International Journal of Scientific Engineering and Science
Volume 6, Issue 2, pp. 152-156, 2022. ISSN (Online): 2456-7361

Implementation of Value Engineering to Optimize the Designing of the Southern Java Road Project

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Abstract— *This study examines the application of value engineering to optimize the design and implementation of the south Java road construction projects in Indonesia, particularly in the LOT-6 work package (Prigi-Tulungagung regency border-Klatak-Brumbun). This study implements a qualitative method using a cost analysis approach, evaluation matrix, and zero-one technique to determine the index. The effective length of the southern crossing in the LOT-6 work package is 17.74 Km, with a total project value of IDR 471,553,305,416.23. The implementation of value engineering demonstrated a shift in the centerline to the land corridor due to the design revision. In addition, a discrepancy was found between the Detail Engineering Design (DED) and the actual results in the field. The initial design was in accordance with DED (IDR 71,024,407,368.20). However, after implementing value engineering, the value of the plan changed to IDR 63,117,780,442.51. This demonstrates a substantial reduction in cost (cost-saving) after applying VE for covered road shoulders and asphalt pavement works, which was Rp. 7,906,626,925.69, with a percentage of 11.13% and a total percentage of the value of the whole project reaching 3.32%. The availability of land for road construction projects is expected to be in accordance with the land required in the DED planning. Thus, the geometric alignment of the road can be carried out and meet the road safety requirements.*

Keywords—*Project design, South Java road, value engineering.*

I. INTRODUCTION

National development must be implemented in an integrated, effective, and efficient manner by considering gender mainstreaming in sustainable development and good governance. Road infrastructure is one of the instruments that play an essential role in economic development and equitable welfare distribution in a country. The road network as a means of transportation infrastructure has a critical and strategic position to support the creation of accessibility for the flow of people, goods, and services widely throughout the region [1]. The southern part of Java Island has limited access, especially compared to the northern region. These limitations such as the lack of support for infrastructure such as road networks, telecommunications, electricity, inadequate human resources, in addition to the geographical and topographical conditions in the southern part of Java, which resulted in the low level of economic development and development in the south compared to northern Java which is closer to City center. This illustrates another side that is very different from the north region.

So far, the situation along the southern coast of Java Island, many areas are relatively undeveloped and isolated due to low access to infrastructure. As a result, activities on the northern shoreline become oversaturated and congested. In other words, the government needs to distribute the load and density from the north coast to the south coast through infrastructure development. The southern cross region has no less great potential than the north coast. The south part of Java also has enormous potential for natural resources, human resources, and cultural resources, so it is necessary to accelerate development to promote sustainable economic growth and reduce poverty on the southern coast of Java Island. In the future, the role of the south of cross-region of Java will be increasingly crucial inequitable economic development activities; this is in line with the construction of new access roads for the southern route of the island of Java [2]. For this reason, the central government's program in developing a road network, especially to balance traffic density in the northern coast, requires accelerating road construction in the southern region which will support spatial planning, especially for areas that have not been connected and isolated areas throughout the island of Java.

Fig. 1. The recent road development in the south coast of the East Java region

The government of the Republic of Indonesia is currently starting to develop the economy on the southern coast of Java Island by increasing access to its supporters to create economic equity. The island of Java accounts for 58% of Indonesia's GDP. Still, most of the economic activity in Java is concentrated along the North Coast (Pantura) among adequate infrastructures, such as roads, railways, and ports that have attracted significant investments along the coastline. North in the form of industry, factories, warehousing, and others. In this case, the prominent financing aspect becomes the center of attention for re-analysis to find savings [3]. This has given rise to many alternatives used as the basis for conducting studies that do not correct the mistakes made by the planner or correct the calculations but rather lead to cost savings. Reviewing project methods used by checking project design against project

International Journal of Scientific Engineering and Science
Volume 6, Issue 2, pp. 152-156, 2022. ISSN (Online): 2456-7361

implementation allows for cost savings by identifying and reducing unnecessary costs without reducing the function of the project itself [4].

One method that can be used as a cost-saving study is the value engineering method. The Value Engineering Analysis method has advantages, namely the existence of a systematic, neat, and planned approach in conducting value analysis from the subject matter to its function or use but remains consistent with the appearance, quality/quality, and maintenance of the project [5]. Therefore, it is necessary to have a Value Engineering so that unnecessary costs and efforts can be eliminated so that the value or price of the project can be reduced [6]. Value Engineering needs to be applied to development projects to lower costs than the initial budget planning. Value Engineering is a planned approach to identify and reduce unnecessary expenses. Value engineering is used to find alternatives or ideas that aim to produce a better cost lower than the previously planned price with functional limitations and quality of work [7].

According to the construction data of 2016, of the 1,600 km South Corridor Road, which stretches from Banten province to East Java province, 432 km of roads have not been connected. This condition is mainly found in Central Java, Yogyakarta, and East Java. Thus, the government of the Republic of Indonesia applied for financing to the Islamic Development Bank (IsDB) to accelerate the Trans-South Java Road Development Project (TRSS) through the Directorate General of Highways, East Java National Road Implementation Center, Ministry of Public Works, and Public Housing, namely as financial support for development for the 2019-2022 budget year. The use of these debt funds is undoubtedly a strong reason for the importance of monitoring and analyzing the suitability of designs and development results in the field. Implementation of value engineering can demonstrate the consistency of planning documents for road and bridge construction projects and provide alternative options for structural component replacement if design optimization is necessary. This study seeks to identify the impact if the centerline is shifted to the land corridor, determine the steps and stages in the value engineering process related to the completion of the alternative design selection if there is a difference between the Detail Engineering Design (DED) and the actual field at the implementation stage. Construction works (civil works) and determining design optimization strategies for volume differences that have implications for additional costs and project implementation time.

II. METHOD

This research uses qualitative methods with research materials in detailed planning drawings or DED (detailed engineering design), a map of the work location, a road map (plan), a longitudinal profile, and a cross-section. Other complementary documents include a map of land acquisition issued by the Minister of Environment and Forestry and a detailed drawing document of the right of way (ROW) planning. In addition, secondary data includes a list of Work Unit Price Analysis (AHSP), a list of materials or building materials used, DED drawings, a list of daily labor data (daywork), RAB data. Data were collected using survey techniques, with respondents consisting of supervisory consultants (supervision consultants), service providers (contractors), and service users (owners). Qualitative data analysis was carried out using a cost analysis approach, evaluation matrix, and zero-one technique to find the index.

The application of the value engineering concept is based on the theory of Dell'Isola (1982), which has previously been used by Lestari (2011). Three essential elements are needed to measure a value: function, quality, and cost. (cost). Thee three elements can be interposed through the following equation:

$$\text{Value} = \frac{(Funcion+Quality)}{Cost} \quad (1)$$

Once items that have the potential for VE have been determined, a function analysis can be carried out using the Cost/Worth (C/W) ratio equation, as described as follows:

$$\textit{Index Function Analysis} = \textit{Cost / Worth} \quad (2)$$

Cost is the total cost of a work item, and worth is a form of cost that only has a functional value for the work item (Dell'isola, 1975; Pratiwi, 2014; & Listiono, 2011).

Finally, the zero-one analysis is described by Asiyanto (2005) and Listiono (2011) as one of the decision-making methods to determine the priority order of functions, namely from the "more important" category with a score of "1", and the "less important" with a score of "0". In the end, the calculation of alternative weights can be carried out according to the following formula:

$$Alternative\ weight = \frac{\text{Number of rank obtained}}{\text{Total rank}} \text{ x } 100 \quad (3)$$

III. RESULT AND DISCUSSION

The scope of activities of the TRSS Project (Development of Trans South Java Road Project Under IDB Financing No. IDN-1012) is under the auspices of the Directorate General of Highways of the National Road Implementation Center for East Java, and Bali Provinces, namely for the category of civil works including road and bridge works.

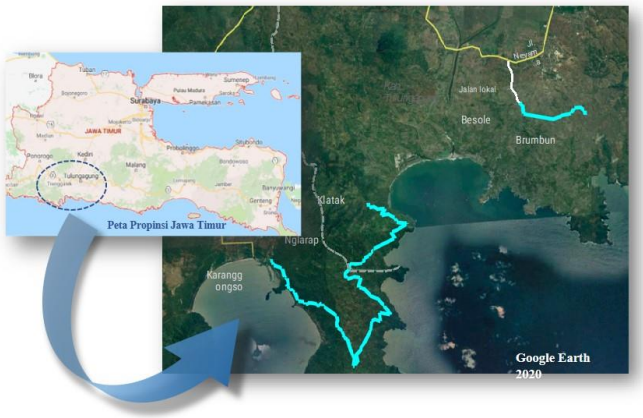

Fig. 2. Location of LOT-6 of The Trans South Java Road Project

Figure 2 shows the construction project location. Preparation and technical planning activities for 4 (four) TRSS project packages were carried out in 2019 by Planning Consultants under the coordination of the East Java National Road Implementation Center, East Java - Bali National Road Implementation Center, Directorate General of Highways

International Journal of Scientific Engineering and Science
Volume 6, Issue 2, pp. 152-156, 2022. ISSN (Online): 2456-7361

Ministry of Public Works and Public Housing.

At the initial phase of the construction work, there were obstacles caused by differences in the land prepared with the traces in the initial document (detail engineering design / DED). The impact due to this difference in road alignment results in no longer matching the volume of work and geometric planning and has implications for the cost of the project contract value. The design plan in the form of a cross-section of the road contained in the Detail Engineering Design (DED) document is as follows:

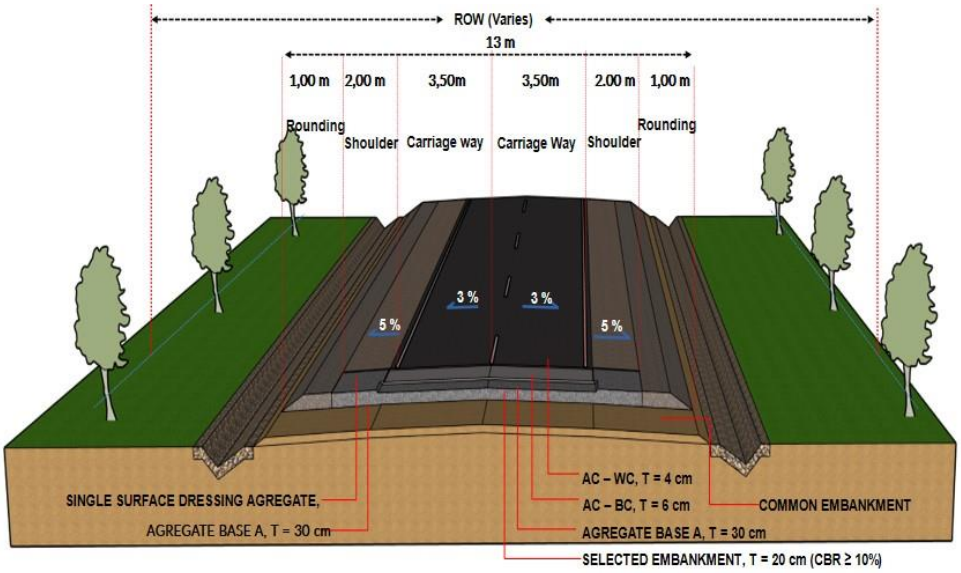

Fig. 3. Cross-section imagery of the road design on the flat ground surface

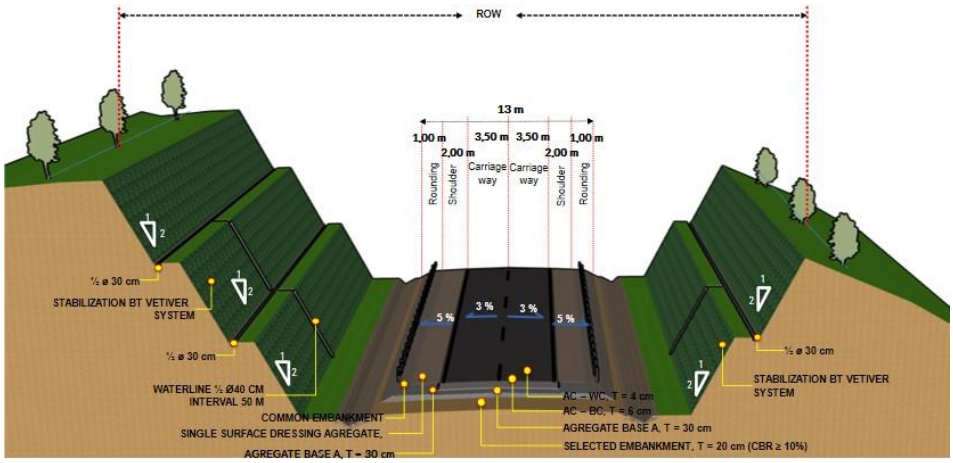

Fig. 4. Cross-section imagery of the road design on sloping excavation surface

Furthermore, a summary of the analysis of the application of value engineering in the Trans South Java Road Project (TRSS) can be explained in table 1, which focuses on the results of the evaluation of work item analysis after the value engineering approach is applied. The work items analyzed are covered shoulder work and asphalt pavement work. At this stage, a cost-benefit analysis is needed to formulate innovative ideas to optimize construction development. Value Engineering (Value Engineering) so that unnecessary costs and efforts can be eliminated so that the value or price of the project can be reduced (Ariva, 2020). Value Engineering needs to be applied to development projects to lower costs than the initial budget planning. The cost-saving optimization value obtained by the value engineering method also involves optimizing the operation of all supporting facilities, which are oriented towards the total cost of ownership, operation, and maintenance.

The infrastructure project for developing the Trans South Java Road Network or the Trans South Java Road Project (TRSS), namely the work package LOT-6 (Prigi-Tulungagung regency border-Klatak-Brumbun), has an effective length specification of 17.74 Km, with a total value of Rp. 471.553.305.416.23. After conducting a survey, implementing value engineering, and data analysis, it was found that the implementation of the development work had several problems. The first problem is related to the impact caused by shifting the centerline to the land corridor due to the design revision (design review). This first finding demands innovation and creativity to reduce the cost element. The completion of the road

International Journal of Scientific Engineering and Science
Volume 6, Issue 2, pp. 152-156, 2022. ISSN (Online): 2456-7361

construction process must prioritize aspects of performance, durability, reliability, quality, function, benefits, aesthetics, and other aspects. This aims to ensure that the development results follow the original design and objectives: good quality, time, and cost.

TABLE 1. The results of the analysis of work items based on the value engineering

No.	Alternatives of construction	Initial Design	Final VE Design
1.	Shoulder	a. Aggregate foundation layer (Grade A) b. LPA foundation layer (t = 38cm) c. Spraying of prime coat d. Asphalt coating (surface dressing) with liquid asphalt, lt e. Sowing of aggregate grains (chipping) f. Compaction with a rubber wheel compactor/PTR	a. Aggregate foundation layer (Grade A) b. LPA foundation layer (t = 38cm) c. Installation of separator (bond breaker) plastic material d. Overlay of concrete aggregate (fc' 15 Mpa) e. Concrete slab (t = 10 cm) f. Finishing finishing with texture and curring
2.	Asphalt Pavement	a. Aggregate foundation layer (Grade A) b. LPA foundation layer (t = 30cm) c. Spraying of prime coat d. Laying and compacting of laston layer between CBC/asphalt concrete binder course (t = 6cm) e. Spraying adhesive layer (tack coat) f. Overlay and compaction of ACWC/asphalt concrete wearing course layer (t = 4 cm)	a. Aggregate foundation layer (Grade A) b. LPA foundation layer (t = 15cm) c. Spraying of prime coat d. Laying and compacting of laston layer between CBC/asphalt concrete binder course (t = 6cm) e. Spraying adhesive layer (tack coat) f. Overlay and compaction of ACWC/asphalt concrete wearing course layer (t = 4 cm)

The second problem is related to the suitability of the development results with the initial design. The implementation of value engineering shows that this discrepancy problem occurs in the construction phase (civil works), where the Detail Engineering Design (DED) is not the same as the actual results in the field. The stages generally used in a value engineering analysis include the information gathering stage, the analysis stage, the creativity, innovation stage, the presentation implementation stage, and follow-up. Furthermore, the third problem is related to cost efficiency, thus requiring the selection of design alternatives. Design and material options are selected by analyzing the function using the Cost/Worth (C/W) ratio equation. If the index value is more significant than 1~1.5, the analyzed work item can have a high "unnecessary cost." Therefore, it is necessary to optimize the cost savings of 2 (two) work items analyzed using the value engineering method, where the initial design according to the DED is Rp. 71,024,407,368.20. In contrast, the final design after implementing value engineering is Rp. 63,117,780,442.51. Thus, after value engineering has been carried out, the cost-saving for the covered road shoulder and asphalt pavement works is Rp. 7,906,626,925.69. This number represents a percentage of 11.13%, and the percentage weight of the whole project is 3.32%.

Value engineering has been widely implemented in construction projects in Indonesia, starting in 1986 with the construction of the Cawang flyover. In 1987, the National Planning and Development Agency (Bappenas), Ministry of Finance, Directorate General of Human Settlements recommended applying the Value Engineering method for all construction of official houses and state buildings with a budget of more than one one billion rupiahs. However, the value engineering method is not widely developed and implemented, especially in state government development projects. On the other hand, the VE method is still commonly implemented in private construction projects. From now on, several projects - especially private projects- have implemented value engineering methods, such as the construction of the Orlens Fashion Shophouse in Manado [14], the BPKP Building Construction Project in Yogyakarta [15], and the Grand Hotel of Banjarmasin [16].

Various previous studies have described the significance of applying the value engineering method, so it is quite unfortunate if the method is not used, especially in government-affiliated development, both central and local. The concept of Value Engineering is generally implemented in projects related to the construction sector, including road construction. Several previous studies have shown the importance of implementing Value Engineering in construction projects, including by Sitorus (2020) in the Timika Boundary Tugu Papua road improvement project, Lasmasari (2010) in the construction of the Babatan – Tegineneng toll road, Lampung Province, Saragih et al. (2014) in the Semarang Solo, Central Java toll road project, Tsalits (2019) on the Surabaya Middle East Ring Road (Merr) road project, Anisyah (2019), on the East Ring road project, Sidoarjo Regency, East Java, Rumpesak (2017) on a road project in the city of Manado, Rumintang (2018) on the construction work of the UPN Veterans East Java Informatics Engineering building, Sudiarsa et al. (2020) on the construction of an alternative road above Tukad Mati Badung, and Hizkia (2021) on the construction of the Medan – Binjai toll road project.

IV. CONCLUSION

The implementation of value engineering shows a shift in the centerline to the land corridor due to the design revision. In addition, problem-solving occurred during the construction phase (civil works), where a discrepancy was found between the Detail Engineering Design (DED) and the actual results in the field. This finding indicates a reduction in cost (cost-saving) after applying VE for covered road shoulder work and asphalt pavement work with a percentage of 11.13%, and the percentage weight of the whole project reaches 3.32%. The availability of land for road construction projects is expected to be in accordance with the land required in the DED planning so that the geometric alignment of the road can be carried out and meet the road safety requirements. Further research is recommended to analyze aspects of ease of implementation,

social and economic aspects, occupational safety and health (K3), and the environment in detail in implementing the Trans South Java Road Project/TRSS development project.

ACKNOWLEDGEMENT

Dedicated appreciation is conveyed to all the parties who were willing to be the respondents of this study; supervisory consultants, service providers (contractors), and service users (owners) of the Trans South Java Road Project/TRSS.

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