COST ANALYSIS FRAMEWORK FOR SEDIMENT MANAGEMENT IN RESERVOIR INFRASTRUCTURE

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DEDICATION

" To My Beloved Wife (Rizki Zahrotul Iza) and Son (Rahmatusifa Annajwah), thank you for being wonderful to me"

" To My Mother that I Love"

"To Abah and Umik that I Love"

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ABSTRACT

Water is importance element for the continuity of the life of human being. Generally, the human being was created and had settled down in orders to get basic needs in daily life. . In the present day, the scarcity of water due to human population increase, climate changes, drought, environment change, etc., causes need to store the freshwater is very importance and urgently and the build of dam reservoir is the one answer for that problem. The biggest problem that occurs in the dam reservoir is sedimentation. Sedimentation problem can make reduce gross storage of dam reservoir. Sedimentation management is one way of maintenance process for make sediment removal in dam reservoir. Maintenance cost for that dam reservoir can't direct separately, because that social function and business benefit working together. The cost analysis framework was undertaken to identifies and describe the estimated costs associated with the baseline , development and alternatives, and calculates comparative costs between them, also integration of risk factor management approaches into routine practice for the pilot teams. Because of that, is importance to know component cost and development of component cost that used for make cost analysis. In this research that to get guidance for make cost analysis base on component cost and also to developed, that type of research is develop theory and model, base on studies of published material and compare between theoretical. Research finding that almost eighty percent (80%) most of respondent that involved in cost analysis or cost estimate agree that practically to make framework for cost analysis is importance that the beginning, component cost base on theory and furthermore to make guidance is combine component cost in theory and practically, beside depend on the drawing, specification or other thing that needed for make cost analysis.

Keyword : Cost analysis framework, Sedimentation management, Cost estimate, and Maintenance cost

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INTRODUCTION

1.1 Background

Water is importance element for the continuity of the life of human being. Generally, the human being was created and had settled down in orders to get basic needs in daily life. In the present day, the scarcity of water due to human population increase, climate changes, drought, environment change, etc., causes need to store the freshwater is very importance and urgently. The impact from that happen caused to constructed dam reservoirs to store the fresh water's is importance. Another purpose of constructed dam reservoirs is used for flood prevention and used for power generation purposes for the last 50 - 100 years.

Today, dam reservoir problem that should be observed is decreasing of dam reservoir effective capacity and dam reservoir lifetime, that some of them getting older because of some environmental damages. One of problem is caused by sedimentation. Trapping of sedimentation on the upstream of the dam reservoir body is importance things, because it is a very serious problem for many countries for dam reservoir maintenance. Sedimentation has influence to life cycle of reservoir infrastructure as water reservoir. Increasing of sedimentation in the reservoir can make gross storage capacity less than gross storage capacity design. Additionally, performance operation from capacity decrease, significantly make the benefits

gained from hydroelectric power generation, irrigation, water supply and flood control decreases in a considerable amount because of the sedimentation. Sedimentation also give indirectly affected to the downstream and upstream of the dams reservoir. In the downstream sediment causes degradation in channel and changes in aquatic life or the environment condition. On the other hand, negative effects of sedimentation in upstream of a reservoir make increase of local ground water table, channel flood capacity reduction, decrease of bridge navigational clearance, and water diversions and withdrawals influence.

It happened also in Indonesia, especially in Brantas River in East java. In the report On Engineering Studies For The Brantas Rives And The Bengawan Solo River Basins (2005) by Nippon Koei CO, LTD said that since the basin development master plan for the Brantas River basin was formulated in 1962, eight dam reservoirs have been constructed for domestic and industrial water supply, power generation, flood control and irrigation (Sengguruh, Sutami, Lahor, Wlingi, Lodoyo, Selorejo, Bening, and Wonorejo). Large amount of sediment inflow and sedimentation to be importance problem because of that the principal reservoirs of the Brantas River basin are rapidly losing their gross storage capacities (from 30 to 90 % of the original storage capacities). Sengguruh, Wlingi and Lodoyo dam reservoirs (as smaller dams) for example, their effective storage capacities were reduced to around fourthy percent (40%) and the biggest Sutami dam reservoir had a large-scale storage loss in the past 31 years since its construction. Detailed sedimentation characteristics in each dam reservoir are presented below.

In Sengguruh dam, which has a catchment area of 1,659 km^2, is located on the upstream reach of the Brantas River and at just downstream reach of the confluence of the Brantas River and the Lesti River. The location is around 25 km south of Malang City, and approximately 14 km upstream reach of the Sutami dam. Since completion in 1988, sediment accumulation in the Sengguruh reservoir has rapidly reduced its effective storage capacity up to 41.5% of the design storage capacity. Especially, the rate of sedimentation was high immediately after completion and around 15 million m^3 of sediment was deposited in the reservoir in the first nine years, which corresponded to 70 % of the designed gross storage.

In Sutami dam reservoir, has a large scale storage capacity, however, the storage capacity decreasing process of the early years after construction (1973 - 1977) had been very quickly, and decrease of gross storage capacity was about 82 million m^3 for 4 years. After construction of the Sengguruh dam, the rate of the storage capacity decrease slowed down in comparison with that of before construction of the Sengguruh dam. The present gross storage capacity corresponds to 50.9% of that of designed condition, and the effective storage capacity is 57.4% of the designed condition.

In Lahor dam, which has a catchment area of 170 km^2, was constructed in 1977, and it was connected with the Sutami reservoir by a connection tunnel. The two reservoirs, therefore, are functioning as one reservoir. In 2002, 25 years after the dam completion, the gross storage capacity of the Lahor dam was 85% of that of designed. The sedimentation rate of the Lahor reservoir is less than other reservoirs in the Brantas River basin.

In Wlingi dam, which has a catchment area of 2,890 km^2, is located on the southern skirts of Mt. Kelud in the upstream reach of the Brantas River, and at around 25 km downstream reaches of the Sutami dam. The Wlingi dam was constructed in 1977 for the purpose of hydropower generation for peak demand and irrigation water supply, and it was also expected to take a role of temporary storage of the erupted material from Mt. Kelud. After construction of the Wlingi dam, the sedimentation rate has been very rapid, and annual average sediment deposit in the reservoir up to 1988 was around 1.3 million m^3. In January 1990, just before the eruption of the Mt. Kelud, the gross storage capacity of the Wlingi reservoir was reduced to 19.2% of the designed gross storage capacity. As stated above, regardless of the eruption of Mt. Kelud, the Wlingi reservoir was suffered by high rate of the sediment inflow. Mt. Kelud erupted in February 1990. After this eruption, the Wlingi reservoir were filled up completely by the sediment and the removal works of deposited sediment in the Wlingi reservoir by dredging and sediment flushing were implemented to restore the storage capacity.

In Lodoyo Dam, that was constructed in 1983 for the purpose of after bay of

the Wlingi dam and power generation. The decreasing rate of storage capacity in the Lodoyo reservoir is high like the Wlingi reservoir. The gross storage capacity of the Lodoyo reservoir in 2003 was reduced to 2.03 million m^3, which corresponds to 39% of the designed gross storage capacity of 5.20 million m^3. There was not significant change in the decreasing rate of the storage capacity after the eruption of Mt. Kelud in 1990, owing to temporary storage effect of the Wlingi reservoir for the erupted material from Mt. Kelud.

In Selorejo dam, which has a catchment area of 236 km^2, is located at the upstream reach of the Konto River and there are many devastated areas in the mountain hill slope surrounding the reservoir. The Selorejo dam was constructed in 1972 as a multipurpose dam for irrigation water supply, power generation and flood control. The gross storage capacity of the Selorejo reservoir has been decreased to 44.01 million m^3, which corresponds to 70.6% of the designed gross storage capacity of 62.30 million m^3. The decreasing process of the storage capacity is moderate in comparison with those of the other dams on the Brantas River.

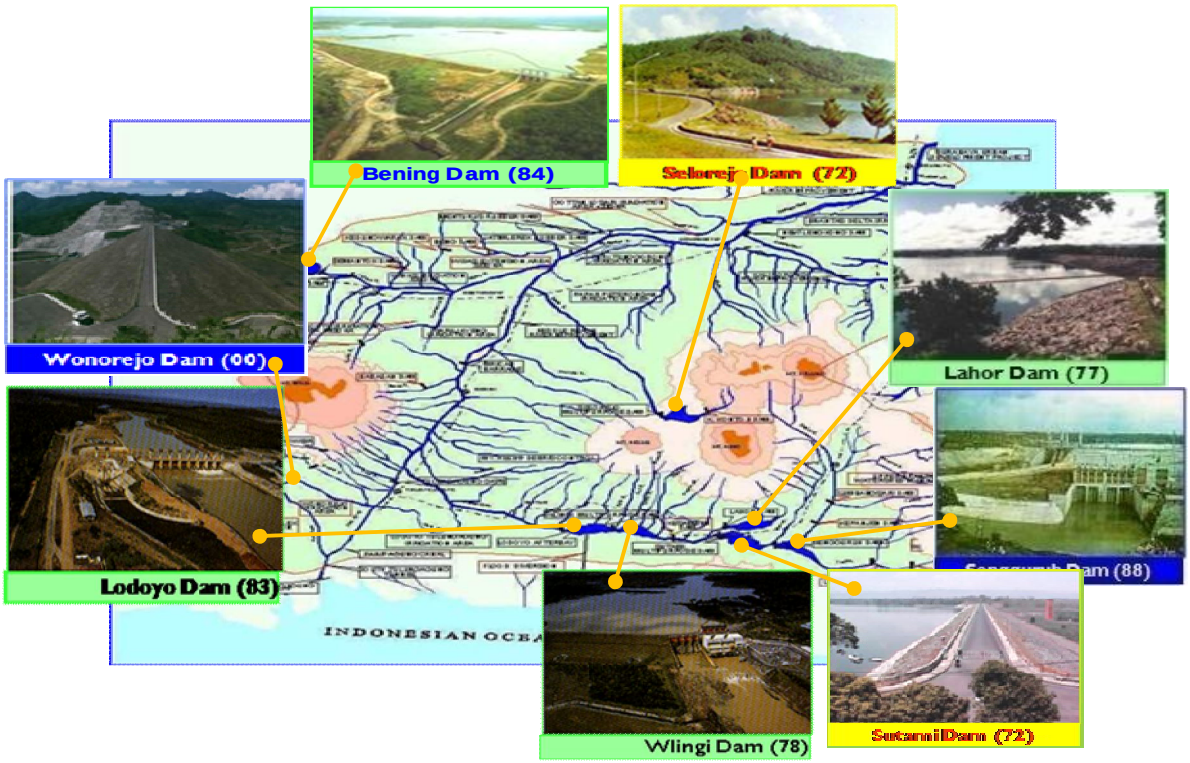

Figure 1.1 Dam Reservoir Infrastructure in Brantas River basin, East Java

Source: www.Jasatirta1.co.id

Sedimentation in dam reservoir infrastructure in the Brantas River basin to be seriously problem, because the position that closely with power plant infrastructure that use water for the turbine operation. All problem that appearance from the impact of sedimentation is reduction to gross storage capacity of dam reservoir function as collected water from rain water for flood management, electricity production and rice production / irrigation water supply ; build up new one for increasing supply of live human being (new gross capacity) needed of high investment ; for life cycle of dam reservoir function, still needed maintenance cost (for decommissioning, the maintenance cost is higher if that contain full sedimentation). In the report On Engineering Studies For The Brantas Rives And The Bengawan Solo River Basins (2005) by Nippon Koei CO, LTD said that element of reservoir sediment management can be categorized as follows : reduce of sediment inflow to reservoir, routing of sediment pass or through the reservoir, discard of deposited sediment, provide large storage volume and sediment placement, as shown in the following figure. 1.2.

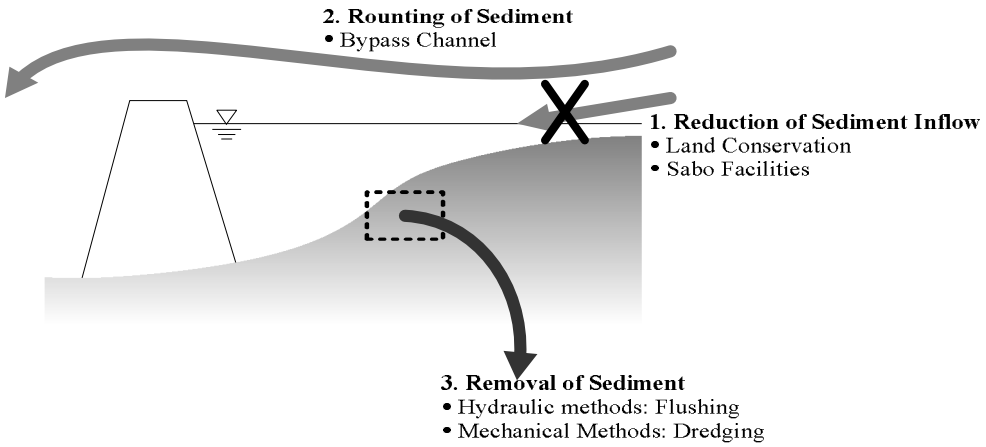

Figure 1.2 Measures to Reduce Sediment in Reservoir

Source: Nippon Koei CO, LTD, 2005 - Engineering Studies for the Brantas Rives And The Bengawan Solo River Basins.

Sedimentation management that use in Wlingi and Lodoyo dam reservoir maintenance is removal sediment by flushing (use hydraulic principle methods), Dredging (use mechanical principle method) and variation of flushing and dredging, this is because that methods is sustainable. The cost and applicability of each

strategy have variation from one site to another and function of sediment accumulation.

Cost analysis is the act of developing, analyzing, and documenting cost estimates using analytical approaches and technique. A cost analysis was undertaken to describe the estimated costs associated with the development and integration of risk factor management approaches into routine practice for the pilot teams, and also used for produce cost estimates or budgeting. Cost analysis involved every compound that have influence for estimation, as material cost (direct and indirect); labor cost (direct and indirect); equipments and resources cost (direct and indirect); and overhead cost.

Perum Jasa Tirta I (PJT I) as public company that representated of government that have responsibilities for operation and maintenance for dam reservoir along Brantas River basin have social liability and business benefit. This research will be focused on the cost analysis framework that has effect to the financial income for PJT (business benefit side). The importance that should be know is the social function and business benefit is working together. No completely compound of cost analysis in estimated cost, caused analysis of financial benefit to be false. Financial analysis in sediment management not always use for calculate the project cost benefit, but also to know how far the influence of cost that been use to financial income for PJT I, beside that this purpose can use for cost budgeting in the future. Flushing for example, the water that been use not come from material that buying from supplier but they have influence directly to PJT I financial income and influence to the irrigation water policy.

1.2 Problem Statement

Large amount of sediment inflow and sedimentation to be importance problem because the reservoirs that constructed in the Brantas River basin is rapidly losing their gross storage capacities (from 30 to 90 % of the original storage capacities).

Sedimentation management is one choice for maintenance program. Dam reservoirs perform routine removal sediment by dredging every year. But the ability dredging of the reservoir is not sufficient, because the cost is relatively expensive, even that have good effectively for removal sediment. Other removal sediment that performs in dam reservoir is conducted to flushing. The applicability of each strategy have variation from one site to another and also sediment accumulation function. Maintenance cost for sediment management in dam reservoir can't direct separately between social function and business benefit, because that function working together. Incompletely component cost analysis for sedimentation management caused mistake for financial analysis (business benefit side) and cost benefit analysis (social function side).

With that circumstances, identification and development of component of cost is importance to analyze, so the cost analysis framework for sediment management in the reservoir infrastructure can be finding.

The question of problems that arises is whether component of cost analysis framework for sediment management that already applied is complete or not ?

1.3 Objective of the Research

The following objectives are proposed for this theses research that according with the problem statement (above) is:

a) To identify the components of cost analysis.
b) To develop cost analysis framework based on component of cost analysis.

1.4 Scope of the Research

The scope of this research is:

a) Object specification is dam reservoir that located in Province of East Java, Indonesia and has function as water supply for power generation.
b) For dredging methods dam reservoir that choice is Sengguruh; Sutami; Wlingi and Lodoyo; and for flushing methods dam reservoir that choice is Wlingi and Lodoyo.
c) Number of data that will be used is two (2) – five (5) years (for dreging methods) and two (2) years (for flushing methods)
d) Cost analysis framework will be focus on the dredging method, and flushing methods.
e) Research will be doing from documentary study

1.5 Importance of the Research

Sedimentation velocity at each reservoir accumulating basin impacted on step-up sedimentary sediment volume at deep accumulating basin which directly impacted on that life cycle for that infrastructure it self. To settle that problem, two of alternative maintenance for removal sedimentation that was done is dredging methods and flushing methods (with some dredging and excavation process for make sediment comes out from water intake for power plant).

The aim of this study is to understand the problems associated with cost analysis framework for sediment management in reservoir infrastructure so that it can be used for get cost analysis framework guideline in next project for estimator in the same location or other location, because maintenance cost is importance matter for routine sediment removal. Beside that, completely of cost analysis framework has impact for true financial analysis and cost benefit analysis.

1.6 Organization of the Chapters

1.6.1 Chapter 1 – Introduction

Discuss the backgrounds of the study and clearly stated the problem statement, objective, scope of study, importance of the study, methodology and organization of the chapter. It frames the study effort and gives it specific focus to the research.

1.6.2. Chapter 2 – Literature Review

Discuss about the theoretical that will use in this research. Theory that will be explain as follow reservoir, Sedimentation, Sediment Management, Measurement and Quantification of Sediment Budget, and Cost Analysis.

1.6.3. Chapter 3 – Research Methodology

Discuss about research methodology phase and explanations for every phase.

1.6.4. Chapter 4 – Data Collection, Cost Analysis Framework Draft and Analysis Data

Discuss about data collection, cost analysis framework draft, and analysis data.

1.6.5. Chapter 5 - Conclusion and Recommendation

This chapter is the final chapter that summaries the finding of the research according to the research objectives. It also contains the problems encountered during the research as well as the recommendation for future research.

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