Value Engineering: Application In Avtur Pipeline Work At Juanda International Airport

Kustamar, Maranatha Wijayaningtyas, Muhammad Irfan

Abstract: Value engineering is applied to find alternatives for more appropriate costs than those previously planned, within the framework of functions, structural strength and the quality of work; it employs an evaluation method to analyze the technique and value of a project, of which the purpose is to seek new alternatives for more efficient costs within the framework of functions, as well as a task-planning stage capable of identifying and optimizing costs and unnecessary efforts. The objective of this study was to obtain the most effective and efficient alternative type of work through value engineering applied to the engineering, procurement, and Avtur pipeline construction projects at Juanda International Airport, as well as to calculate the projects' cost saving and percentage. This research employed a descriptive survey method and technical primary data obtained from the project, such as the technical specification drawing (bestek), budget estimation and cost planning (in Indonesia it's called Rancangan Anggaran Biaya, or abbreviated as RAB), as well as work plan and conditions (in Indonesia it's called Rencana Kerja dan Syarat-syarat, or abbreviated as RKS). Furthermore, this research also used secondary data – supporting data which can be used as input and reference in conducting value engineering analysis; this includes unit price lists and worker analysis, data of materials, heavy equipment data, labor data, Ministry regulations, and other useful data. Based on the analysis results, it was revealed that after applying value engineering to the engineering, procurement, and Avtur pipeline construction projects at Juanda International Airport, the effective and efficient material and method used was drilling using HDD (Horizontal Directional Drilling). The initial design's cost of installing aviation pipe at Juanda airport using iron sheet pile required 20% higher cost compared to without using it, while using HDD for drilling required 40% cheaper cost; in conclusion, it was far more economical, and saved 40% cost of life cycle calculated under the assumption that it was for 10 years of use.

Index Terms : Airport, HDD, Saving Cost, Saving Time, Value Engineering.

1. INTRODUCTION
The construction project has undergone many developments in material innovation, implementation methods, and contract systems [1]. The innovation seeks to develop and improve the performance of the construction project. Moreover, the types of contracts based on the task division are conventional, specialist, design construction/built, turn-key, engineering procurement construction (EPC), build operate transfer (BOT), build lease transfers (BLT), and force accounts contracts. The EPC and conventional projects have different material procurement processes [2]. In these projects, quality is crucial as any defects will automatically lead to cost overrun. Thus, good quality management is needed at the beginning of the stage for a successful project implementation. EPC is more complex than ordinary construction projects; it carries many problems, for instance, interdependent activities, overlapping phases of each activity, activities split into more detailed ones, organizational structure complexity, and unpredictable accuracy during the implementation period.

According to Yeo & Ning [3], procurement management is needed due to various factors: procurement connects engineering and construction functions, relies on external parties (sub-contractors), requires communication and negotiation with external parties, takes part of the total EPC project costs and is difficult to manage. The quality of goods and services produced by the project is also essential to meet the overall project quality objectives. Problems with delays in the procurement process often occur in EPC projects. Gasification News in 2007 reported that the Gas to Liquid (GTL) project in Qatar undertaken by Conoco Philips, Marathon, and Sasol Chevron was delayed due to logistical factors and was restarted in 2013. The Sonatrach GTL project in Algeria was delayed for 6 months due to the contract tendering process [4]. The Integrated Gasification Combined Cycle (IGCC) project in Illinois, United States, was delayed due to project licensing [5]. Based on this explanation, it is safe to say that the procurement process is the main factor in the EPC project. Value engineering is a creative and planned approach to streamline the costs required by the project [6]. It is used to find alternatives for more appropriate costs than those previously planned, within the framework of functions, structural strength and the quality of work. It involves project owners, planners, experienced experts in their respective fields, and value engineering consultants. It employs an evaluation method to analyze the technique and value of a project, of which the purpose is to seek new alternatives for more efficient costs within the framework of functions, as well as a task-planning stage capable of identifying and optimizing costs and unnecessary efforts. Therefore, we need a product value improvement without the slightest quality and safety reduction. The analysis was conducted to economize the costs by proposing several alternatives to be applied with the proper concept to obtain alternative materials without reducing the function. It was expected that the substitute materials are cheaper, faster to work on, and do not reduce the quality and aesthetics of the initial material. PT. XYZ as a company engaged in the field of Engineering, Procurement and Construction (EPC) involves in the land excavation construction projects to plant aviation fuel pipelines at Juanda International Airport. The company's scope of work on this project is in the EPC field. During the course of the project, the company has experienced various obstacles. The work plan to identify as well as optimize costs and unnecessary effort can be one of the determining factors. Therefore, applying value engineering in the engineering, procurement, and Avtur pipeline construction projects at Juanda International Airport is essential.

r is an Associate Professor of Civil Engineering Program, Malang National Institute of Technology, Indonesia. E-mail: kustamar@lecturer.itn.ac.id
• Maranatha Wijayaningtyas is an Assistant Professor of Civil Engineering Program, Malang National Institute of Technology, Indonesia. E-mail: maranatha@lecturer.itn.ac.id
• Muhammad Irfan is a Master Candidate of Civil Engineering Program, Malang National Institute of Technology, Indonesia. E-mail: seransintius.ss@gmail.com
2. LITERATURE REVIEW

2.1 PROJECT MANAGEMENT
Project management is the activity of planning and organizing a project in which there is an organizational structure consisting of managers as project leaders who control resources and oversee the work and its members; the members coordinate with each other, and work hard together to achieve the desired goals, within the allotted time to work on the project. Project management is the effort or activity of planning, organizing, leading, and controlling company resources to achieve predetermined short-term goals as efficiently and effectively as possible [7].

2.2 ENGINEERING VALUE
Value engineering used in evaluations, value engineering is the process of a creative approach considering technological innovation to recognize the primary and secondary cost elements based on a particular need. If it is beneficial for the needs (customers), the cost is incurred without reducing quality along with maintaining the environment and prioritizing safety. Meanwhile, according to James O’Brien in the book Value Analysis is Design and Construction, he asserted that value engineering is one of the well-known techniques and has considerable potential for success in controlling costs. Zimmerman and Hart in Donomartono [8] stated that value engineering is a value study on a project or product that is being developed. It analyzes the value of the project as it being designed; so, it is an evaluation method analyzing the techniques and values of a project or product involving owners, planners and experienced experts in their respective fields with a systematic and creative approach sought to produce a fixed quality with the lowest possible cost, which is within the framework of functions, as well as a task-planning stage capable of identifying and optimizing costs and unnecessary efforts [9]. The approach is to analyze the value of its function; thereby, value engineering is always oriented to values. In value engineering, the effort is done through performance improvement and not by cost reduction, which is not the main goal in using the value engineering method [10]. By applying it, product improvement is expected in the result.

3. RESEARCH METHODOLOGY

3.1 TYPE OF RESEARCH
This research utilized descriptive survey method. The purpose of this study is to describe the variables relating to the problem and unit in the phenomenon under study. The researchers collected technical primary data from the project, such as the technical specification drawing (bestek), budget estimation and cost planning (In Indonesia it’s called Rencangan Anggaran Biaya, or abbreviated as RAB), as well as work plan and conditions (In Indonesia it’s called Rencana Kerja dan Syarat-syarat, or abbreviated as RKS). The data of case study were obtained from primary and secondary data.

3.2 RESEARCH LOCATION
The research is conducted in the Avtur Pipeline Engineering, Procurement, and Construction (EPC) project at Juanda International Airport.

3.3 DATA SOURCES
Data sources used in this study are as follows:

1. Primary data sources, which were the main data used in conducting value engineering analysis. This can be in the form of technical data obtained from the project, such as the technical specification drawing (bestek), budget estimation and cost planning (In Indonesia it’s called Rencangan Anggaran Biaya, or abbreviated as RAB), as well as work plan and conditions (In Indonesia it’s called Rencana Kerja dan Syarat-syarat, or abbreviated as RKS).

2. Secondary data sources, which were supporting data that can be used as input and reference in conducting value engineering analysis. This includes unit price lists and worker analysis, data of materials, heavy equipment data, labor data, Ministry regulations, and other useful data.

3.4 DATA COLLECTION METHODS
To obtain data in the preparation of this study, the researchers employed the following methods:

1. Primary data were collected by conducting direct surveys or observations, and by conducting interviews with the consultants handling the project and interested in the activities concerning value engineering research.

2. Secondary data were collected by conducting direct surveys on agencies or companies that are interested in the research. This was conducted on building material companies, heavy-equipment rentals, consultants, labor agencies, building contractors, and agencies working in construction services.

3.5 DATA ANALYSIS
From the collected data, an analysis of value engineering was conducted for cost saving in the following phases:

1. Information Phase
At this phase, the researchers obtained information relevant to the object of study, and processed the data as needed (in the later phase). General information needed includes:
   - Project’s name
   - Project’s location
   - Project’s owner
   - Project’s value
   - Building area
   - Project’s specifications

2. Creative Phase
In value engineering, creative thinking is very essential for developing ideas to bring up cost-saving and functional alternatives, including:
   a. The Materials
      The use of alternative materials emerges due to the increasing production of material types having the same function as certain others. Along with the development of technology, these types of materials can be made or printed with different qualities, resulting in different costs. Accordingly, value engineering analysis is conducted to properly select the alternative materials with the same quality and function but with a lower cost.
   b. The Work Methods
      Performing a work has its own methods. In the past, people relied on human labor using simple tools, so it took quite a long time to finish a job. With advances in technology, the working tools
have now been more sophisticated, for example, dozers, excavators, cranes, and others which can assist in completing construction work faster than human labor or simple tools. Thereby, the analysis of value engineering uses the work methods as its guide, because the shorter the time needed to complete the work, the smaller the costs incurred.

c. The Work Time-schedule
Every work in a project must have a time schedule. In some cases, a fixed work weight might need a shorter time to finish than it was initially planned, provided the work is not in the critical path. It can be done by changing the method of work, increasing the number of workers, and others. Thus, an alternative of reduced work time can be used as a guide because it will affect the budget calculation.

3. ANALYSIS PHASE
At this phase, the value/cost of the work item is calculated according to the design alternatives offered. In calculating costs, one can assess the materials, labor, time and dimensions of work items. This phase used the paired comparison method, of which the steps are:

a. Finding the criteria that fit the item to be applied with value engineering.

b. After the first step is done, the paired comparison method is applied to identify good criteria weights. With this method, the researcher can figure out the weight and order of criteria submitted for work items to be applied with value engineering.

c. Finding the index value of each criterion’s alternative on wall and roof work by using the paired comparison method.

d. Find the value of each alternative by multiplying the weight of each criterion by the index value of each alternative. After finding the value of each alternative, the total number is determined. Next, the highest value of the several alternatives will be identified to assist with the selection.

e. Determining cost/worth value to find the value saving ratio of construction if the engineering value is applied on the components. The cost value is obtained from the work’s initial cost, while the worth value is obtained from the cost after applying value engineering to the work components.

3.6 THE ANALYSIS RESULTS
The analysis results are divided into 2 (two) stages:

1. Development Stage
Preparing the written recommendation provided with information and calculation of the selected alternatives, and taking the technical and economic implementation into account; the steps are as follows:

• Creating concept/design for comparison.
• Comparing the initial concept with the proposed/alternative design.
• Comparing life cycle cost analysis of investment with the initial costs, operating and maintenance costs, as well as annual and operating costs

2. Recommendation Stage
The recommendation is in form of spoken or written presentation of the alternatives proposed by the value engineering team; the presentation is conducted in the presence of all parties: the owner, planner, and executor. This stage also includes the recommended alternatives according to certain consideration. The recommendation format contains:
• The initial plan of wall and roof construction
• Proposed alternative selection for replacing wall and roof components
• The basis of consideration used in determining the proposed alternatives
• The value of initial costs.

4. ANALYSIS AND DISCUSSION
This chapter presents and discusses the research results of applying value engineering in the Engineering, Procurement, and Construction (EPC) work of the Avtur Pipeline at Juanda International Airport; the work utilized 3 methods: 1) soil excavation using iron sheet pile (initial design/as stated in the work contract), soil excavation without using sheet pile (initial design/as stated in the work contract), and earth excavation using HDD (Horizontal Directional Drilling). By comparing the three methods, the research is expected to find the most effective type of material to use and the amount of cost savings.

4.1 RESEARCH RESULTS
Value engineering is one of the techniques to control costs using a value analysis approach to its function, and it conveys considerable potential for success. The process is conducted by emphasizing as much cost reduction as possible while maintaining the expected level of quality and durability. Value engineering, in general, is an activity involving efforts to optimize the quality or quantity of materials used in the work of a construction project. In other words, it is an effort to implement a construction project with the lowest cost, easy methods of work, and short time completion. Value engineering studies can be conducted by planners and executors to examine cost saving opportunities without reducing the overall construction performance, which will certainly benefit all parties involved. The purpose of value engineering is to distinguish and separate between the necessary and unnecessary, in which alternatives can be found to meet the needs (and to get rid of the unnecessary) at the lowest cost with the same or even better performance. From its application, it is expected that saving can be achieved within the following elements:

1. Costs
2. Time
3. Materials

4.2 PRE-STUDY PHASE
This phase is the initial stage of value engineering study in that collecting much information regarding the design of the project planning, obtained from general data, so that the design framework of the project is clearly defined. In this project, the work includes:

1. Excavation Work
   This work is the first crucial work done to build an aviation fuel pipeline at Juanda international airport.

2. Structural work.
   This work includes the installation of avtur distribution pipes.

3. Architectural work.
This work includes dredging the pipework.

4. Mechanical and Electrical Work (M/E)

This includes the works of electrical installation, manufacturing of artificial air handling, fire fighting, communication system installation and security camera installation.

5. Supporting Work Facilities.

This includes the work of making parks, installing paving, parking facilities, employee facilities, and public facilities.

4.3 INFORMATION PHASE

In value engineering, this phase is the basic foundation for every value inquiry; all important information is collected to carefully understand the object being investigated. The information is analyzed to find the functions of objects to classify them into primary or secondary one. The main function of the avtur pipeline construction in Juanda International Airport is to meet the needs of aircraft fuel requiring materials, working processes, and costs. Based on information obtained from the construction of the avtur pipeline, the work utilized iron sheet pile (initial design/as stated in the work contract). As an alternative, the work can be performed without using iron sheet pile (VE1) or HDD (VE2). Based on the data, the three alternatives of works for the avtur pipeline construction in Juanda International Airport are as follows: The costs of installing avtur pipes without iron sheet pile at Juanda International Airport 2 is presented in Table 1.

### Table 1. The Summary of Costs for Installing Avtur Pipes without iron sheet pile

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit Price (IDR)</th>
<th>Volume (M3)</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Excavation Work 1 m deep</td>
<td>20,000</td>
<td>23.550</td>
<td>471,000,000.00</td>
</tr>
<tr>
<td>Hard Soil Excavation Work 1 m deep</td>
<td>31,210</td>
<td>6.601</td>
<td>206,017,210.00</td>
</tr>
<tr>
<td>Soil Disposal of 150 m</td>
<td>25,672</td>
<td>1.000</td>
<td>25,672,000.00</td>
</tr>
<tr>
<td>Backfill</td>
<td>9,584</td>
<td>30.151</td>
<td>288,967,184.00</td>
</tr>
<tr>
<td>Soil Compaction</td>
<td>25,000</td>
<td>30.151</td>
<td>753,775,000.00</td>
</tr>
<tr>
<td>Sand Fill</td>
<td>223,760</td>
<td>30.151</td>
<td>6,746,587,760.00</td>
</tr>
<tr>
<td>Gravel and Sand Fill</td>
<td>256,700</td>
<td>30.151</td>
<td>7,739,761,700.00</td>
</tr>
<tr>
<td>Preferred Soil</td>
<td>119,540</td>
<td>30.151</td>
<td>3,604,250,540.00</td>
</tr>
<tr>
<td>Finishing</td>
<td>50,000</td>
<td>30.151</td>
<td>1,507,550,000.00</td>
</tr>
<tr>
<td>Main Header Pipe Fee 16 &quot;</td>
<td>1,500,000</td>
<td>30.151</td>
<td>45,226,500,000.00</td>
</tr>
<tr>
<td>Pipe Installation Wages</td>
<td>150,000</td>
<td>30.151</td>
<td>4,522,650,000.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>71,092,731,394</strong></td>
<td></td>
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</table>

The results of the study indicated that the installation process of avtur pipes without using iron sheet pile required IDR 71,092,731,394. The costs of installing avtur pipes with iron sheet pile at Juanda International Airport 2 is presented in Table 2.

### Table 2. The Summary of Costs for Installing Avtur Pipes with iron sheet pile

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit Price (IDR)</th>
<th>Volume (M3)</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Excavation Work 1 m deep</td>
<td>20,000</td>
<td>23.550</td>
<td>471,000,000.00</td>
</tr>
</tbody>
</table>

The results of these calculations indicate that the use of HDD resulted in lower costs and more effective processing. The required cost was IDR 50,113,753,600. The cost of installing avtur pipes using HDD was much lower because it did not need much labor; besides, it did not require too much backfill and improvement of the topsoil. Based on the analysis results, it can be concluded that HDD methods and materials were effective and efficient after applying value engineering in the EPC of the Avtur pipeline network at Juanda International.
4.4 Function Analysis Phase
At this phase, an analysis of the functions of the three methods for the Avtur pipeline construction at the Juanda International Airport is conducted. These methods carried the same main function, which was constructing pipelines to distribute avtur to aircrafts at the airport.

4.5 Creation Phase
After identifying the function of constructing avtur pipeline at the Juanda International Airport, the alternatives considered are:
1. Initial costs.
2. Operational costs.
3. Energy efficiency costs.
Construction is a job requiring much capital. A large sum of money invested into a complex network of recipients and at various stages of process; consequently, managing all construction costs will ultimately result in the most appropriate cost and the best value for the project. This requires the ability to select methods and materials as the main tools for success indicators. Time and cost greatly affect the success and failure of a project. Benchmarks for project success are usually viewed from the short completion time with minimal costs without reducing the quality of the work. Table 4 presents the comparison of the three methods of avtur pipe installation at Juanda Airport:

<table>
<thead>
<tr>
<th>Table 4. The Percentage of Avtur Pipeline Installation Costs Compared to the Initial Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methods</td>
</tr>
<tr>
<td>Avtur Pipe Installation with Sheet Pile Iron (Initial Design)</td>
</tr>
<tr>
<td>Avtur Pipe Installation without Sheet Pile Iron (VE1)</td>
</tr>
<tr>
<td>Avtur Pipe Installation Using HDD (VE2)</td>
</tr>
</tbody>
</table>

Based on table 4, compared to the initial design, the cost of installing avtur pipes using iron sheet pile required 20% higher than without using it. Meanwhile, compared with the use of HDD, the cost required was 40% cheaper. Accordingly, it can be concluded that using HDD led to much more economical costs.

4.5 The Amount of Cost Saving and Percentage in The EPC Work of Avtur Pipeline at Juanda International Airport.
Construction is a job requiring much capital. A large sum of money invested into a complex network of recipients and at various stages of process; consequently, managing all construction costs will ultimately result in the most appropriate cost and the best value for the project. This requires the ability to select methods and materials as the main tools for success indicators. Time and cost greatly affect the success and failure of a project. Benchmarks for project success are usually viewed from the short completion time with minimal costs without reducing the quality of the work. Compared to the initial design, the cost of installing avtur pipes using iron sheet pile required 20% higher than without using it. Meanwhile, compared with the use of HDD, the cost required was 40% cheaper. Accordingly, it can be concluded that using HDD led to much more economical costs.

5 Conclusion and Suggestion
5.1 Conclusion
Based on the results of the study, the conclusion is as follows:
1. Based on the analysis results, it can be concluded that HDD methods and materials were effective and efficient after applying value engineering in the EPC of the Avtur pipeline network at Juanda International.
2. Based on the table comparing the three methods, the cost of installing avtur pipes using iron sheet pile required 20% higher than the initial design (without iron sheet pile). Meanwhile, if compared with the use of HDD, the cost required was 40% cheaper. Accordingly, it can be concluded that using HDD led to much more economical costs.
3. Pipeline installation using HDD saved 40% cost of life cycle calculated, under the assumption that it was for 10 years of use.

5.2 Suggestion
Based on the results of the study, the suggestions are:
1. For airlines and construction services: Based on the results of this study, the progress of construction technology is fast enough. Thus, the construction works of land excavation and pipes installation can consider the use of HDD.
2. The researchers suggested for further and more detailed research regarding the use of HDD, so the effectiveness of using HDD can be more accurately predicted.

References