

Operating Costs

There are 3 factors that affect operational costs, among others; HVAC Usage Fee, Electricity Usage Cost and Lighting Cost (Mustamin, R. S. (2016)

Building Façade

According to (Rathnayake, Lau, and Chow 2020) The façade, which is the skin of the building, separates the interior space from the external environment. There is an urgent need to design and construct building façades to be more energy-efficient, as about 20–60% of building heating and cooling energy is affected by façade design and construction. There are 3 main factors in planning the façade of the building, among others; Alternative Materials, Material Criteria and Documents.

- Factors that affect the change in alternative building façade materials include: User Demand (Jalaei, F., & Jrade, A. (2014), Alternative Significance (Jalaei, F., & Jrade, A. (2014) and Material costs (Bahri), K., & Indryani, R. (2018).
- Factors that affect the change in the criteria for building façade materials include; Material Strength Bahri, K., & Indryani, R. (2018), Implementation Techniques Bahri, K., & Indryani, R. (2018), Completion Time (Hartono, W. (2013).
- Factors influencing changes to the building façade planning document include; Detailed drawings and clarity of specifications (Akhund et al, 2017), Completeness of Bill of Quantity (Woo & Bui, 2007) and work schedule (Ugw Kumarswarmy, 2015).

MATERIALS & METHODS

The research is focused on statistical analysis to identify variables that have a significant effect on the application of BIM 6D Value Engineering for the Building Façade project. Statistical analysis includes the process of validating variables using the SPSS program and then analyzed using the RII formula so that the top 10 most influential sub-factors in the study and the 10 lowest-ranking sub-factors are the least influential in the study.

Table 1. Research Variables

NO	MAIN FACTOR	CATEGORIES	X	VARIABLE	REFERENCE
1	**COST (X1)**	**Design Cost Analysis**	X1	Material Type	Jalaei, F., & Jrade, A. (2014).
			X2	Functional analysis	Zhou, C., Wang, B., & Guo, Y. (2014).
			X3	Life Cycle Cost	Bertolini, V. (2016).
			X4	Item Cost	Bertolini, V. (2016).
			X5	Development Cost	Bertolini, V. (2016).
			X6	implementation costs	Bertolini, V. (2016).
			X7	Change Fee	Bertolini, V. (2016).
		Operational Cost Analysis	X8	HVAC Usage Fee	Mustamin, R. S. (2016).
			X9	Electricity Usage Fee	Mustamin, R. S. (2016).
			X10	Lighting/Lamp Cost	Mustamin, R. S. (2016).
		Maintenance Cost Analysis	X11	Routine Fee	Kim, J., Han, S., & Hyun, C. (2016).
			X12	Cost of repairs	Kim, J., Han, S., & Hyun, C. (2016).
			X13	Rejuvenation / Rehabilitation Costs	Kim, J., Han, S., & Hyun, C. (2016).
2	**BIM 6D (X2)**	**BIM 6D**	X14	Education and Age QS BIM	(Qiping Shen & Guiwen Liu, 2014)
			X15	Operator Experience & Productivity	(The Tavistock Institute , 2016)
			X16	Number of Teams	(Leung & Kong, 2017)
			X17	Operator Remuneration	(Hansae Kim, 2004)
3	**Office Building Envelope (Y)**	**Material Alternatives**	X18	User request	Jalaei, F., & Jrade, A. (2014).
			X19	Alternative significance	Jalaei, F., & Jrade, A. (2014).
			X20	Material Cost	Bahri, K., & Indryani, R. (2018).
		Material Criteria	X21	Material Strength	Bahri, K., & Indryani, R. (2018).
			X22	Implementation Technique	Bahri, K., & Indryani, R. (2018).
			X23	Completion time	Hartono, W. (2013).
			X24	Implementation Method	Hartono, W. (2013).
			X25	Maintenance costs	Hartono, W. (2013).
			X26	Aesthetics	Bahri, K., & Indryani, R. (2018).
		DED documents	X27	Detailed Drawings and Clarity of Specifications	(Kaming et.al,1997), (Akhund et al,2017)
			X28	Completeness of Bill of Quantity	(Woo & Bui, 2007)
			X29	Work schedule	(Ugw Kumarswarmy, 2015)

The table above is the influential variables in statistical analysis in research related to BIM 6D value engineering in office building façade projects.

RII calculation uses formula (1).

RII (sub factor/variable) = $\frac{\sum W}{(A \times N)}$.

RII = Relative Importance Index.

W = weighting given to each factor by the respondents (ranging from 1 to 5)

A = The highest weight (in this study 6)

N = Total Respondents

RII Main Factor = mean RII main factor value.

RII Variable = mean RII main factor value.

The relationship between the variables with the purpose of this study is depicted using a fishbone diagram as shown in figure 1. The diagram depicts a fish head as the purpose of the study while the bone skeleton is a factor variable that affects the success of the 6D BIM value engineering process on the façade project of office buildings.

RESULT & DISCUSSION

The results of the relationship between variables X1, X2 and Y will be obtained based on the outcome of the analysis in the table of variables.

The research variables were obtained from secondary data based on the literature of previous studies, while the statistical analysis was obtained by processing primary data from questionnaires distributed to related project stakeholders. The research data will be processed through SPSS software version 25.

Statistical Analysis

Validity and Reliability Test

The r-table value with a significancy level used 5% obtained r-table Product Moment df = 29-2 = 0.3673. The validity test results of the factors causing change orders on time and cost performance show valid variables because of the value of r-table > 0.3673. The reliability test in this study uses the internal reliability coefficient of alpha, the questionnaire questions can be

said to be reliable if the Cronbach Alpha coefficient is above 0,6. The results of the reliability test can be seen in the table below:

Table 2. SPSS reliability test Case Processing Summary

Case Processing Summary			
		N	%
Cases	Valid	28	100.0
	Excluded[a]	0	.0
	Total	28	100.0
a. Listwise deletion based on all variables in the procedure.			

(Source. Analysis Results, 2021)

The reliability testing was processed using the Statistical Package for Social Science (SPSS) software. The results of the reliability test on the risk factors are 0.938, as in table 3. Therefore, 0.939 > 0.60 so that the questionnaire instrument is **valid.**

Table 3. SPSS reliability test Reliability Statistics

Reliability Statistics	
Cronbach's Alpha	N of Items
.939	29

Analysis RII

After the validation is carried out using the SPSS program, further analysis can be carried out using the RII method.

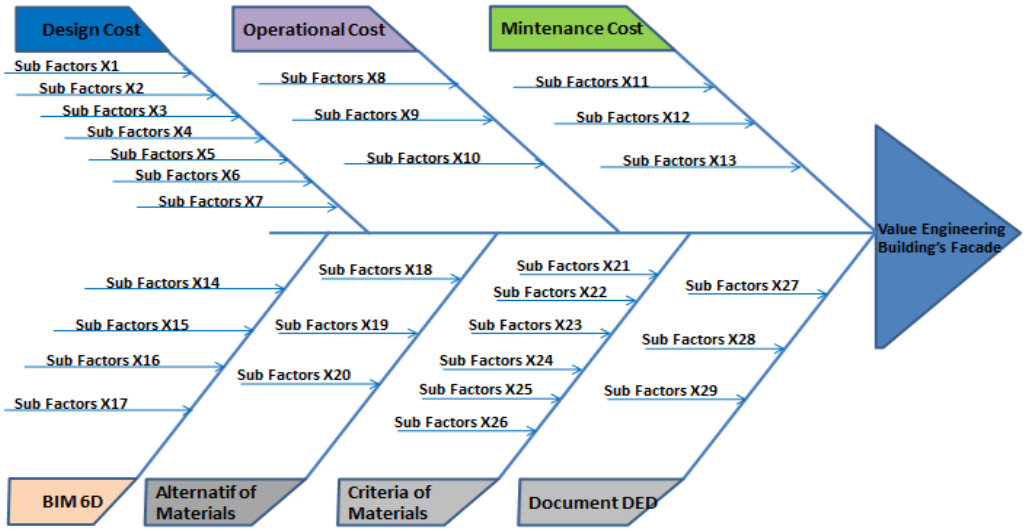

Figure 1. Main Factor & Sub Factor Category of Successful Optimization of 6D Value engineering

Results of the Study of Key Success Factors with RII

Based on the simulation results of RII analysis as shown in table no. 2 obtained the order of the rating of the main factors from the significant to the insignificant according to the respondent is:

a. Operational Cost (RII=0,869)

Operational Cost is the main factor that got the highest ranking in the RII calculation, Operational cost got the highest score with a value of 0.869 which is a value that has a significant influence as a success factor in calculating the value engineering project of the building façade. In this main factor, there is a factor that has the most significant effect HVAC Cost (0.900).

b. Document DED (RII=0,848)

Based on the RII analysis calculations, Document DED cost got the second-highest score with a value of 0.848. In this main factor, some sub-factors have a significant effect, namely Detailed Images and Clarity of Specifications (0.857), Completeness of Bill of Quantity (0.850) and Work Schedule (0.836).

c. Material's of Works. (RII=0,843)

Material works got third place with a value of (0.843) in this main factor some sub-factors have a significant influence, namely Material Costs (0.864), User Requests (0.864), Alternative Significance (0.864).

d. Criteria's of Works. (RII=0,816)

Criteria's works got the fourth order with a value (0.816) in this main factor, some sub-factors that have a significant effect are Aesthetics (0.893), Material Strength (0.836), Implementation Techniques (0.821).

e. Maintenace Cost (RII=0,771)

Maintenance Cost got the fifth place with a value of (0.771) in this main factor some sub-factors have a significant influence, namely Routine Costs (0.800), Repair Costs (0.771), Implementation Techniques (0.743).

f. BIM 6D (RII=0,748)

BIM 6D got the fifth place with a value of (0.748) in this main factor some sub-factors have a significant influence, namely Operator Experience & Productivity (0.771), Education and Age of QS BIM (0.764), Operator Remuneration (0.736).

g. Design Cost (RII=0,701)

Design Cost is in the last order with a significance value (0.701) in this main factor some sub-factors have a significant influence, namely Material Type (0.807), Functional Analysis (0.757), Product cost (item cost) (0.750).

Table 2. Relative Importance Index Table

MAIN Factors		Kode Sub Factor	Sub Factors	Result weight					Sub Factor RII	Rank
				1	2	3	4	5		
COST	**X1**	X1	Type of Materials	1	4	2	7	14	0,807	**12**
	Design	X2	Function Analysis	2	3	4	9	10	0,757	**21**
	Cost	X3	Life Cycle Cost	1	7	5	9	6	0,686	**26**
		X4	Item Cost	-	4	9	5	10	0,750	**22**
		X5	Development Cost	1	6	11	6	4	0,643	**28**
		X6	Implementation Cost	1	6	10	7	4	0,650	**27**
		X7	Change Fee	1	10	9	2	6	0,614	**29**
	Operational	X8	Usage HVAC Cost	-	1	4	3	20	0,900	**1**
	Cost	X9	Electricity Usage Cost	-	5	1	3	19	0,857	**4**
		X10	Lighting Usage Cost	-	3	3	6	16	0,850	**7**
	Maintenance	X11	Daily Cost	-	-	9	10	9	0,800	**14**
	Cost	X12	Improvement Cost	-	-	11	10	7	0,771	**18**
		X13	Rehability Cost	-	3	7	13	5	0,743	**23**
BIM 6D	**X2**	X14	Education and Age QS BIM	-	2	7	13	6	0,764	**20**
	BIM 6D	X15	Experience & Operator Productivity	-	2	6	14	6	0,771	**19**
		X16	Number of Team	-	2	12	9	5	0,721	**25**
		X17	Remuneration Operator	-	1	12	10	5	0,736	**24**
Façade's Office Building	**Y**	X18	User Request	-	-	4	12	12	0,857	**5**
	Material's of Work	X19	Significancy of Alternative	-	1	4	16	7	0,807	**13**
		X20	Material Cost	-	-	5	9	14	0,864	**3**
		X21	Material Strength	-	-	6	11	11	0,836	**10**
		X22	Implementation Technique	-	2	4	11	11	0,821	**11**
	Criteria's of Work	X23	Completion Time	1	1	7	10	9	0,779	**17**
		X24	Method of Work	-	1	8	11	8	0,786	**16**
		X25	Maintenance plan	-	1	6	14	7	0,793	**15**
		X26	Aesthetic	-	-	2	11	15	0,893	**2**
		X27	Detail Drawing and clarity of Specification	-	-	5	10	13	0,857	**6**
	Document DED	X28	Completion Bill of Quantity	-	-	4	13	11	0,850	**8**
		X29	Schedule of Work	-	-	7	9	12	0,836	**9**

CONCLUSION

The most influential factor in the success of the BIM 6D Value engineering application in the office building façade project in this study is the calculation of the Main Factor; Operational Cost with a significance value (RII=0.869). In detail, 10 sub-factors have a significant influence starting from the top, namely: a) Usage HVAC Cost, b) Aesthetic, c) Material Cost, d) Electricity Usage Cost, e) User Request, f) Detail Drawing and clarity of Specifications, g) Lighting Usage Cost, h) Completion Bill of Quantity, i) Schedule of Work, j) Material Strength. The 10 sub-factors that have the least significant effect

are: a) Change fee, b) Development Cost, c) Implementation Cost, d) Life Cycle Cost, e) Number of Team, f) Remuneration Operator, g) Rehability Cost, h) Item Cost, i) Function Analysis, j) Education and Age QS BIM.

ACKNOWLEDGMENTS

This research is fully supported by Plaza Indonesia Realty.co, one of the major Indonesian state-Realty companies, including Mrs. Indria Rani, Mrs. Rina Dharmayanthi and Project Development & WAM Team. I am very honored to be involved and collaborate with Plaza Indonesia Project Team to participate in accelerating the implementation of BIM 6D in Indonesia, towards Construction 4.0.

Conflict of Interest: None

Source of Funding: None

REFERENCES

1. Rompas AN. Et al. Penerapan Value Engineering pada Proyek Pembangunan Ruko Orlens Fashion Manado. 2013;1(5): 335–40.
2. Kartohardjono A, Nuridin N. Analisis Value Engineering Pada Proyek Pembangunan Apartement Di Cikarang. Konstruksia. 2018;9(1):41–58.
3. Perera S, Karunasena G, Selvadurai K. Application of Value Management in. 2003;04(01):3–12.
4. Wao JO. Value Engineering Evaluation Method for Sustainable Construction. AEI 2017 Resil Integr Build - Proc Archit Eng Natl Conf 2017. 2017;1091–102.
5. Hartono W. Aplikasi Value Engineering Dengan Metode Analytical Hierarchy Process (Ahp) Terhadap Struktur Pelat. 2013;1(4):401–7.
6. Bahri K, Indryani R. Penerapan Rekayasa Nilai (Value Engineering) Pekerjaan Arsitektural pada Proyek Pembangunan Transmart Carrefour Padang. J Tek ITS. 2018;7(1):3–7.
7. Bertolini V. Aplikasi Value Engineering Pada Proyek Pembangunan Gedung (Studi Kasus Hotel Grand Banjarmasin). J IPTEK. 2016;20(2):53.
8. Fu M, Liu R. Construction Research Congress 2018. Proceeding Constr Res Congr 2018 [Internet]. 2018;(Vdc):429–38. Available from: https://ascelibrary.org/doi/pdf/10.1061/9780784481301
9. Moon S, Choi E, Hong S. Creation of Robust Design Alternatives for Temporary Construction in Value Engineering. J Constr Eng Manag. 2016;142(3):1–11.
10. Mulyono EC, Iskandar T. Aplikasi Value Engineering pada Pekerjaan Struktur Atap Gedung Kuliah Fakultas Perikanan Universitas Mataram Nusa Tenggara Barat. 2016;
11. Zhou C, Wang B, Guo Y. An Innovative Application of AHP and Value Engineering Techniques in Project Management of High-Rise Buildings. ICCREM 2014 Smart Constr Manag Context New Technol - Proc 2014 Int Conf Constr Real Estate Manag. 2014;619–26.
12. Kim TH, Lee HW, Hong SW. Value engineering for roadway expansion project over deep thick soft soils. J Constr Eng Manag. 2016;142(2):1–9.

How to cite this article: Credana PP, Susetyo B. Key success factors: application 6D BIM to reduce initial cost, operational cost & maintenance cost in project façade high-rise office using RII method. *International Journal of Research and Review*. 2021; 8(11): 470-475. DOI: *https://doi.org/10.52403/ijrr.20211159*

******