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Cost Analysis of Facade Work in High-Rise Building by Value Engineering Method

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ABSTRACT

The façade of the building plays an important role to complement the structure shape and determine the visual impact on urban environments. The façade of the building itself has a heavy work or high cost value in the sub-section of the architectural masterpiece. It becomes a gap that we can review how much it costs to work. Value engineering issues that often arise are considered a reduction in costs. In the end that often happens precisely emphasis on material substitution, reducing or eliminating certain elements that lead to lower quality. Implementation of correct value engineering if done such as using alternative materials/materials contained in the work plan and requirements, but still in the equivalent specifications. In this study will be discussed the cost analysis of the selection of glass facade material without compromising the main function of the material itself. By using the value engineering method, it can be seen that the cost efficiency that can be saved is 5.93% of the planned budget for the work.

Key Words: *Value Engineering, Cost Analysis, Façade Work, Facade Glass, High-Rise Buildings.*

1. INTRODUCTION

In this study will discuss the cost analysis of the material selection of glass facades without compromising the main function of the material itself. It is necessary to review the impact of the implementation of value engineering methods on high-rise building facade work. By using value engineering method, it is expected to save the cost of the package of the work of the glass facade. However, the necessary stages of the process are required in this method, so it can be decided to select the right material.

2. LITERATURE REVIEW

In this chapter, it contains the explanation of the intent and purpose of the principles of value engineering developed by Lawrence D. Miles in the 1940 of the company Generic Electric, to solve the problem of lack of material from products that will be Produced during the Second World War [1]. But in the development of this method adopted and applied in the field of construction and how the results of the application of engineering value to the work of the in a high-level building project [2].

2.1 Theoretical Review

The review of the library contains the explanation of intentions and objectives of the principles of value engineering developed by Lawrence D. Miles in the 1940 of the company Generic Electric, to solve the problem of lack of material from the product will be produced during the Second World War [1]. But in the development of this method adopted and applied in the field of construction and how the results of the application of engineering value to the high-level building project.

2.1.1 Value Engineering

Value Engineering as a structured and creative problem solving technology is a solution to the challenges of economic globalization. Industries that use the value Reducas approach will add the important and subsequent the will emerge as the winner of the competition [3]. The method developed by Miles is known as Value analysis technique and is the standard method of General Electric Company for the study of value improvement [4]. After this value analysis technique is known, then began to be used in production processes in other companies and then this method develops no longer just analyze the finished product, but also seek a Engineering (Engineering) for products to be made or better known as value engineering methods. Value Engineering (VE) method this is the method arises because there are many costs that are not needed in a project plan, in Value Engineering (VE) an evaluation method is used to analyze the resources of a project, where new alternatives are sought for produce more efficient and effective costs and time so that it will increase profit and revenue for contractors and owners [5].

The procedure is named as a work plan (Job Plan) consists of 3 stages:

- Pre Workshop study,
- Value Job Plan), and
- Post Workshop study.

Each of these stages should follow the process flow diagram as in the following figure:

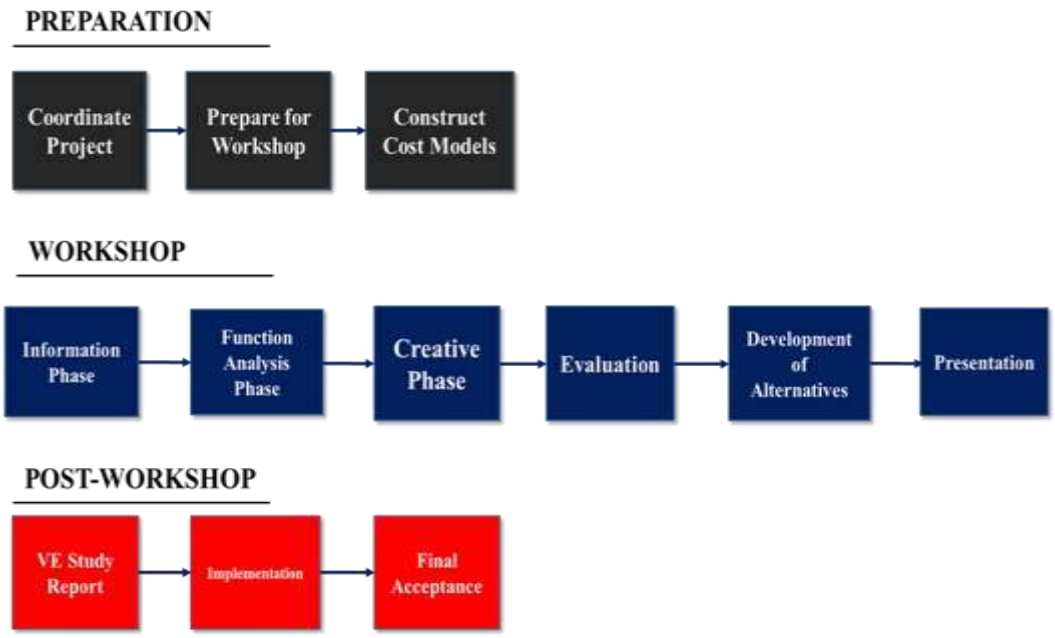

Figure 2.1 VE Process Summary
Source : New York University on 04/26/15. Copyright ASCE

The stages in this value engineering are 6 stages namely information stage, phase analysis function, creative phase, evaluation stage, development stage, and the presentation phase after the stage combined with the data of the case studied, it will be obtained The conclusion that value engineering can make the Budget Estimate cost to be greater than the budget plan and the project can be implemented.

2.1.2 Façade

Curtain wall design must fulfill several design criteria as follows:

1. Environmental criteria: Tackling water penetration, preventing air leakage, controlling light, heat radiation, heat conduction, moisture, preventing noise and weather resistance.

2. Structural criteria: wind-load resistance, flexible to the movement of structures, thermal expansion and contractions and moisture, flame retardant.

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3. Cost Criteria: glass curtain wall costs vary between 5 – 20% of the total building. Careful consideration between early and operational is required.

4. Building regulatory criteria: meet local building regulatory requirements. Generally the requirements of fire rating, wind loading and earthquake resistance, zoning regulations and local ordinance are to be met.

5. Aesthetic criteria: exterior appearance in accordance with a particular architectural design in the context of the city's cultural and local governance.

6. Construction criteria: The right erection method with local tread conditions, implementation schedule, manpower capability and construction management used.

7. Maintenance criteria: Routine cleaning, preventive maintenance, replacement of spare parts during building age [6].

Glass development trends in Indonesia, especially in Jakarta :

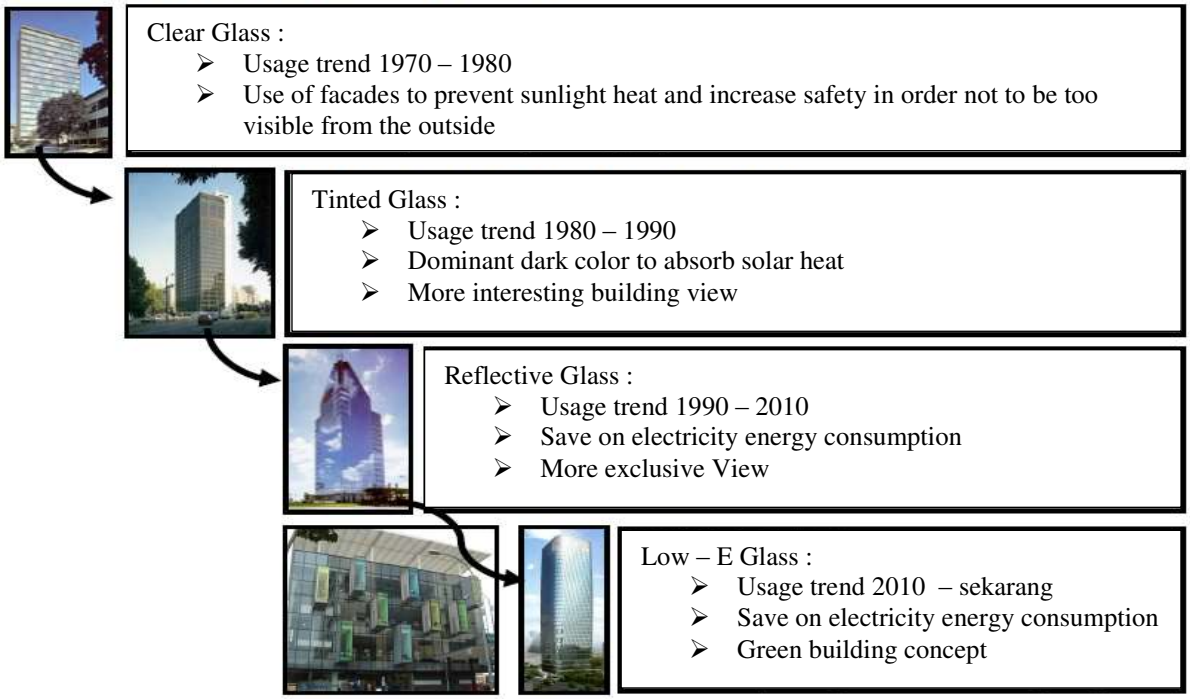

Figure 2.2 Glass development trends
Source : ***LP2FI [7]***

Table 2.1 Technical Characteristic

No.	Glass type	Glass thickness (mm)	Transmittance		U-Value W/m2.K	Shading Coefficient (SC)
			light (LT)	Energy (ET)		
1	clear	5mm	86%	67%	5.68	0.86
2	clear laminated	10.38 mm= 5+0.38+5 mm	85%	64%	5.63	0.84
3	clear (IGU)	22 mm = 5+12+5 mm	80%	69%	2.80	0.86

Source : SNI-03-6389-2000

3. RESEARCH METHOD

The research methodology used by writing this thesis more clearly discusses the research draft, research variables, research instruments, ranging from data types and sources, data collection techniques, population and sempel, methods Research analysis and schedule of research implementation used to solve the problem in the research. The research method according to [8] is essentially a scientific way to obtain valid data with the purpose of finding, proving and developing a knowledge so that the

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results can be used to understand, solving and anticipating problems. Research was conducted in analyzing a problem and reviewing the influence of value engineering implementation on the facade glass finishing work on the construction of high rise buildings to project costs.

There are two common data collection techniques used in quantitative research, namely:

A. Survey method
B. Case Study Analysis Method

In the picture below will be explained about the flow diagram of this research process. The reason for the use of value engineering because it takes an innovation against one of the jobs, for that is done Budget analysis is obtained that the work item that can be developed is the work of the glass façade. On this facade work glass costs look less efficient, because the perceived can still have alternative glass materials that can be used.

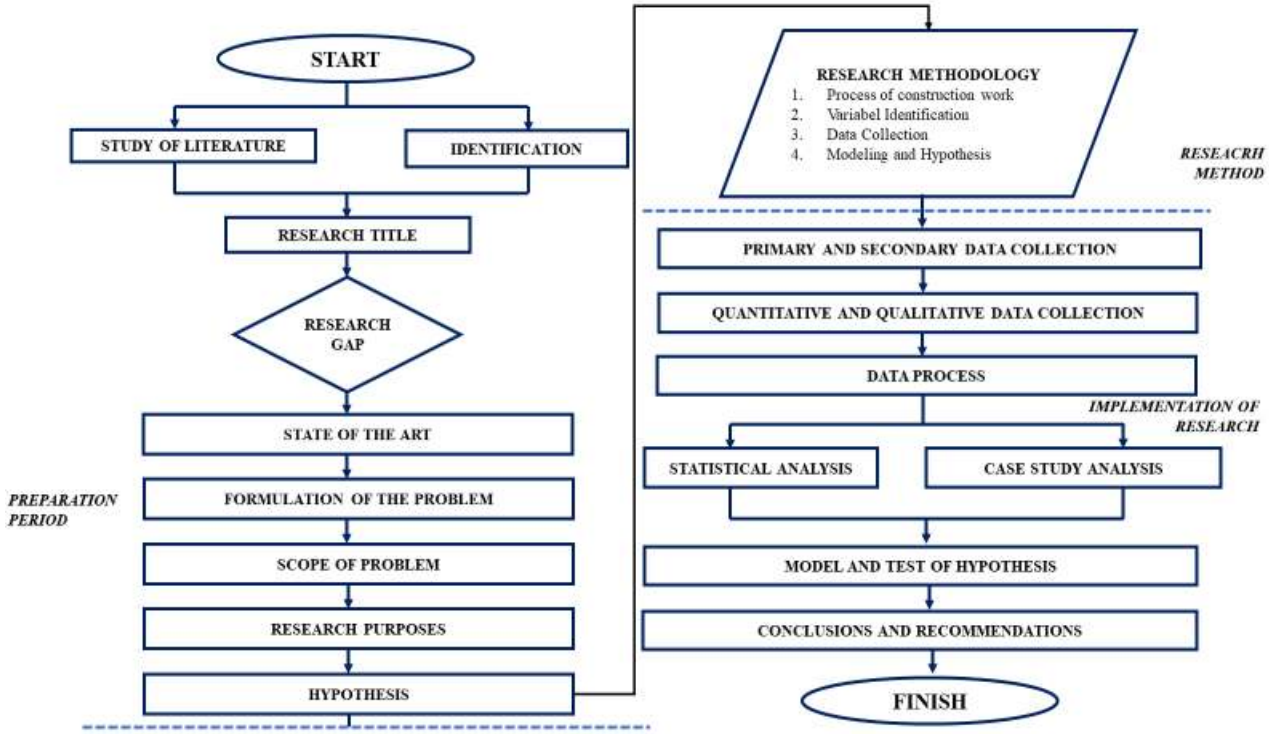

Figure 3.1 General details of research stage flow Diagram

The method of case study analysis is defined as the research done to determine the consequences of a treatment given intentionally by researchers. The purpose of experimental research is to know the effect of an action or treatment of the symptoms of one project with another project that uses different treatment. The experiment's research results are used to predict what will happen in the future based on the relationship between the variables that have been established.In this study, will focus on the discussion on case studies (Point B).

4. ANALYSIS

The objects taken in this research are high-level building projects with functional as office buildings. In This study I limited the discussion on the work of facade glass. Through the application of Rekasaya value using the method or technique of the work plan of Value Engineering (Job Plan) based on the theory of Dell'isola in the book Mohammed Ali Berawi (2014). This research activity is limited to the implementation stage from the viewpoint of Owner in adjusting the budget.

4.1 Information Phase

4.1.1 Characteristics of the project

The construction of the building consists of 40 floors and 7 basements. As the Golden Triangle area of Jakarta, the office building is expected to also provide an artistic value for its own. One of the design advantages of this building is the design of facade is quite elegant. For system façade to be used is full system curtainwall.

4.1.2 Initial Cost Model

The scope of façade work is divided into 3 major parts, among others:

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A. Preparation work
B. Façade work
C. Jobs Add/Less

Table 4.1 Recapitulation of budget plan cost facade

No	Item of work	Total Cost (Rp.)	Precentage (%)
A	Preparation work	Rp 3.483.700.000	3,45%
B	Façade work	Rp97.213.978.345	96,25%
C	Jobs Add/Less	Rp302.321.655	0,30%
Total		**Rp101.000.000.000**	**100,00%**
Total + ppn 10 %		**Rp111.100.000.000**	

Source : Project Data

Table 4.2 Façade Breakdown Material

No	Pekerjaan Material Fasad	Total Price (Rp.)	Precentage (%)
1	Glass	Rp52.404.659.448	53,91%
2	Almunium Frame	Rp34.704.659.448	35,70%
3	Accesories	Rp2.104.659.449	10,39%
Total		**Rp97.213.978.345**	**100,00%**

Source : Project Data

4.1.3 Pareto Distribution Analysis

From the bottom diagram distribution is the basis of decision making in glass material selection as a target of value engineering study. In addition to the consideration of available time and restrictions on the topic of research, the study of value engineering is only focused on the glass facade Material.

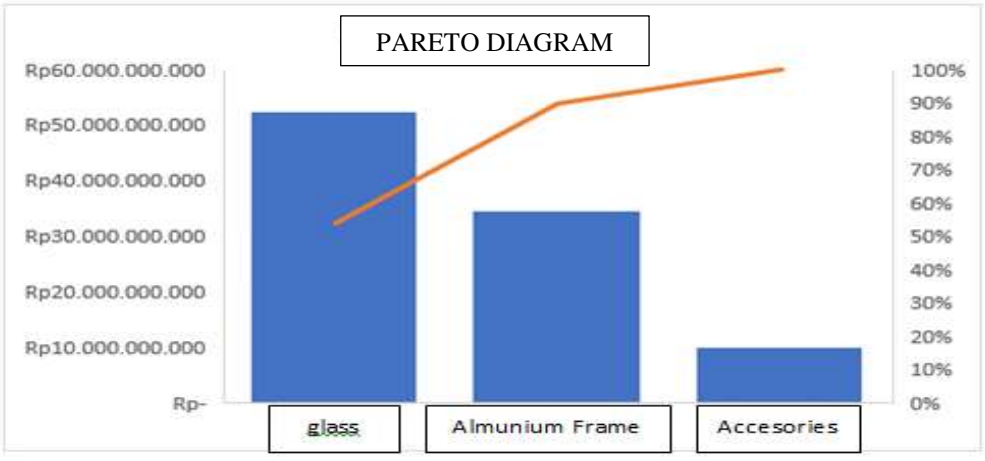

Figure 4.1 Distribution Pareto Diagram

4.2 Function Analysis Phase

The Identify function is the first step in the function analysis stage. In this phase the results at the previous stage identified each function, then grouped and identified each type. The function of each item consists of an active verb and a measured noun.

Table 4.3 Facade Work Glass Function Definitions

ITEM	VERB	NOUN	FUNCTION
Glass Façades	Reduce	Heat	Primary

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	Increase	Lighting	Primary
	Give	Beauty	Secondary
	Control	Energy	Secondary

Source : Proccesed Literature

Classification is done to all function elements of each function that exist so it can be clearly known classification of function in the work item as below:

Table 4.4 Classification of Facade Glass Function

Primary Function	Reduce heat
	Improving lighting
Secondary Function	Aesthetic/Embellish Space
Secondary Function	Controlling energy

Source : Proccesed Literature

The data provided in figure 4.2 describes the goal of the FAST diagram analysis which is to illustrate the relationship between each function and to ease the understanding of each function's verity [9].

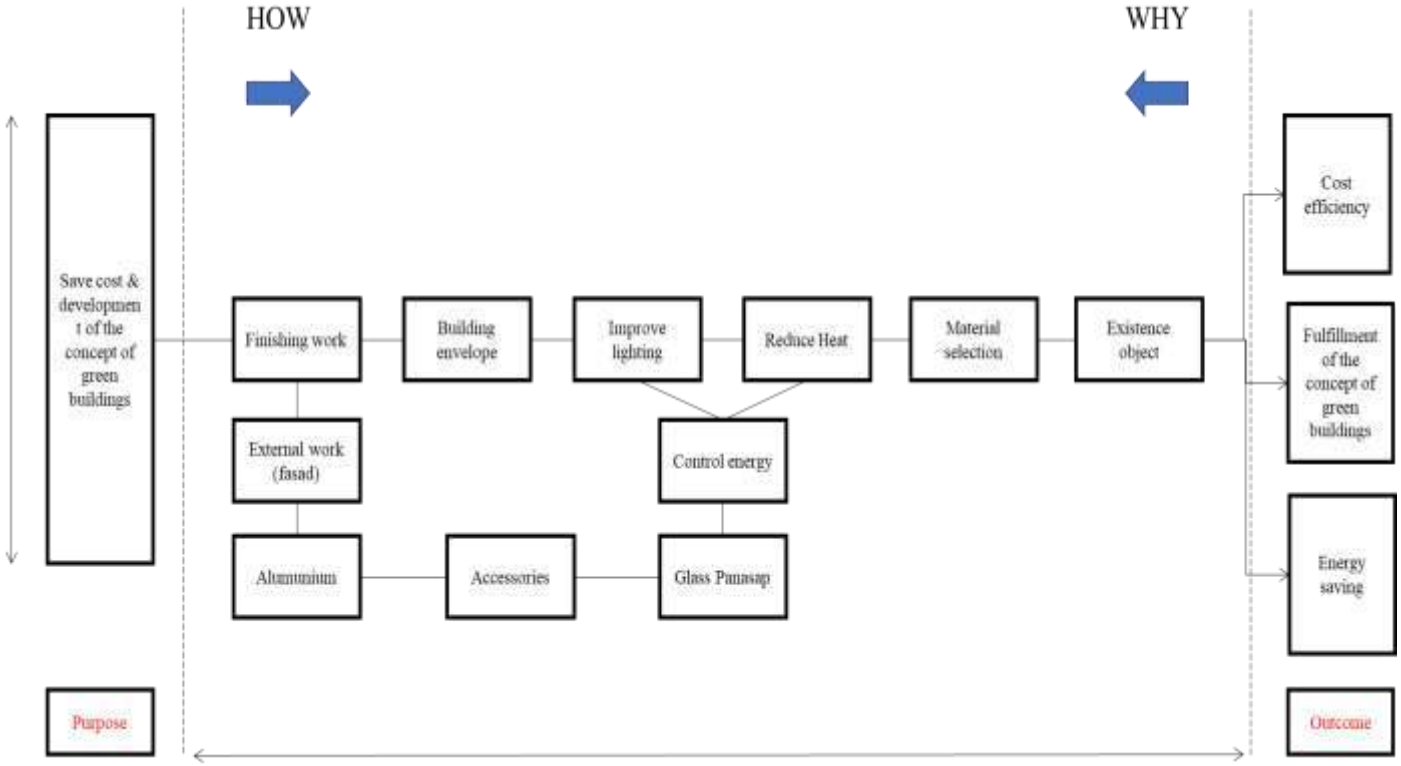

Figure 4.2 *Technical FAST Diagram* before adding function

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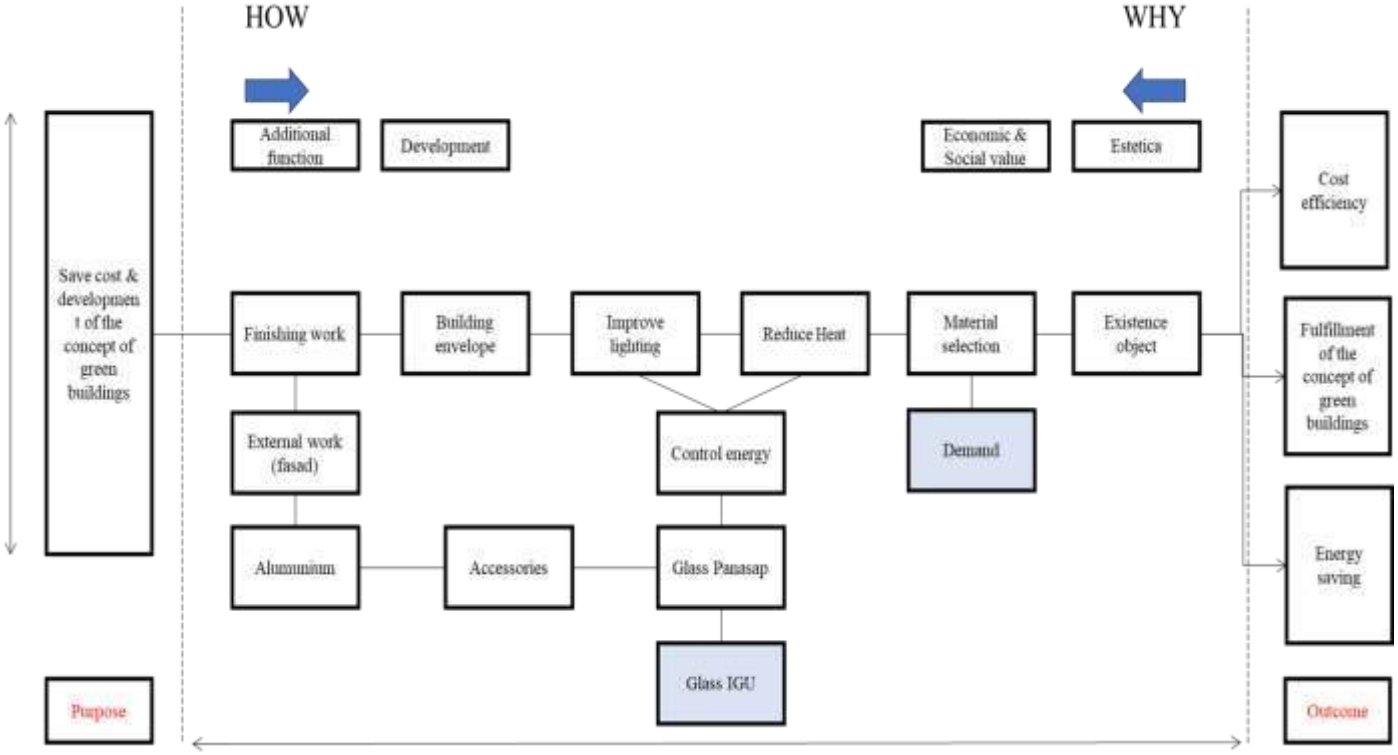

Figure 4.3 *Technical FAST Diagram* after adding function

From the results of the preparation of functions in the technical FAST diagram in the picture get:
A. Output of basic functions: cost efficiency, fulfillment of green building concept and energy saving
B. Basic/Primary functions: increase light, reduce heat and control energy
C. Hint function: The right material selection and the right material selection is not beyond the minimum specification limit.
D. function cause: cost-saving and green building development
E. All-time support function: aesthetic, economic and social value
F. Object design function: for building sheath

Table 4.5 Cost to Worth Analysis

Analysis Function						
Item	Glass Façade Work				Description	B=Primer
Function	Building exterior protection					S= Sekunder
No	Deskripsi	Function			Cost	Worth
		Verb	Noun	Type		
1	Glass	Protection	Heat & Wind	B	Rp 52.404.659.448	Rp 46.638.386.148
TOTAL						
Cost/Worth Index			1,12	Percent	53,91 %	47,97 %
				diffrence	5,93 %	

Source : Self Proccesed

4.3 Creative Phase

In the creative stage developed a number of alternative methods to achieve basic functions. The question that must be answered at this stage is what alternative things can be done to display the function space. Therefore, understanding of the problem is necessary to solve the problem. Items at the cost worth stage are considered high enough to be a focus on choosing an alternative replacement.

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Table 4.6 Comparison Table of Façade Glass Material Cost

EXISTING			PROPOSED		
NO	MATERIAL TYPE	TOTAL PRICE (Rp.)	NO	MATERIAL TYPE	TOTAL PRICE (Rp.)
1	12 mm Panasap Dark Blue	Rp 52.404.659.448	1	8 mm Clear HS with soft coat Low-E on surface - IGU	Rp 46.638.386.148
2	8 mm Panasap Blue		2	6 mm Clear HS glass	
Total		Rp52.404.659.448	Total		Rp46.638.386.148
Weight of work		53,91 %	Weight of work		47,97%
Difference 5,93 %					

Source : Self Proccesed

4.4 Evaluation

In the analysis of profit and loss, ideas gained at the creative stage noted the advantages and disadvantages, then given the weight of value. Idea evaluation should be as objective as possible. The next step is the advantages and disadvantages of each creative idea is noted, then each alternative is rated (rating). This award aims to classify alternatives in the order of profit and loss.

Table 4.7 Comparison Table Analysis of Material Alternatives Use

Glass Facades	
Advantages	Disadvantages
Reduced air conditioning and electricity loads	Must use Coating,The resulting color is less the exact same
Maximize Light	
Low reflector level	

Source : Self Proccesed

4.5 Development of Alternative

In this section will be affected one of the impacts due to the implementation of value engineering in the facade glass material, in addition to the impact of the cost saving of air conditioner in the room, value engineering also affects the selection of light fixtures due to lighting From the replacement of the glass material itself. The LCC analysis will be simulated with the lifetime of the building for 5 years, 10 years, 20 years, and 30 years. This is done to determine the impact of the simulation timeframe on the overall cost savings level. Here is the result of the simulation that has been done with a discount rate of 6.5%. In this study, the effect of using glass is on the savings on the use of air conditioning and lamps. However, in this LCC calculation opportunity will only be discussed in the simulation of the usage calculation of lamps on 1 floor area of the building in a few years in the future.

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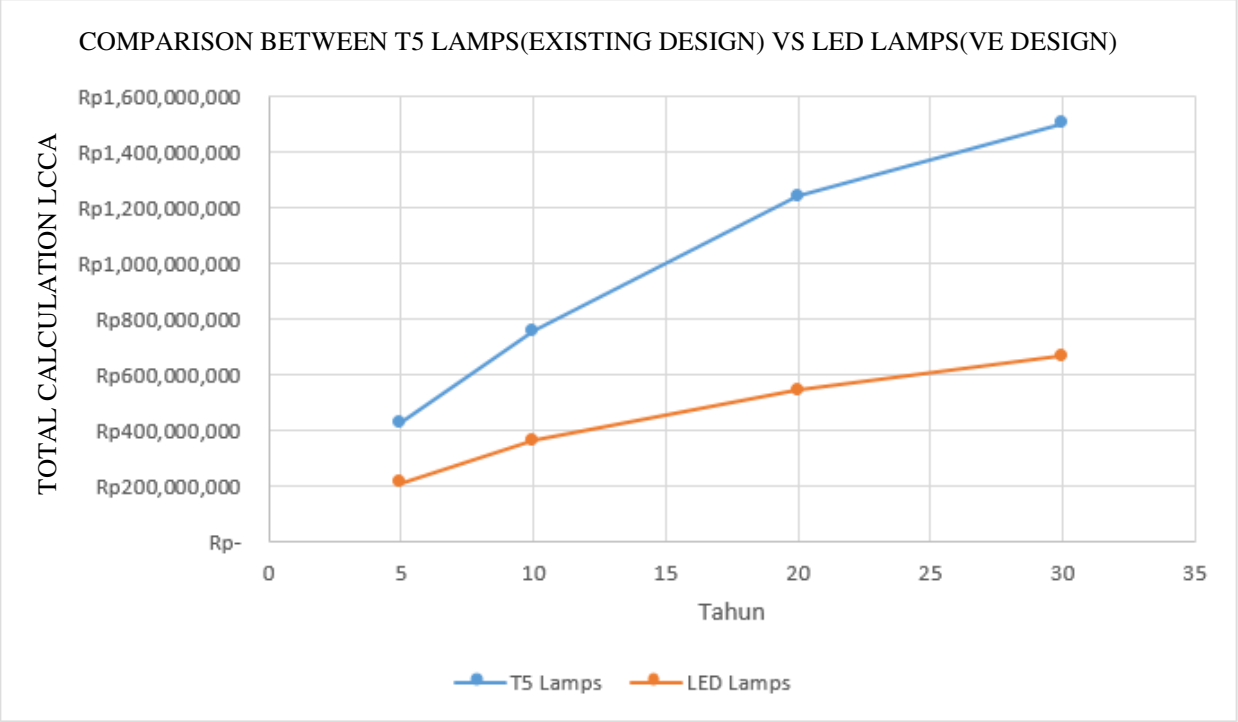

Figure 4.4 Diagram Distribusi Pareto

Based on the results of the calculation of LCC that has been done, it is evident that the use of LED lamps is more cost effective even more than 50% compared with the use of T5 lamps.

4.6 Presentation

This stage is the process of submitting the best ideas proposed to be accepted and implemented for the owner. Recommendations can change the design and savings to be one of the sizes that the proposal can be accepted. In the recommendation stage presented privilege and the concept of excellence of new design proposals that could be the basis of reason for the owner to accept the change.

Tabel 4.8 Presentation Stage

Material Items : Glass Facades	
Function : Outer casing of the buildin	
1	Initial plan :
	12 mm Panasap Dark Blue dan 8mm Panasap Blue. Cost Rp 52.404.659.448
2	proposed :
	Glass 8 mm Clear HS with soft coat Low-E on surface –IGU and Glass 6 mm Clear HS. Cost Rp 46.638.386.148
3	Cost savings : Rp. 5.766.273.300
	Total Percent 5,93 % From the initial design
4	Basic considerations :
	Based on value engineering and decision-making analysis

Source : Self Proccesed

5. CONCLUSION

From the result of this study is by applying value engineering to the glass material the façade can decrease the cost performance by 5.93% of the initial cost. For subsequent research it is possible to develop on the implementation of value engineering on other work facade items. Further research can also be developed by combining the results of the implementation of the field by measuring the level of quality control to the implementation. Based on the results of the calculation of LCC that has been done, proved that replacement of glass material also affects the use of lamps more cost effective even more than 50%.

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