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VALUE ENGINEERING FOR DRAINAGE SYSTEM PLANNING ON SOEKARNO HATTA ROAD MALANG CITY

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KEYWORDS
value engineering, drainage, cost

ABSTRACT

The development of residential areas is very rapid, both in hilly areas and in "water parking" areas. So that puddles occur in several places, where in the past it did not occur. Floods/puddles during the rainy season that occur in the channel area of Jalan Soekarno - Hatta are caused by the capacity of the existing drainage system being no longer able to accommodate rainwater runoff. The aim of this research is Determining alternative drainage structure designs that are more efficient and effective is carried out on Jalan Soekarno - Hatta Malang City using the Value Engineering method and determining cost and time savings after carrying out Value Engineering in the drainage system planning work on Jalan Soekarno - Hatta Malang City. The results of this study is After doing Value Engineering by following the work plan (Job Plan) alternative 2 has been obtained which is efficient because the cost is cheaper (Rp. 15,881,356.00) than other alternatives, and alternative 2 is more effective because time (23 days) is faster than other alternatives . Whereas the initial cost of the U Gutter pair (existing) work on the Drainage System Planning project to Overcome Floods on Jalan Soekarno - Hatta Malang City is Rp. 17,139,144,126.35. While the cost after being in VE, namely alternative 2 Box Culvert Structure, is Rp. 17,014,195,372.72 so that there is a cost savings of Rp. 124,948,753.62 or 0.46%

INTRODUCTION

Background behind function and purpose from Value Engineering is something approach systematic for get optimal value of every expenditure through a method investigation, expenses that do not need can omitted, so can produce a repair value and savings, the approach through a effort directed creative to analysis function where things that add up cost without add function thought for removed (Tjaturono, 2007) .

Malang city is area experiencing cities very fast development. one growing aspect rapidly ie area settlements, where throughout corner medium Malang city popping up area new housing. Development area settlement is very rapid, both in the area hills nor water park area. So that puddles occurred in some place, where in earlier times no happened. Flood / inundation in season the rain that occurred in the channel area of Jalan Soekarno - Hatta was caused by capacity system existing drainage no again capable accommodate rainwater runoff. Besides, there are a number of channel that has experience sedimentation and channel inlet not enough adequate. puddle happened because increasing surface water runoff consequence

rain, p this more caused by more decrease vegetation cover and height intensity rain. Happening change in runoff trend surface, sometimes not accompanied with arrangement system adequate drainage, or on the contrary change of use land no notice system existing drainage.

System drainage in Malang City general there is two type type channel, that is channel open and closed. Especially on channels drainage closed, partially big already enough old legacy era Dutch colonialism. the conditions many experience decline quality like happening obstruction and no the function of the manhole as a street inlet. circumstances this is very worrying for residents and users road if occur resultant waterlogging enhancement intensity bulk rain. reviewed from condition physical city which is plains tall with Genre main form river, then channels in the city of Malang can shared into 2 (two) channels drainage macro and drainage micro. Drainage closed, generally is Dutch heritage found in the area housing area luxury (Ijen area) and center city. Drainage open, generally is effort development by the government city together with Public local, have available evenly on the sides left right road. Besides function as channel rainwater disposal, drainage in Malang City is also functioned as channel disposal waste domestic (mix drain) which is no live has cause sedimentation processes caused to happening water overflow.

Obtained data in the form of secondary and primary data . the data obtained from document contract, which contains RAB information (Plan Budget Cost), drawings, contract period (Schedule), manpower work and source data power equipment On stage design with method engineering type construction beginning with shape and type / type construct more cheap, sturdy and efficient as well as engineering planning method implementation. Research results this form manipulation value (*Value Engineering*) construction drainage city, for reach efficiency fee on stage design construction and planning method implementation job.

Drainage

Drainage is method diversion water flow natural or artificial from surface land or lower land for an area or area /territory for avoid stagnant water (rainwater / waste water in a the place or area, that is with method handle excess water before enter to channel or river. Whereas system drainage is defined as series functioning waterworks for reduce and/ or throw away excess water from something area / land, so area / land the could enabled optimally. System drainage is part from infrastructure very important urban, so system good drainage could liberate city from puddles of rainwater, so no can ignored in something planning.

System Drainage Urban

In instruction technical Regulation of the Minister of Public Works 12/PRT/M/2014, understanding drainage urban is drainage in functioning urban areas manage / control surface water, so no disturbing and/ or harm society. Whereas System drainage urban is one unity system technical and non- technical from infrastructure and facilities drainage urban.

Alternative Structure Design Drainage

River Stone Pair Structure

Stone used for profession partner must be the originating stone from river or crushed stone from results shaped stone crusher approach rectangle with quality that

has approved and free from layers and defects other. The stones used must have heavy type no not enough of 2.6 tons/m 3, no late in water, max 50% abrasion test, hard, clean, durable, no weathered and not contain ingredient organic. All stones for profession buried masonry while in the field must guarded such likeness, so in condition rather wet at the time will used. Stone must arranged such shape for remove cavities big between adjacent rocks. Stone size for profession masonry 150 – 200 mm.

Box Culvert Structure

The structure of the *box culvert* is made with high quality because *the box culvert* bears the traffic load that crosses its upper side and the wide dimensions of the box culvert are large. This type of *Box Culvert* is generally made directly on site, starting from the work process of formwork fabrication, assembling rebar and concreting (*pouring*). *Box* culverts are known as culverts consisting of four sides which are referred to as box culverts. The standard size is usually 3×12 to 12×12 with a range of 1 and increments. Owned length is usually 6 to 8 meters.

Precast Concrete Lining Structures

Concrete precast must have something strong supple and strong press minimum characteristics match with SNI 1972 concerning Method of concrete slump test, SNI 1974 concerning Method of strength test press concrete with printed cylinder test object and SNI 4431 concerning Method of strength test flexible.

Profile - pro concrete precast the consider weight, length and width for the transport. Connection between profile the must minimize from leak.

Ferrocement Structure

Structure *ferrocement* is something type Wall concrete thin bone (3.00) cm, which was made of hydraulic cement mortar, with ratio mix 1 cement: (2-3) sand, given reinforcement (≤ 6.0 mm) with layer wire woven (*wiremesh*) size ≤1.0 mm, continuous and tight. *ferrocement* is technology construction alternatives that have used in provision water supply and various development channel drainage.

RCP Culvert Structure

Structure The RCP culvert is reinforced concrete pipe (*Reinforced Concrete Pipe*) is a pipe that has a circular shape with materials such as cement, sand, crushed and split stone, and also has reinforcement or reinforcement in it

RESEARCH METHOD

Subject Study

In this research, the research subject is the system dimensions of channel drainage on the Soekarno - Hatta road, while to obtain a comparison of designs, the authors carry out analysis of hydraulics and hydrology planning channels, analysis of calculation of the volume of work and costs, as well as time implementation of five designs. channel drainage work system.

Location and Time of Research

The research location is on Soekarno-Hatta Street, Malang City and its surroundings. elicitation time i will do it for two mr land animals from previous research studies, interviews and data collection.

Procedure Data Collection

Procedure data collection for a number of alternative the are :

1. Primary data
2. Secondary Data

Data Analysis Techniques

Analysis method Analytical Hierarchy Process (AHP)

proposed Analytic *Hierarchy Process* (AHP). in study this aim for give evaluation for factor measurable and not measurable influence decision election type construction channel drainage. Election method based on characteristics issues and considerations advantages and disadvantages from method other. Researcher evaluate the importance of each criterion according to mark partner compared criteria.

Pareto analysis

Steps in do analysis of the Law of the Pareto Distribution is:

1. Collect data about costs and what components are in the project being reviewed.
2. Order the total component costs (cost + VAT) from largest to smallest.
3. Add up the cumulative total component costs.
4. Count percentage component profession and add up cumulatively.
   PKp = (Kp/ TKp)x 100%
   Description:
   PKp: % Component profession
   Kp: Component profession
   TKp: Total components profession
5. Calculate the percentage of total component costs and total them cumulatively.
   PBKt = (BKt / Bt) x 100%
   Description:
   PBKt : % Cost total component of BKt : Cost total component
   Bt : Total cost
6. Plot of the cumulative percentage of work components (X axis) and the cumulative percentage of work component costs (Y axis).
7. Pareto chart (where 20% of work components will generate 80% of work costs).

After pareto, made based on identification activity, alternative quantitated qualitative. Then made in Diagram Activities - activities that are replaced with alternative based on analysis.

Hierarchical Model Arrangement

Arrangement of hierarchical models this aim break something complex problem arranged Becomes something form hierarchy. Something structure hierarchy alone consists from which elements grouped in levels (*levels*).

Interest Level Weighting Criteria

weighting level interest criteria with analysis multi criteriais analysis which worn for determine choice with usemethod assessment and weighting to a number of influencing criteria taker decision in make decision.

Determination Order Priority Proposal

Final step of the determination process priority on method new this is determination order priority for proposal planning construction channel drainage.

Evaluation Results Ratio Order Priority Proposal

Next step is do evaluation ratio Among order priority the. From results ratio the expected later could is known advantages and lack on second results order priority proposal the so that could pulled conclusion and suggestions from study this

RESULTS AND DISCUSSION

Stage Information

As for information project data obtained as following:

a. Project Name: JI Primary Rehabilitation DED Sengkaling Kiri Malang City.
b. Research Location: Soekarno Hatta Street, District Lowokwaru , Malang City. (Got seen in figure 4)
c. Owner Project : Department of Employment General Source Provincial Water Resources East Java.
d. Consultant Planner : CV. Create Yasa .
e. Estimation Cost Project : Soekarno Hatta Road Channel:

Rp. 16,000,000,000 (incl VAT 11%). Length = 1076 m

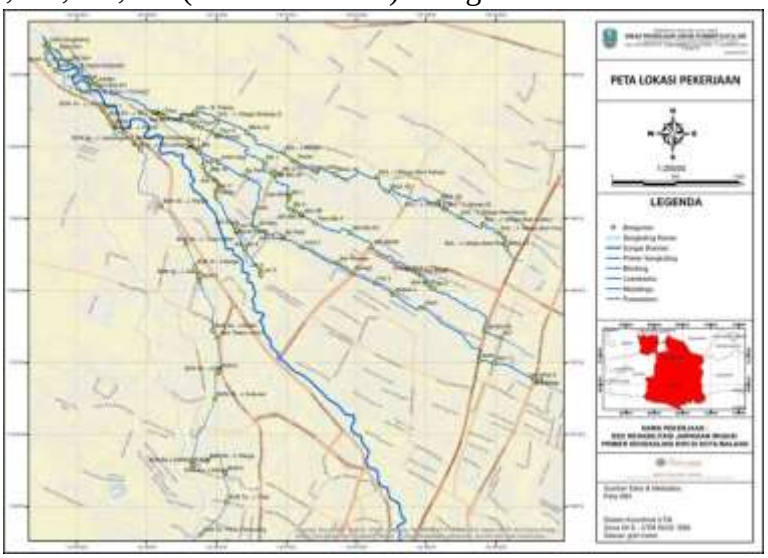

Figure 2
Research Locations

Table 1
Recapitulation Plan Budget Cost and Weight Profession
Channel Soekarno-Hatta Road Drainage

NO.	JENIS PEKERJAAN	JUMLAH BIAYA (Rp)
1	2	3
I.	PEKERJAAN PENDAHULUAN	1,066,173,435.00
II.	PEKERJAAN TANAH	986,276,231.50
III.	PEKERJAAN LANTAI PEDESTRIAN DAN JALAN	1,598,671,000.00
IV.	PEKERJAAN SALURAN DAN PASANGAN	10,707,838,468.67
V.	PEKERJAAN LAIN-LAIN	55,455,450.00
	JUMLAH Rp. =	14,414,414,585.17
	PPN 11 % Rp. =	1,585,585,604.37
	JUMLAH TOTAL =	16,000,000,189.54
	DIBULATKAN Rp. =	**16,000,000,000.00**

Source : CV. Create Yes sa Year 2022

From table 1 with analysis *Breakdown* can identified the job to be done Value Engineering (*Value Engineering*), ie profession land, work pedestrian and street floors, work Profession channels and pairs, ie of 92.22% in drainage Soekarno-Hatta road. For look potential work items to be VE, cost of work items the compared to with overall total cost project. For more he explained could seen in Table 2.

Table 2

Earthworks Breakdown, Occupation Floors and Pedestrians, Jobs Soekarno Hatta Street Channels and Couples

NO	JENIS PEKERJAAN	VOL	SAT.	JUMLAH (Rp.)	BOBOT (%)
I	**PEKERJAAN TANAH**				
1	Menggali dengan Excavator dan material atau hasil galian dimuat ke Dump Truck	10,600.00	M3	317,947,000.00	2.39
2	Penggalian 1 m 3 tanah biasa sedalam 1 m	100.00	M3	7,656,500.00	0.06
3	Timbunan Pasir Sebagai Bahan Pengisi	625.00	M3	138,550,000.00	1.04
4	Pemadatan Pasir sebagai Bahan Pengisi	625.00	M3	8,500,000.00	0.06
5	Urugan Tanah Kembali	6,620.90	M3	384,508,767.50	2.89
6	Angkutan Tanah Biasa menggunakan DT untuk Jarak 1 Km	2,929.25	M3	81,198,810.00	0.61
7	Angkutan Tanah Biasa menggunakan DT untuk Jarak 2 Km	1,049.85	M3	47,915,154.00	0.36
				986,276,231.50	**7.42**
II	**PEKERJAAN LANTAI PEDESTRIAN DAN JALAN**				
1	Pemasangan Lantai Keramik Tile Kasar 40 x 40 cm (warna gelap/Terang)	3,000.00	M2	1,397,190,000.00	10.51
2	Pemasangan Lantai Granit diglasur 40 x 40 cm (warna gelap) Untuk Fasilitas Tuna Netra	192.00	M2	78,456,000.00	0.59
3	Pemasangan Curbing / canstin Type B (Pj. 50 cm)	1,000.00	M1	123,025,000.00	0.93
				1,598,671,000.00	**12.03**
III	**PEKERJAAN SALURAN DAN PASANGAN**				
1	Pengadaan dan pemasangan Beton U-Gutter & Cover K-350 (3000.3000.225) (Fabrikan)	458.33	M1	4,267,010,000.00	32.10
2	Pengadaan dan pemasangan Beton U-Gutter & Cover K-350 (2500.3000.225) (Fabrikan)	166.67	M1	1,370,223,333.33	10.31
3	Pengadaan dan pemasangan Beton U-Gutter & Cover K-350 (2000.3000.225) (Fabrikan)	208.33	M1	1,712,779,166.67	12.89
4	Pasang Box culvert Gorong-gorong K-350 (3000.3000.225) (Fabrikan)	22.00	M1	240,087,980.00	1.81
5	Pekerjaan Beton Cor Setempat Cover U-Gutter K-350	101.00	M3	362,595,555.00	2.73
6	Pekerjaan Beton Mutu, f'c = 19,3 MPa (K225), Slump (12±2) cm, w/c = 0,58	448.60	M3	527,279,119.49	3.97
9	Pembesian dengan Besi Polos atau Ulir	2,937.46	Kg	45,253,054.68	0.34
7	Pemasangan Plastik Polythene T=125 Mikron	3,946.00	M2	81,662,470.00	0.61
8	Pekerjaan Beton Struktur Pelat Injak Tb.20 K-350 (Fabrikasi)	15.00	Pcs	19,108,050.00	0.14
9	Pemasangan Pelat Injak Tb.20 K-350 (Fabrikasi)	15.00	Pcs	609,375.00	0.00
10	Bekisting Balok Beton Biasa Menggunakan Multiflex 12 mm atau 18 mm, JAT ≤ 1,0 m	2.59	M2	316,198.08	0.00
11	Pembesian Jaring Kawat (Wire mesh)	24,407.05	Kg	1,657,800,057.15	12.47
12	Box Tangkapan Air K-350 + Pemasangan 0.67 x 0.52	200.00	Unit	96,089,000.00	0.72
13	Box Pelaluan Air K-225 + Pemasangan 0.20 x 1.20	184.00	M1	197,087,920.00	1.48
14	Grill Manhole (Cover & Frame) Cast iron tb7 cm Fabrikan 1.00 x 1.00 Tebal 0.07 cm	8.00	Unit	33,075,560.00	0.25
15	Grill Box Tangkapan Air (Cover & Frame) Fabrikan 0.50 x 0.50	8.00	Unit	8,000,000.00	0.06
16	Mortal Tipe N (Setara Campuran 1 PC:4 PP) (dengan Molen) /Saluran Primer	21.90	m3	24,542,782.50	0.18
17	Plesteran tebal 1 cm dengan campuran 1 PC:3 PP / Saluran Primer	12.00	m2	899,100.00	0.01
18	Pemasangan Pavingstone kembali	41.20	m2	7,477,800.00	0.06
19	Lapis Penetrasi Asbuton	43.20	M3	49,555,428.96	0.37
20	Pemasangan Minipile uk. 20x20x300	9.00	m'	6,386,517.80	0.05
				10,707,838,468.67	**80.55**
				13,292,785,700.17	**100.00**

Source: CV. Create Yes sa Year 2022

Stage Creative (Speculation)

There are 5 design alternatives as a comparison to the initial plan of the structure by using:

1. River Stone Pair Structure
2. *Box Culvert* Structure
3. Lining Structure Concrete Precast
4. Structure *ferrocement*
5. Structure RCP culvert

Analysis Stage

At this stage what is important is the analysis of input ideas or alternatives. Bad ideas will be eliminated. Alternatives or ideas that arise are formulated and considered for their advantages and disadvantages which are viewed from various angles and then a ranking or assessment is made. In this evaluation the Zero One method and the Evaluation Matrix are used.

Profit and Loss Analysis

analysis is the most crude screening stage among the valuation methods used in the valuation stage.

Table 3
Profit and Loss Analysis

No	selected idea	Potential Profit	Potential Losses
1	Structure Stone Couple	- Strong withhold current, hold slide - Easy formed and worked on - Cost cheap	- Less durable and long lasting - Long working process - Need maintenance routine
2	*Box Culvert* Structure	- Strong withhold current, hold slide - Durable and long lasting - Easy and fast in installation - Construction safe	- Mobilization difficult need large place _ - Cost is expensive - Only dimensions certain
3	Concrete Lining Structure Precast	- Strong withhold current, hold slide - Durable and long lasting - Easy in installation	- Construction limited in height - Need addition lock or other ingredients for lining installation
4	Structure *ferrocement*	- Could formed on site profession - Dimensions could adapt	- Long in installation
5	Structure RCP culvert	- Strong withhold current, hold slide - Durable and long lasting - Easy and fast in installation - Construction safe	- Mobilization difficult need large place _ - Cost is expensive - Only dimensions certain

Source: Analysis Results year 2022

Determining Alternative Ratings

Aspects to be considered are:

1. Technical aspects (safe-hazardous safety against sliding and carrying capacity)
2. Aspects of implementation costs (low cost of construction and operation and maintenance)
3. Aspect Time of execution of work (fast execution of work)
4. Aspects of material availability (easy to difficult availability of materials on location)
5. Aspects of the use of human power (more or less needed)

6. Aspects of the implementation method (difficulty-simple implementation method)

Results Analysis

Pareto analysis

For Pareto analysis every alternative could seen in the picture following this:

Table 4
Pareto Analysis Alternative 1 (River Stone Structure)

NO.	JENIS PEKERJAAN	JUMLAH BIAYA (Rp)	PROSENTASE BIAYA (%)	PROSENTASE BIAYA KUMULATIF (%)
I.	PEKERJAAN SALURAN DAN PASANGAN	**13,246,208,148.27**	**78.14**	**78.14**
II.	PEKERJAAN LANTAI PEDESTRIAN DAN JALAN	1,598,671,000.00	9.43	87.57
III.	PEKERJAAN PENDAHULUAN	1,066,173,435.00	6.29	93.86
IV.	PEKERJAAN TANAH	986,276,231.50	5.82	99.67
V.	PEKERJAAN LAIN-LAIN	55,455,450.00	0.33	100.00
		16,952,784,264.77	100.00	

Figure 3
Alternative Pareto Chart 1
Source : Calculation analysis results year 2022

Table 5
Pareto Analysis Alternative 2 (Structure *Box Culvert*)

NO.	JENIS PEKERJAAN	JUMLAH BIAYA (Rp)	PROSENTASE BIAYA (%)	PROSENTASE BIAYA KUMULATIF (%)
1	2			
I.	PEKERJAAN SALURAN DAN PASANGAN	**9,643,201,956.23**	**72.23**	72.23
II.	PEKERJAAN LANTAI PEDESTRIAN DAN JALAN	1,598,671,000.00	11.98	84.21
III.	PEKERJAAN PENDAHULUAN	1,066,173,435.00	7.99	92.20
IV.	PEKERJAAN TANAH	986,276,231.50	7.39	99.58
V.	PEKERJAAN LAIN-LAIN	55,455,450.00	0.42	100.00
		13,349,778,072.73	100.00	

Source : Calculation Analysis Results year 2022

Figure 4
Alternative Pareto Chart 2
Source: Calculation analysis results year 2022

Table 6
Pareto Analysis Alternative 3 (Concrete Lining Structure Preprinted)

NO.	JENIS PEKERJAAN	JUMLAH BIAYA (Rp)	PROSENTASE BIAYA (%)	PROSENTASE BIAYA KUMULATIF (%)
I.	**PEKERJAAN SALURAN DAN PASANGAN**	**11,895,925,690.76**	**76.24**	**76.24**
II.	**PEKERJAAN LANTAI PEDESTRIAN DAN JALAN**	1,598,671,000.00	10.25	86.49
III.	**PEKERJAAN PENDAHULUAN**	1,066,173,435.00	6.83	93.32
IV.	**PEKERJAAN TANAH**	986,276,231.50	6.32	99.64
V.	**PEKERJAAN LAIN-LAIN**	55,455,450.00	0.36	100.00
		15,602,501,807.26	100.00	

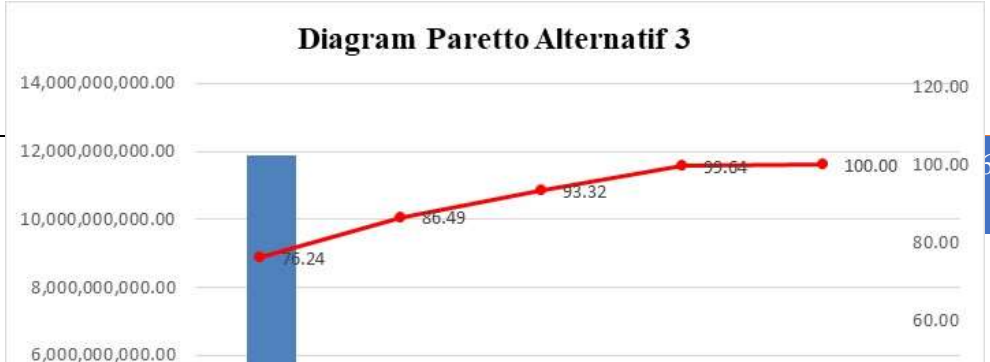

Figure 5
Alternative Pareto Chart 3
Source: Calculation analysis results year 2022

Table 7
Pareto Analysis Alternative 4 (Structure *ferrocement*)

NO.	JENIS PEKERJAAN	JUMLAH BIAYA (Rp)	PROSENTASE BIAYA (%)	PROSENTASE BIAYA KUMULATIF (%)
I.	PEKERJAAN SALURAN DAN PASANGAN	12,176,309,690.76	76.66	76.66
II.	PEKERJAAN LANTAI PEDESTRIAN DAN JALAN	1,598,671,000.00	10.07	86.73
III.	PEKERJAAN PENDAHULUAN	1,066,173,435.00	6.71	93.44
IV.	PEKERJAAN TANAH	986,276,231.50	6.21	99.65
V.	PEKERJAAN LAIN-LAIN	55,455,450.00	0.35	100.00
		15,882,885,807.26	100.00	

Source: Calculation Analysis Results year 2022

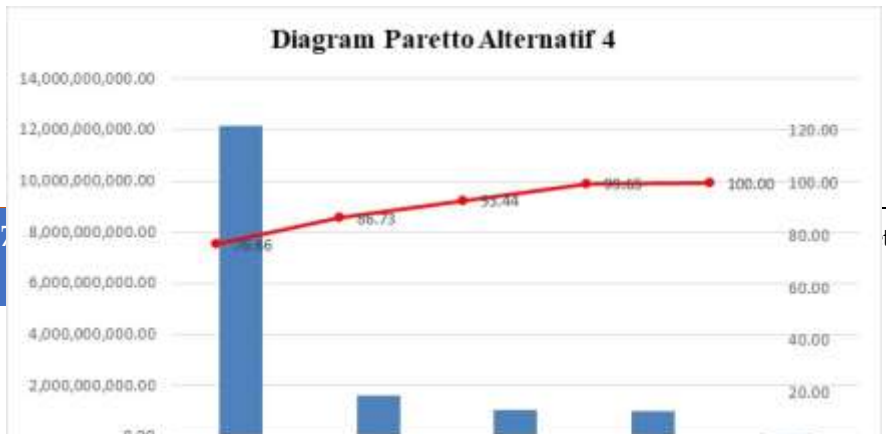

Figure 6
Alternative Pareto Chart 4
Source: Calculation analysis results year 2022

Table 8
Alternative Pareto Analysis 5 (Structure RCP Culvert)

NO.	JENIS PEKERJAAN	JUMLAH BIAYA (Rp)	PROSENTASE BIAYA (%)	PROSENTASE BIAYA KUMULATIF (%)
I.	PEKERJAAN PENDAHULUAN	**15,122,281,345.64**	**80.31**	**80.31**
II.	PEKERJAAN TANAH	1,598,671,000.00	8.49	88.80
III.	PEKERJAAN LANTAI PEDESTRIAN DAN JALAN	1,066,173,435.00	5.66	94.47
IV.	PEKERJAAN SALURAN DAN PASANGAN	986,276,231.50	5.24	99.71
V.	PEKERJAAN LAIN-LAIN	55,455,450.00	0.29	100.00
		18,828,857,462.14	100.00	

Source : Calculation Analysis Results year 2022

Figure 7
Alternative Pareto Chart 5
Source: Calculation analysis results year 2022

Analysis of Time, Energy and Cost Requirements

From the results Pareto analysis above, obtained work items each the biggest and most different alternative. Thus, work items the could analyzed need time, effort and cost. So that from analysis the gotcal alternative elected. Needs analysis time, effort and cost each alternative could seen in the table following this:

Table 9
Analysis of Time, Energy and Cost Requirements Alternative 1 (Structure River Stone Pair)

No	Alternatif Konstruksi	Volume	Harga Satuan	Total Biaya
1	Mortal Tipe N (Setara Campuran 1 PC:4 PP) (dengan Molen)	7400.00	Rp 1,120,675.00	Rp 8,292,995,000.00
2	Plesteran tebal 1 cm dengan campuran 1 PC:3 PP / Saluran Primer	9600.00	Rp 74,925.00	Rp 719,280,000.00
No	**Alternatif Konstruksi**	**Jumlah Hari**		
1	Mortal Tipe N (Setara Campuran 1 PC:4 PP) (dengan Molen)	361.00		
2	Plesteran tebal 1 cm dengan campuran 1 PC:3 PP / Saluran Primer	289.00		

Source : Calculation analysis results year 2022

Table 10
Analysis of Time, Energy and Cost Requirements Alternative 2 (Structure *Box Culvert*)

No	Alternatif Konstruksi	Volume	Harga Satuan	Total Biaya
1	Pasang Box culvert (2500.3000.225) (Fabrikan)	166.67	Rp 5,667,340.00	Rp 944,556,666.67
2	Pasang Box culvert (2000.3000.225) (Fabrikan)	208.33	Rp 5,667,340.00	Rp 1,180,695,833.33
3	Pasang Box culvert K-350 (3000.3000.225) (Fabrikan)	480.33	Rp 9,913,090.00	Rp 4,761,587,563.33
No	**Alternatif Konstruksi**	**Jumlah Hari**		
1	Pasang Box culvert (2500.3000.225) (Fabrikan)	6.00		
2	Pasang Box culvert (2000.3000.225) (Fabrikan)	7.00		
3	Pasang Box culvert K-350 (3000.3000.225) (Fabrikan)	10.00		

Source: Calculation analysis results year 2022

Table 11

Analysis of Time, Energy and Cost Requirements Alternative 3 (Concrete Lining Structure Preprinted)

No	Alternatif Konstruksi	Volume	Harga Satuan	Total Biaya
1	Pasang Linung Beton Pracetak K350 (3000.3000.150)	1300.00	Rp 3,374,375.00	Rp 4,386,687,500.00
2	Pekerjaan Beton Cor Setempat Cover U-Gutter K-350	1000.00	Rp 3,590,055.00	Rp 3,590,055,000.00
No	**Alternatif Konstruksi**	**Jumlah Hari**		
1	Pasang Linung Beton Pracetak K350 (3000.3000.150)			
	Pekerjaan Beton Berstruktur K-350	108.00		
	Pekerjaan Pembesian Besi Beton Polos	92.00		
	Acuan untuk Beton Struktur (Bekisting)	32.00		
	Pembongkaran Cetakan dan Penyiraman Beton	32.00		
2	Pekerjaan Beton Cor Setempat Cover U-Gutter K-350			
	Pekerjaan Beton Berstruktur K-350	108.00		
	Pekerjaan Pembesian Besi Beton Polos	92.00		
	Acuan untuk Beton Struktur (Bekisting)	32.00		
	Pembongkaran Cetakan dan Penyiraman Beton	32.00		

Source : Calculation analysis results year 2022

Table 12
Analysis of Time, Energy and Cost Requirements Alternative 4 (Structure *ferrocement*)

No	Alternatif Konstruksi	Volume	Harga Satuan	Total Biaya
1	Pasang Ferrocement K350 (3000.3000.150)	1300.00	Rp 3,590,055.00	Rp 4,667,071,500.00
No	**Alternatif Konstruksi**	**Jumlah Hari**		
1	Pasang Ferrocement K350 (3000.3000.150). Terdiri dari :			
	Pekerjaan Beton Berstruktur K-350	108.00		
	Pekerjaan Pembesian Besi Beton Polos	92.00		
	Acuan untuk Beton Struktur (Bekisting)	32.00		
	Pembongkaran Cetakan dan Penyiraman Beton	32.00		

Source : Calculation analysis results year 2022

Table 13
Analysis of Time, Energy and Cost Requirements Alternative 5 (Structure RCP Culvert)

No	Alternatif Konstruksi	Volume	Harga Satuan	Total Biaya
1	Pasang Gorong-gorong K-350 (3000.3000.225) (Fabrikan)	1000.00	Rp 12,324,490.00	Rp 12,324,490,000.00
2	Pekerjaan Beton Mutu, f'c = 19,3 MPa (K225), Slump (12±2) cm, w/c = 0,58	483.70	Rp 1,175,390.00	Rp 568,535,308.49
3	Pembesian dengan Besi Polos atau Ulir	3027.87	Rp 15,405.50	Rp 46,645,777.66
No	**Alternatif Konstruksi**	**Jumlah Hari**		
1	Pasang Gorong-gorong K-350 (3000.3000.225) (Fabrikan)	20.00		
2	Pekerjaan Beton Mutu, f'c = 19,3 MPa (K225), Slump (12±2) cm, w/c = 0,58	64.00		
3	Pembesian dengan Besi Polos atau Ulir	212.00		

Source: Calculation analysis results year 2022

***Value Engineering* Analysis**

As for the comparison cost design initial (Existing) with design *Value Engineering* for profession channel drainage structure stone masonry, structure *box culvert*, concrete lining structure precast, structure *ferrocement*, structure RCP culverts after being counted *Present Value* (Future Price) could seen in table 14. below this.

Table 14
Ratio Cost Initial work and after in VE

No	Alternatif yang dipilih	Jumlah PV
1	Eksisting	Rp 16,000,000,000.00
2	Struktur Pasangan Batu Kali	Rp 18,817,590,000.00
3	Struktur Box Culvert	Rp 14,818,253,000.00
4	Struktur Lining Beton Pracetak	Rp 17,318,777,000.00
5	Struktur Ferrocement	Rp 17,630,003,000.00
6	Struktur Pipa Gorong-gorong RCP	Rp 20,900,031,000.00

Source : Calculation analysis results

Feasibility Level Analysis

Here will counted mark *Present Value* his for 5 alternatives

Table 15

Calculation *Present Value* (PV) Alternative 1 Structure Stone Couple

Tahun	Konstruksi	O&P	PV
1	Rp 18,817,590,000.00		Rp 18,181,246,376.81
2		Rp 752,703,600.00	Rp 727,249,855.07
3		Rp 814,651,106.28	Rp 787,102,518.14
4		Rp 876,598,612.56	Rp 846,955,181.22
5		Rp 938,546,118.84	Rp 906,807,844.29
6		Rp 1,000,493,625.12	Rp 966,660,507.36
7		Rp 1,062,441,131.40	Rp 1,026,513,170.43
8		Rp 1,124,388,637.68	Rp 1,086,365,833.51
9		Rp 1,186,336,143.96	Rp 1,146,218,496.58
10		Rp 1,248,283,650.24	Rp 1,206,071,159.65
	TOTAL	PV	**Rp 26,881,190,943.07**

Source : Calculation analysis results

Table 16

Calculation *Present Value* (PV) Alternative 2 Structure *Box Culvert*

Tahun	Konstruksi	O&P	PV
1	Rp 14,818,253,000.00		Rp 14,317,152,657.00
2		Rp 148,182,530.00	Rp 143,171,526.57
3		Rp 155,932,476.32	Rp 150,659,397.41
4		Rp 163,682,422.64	Rp 158,147,268.25
5		Rp 171,432,368.96	Rp 165,635,139.09
6		Rp 179,182,315.28	Rp 173,123,009.93
7		Rp 186,932,261.60	Rp 180,610,880.77
8		Rp 194,682,207.91	Rp 188,098,751.61
9		Rp 202,432,154.23	Rp 195,586,622.45
10		Rp 210,182,100.55	Rp 203,074,493.29
	TOTAL	PV	**Rp 15,875,259,746.36**

Source : Calculation analysis results

Table 17

Calculation *Present Value* (PV) Alternative 3 Structure Concrete Lining Precast

Tahun	Konstruksi	O&P	PV
1	Rp 17,318,777,000.00		Rp 16,733,117,874.40
2		Rp 346,375,540.00	Rp 334,662,357.49
3		Rp 367,954,736.14	Rp 355,511,822.36
4		Rp 389,533,932.28	Rp 376,361,287.23
5		Rp 411,113,128.43	Rp 397,210,752.10
6		Rp 432,692,324.57	Rp 418,060,216.97
7		Rp 454,271,520.71	Rp 438,909,681.85
8		Rp 475,850,716.85	Rp 459,759,146.72
9		Rp 497,429,912.99	Rp 480,608,611.59
10		Rp 519,009,109.14	Rp 501,458,076.46
	TOTAL	PV	**Rp 20,495,659,827.16**

Source : Calculation analysis results

Table 18

Calculation *Present Value* (PV) Alternative 4 Structure *ferrocement*

Tahun	Konstruksi	O&P	PV
1	Rp 17,630,003,000.00		Rp 17,033,819,323.67
2		Rp 528,900,090.00	Rp 511,014,579.71
3		Rp 567,139,566.51	Rp 547,960,933.82
4		Rp 605,379,043.01	Rp 584,907,287.94
5		Rp 643,618,519.52	Rp 621,853,642.05
6		Rp 681,857,996.03	Rp 658,799,996.16
7		Rp 720,097,472.54	Rp 695,746,350.28
8		Rp 758,336,949.04	Rp 732,692,704.39
9		Rp 796,576,425.55	Rp 769,639,058.50
10		Rp 834,815,902.06	Rp 806,585,412.61
	TOTAL	PV	**Rp 22,963,019,289.13**

Source : Calculation analysis results

Table 1 9

Calculation *Present Value* (PV) Alternative 5 RCP Culvert Pipe Structure

Tahun	Konstruksi	O&P	PV
1	Rp 20,900,031,000.00		Rp 20,193,266,666.67
2		Rp 209,000,310.00	Rp 201,932,666.67
3		Rp 219,931,026.21	Rp 212,493,745.13
4		Rp 230,861,742.43	Rp 223,054,823.60
5		Rp 241,792,458.64	Rp 233,615,902.07
6		Rp 252,723,174.85	Rp 244,176,980.53
7		Rp 263,653,891.07	Rp 254,738,059.00
8		Rp 274,584,607.28	Rp 265,299,137.47
9		Rp 285,515,323.49	Rp 275,860,215.93
10		Rp 296,446,039.70	Rp 286,421,294.40
	TOTAL	PV	**Rp 22,390,859,491.47**

Source : Calculation analysis results

Table 20

Recapitulation of Calculation Results *Present Value* (PV)

No	Keterangan	Alternatif 1	Alternatif 2	Alternatif 3	Alternatif 4	Alternatif 5
1	Biaya Awal	Rp 18,817,590,000.00	Rp 14,818,253,000.00	Rp 17,318,777,000.00	Rp 17,630,003,000.00	Rp 20,900,031,000.00
2	Umur Rencana (tahun)	10	10	10	10	10
3	Rata-rata bunga per tahun	3.50%	3.50%	3.50%	3.50%	3.50%
4	O & P tahunan	Rp 752,703,600.00	Rp 148,182,530.00	Rp 346,375,540.00	Rp 528,900,090.00	Rp 209,000,310.00
5	Peningkatan O & P per tahun	8.23%	5.23%	6.23%	7.23%	5.23%
6	Tingkat Inflasi per tahun	4.23%	4.23%	4.23%	4.23%	4.23%
	Nilai Present Value	**Rp 26,881,190,943.07**	**Rp 15,875,259,746.36**	**Rp 20,495,659,827.16**	**Rp 22,963,019,289.13**	**Rp 22,390,859,491.47**

Source: Calculation analysis results

Table 2 1
Amount savings *Present Value* (PV) Between Existing and Alternative

No	Alternatif yang dipilih	Jumlah PV	Penghematan	Persentase
1	Eksisting	Rp 17,119,804,896.12		
2	Struktur Pasangan Batu Kali	Rp 26,881,190,943.07	-Rp 9,761,386,046.95	-36.31
3	Struktur Box Culvert	Rp 15,875,259,746.36	**Rp 1,244,545,149.76**	**4.63**
4	Struktur Lining Beton Pracetak	Rp 20,495,659,827.16	-Rp 3,375,854,931.04	-12.56
5	Struktur Ferrocement	Rp 22,963,019,289.13	-Rp 5,843,214,393.01	-21.74
6	Struktur Pipa Gorong-gorong RCP	Rp 22,390,859,491.47	-Rp 5,271,054,595.35	-19.61

Source : Calculation analysis results

From Table 21, then alternative selected is alternative 2. With Savings: Rp. 17,014,195,372.72 – Rp. 15,875,259,746.36 = Rp. 1,244,545,149.76. Or save 4.63% .

Table 22
Total Value Engineering Analysis Results

No	Alternatif yang dipilih	Aspek teknis	Aspek Biaya		Aspek Waktu pelaksanaan pekerjaan (Hari)		Aspek ketersediaan bahan	Aspek penggunaan tenaga manusia	Aspek metode pelaksanaan	Nomor
1	Struktur Pasangan Batu Kali	berbahaya keamanan terhadap kelongsoran dan daya dukung	Rp 18,817,590,000.00	Lebih Mahal	650.00	Lama	Mudah	91.00 (Banyak)	Mudah	5
2	Struktur Box Culvert	Aman terhadap kelongsoran dan daya dukung	Rp 14,818,253,000.00	Lebih Murah	23.00	Cepat	Mudah	32.00 (Sedikit)	Mudah	**1**
3	Struktur Lining Beton Pracetak	berbahaya keamanan terhadap kelongsoran dan daya dukung	Rp 17,318,777,000.00	Lebih Mahal	264.00	Lama	Sulit	142.00 (Banyak)	Sulit	4
4	Struktur Ferrocement	Aman terhadap kelongsoran dan daya dukung	Rp 17,630,003,000.00	Lebih Mahal	264.00	Lama	Mudah	151.00 (Banyak)	Sulit	3
5	Struktur Pipa Gorong-gorong RCP	Aman terhadap kelongsoran dan daya dukung	Rp 20,900,031,000.00	Lebih Mahal	84.00	Cepat	Sulit	32.00 (Sedikit)	Sulit	2

Source : Calculation analysis results

From Table 22 of results analysis , then alternative selected is alternative 2

CONCLUSION

Has been obtained efficient alternative 2 because cost morecheap (Rp. 15,881,356.00) from alternative other, and alternative 2 more effective because time (120 Days) morefast from alternative other.

Cost once in VE ie Alternative 2 The Box Culvert structure is Rp. 17,014,195,372.72 up there is savings cost Rp. 124,948,753.62 or 0.46%.

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