

# **An Analysis of Upper Structural System Work Cost Management Factors at Cimanuk Bridge Project at Majalengka, West Java**

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**ABSTRACT:**The process of choosing the bridge structural materials has its own uniqueness. At Cimanuk Bridge project, the upper structure material selection is done using concrete material. However, steel structure is the main priority at the construction implementation on site. Furthermore, cost management should be taken into consideration in implementing upper structure work, especially if there is a change order. Construction and the development of infrastructure are fundamental to economic growth and societal advances. Unfortunately, project cost overrun and scope creep are common on infrastructure and construction projects. That is why this research does a systematic analysis to identify structural work costing indicators, specifically for the bridge project. The overall research problems are: analyzing the current condition of construction project budget implementation, identifying the bridge project work costing indicators, analyzing the upper structural system construction project budget using steel and concrete materials for Cimanuk Bridge. However, this research focuses in the process to analyze and identify the bridge structural project work costing indicators. This research uses the research methodology starting from the primary data collection, research findings review, and the recommendation which is expected to bring improvement needed by the project examined. Specifically this project is limited to before the analysis process. The method used is the quantitative method. Based on an analysis of upper structural system work costing management factors, it can be summarized that there are only 2 strong correlation factor components which are structured in 7 independent variables are chosen at correlation test and inter-correlation test. Component factor 1 consists of X7 (ignoring the risk factor at the project location), X9 (ignoring the inflation and escalation factor), X10 (incomplete contract clause), X13 (too many working repetitions because of bad quality), X14 (the cost of material double order), X15 (the cost for worker wage), X31 (monitoring working performance to the expenses spent on the project). Component factor 2 consists of only X7.

**KEYWORDS:**project cost management, construction, upper structure, bridge.

## **I. INTRODUCTION**

Indonesia is a country famous of many islands and rivers stretched from Sabang to Merauke. To reach the equitable development, a construction is needed as a connection between two separated lands so that pedestrians and vehicles can pass. To connect both of the land sides, a construction is built which is usually called bridge. Generally, materials used for bridges are steel and concrete. These two materials are chosen because steel and concrete are considered more general and stronger than other materials.

Comparing these to materials is difficult because both of the materials have their own advantages and disadvantages. For example, steel material is famous by its advantage on installation duration and the on-site condition which is tend to be clean due to less residue left. However, steel is hard to shape. On the other hand, concrete material has opposite

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characteristics compared to steel. This material is easy to shape using the mold made. The disadvantage is that the usage of concrete tends to make the on-site condition becomes dirty due to its residue and the casting work splashes.

Cimanuk Bridge construction project has uniqueness. At the planning step, concrete material was chosen as the bridge upper structure. However, after a project budget observation was done, it was found that concrete structure needs a quite high scaffolding cost. Because of that, steel material was chosen as the upper structure material of the bridge. That is why it is important to identify and analyze what bridge upper structure factors needed to be paid attention on regarding the project budget. The importance to understand and analyze the costing factors of the bridge upper structure project is relevant to the definition of a project which is an activity done with limited time and resources to attain determined final result.

The problem in this research is about what are included in upper structural system costing management variables and factors at Cimanuk Bridge construction project, including analyzing the factors in this research. Furthermore, in order to implement the bridge upper structure work, it is needed to pay attention on the corrective actions on project budget management which later affects the project performance. That is why it is important to do a systematic analysis in this research to identify structure work costing indicators, specifically at bridge projects.

Cimanuk Bridge construction project becomes one example of a construction project that implements costing management. The costing management implementation of this project is the bridge structure material substitution from concrete into steel at the planning step. What unique is the change order is applied as a cost efficiency tool. Instead, at the ideal condition, change order is one of the causes of cost overruns. To determine the most important costing management factors of Cimanuk Bridge, the researcher is going to identify the costing indicators that affect project performance the most.

Through this research, construction services subjects are expected to understand the project budget based on the materials characteristics and construction method used, so that proper structure materials decisions based on the cost, quality, and project execution time can be taken at the Cimanuk Bridge construction project implementation.

## II. LITERATURE REVIEW

### Project Cost Management

The definition of project budget is the effort to attain the fund or capital used to fund a project. The sources and types of the project funding may come from private capital, debt, or BOT (Build-Operate-Transfer). In BOT system, some companies act as the project sponsors by forming a consortium. The consortium works on the fund, implementing the project construction, and operating project result installation to get the return. The project operation is arranged on an agreement in a certain period based on the return desired which later is given back to the project owner. Economic evaluation of the large projects is very important not only from the aspect of investor and direct users of the infrastructure. Those results are very important for the society as a whole. "Due to large amount of money involved and great impact of project results on its environment, large infrastructure projects attract great attention of media and public. It is hard to hide when expected results are not met [1]. Now there are software can be help to control cost project management software such as Primavera [2] and MS Project [3] describes detailed cost and schedule integration.

### Construction Process

A project has a definite starting and finishing point [4] and construction process is a series which starts from an idea which comes out from the need, the feasibility study, the decision to build and prepare a more detailed description (elaboration) about that need formulation (briefing), manifestation into the preliminary design, design development and detailed design, administration preparation to implement the construction by choosing the implementers candidates (procurement), implementing the construction at the provided site (construction), the maintenance and the building utilization preparation. in complex projects, estimating the designing, engineering, project management and commissioning costs is much more challenging than in a project with more restricted scope. "The larger the project is, the larger is the amount of engineering work related to it and also the effect of the engineering costs to the total costs of the project is more significant" [5]. Cost of construction project is defined as a price to a client including consultant's fees, main contractors' and trade contractors' charges including their overhead

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and profit [6]. Cost is one of the major consideration in entire cycle of construction projects. Unfortunately, majority of the projects failed to achieve project completion according to the contract cost [7].

## Project Cost Analysis

Project cost analysis is primarily a method of cost control for the project taken. That cost control, project costs incurred to analyze, analyze and find cost savings or overruns reasons, so as to achieve improved management, improve economic efficiency. Project cost analysis includes a comprehensive analysis and detailed analysis of two kinds. Comprehensive analysis of the project cost. According to a comprehensive analysis of the cost of the project, the cost of the project is that labor costs constitute costs, material costs, construction machinery royalties, other direct costs and construction management fees. it is analyzed by a comprehensive analysis of the cost of the project to compare the actual cost of the construction costs and annual budget units. Through a comprehensive analysis of the project, it can be found to reduce project costs or overruns of the main reasons to take appropriate measures, the cost control within the target range. Detailed analysis of the project cost. Detailed analysis of the project cost analysis can be divided into labor costs, material costs analysis, construction machinery royalty analysis, analysis of other direct costs, indirect costs, such as several analyses [8].

## III. RESEARCH METHODOLOGY

### Cimanuk Bridge Project

#### a. General Description

Cimanuk Continuous Composite Girder Bridge structure is a girder structure with bolt joint. The bridge is planned with composite system where the concrete floor, together with steel girder, endures the dead load and the live load.

#### b. Planning Criteria

##### - Structure Type

The steel bridge structure is the girder structure with bolt joint.

##### - Geometry

The dimension of Continuous Composite Girder Bridge is as follows:

Distance between girders	: 3.25
Span	: 50 + 90 + 50 m
Road width	: 14.8 m
Pavement width	: 0.5 m
Road slope	: 2%

### Research Process

This research process starts from looking for problem issues, construct the research problems, conducting library reviews and relevant research findings, preparing research instruments, collecting research data, and analyzing data. There were a total of 43 respondents who were given a questionnaire and analyzed in this study. The prospective respondents who will fill out the questionnaire must meet the following requirements: derived from a contractor company working on the Cimanuk bridge construction project, have a minimum education of bachelor degree or equivalent, experienced working in the field of construction of the bridge for at least 2 years, have a position staff to the board of directors and directly involved in the field of bridge construction.

### Research Operational Model

The Research Operational Model in this study is described in Figure 1. The model consists of research problem issues, research problem, research instrument that are 5 construction cost factors i.e. project cost planning management, project cost forecast, project cost budget determination, project cost control, and the roles of project manager. Based on the data from the respondents, then using the quantitative research method to analyse the factors that have strong correlation to the project performance.

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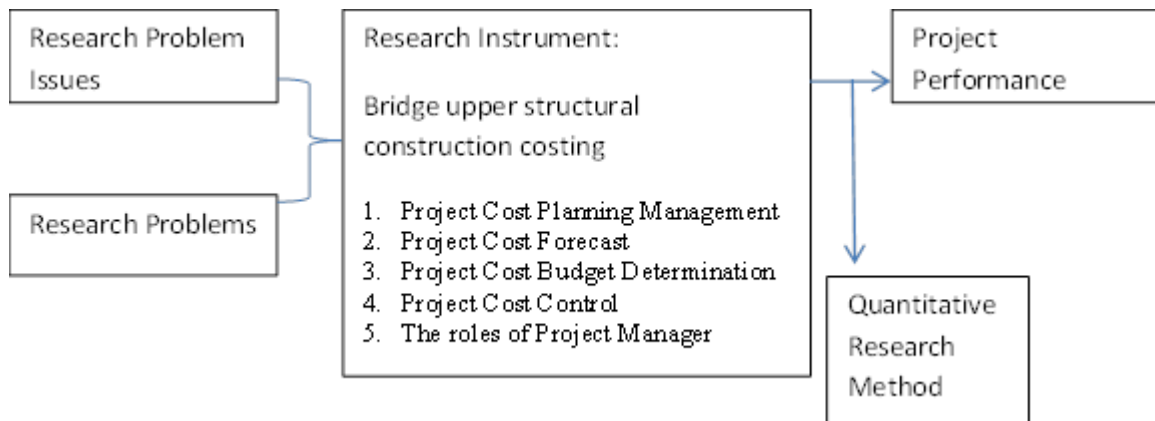


Figure 1. Research Operational Model

## IV. RESEARCH FINDINGS DISCUSSION

Based on the research problems that are going to be solved, the analysis is as the following: regarding the existing project budget condition to the construction implementation process, there are five important factors to be noticed, which are:

1. Project Cost Planning Management[9]
2. Project Cost Forecast[9]
3. Project Cost Budget Determination[9]
4. Project Cost Control[9]
5. The roles of Project Manager.

These five factors affect project budget performance. It is important to notice these five factors for the implementation at the site. The construction implementation contract should be well understood by the assignor and the assignee. This research identifies a few indicators of bridge structure construction project budget, which are:

1. Project Cost Planning Management
  - X1. Specification changes
  - X2. Lack of information about vendors
  - X3. Value engineering implementation at the design step
  - X4. Wrong budget planning
  - X5. The mistake in implementing the combination and composition number of the tools working at the project
  - X6. Ignoring contingency costs
  - X7. Ignoring risk factors at project location
2. Project Cost Forecast
  - X8. Wrong budget forecast
  - X9. Ignoring the inflation and escalation effects
  - X10. Incomplete contract clauses
3. Project Cost Budget Determination
  - X11. Bridge upper structure materials cost [10]

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- X12. Incomplete project data and information
- X13. Too many work repetitions because of the bad quality
- X14. Costs emerge because of material double order
- X15. Costs of worker wage[11]
- X16. Crane and heavy equipment renting costs
- X17. Temporary support renting costs
- X18. The costs of bridge upper structural installation/erection equipment
- X19. Lack of coordination between the main contractor and the sub-contractor
- X20. The costs emerge from the storage mistake at the side which is not good
- X21. High frequency of implementation changes
- X22. Lack of coordination between the construction manager, planner, and the contractor.
- X23. The costs of schedule acceleration
- 4. Project Cost Control
  - X24. Bad financial control
  - X25. The costs emerge from careless contract management
  - X26. Project cash flows
  - X27. Owner payment which is over due
  - X28. The identification of agreed basic budget changes factors
  - X29. Ensure all change order requests are made at the right time
  - X30. Preventing not approved change order
  - X31. Monitoring project performance to the fund granted for the project
  - X32. Controlling the cost overrun at the desired limit
- 5. The roles of Project Manager
  - X33. Construction materials knowledge
  - X34. Cost management knowledge[12]
  - X35. Project handling experience
  - X36. Project manager leadership

The questionnaires were distributed to 43 respondents at the bridge contractor company who do the Cimanuk Bridge Project. From the questionnaire distribution, it is known that most respondent come from the age ranging 25-30 years old, which is 74.42% of the respondents. For the last education criteria, most of the respondents have Bachelor degree which is 74.42% of the respondents. For the working period criteria, most of the respondents work in the range 5-10 years, which is 88.37% of the respondents. Staff position is dominating with 79.07% of the respondents. In this research, correlation analysis was done to measure the relationship between all independent variables in Cimanuk Bridge Project budget management factors. The correlation analysis in this research was done using SPSS version 24. Because this research data is numeric, so the correlation analysis done was Pearson Product Moment correlation analysis. Independent variables with correlation value  $r \geq 0.35$  are considered having a strong relation with cost performance. There are 17 variables out of 36 variables in this research which pass the correlation test. Those variables then go to inter-correlation analysis to know the relationship between one independent variable with other independent variables chosen from the correlation test.

In this analysis, the independent variables that cause a high correlation between other independent variables ( $r$  value  $r \geq 0.35$ ) will be deleted so that the model will be free from the independent variables which are highly correlated. Variables which pass the inter-correlation test are X7 (ignoring the risk factor at the project location), X9 (ignoring the inflation and escalation factor), X10 (incomplete contract clause), X13 (too many working repetitions because of bad quality), X14 (the cost of material double order), X15 (the cost for worker wage), X31 (monitoring working performance to the expenses spent on the project). The next examination step is analyzing the factors to identify variables based on their similarities. The similarities are shown by the high correlation value. The items with high correlation will form a factor crowd. The basic principle in factor analysis is simplifying data description by reducing the variables amount. One of the factor examinations is KMO and Barlett's test which is an examination tool used to measure inter-correlation factor between variables and whether factor analysis can be done. The data which can be

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analyzed has criteria as the following: KMO value >0.5 and Barlett's test of sphericity at <0.05 significance. Below is the variable processing result by using SPSS version 24 software (Table 1).

Table 1. KMO dan Barlett's Test Result

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.681
Bartlett's Test of Sphericity	Approx. Chi-Square	47.312
	df	21
	Sig.	.001

Anti-Image Matrix is used to know if there is any compatibility between variables in 1 factor. If the value is less than 0.5, that variable should be removed from the mode. The test result can be seen in Table 2.

Table 2. Anti-Image Matrix

		Anti-image Matrices						
		X7	X9	X10	X13	X14	X15	X31
Anti-image Covariance	X7	.760	-.183	-.068	.115	-.116	.010	-.210
	X9	-.183	.756	-.181	.049	-.102	-.046	-.070
	X10	-.068	-.181	.697	-.217	.008	-.142	-.037
	X13	.115	.049	-.217	.646	-.299	.024	-.140
	X14	-.116	-.102	.008	-.299	.726	.016	.023
	X15	.010	-.046	-.142	.024	.016	.849	-.197
	X31	-.210	-.070	-.037	-.140	.023	-.197	.728
Anti-image Correlation	X7	.664 <sup>a</sup>	-.241	-.094	.164	-.157	.012	-.283
	X9	-.241	.749 <sup>a</sup>	-.250	.070	-.137	-.057	-.094
	X10	-.094	-.250	.732 <sup>a</sup>	-.323	.011	-.185	-.052
	X13	.164	.070	-.323	.574 <sup>a</sup>	-.437	.033	-.204
	X14	-.157	-.137	.011	-.437	.642 <sup>a</sup>	.020	.032
	X15	.012	-.057	-.185	.033	.020	.724 <sup>a</sup>	-.251
	X31	-.283	-.094	-.052	-.204	.032	-.251	.724 <sup>a</sup>

a. Measures of Sampling Adequacy(MSA)

Table 3. Factor Component

	Component Matrix <sup>a</sup>	
	Component 1	Component 2
X7	.559	.437
X9	.627	.273
X10	.699	-.086
X13	.591	-.650
X14	.569	-.546
X15	.478	.354
X31	.660	.259

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

Total Variance Explained result of this factor analysis in this research is 53.094%. this means that the factor formed by the seven independent variables explains the factors in Cimanuk bridge upper structure costing management quite well. Moreover, there are 2 factor components in the table which have the Eigen value more than 1 which means those seven independent variables analyzed will next form 2 factor components. Factor component explains the variables which

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form 2 factor components from the factor analysis. Every variable in factor analysis must possess a strong correlation with its component factors. Every question item (variable) must have loading factor value  $>0.4$ . Below are the loading factors for every variable of their factors as shown in Table 3.

Based on Table 3 results, the loading factor value for each independent variable to their components are more than 0.4 which means there are 7 independent variables that have strong correlation to their components.

There are 36 independent variables in this research which are analyzed in 5 factors. However, after a series of data analysis process were done which includes the correlation test and factor test, there are only 2 factor components which are structured in 7 independent variables are chosen at correlation test and inter-correlation test. Component factor 1 consists of X7, X9, X10, X13, X14, X15 and X31. Component factor 2 consists of 1 variable only i.e. X7.

## V. CONCLUSION

This research concludes several main points correspond with the research problems as follows. Regarding the existing project budgeting condition to the construction implementation process, there are 5 important factors to be noticed regarding the upper structure costing at Cimanuk Bridge project. This research identifies 36 variables of bridge upper structure construction project costing which affect construction implementation performance. There are 36 independent variables in this research which are analyzed in 5 factors. However, after a series of data analysis process were done which includes the correlation test and factor test, there are only 2 strong correlation factor components which are structured in 7 independent variables are chosen at correlation test and inter-correlation test. Component factor 1 consists of X7 (ignoring the risk factor at the project location), X9 (ignoring the inflation and escalation factor), X10 (incomplete contract clause), X13 (too many working repetitions because of bad quality), X14 (the cost of material double order), X15 (the cost for worker wage), X31 (monitoring working performance to the expenses spent on the project). Component factor 2 consists of only the variable of X7.

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