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EVALUATION OF THE JLANTAH DAM INFLOWING AREA AS A REFERENCE OF EFFICIENCY TOWARDS IMPLEMENTATION TIME AND COST

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ABSTRACT

Jlantah Dam is located on the Jlantah River, Karanganyar Regency, Central Java Province. The construction of the Jlantah dam serves irrigation needs, raw water supply, flood reduction, and tourism.
In the implementation of the construction, there are problems with land acquisition in the reservoir inundation area. This problem will affect the time and cost of implementing the construction of the Jlantah Dam. Therefore, it is necessary to carry out a simulation to determine the optimum reservoir volume of the reservoir that can fulfill the benefits of the dam, the implementation of which is not hampered by land acquisition in the inundation area and is efficient in terms of time and cost of implementation.
In determining the inundation area of the reservoir, a capacity curve based on the topographic map is used to determine the area and volume of the reservoir at each elevation, then a simulation is performed to calculate at what elevation the reservoir can fulfill its planned utilization. The simulation was carried out with 2 (two) alternative conditions, namely the conditions at the crest elevation + 685 and the crest elevation + 682. From these two alternatives, it can be seen the reliability of the reservoir for each condition. The results of the evaluation obtained from the two mercury elevations have the greatest benefit value at + 685 elevations with a reservoir reliability value of 97.22%, a BCR value of 1.218, and an IRR value of 5.88% with a total cost of Rp. 1,750,818,179,096.

Keywords: *jlantah dam, dam reservoir, duration, cost, simulation*

INTRODUCTION

Jlantah Dam is located on the Jlantah River, Village Tlobo, District Jatiyoso, Regency Karanganyar, Province Central Java. Dam construction Street function as raw water supply 150 l/sec, fulfill the need for irrigation in an area of 1,493 Ha, for generator electricity power micro hydro (PLTM) 625 MW, and tourism.

In the implementation of Dam Construction Street, available constraint liberation land in the inundated area reservoir. With the design initial, elevation peak lighthouse overflow in Elv. + 685.00 or 5 meters from base abundant, necessary done liberation land area of 50.45 Ha. But in implementation, the land is still not yet free in a manner whole (Hidayat, 2011). New land free 32.11 Ha. Not yet free land in a manner whole will influence to cost implementation of the Dam Construction Walk, then from That needed optimization design for obtaining optimum inundation area of facet cost implementation (Ulfa, 2016).

Optimization design to be done is with a number of alternatives like determining elevation lighthouse overflow from elevation design start and deepening the upstream area or inundation area dam (Takeda & Sosrodarsono, 2003). Alternative First use simulation with condition elevation in accordance with reservoir plan at + 685 m. The land area affected released puddles in an area of 50.44 Ha (Febriantoro, 2023).

Alternative second-use simulation with condition lower elevation lighthouse spillway at + 682 m. land area liberation affected 45, 66 Ha. With a number of optimization designs expected

can obtain optimization of the best design from facet cost implementation and benefits dam (Febriantoro, 2023).

The objective of the study is to analyze the optimum storage volume of the Jlantah Dam. Analyzing the influence of inundation area Jlantah Dam to and costs and benefits implementation (Shalimar & Ronoatmojo, 2023). Analyze optimization the best it can be recommended related the area of the inundation area for implementation construction can still with time and cost more implementation efficient without reducing expediency from the dam. The results of this study are expected to provide benefits, namely obtaining the optimization of the volume of the reservoir and the area of the inundation area so that the construction of the Jlantah Dam can run in an efficient time and cost.

METHODS

Preliminary Survey and Literature Study

A preliminary Survey was done to know the condition area to be studied and identified problems that exist in the field, so can do steps taken To use look for solutions to problems that occur. A preliminary survey was conducted about area studies to agency related and see direct to the field (Soewarno, 1995).

Data collection

After identifying problems that exist in the field so step furthermore is looking for supporting data to finish problem the. The data in question is secondary data. Secondary data is the data obtained in a manner No direct form notes nor results research from party other. The secondary data includes:

1. Land acquisition plan data, to find out the land affected by the reservoir inundation area
2. Topographical data, to determine the elevation of the dam construction site and determine the curve of the reservoir capacity
3. Discharge data, to determine the inflow of the reservoir
4. Dam Technical Data, to find out the technical plan for dam construction, peak elevation, spillway elevation, and reservoir outflow.

Data analysis

From stage data collection later data processing. The stages data analysis/calculation process includes:

1. Reservoir simulation, from the outflow and inflow discharge data, a storage volume reservoir simulation is carried out. Simulation is done with 2 (two) alternatives condition.
2. Alternative First use simulation with condition elevation in accordance with reservoir plan at + 685 m. The land area affected released puddles covering an area of 50.44 Ha covering 6 hamlets
3. Alternative second-use simulation with condition lower elevation lighthouse spillway at + 682 m. land area the affected land acquisition is 45.66 Ha covering 4 hamlets

4. In each simulation made, the reliability of the reservoir can be known, the effect of the inundation area on the relief area can be calculated, and benefit and cost analysis can be done.
5. Benefit value is obtained from results mark agriculture and raw water.
6. The cost value is obtained from cost liberation land, cost construction, and costs of operation and maintenance.
7. Evaluation time obtained from results acceleration time liberation land until implementation is done.
8. Evaluation of the simulation results, the final evaluation is carried out on implementation cost efficiency.

RESULTS AND DISCUSSION

Dam Data Street

Analysis Simulation Reservoir

Simulation on the reservoir intended for know level success reservoir based on water availability and quantity water needs to be issued from a reservoir that is for irrigation and raw water. Capacity reservoir effectively counted with the use of curve arch capacity possible reservoir seen in the curve data capacity Jlantah Dam (Chayati et al., 2023).

In this paper, the reservoir storage simulation analysis is made in 2 conditions, namely the condition based on the elevation reservoir plan (+ 685 m), with lowering condition elevation reservoir 3 meters (+ 682 m).

1. elevation lighthouse overflow + 685, storage volume effective of 8,305,562 m3 with wide inundation 504,477 m2
2. elevation mrcu overflow + 682, storage volume effective of 6,869,262 m3 with wide inundation 457,115 m2

Furthermore can seen in Table 1. following:

Table 1. Storage volume and inundation area (Calculation Results, 2022)

elevation Lighthouse Abundant	**Storage Volume Effective**	**Inundation Area**
m	***m*** ^{3}	***m2***
685	8,305,562	504,477
682	6,869,262	457,115

Analysis Reliability and Failure of Reservoir Storage

reservoir storage simulation with 2 conditions, the probability of failure and reliability of the reservoir is obtained. The reliability of the reservoir is the percentage of conditions in which the reservoir is able to meet its needs (Barkhordari & Hashemy Shahdany, 2022).

1. Condition elevation lighthouse spillway + 685 m,

Table 2. Total Period Served To Condition Reservoir MAN + 685 Reservoir (Calculation Results, 2022)

reservoir	Period Served	In Year
Fulfilled	1435	39,86
No Fulfilled	41	1.14
Total	1476	41

$$\% \text{ Success} = \frac{\sum periode\ terpenuhi}{\sum Periode\ total}$$

$$= \frac{1435}{1476} = 97.22\ \%$$

% Failed = 1- % Success = 1 – 97.22 % = 2.78 %

2. Overflowing lighthouse elevation conditions + 682 m,

Table 3. Total Period Served to Condition Reservoir MAN + 682 Reservoir (Calculation Results, 2022)

Reservoir	Period Served	In Year
Fulfilled	1382	38,39
No Fulfilled	94	2.61
Total	1476	41

- % Success $= \frac{\sum periode\ terpenuhi}{\sum Periode\ total}$
- $= \frac{1382}{1476} = 93.63\ \%$
- % Failed = 1- % Success = 1 – 93.63 % = 6.37 %

Once the reliability of the reservoir is known, then an analysis is carried out on the affected land (land acquisition costs), construction costs, and the benefit value of the reservoir, to obtain the *Benefit Cost Ratio* in the two simulated dam conditions.

Affected Land Analysis

Analysis of the land affected by the elevation of the crest of the overflow + 685 m.

Based on Table 4. it can be seen that the area of inundation affected at the elevation of the crest of the overflow + 685 m is 504,477 m2. With an inundation area at an elevation of + 685 m, there are 2 affected villages including Village Tlobo and Village Karangsari The cost for land acquisition for houses is 2.6 million/m2, Ricefield of 1.5 million /m2 and land crops 800 thousand / m2(Putera et al., 2021).

Table 4. Calculations Cost Liberation Land Affected by Elevation Lighthouse Spillway + 685 m (Calculation Results, 2022)

No.	Items	Area (m $^{2)}$	Price/ ^{m2}	Total Price
1.	House	146,400	1,250,000	183,000,000,000
2.	Ricefield	305,019	300,000	91,505,700,000
3.	Land Crops	53,059	150,000	7,958,820,000
	Total	504,478		282,464,520,000

Analysis of land affected by the condition of the overflow peak elevation + 682 m.

Based on Figure 4.1. it can be seen that the area of inundation affected by the elevation conditions of the crest of the overflow + 682 m is 457,115 m2.

Table 5. Calculations Cost Liberation Land affected by Elevation Lighthouse Spillway + 682 m (Calculation Results, 2022)

No.	Items	Area (m $^{2)}$	Price/ ^{m2}	Total Price
1.	House	132,400	1,250,000	165,500,000,000
2.	Ricefield	276,656	300,000	82,996,891,500
3.	Land Crops	48,059	150,000	7,208,820
	Total	457,115		255,705,711,500

Cost Construction

Calculation cost development Jlantah Dam based on 2 alternatives condition elevation Lighthouse Abundant. Cost Dam Operation and Maintenance (O&M). is all the required financing for operating activity Operations and Maintenance dam for optimizing function and utilization dams, buildings infrastructure in accordance with age services that have planned in accordance design as well as guard condition the security (Mukimova, 2022).

Calculation Cost Dam Operation and Maintenance (O&M). Street based on estimates cost every the year it started issued in the year first and maintenance periodically every 5 years. With estimated cost of maintenance routine per year 1 % of the total cost of construction and 5% for maintenance periodically every 5 years.

Following big cost operation and maintenance routine and periodic with various condition elevation lighthouse overflow:

1. Cost operation and maintenance routine and periodic with crest elevation conditions + 685 m

Table 6. Calculations Cost Operations and Maintenance Routine Jlantah Dam on Elevation Lighthouse Spillway + 685 m (Calculation Results, 2022)

No.	Description	Unit	Amount	Unit Price (Rp)	Total Price (Rp)
A	Cost operational				
1.	Wages Head Operation and Maintenance	Person/ Year	1	120,000,000	120,000,000
2.	Technician Salary	Person/ Year	5	60,000,000	300,000,000
3.	Administrative Staff Salary	Person/ Year	2	42,000,000	84,000,000
4.	Office Stationery	Month	12	2,000,000	24,000,000
5.	Vehicle operational	Units/ Month	12	4,000,000	48,000,000
B	Cost Maintenance Routine	%	1%	627,285,884,409	6,272,858,844
	Amount				6,272,858,844

Table 7. Calculations Cost Operations and Maintenance Periodically Jlantah Dam on Elevation Lighthouse Spillway + 685 m (Calculation Results, 2022)

No.	Description	Unit	Amount	Unit Price (Rp)	Total Price (Rp)
A	Cost operational	%	5%	627,285,884,409	31,364,294,220
	Amount				31,364,294,220

Cost Operations and Maintenance assumed happen enhancement of 5.5% per year based on ethnic group flower bank credit. Interest rate effective Period (i) used 4% obtained from average percentage level flower effective in the District Karanganyar in period 1 year time last (BPS, 2022).

Calculation results mark Now For cost Maintenance Routine and Periodic for 50 years so Total Fee Amount Operation and Maintenance Jlantah Dam with Condition elevation Lighthouse Spillway + 685 m is as big **Rp. 841.067.774.687.**

2. Cost Operational and Routine and Periodic Maintenance with Elevation Conditions of Mercu Pelimpah + 682 M

Operational and Maintenance Costs are assumed to increase by 5.5% per year based on bank lending rates. The effective interest rate for Period (i) used is 4% which is obtained from the average percentage of the effective interest rate in Karanganyar Regency in the last 1 year (BPS, 2022). The results of calculating the present value for Routine and Periodic Maintenance costs for 50 years, then, Total Cost of Operation and Maintenance Jlantah Dam with Condition elevation Lighthouse Spill + 682 m is as big **IDR 823,271,642.32.**

Operational and Maintenance Costs

Before the Jlantah Dam was built, the irrigable area that could be irrigated was 805 Ha. With the construction of this dam, the target area for irrigation that can be irrigated is 1,493 hectares.

Calculation Increasing Agricultural Production Results

The results of the cropping pattern paddy with 2 periods plant exist an area of 805 Ha is of 5.66 tonnes/ha (BPS Karanganyar, 2021). After awake and operational Jlantah Dam so will available water requirements can irrigate more irrigated areas broad. On calculations, this will do a comparison between before operation reservoir and after operation reservoir with 2 conditions reliability reservoir based on elevation overflow. Expected conditions with the existing Jlantah Dam and the provision of sufficient irrigation water are enhanced intensity planting rice (Bagiawan et al., 2011).

Mark enhancement results in clean sales or income results in agriculture in the amount of IDR 31,127,059,139. the value obtained from the difference between results clean after the reservoir operated with before the reservoir operate. Based on Provincial BPS data Central Java 2022, the average increase price of Milled Dry Grain (GKG) at 5.43%. Interest rate effective

Period (i) used 4% obtained from average percentage level flower effective in Indonesia in period 1 year time last (BPS, 2022).

Calculation results mark now for Enhancement Benefits of Agricultural Products for 50 years in the amount of IDR 29,701,172,806. the value obtained from the difference between results clean after the reservoir operated with before the reservoir operate (Alrayess et al., 2018). Based on Provincial BPS data Central Java 2022, the average increase price of Milled Dry Grain (GKG) at 5.43%. Interest rate effective Period (i) used 4% obtained from average percentage level flower effective in Indonesia in period 1 year time last (BPS, 2022).

Benefit Cost Ratio (BCR)

To obtain the ratio between benefits and costs (BCR) in the thesis this is used to calculate the present value of benefits and costs for 50 years that have been counted. The benefit value is obtained from the total increase in benefits after the operation reservoir for 50 years. Whereas mark Cost is obtained by combining the cost investment initial (cost liberation land and costs construction) as well as cost operation and maintenance for 50 years forward (Pattiapon et al., 2021). Following BCR calculation after operation reservoir with two conditions reliability reservoir based on elevation overflow.

Calculation of BCR Conditions the elevation of the overflow lighthouse + 685 m

Benefits (Benefits) : Increased Agricultural Value
: IDR 2,131,974,220,102
Cost: cost liberation land + cost construction + OP costs
: IDR 282,464,520,000 + Rp. 627,285,884,409 + Rp. 841,067,774,687
: IDR 1,750,818,179,096

$$BCR = \frac{B}{I + PW\ (O + M)}$$

$$BCR = \frac{2.131.974.220.102}{1.750.818.179.096}$$

$$\boldsymbol{BCR = 1,218 > 1}$$

Calculation of BCR Elevation condition of the crest of the overflow + 682m

Benefits (Benefit) : Increased Agricultural Value
: IDR 2,034,311,511,589
Cost (Cost) : costs liberation land + cost construction + OP costs
: IDR 255,705,711,500 + Rp. 624,491,851,498 + Rp. 823,271,642,324
: IDR 1,703,469,205,322

$$BCR = \frac{B}{I + PW\ (O + M)}$$

$$BCR = \frac{2.034.311.511.589}{1.702.469.205.322}$$

$$\boldsymbol{BCR = 1,194 > 1}$$

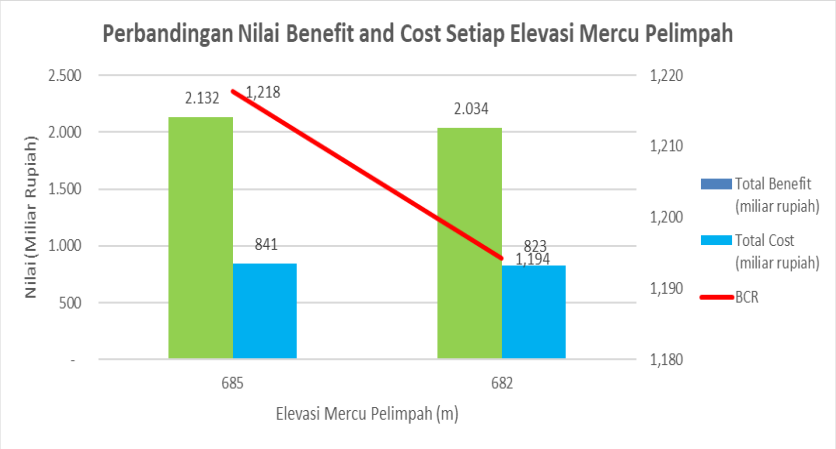

Figure 1. Relationship Between Elevations Lighthouse Abundance, Total Benefit, Cost and BCR

From the results of BCR analysis with 2 conditions based on elevation overflow above, is obtained results that every condition owns BCR value > 1, then Jlantah Dam is worthy for built.

Method of Internal Return (Internal of Return)

IRR is the level ethnic group flower Where benefits and costs have the same value or BCR = 1 or also means NPV value (Net Present Value) = 0. With method interpolation to NPV value and rate ethnic group flower can obtained NPV value = 0 or BCR = 1.

Calculation IRR Overflow crest elevation condition + 685 m

With level ethnic group 5.5% interest yields a positive NPV whereas with 6 % resulting in a negative NPV, with thereby can counted IRR value like calculation under this :

$$IRR = i' + \frac{NPV'}{(NPV'-NPV")} x\ (i"-i')$$

$$IRR = 5.5 + \frac{381.156.041.005}{(381.156.041.005-(-118.885.985.659)} x\ (6.0 - 5.5)$$

IRR = 5.88 % > tribe flower → project worthy held

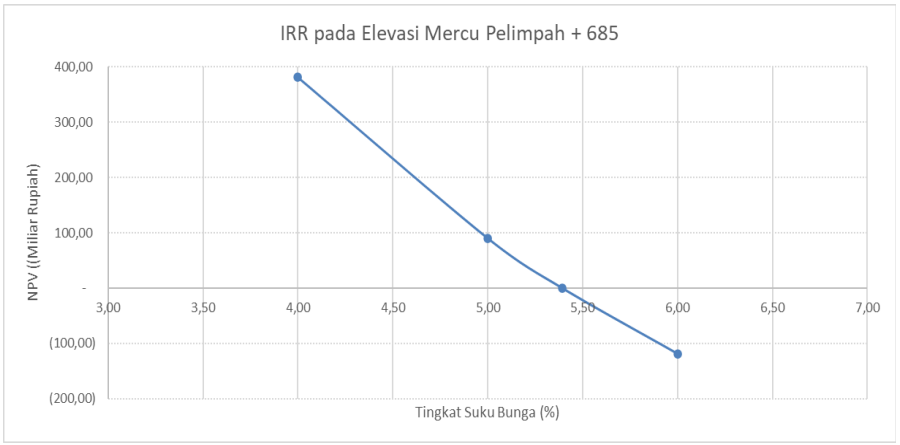

Figure 2. Graph of IRR at Elevation Lighthouse Overflow + 685

Calculation of the IRR Elevation condition of the crest of the overflow + 682 m

With level ethnic group 5.5% interest yields a positive NPV whereas with 6 % resulting in a negative NPV, with thereby can counted IRR value like calculation under this :

$$IRR = i' + \frac{NPV'}{(NPV' - NPV'')} x\ (i''-i')$$

$$IRR = 5.5 + \frac{330.842.306.266}{(330.842.306.266 - (-137.740.086.081))} x\ (6.0 - 5.5)$$

IRR = 5.85 % > rate flower → project worthy held

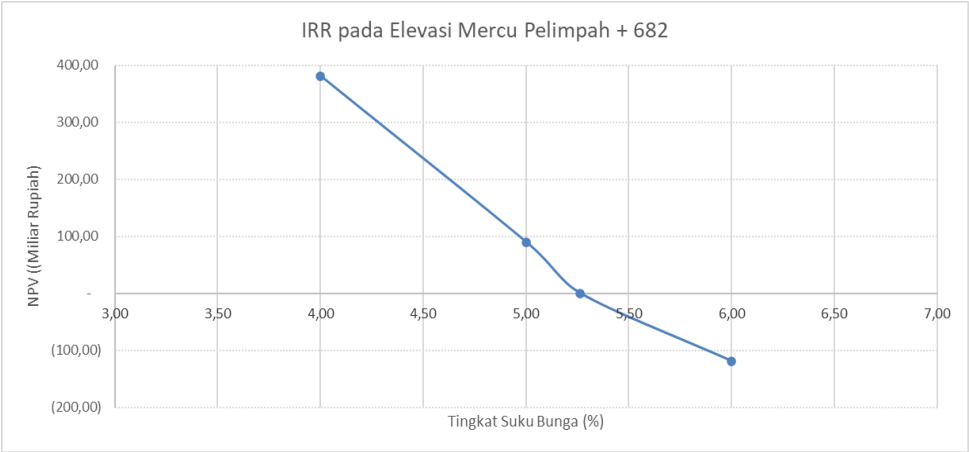

Figure 3. Graph of IRR at Elevation Lighthouse Overflow + 682

Selection Alternatives based on Two Peak Elevation Conditions

Selection of Alternatives with IRR Incremental Analysis

For determine alternative for two conditions elevation lighthouse abundance that has analyzed, then must done IRR incremental analysis. The incremental IRR (ΔIRR) analysis is continuation from IRR analysis if amount available alternatives No single and necessary For Determine ranking/ priority alternative. This happen due to the largest IRR No can worn as guidelines determine alternative best.

Alternative ranking best temporary based on alternatives that have mark investment smallest that is, at elevation lighthouse overflow + 682 as the alternative second.

$$IRR_{(1-2)} = i' + \frac{NPV'}{(NPV' - NPV'')} x\ (i''-i')$$

$$IRR_{(1-2)} = 5.5 + \frac{50.313.734.739}{(50.313.734.739 - 18.854.100.422)} x\ (6.0 - 5.5)$$

$IRR_{(1-2)}$ = 6.3 % > MARR(6 %)→ so alternative One forward, and alternate two falls.

So from the analysis above, is obtained that alternative one (Elevation Lighthouse Overflow + 685) represents the alternative best.

Selection of Alternatives with BCR Incremental Analysis

BCR incremental analysis is the same as the ΔIRR however compare BCR to every alternative. The biggest BCR no can wear as guidelines determine alternative best. Alternative ranking best temporary based on alternatives that have mark investment smallest that is, at elevation lighthouse overflow + 682 m (alternative two). Then counted BCR deviation between alternative one and two so from Analysis above, is obtained that alternative one (Elevation Lighthouse Overflow + 685) represents alternative best (Law, 1979).

Based on results Analysis election alternative best, obtained alternative best is lighthouse spillway at elevation + 685. For lighthouse overflow at elevation such, requires *cost* from facet cost liberation land, cost development, as well cost operation and maintenance of IDR 1,750,818,179,096 and also has a benefit of IDR 2,131,974,220,102. Although need total cost more implementation big in construction, however condition elevation lighthouse spillway at elevation + 685 have more benefits big too.

Land Acquisition Time and Construction Time

Schedule of Land Acquisition and Construction Period

For liberate inundated area of 504,477 m ^{2} (50.47 Ha) of plan beginning need 24 month time with cost exemption of Rp. 282,464,520,000 and schedule construction for finish Jlantah Dam need 48 month time.

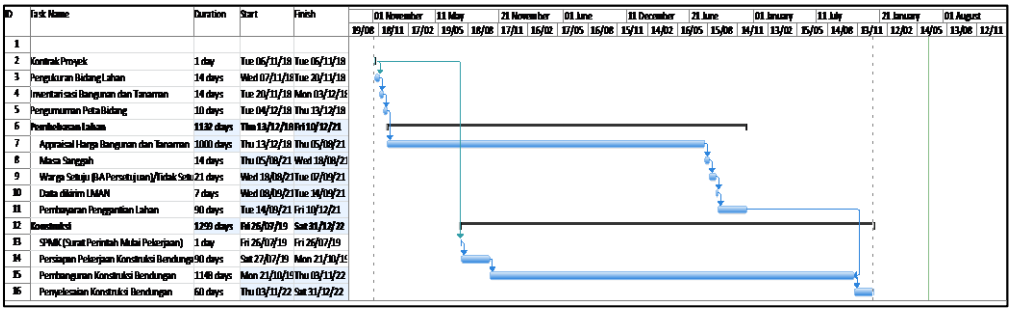

Figure 4. Timetable Release Time Plan Land and Construction (PT. Waskita Works, 2019)

In reality There is lateness time liberation land to be 72 months, so impact on execution time construction that also experienced lateness to be 72 months or completed construction period from 2022 to 2024.

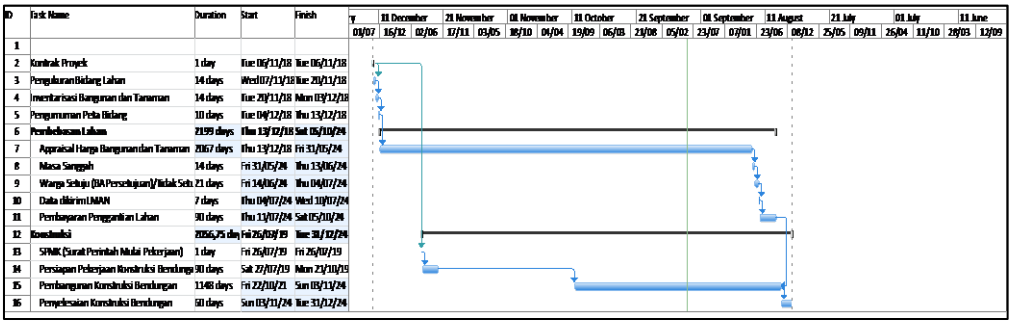

Figure 5. Schedule Realization of Time of Liberation Land and Construction (PT. Waskita Works, 2022)

Calculation of *Indirect Cost During the Construction Period*

During the construction of Jlantah Dam, we were required to count budget *indirect costs* which include the need for financing wages employee projects, and operations projects during the construction period going on (Wilson, 1990). We count in accordance with the plan time implementation beginning Project Jlantah Dam will resolve during four years in the 2019-2022 period. because happen a delay in the implementation consequence of land not yet can be released in accordance timetable plan, then a delay in the original implementation period resolved in time four years (2019-2022) to (2019-2024) will influence the indirect cost budget becomes over budget. Based on calculation *indirect costs* from second table on exists over budget Rp. 9,317,268,830 for addition need cost during implementation for finish Jlantah Dam.

CONCLUSION

From analysis calculation, the storage volume is obtained Dam The most effective way or optimum, namely at elevation lighthouse spillway + 685 m, with storage volume effective of 8,305,562 m3. With Incremental analysis of BCR and IRR, obtained that condition economical development Jlantah Dam that is, at elevation lighthouse spillway + 685 m with:

1. Reliability reservoir 97.22 %,
2. Cost investment (cost liberation land, cost construction, costs operation, and maintenance) of Rp. 1,750,818,179,096
3. The value of the benefits obtained as big IDR 2,131,974,220,102
4. BCR value 1.218
5. IRR value of 5.88%

For the finished construction of Jlantah Dam and fulfilling the most effective volume of storage at an elevation of + 685, there was an over budget of Rp. 9,317,268,830 due will There is cost addition consequence retreat time liberation land. From the Analysis calculation cost liberation land, the most optimum conditions are in conditions elevation lighthouse spillway + 685 m with an inundation area of 504,477 m2 (50.47 Ha), was obtained cost liberation land Rp. 282,464,520,000.

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