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# Empowering Added Value in Highway Project: A Strategy to Improve the Feasibility

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Additional information is available at the end of the chapter

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## Abstract

Most mega-project infrastructure such as highway construction requires an enormous amount of cost. This situation might be a problem to developing countries that have limited national budget plan. On the other hand, the capability to transfer the funding of infrastructure depends on the project attractiveness to the private sector. The evaluation to involve in the project should be supported by a significant value for money from the business perspective. Optimum feasibility plays a vital role in bridging the partnership between the government and private interests. The study uses a case study of highway project development of Trans-Sumatera highway road (TSHR) that spans about 2700 km to elaborate on how project feasibility can be improved through creative method. Value engineering (VE) approach as a systematic way to generate innovative ideas by combining multidiscipline backgrounds perspective is used. The study shows that additional functions for the project include integration with motorbike toll road, dry port, and railway line; others also include tourism, fiber optic, and service area development. The innovative ideas have contributed to the significant increase in the internal rate of return (IRR) to the project from 7.79 to 12.76%. The study also formulates institutional scheme through build operate sharing transfer (BOST) which administers government's role in the project development.

**Keywords:** infrastructure, feasibility, highway, innovation, mega-project, value engineering

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## 1. Introduction

Highway encourages connectivity among regions to expand economic development in a nation. It also eases the traffic flow in developing areas, improves the distribution of goods and services, and provides equity development among regions in a country [1, 2]. The benefits of highway construction directly affect the mobility and accessibility of people and goods and time travel as well as the other benefits of the regional competitiveness and national gross domestic product [3, 4].

Countries such as France, Spain, the United States, Canada, South Africa, China, and Australia have invested in highway project to support their economic enlargement [5]. The construction of infrastructure is argued as one of the solutions to improve the level of competitiveness in price logistics. The strategy will increase more transactional activities and contribute to the macroeconomic development.

Indonesia is a developing country located in South East Asia region, which has a population almost 262 million inhabitants in 2016 [6]. According to the Ref. [7], the state attempts to construct toll road project since 1973 and currently operates 987.44 km that span over the country. Despite its massive construction during the past five years by the government, the total operated highway is left behind from other nations. Japan has developed 8358.3 km of expressway [8]; Korea manages 4193 km of the toll road and expects to operate 6160 km in 2020 [9] and Malaysia as the neighboring country already has 1820 km of toll highways [10]. As the motorway plays a significant role in national competitiveness, expansion of the project is required in Indonesia.

The country attempts to build new highway road in the western part of the country called Trans-Sumatera Toll Road (TSTR) to connect raw material resources to the processing industry. Despite the benefits generated from highway project development, investment cost becomes the main issues that must be encountered besides land acquisition [11, 12]. The project requires 300 trillion rupiahs or equal to US\$ 24 billion for 2700 km of highway development. The government of Indonesia has insufficient funds to accommodate all the required highway construction and thus should take other options by transferring part of the financing obligation to the private investors [13].

Researcher and academicians discussed that the project attractiveness was started by an optimum feasibility [14, 15]. TSTR has a low financial rate of return of about 7.79%. The figure relatively low compared to minimum attractiveness rate of return (MARR) from infrastructure/transportation investors' perspective more than 10% in the country. Consequently, companies hesitate to be involved when the project profoundly compromises their cash flow. Ref. [16] also supported the argument that highway project will succeed when the route is at a dense population and high-income corridor. Considering those problems, improving the feasibility by taking into account added value to the project becomes crucial.

The study will use value engineering (VE) approach in an attempt to improve project feasibility. VE has been implemented in various countries to improve the project or product development through a cost reduction or additional advantage by proposing significant benefits over cost [17, 18]. The United States has implemented VE approach during the past 30 years by including the method into the National Highway System (NHS) project that receives assistance with a total cost of \$50,000,000 or more. VE is proven to improve transportation project performance and successfully saved 5.9% from the total cost of the project in 2015 [19].

The study contributes to the body of knowledge application of value engineering for highway development. The method offers optimum value that can attract investor in financing the project. The result of this study is also expected to be used for similar context not only in transportation but also for other value-added creations.

## 2. Literature studies

Value engineering (VE) is a problem-solving technique that combines knowledge from different backgrounds organized in a team to conduct a thorough analysis and generate alternative solutions to targeted problems [20]. VE also defines as the multidisciplinary team attempt to evaluate the project by using particular standard through VE job plan for improvement. It generates alternatives and further investigates to meet the requirements of safety, quality, operations, maintenance, and aesthetics [21, 22].

Value engineering concept is broadly focused on how values can achieve a balance among time, cost, and quality. Value can be generated from four combinations. First, maintain the functions and quality while cost is reduced. Second, maintain cost while at the same time increase the functions and quality. Third, increase function and quality while reducing the cost. Last, increase functions and quality while reducing the cost.

Function as a primary element in value engineering aims to become foundation and catalyst of innovative solution. The function is categorized into the primary and secondary function. Basic function is a reason for why the system is created or basis for the existence of a product. On the other hand, the secondary function is an indirect use that aims to support the basic functions. Furthermore, the cost is the sum of expenses in developing, producing, and applying product or project and often called as life-cycle cost (LCC). Elements of LCC consist of investment cost, financing cost, operational cost, maintenance cost, cost of change, tax, and salvage value.

A fast diagram is a tool that shows logic diagram from functions of the item, subsystem or facility that illustrated through graphics and aims to test the reliability of identified functions [17]. There are four types of fast diagram models such as classical fast model, hierarchy function model, technical fast model, and customer-oriented fast model. The Classical fast model illustrated the interrelationship between functions in "HOW-WHY" logic. On the other hand, hierarchy function model used hierarchy graphic from functions listed vertically. Furthermore, the technical fast model is another form of classical fast model but adding "all the time" function, "one-time" function, and "same time" function or "caused by" function in the diagram. Last, customer-oriented fast model is developed to reflect customer as the one who determines value in function analysis process. This function adds supportive functions: attract users, satisfy users, assure dependability, and assure convenience. The study follows the technical fast model to achieve targeted outcomes of the project. The sample of the technical fast model can be seen in **Figure 1**.

In general, the diagram has six components such as scope line, critical path, critical path functions, higher level and basic function, secondary and causative function, and supporting function. The description of each component is as follows:

- Scope line

Functions placed between two vertical lines. In the technical FAST diagram, there are two scope line: left scope line and right scope line.

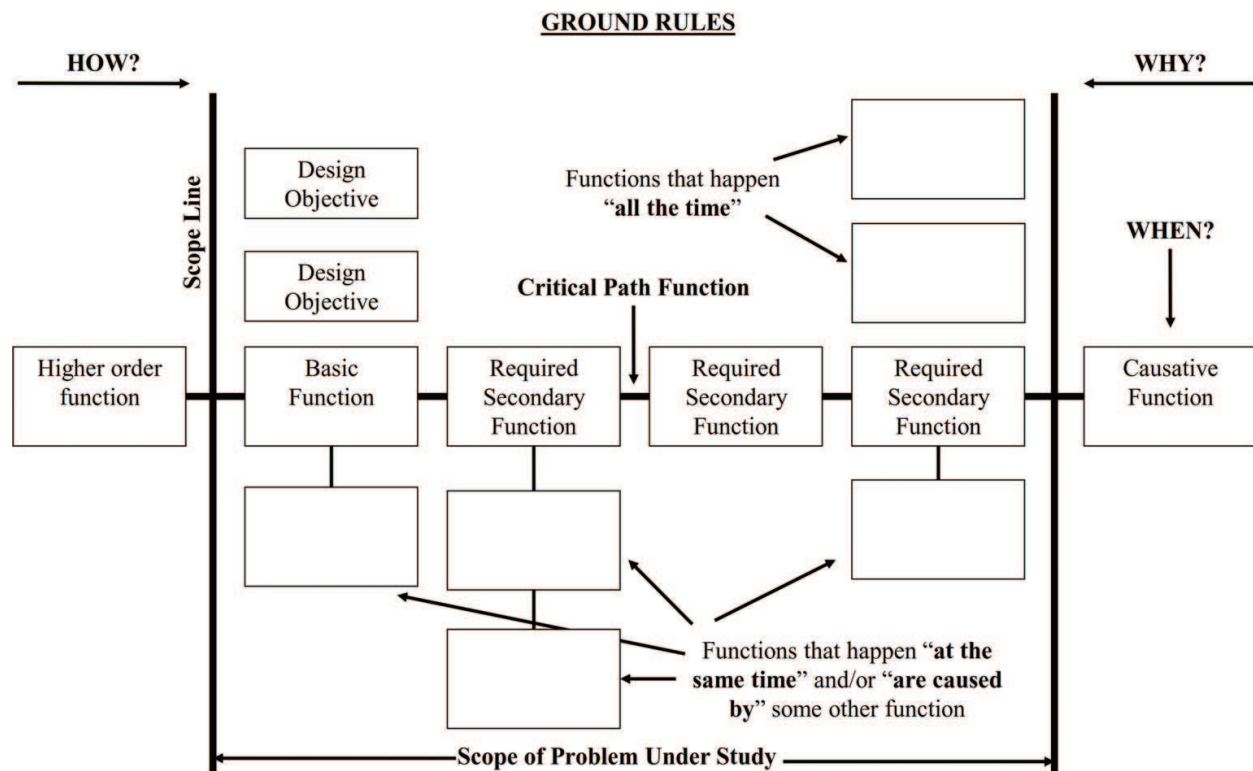


Figure 1. Technically oriented FAST diagram. Source: [23].

- Critical path

Functions are placed on the critical path to fulfill users' expectation. While the critical path is determined, functions inside the scope of the project can be categorized into critical path functions and supporting functions. On the other hand, functions categorized outside the scope of the project are higher-order function and causative function.

- Critical path functions

Functions at critical path have to place the order from the highest level to the lowest level or from left to right. The highest level function inside the scope of a project is called the basic function. Other functions at critical path inside the scope of a project are called required secondary functions.

- Higher level function and basic function

Highest-order functions are placed outside the scope of the problem or left side of the left scope line. These functions require accomplishing user needs and becoming the reason why the project existed. Higher-order function is also responding "WHY" from a basic function, while in contrary, basic function answer "WHY" from the higher-order function.

- Secondary function and causative function

The secondary function is all functions at the critical path with lower level from the basic function. The level of these functions is determined by HOW-WHY questions.

- Supporting functions

Supporting functions are functions inside scope line that are not located at critical path.

### 3. The Trans-Sumatera highway project

The Trans-Sumatera highway road project is one of mega-project infrastructures that is located in an island in the western part of the country called Sumatera Island. The project is estimated to stretch about 2700 km and forecasted require 330 trillion rupiahs. It shall connect eight mainland provinces out of 10 provinces in the area. The project is expected as part of Asian Highway network and includes on Master Plan on ASEAN Connectivity (MPAC).

The project is expected to generate benefits such as accelerate the logistic flow of goods and services distribution as well as open up opportunities about 97 thousand jobs during the project life cycle. It also contributes to the regional development indirectly and improves the property price in competitive ways [24].

Ministry of public works has been developing the route by taking flat topography on the western path of the island. The concept is divided into two corridors: a South-North corridor act as the primary corridor from Lampung province to Aceh province. On the other hand, West-East Corridor serves as the connecting corridor and comprises of three parts such as Palembang-Bengkulu, Pekanbaru-Padang, and Medan-Sibolga. The results show a different financial rate of return (FIRR) in each section and overall produce 7.79%. As the feasibility is below the minimum rate of return (MARR) of transportation companies, most investors tend to hold back their involvement. The government attempts to propose two bidding processes, and none of them were a success to financial close.

As the government tries to accelerate economic development, the construction of infrastructure is necessary for people's mobility and services. Thus, enabling added value to support financial and microeconomic growth should be created.

### 4. Developing conceptual design of Trans-Sumatera highway road

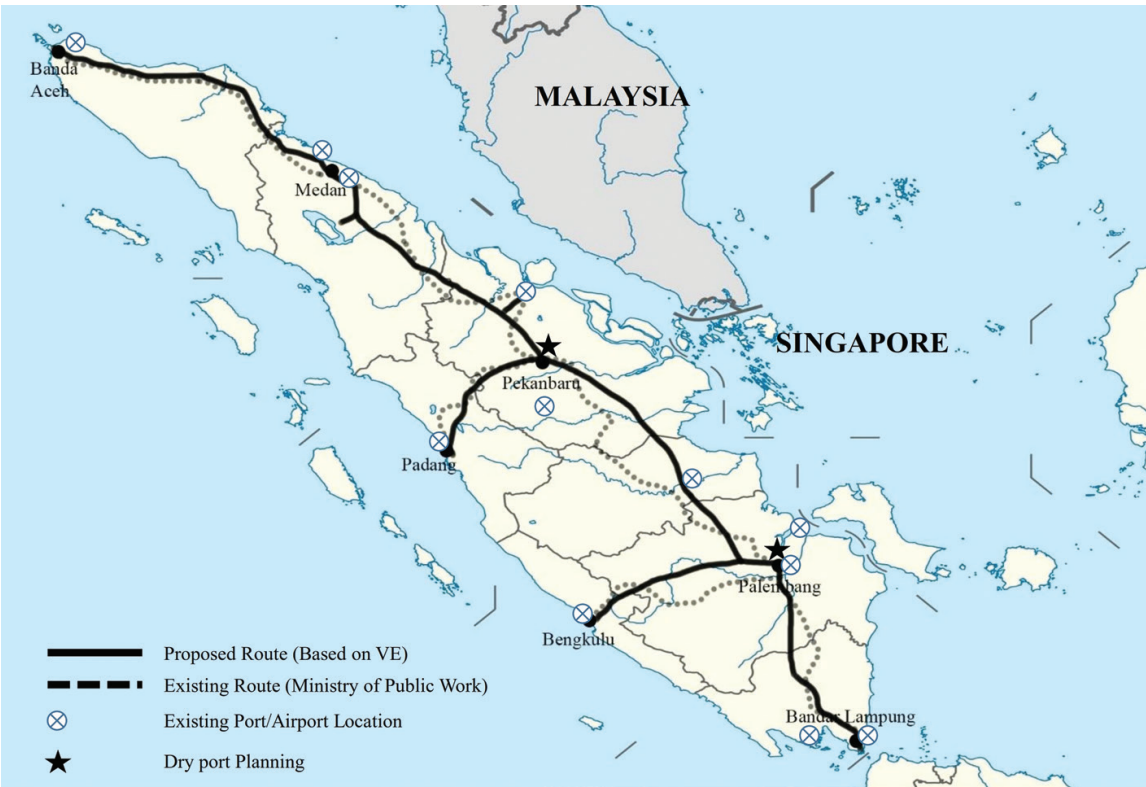
Conceptual design of the highway firstly was conducted by considering population, and economic landscape expressed by gross regional domestic product (GRDP) on the Sumatera island. Location quotient (LQ) was used to generate potential regencies and cities for the highway path. LQ analyzes and estimates the local economic basis and offers financial flexibility by taking into account industrial portfolio. Many sectors have been applying the method for a similar purpose from food, marine, and carbon emission [25–27]. It is expressed by a mathematical model as follows:

$$LQ = \frac{ei/e}{Ei/E} \quad (1)$$



where  $LQ$  is location quotient in a regency/district,  $ei$  is GRDP for  $i$  sector in a Regency/district,  $e$  is GRDP for the whole compared sector in a Regency/district,  $Ei$  is GRDP for  $i$  sector in the province, and  $E$  is GRDP for  $i$  whole compared sector in the province.

The  $LQ$  assess the potential sectors for each regency and cities on eight provinces on the island. The result will be considered as an input to determine the route of the project. The highway should connect regencies/districts that have a substantial impact on the whole island. Thus, a comprehensive route planning by taking into account potential commodity becomes significant to increase the project feasibility. The concept of the highway road can be seen in **Figure 2**. In total, the eight provinces in Sumatera island is connected. Overall, the entire length of the route is about 2427.15 km with 2102.10 km of lowlands, and 325.05 km of hills.



**Figure 2.** Conceptual design of Trans-Sumatera highway road. Source: [28].

## 5. Value engineering on Trans-Sumatera highway road

The value engineering in the study follows VE job plan and collaborates varied background in the process [29].

### 5.1. Information phase

In this stage, data gathering is practically being used to identify the project in more detail. The data and information are generated from journal articles, government and research reports,

regulation, and policy and other related activities. The output was presented but not limited as follows:

- Project objectives

The government has been an attempt to construct the project that stretches over Bakauheni to Aceh connecting not only cities but five airports and six main ports. The project is expected to support economic corridor on the island that mainly relies on natural resources, processing industries, and agriculture products. The project is also part of ASEAN and Asian Highway Network which was signed at 61st UN ESCAP on 26–28 April 2008, Shanghai.

- Project benefits

The project aims to improve goods and services distribution especially among Sumatera and Java Island. As current artery road in the area is of over capacity and mostly of poor condition, the project construction will accelerate economic growth and reduce logistics cost. The project is also believed to allow employment during construction to the operational stage.

- Scope

The project is in the conceptual design phase which assesses the route and potential added value to increase the project feasibility.

- Concept design existing

The project comprises of two corridors that estimated to plan about 2700 km and forecasted require 330 trillion rupiahs. The central corridor is from Lampung province in the southern part of Sumatera to Aceh province in the northern part of Sumatera. On the other hand, connecting corridor consists of three sections: the city of Palembang at South Sumatera to Bengkulu, the city of Pekanbaru at Riau Province to the city of Padang at West Sumatera, and Medan-Sibolga both in North Sumatera.

## 5.2. Function analysis phase

The phase was conducted by identifying function by setting up the scope of the problem, order function, primary function, and others through a FAST diagram. It is a logical model tool that is used to identify, classify, develop, and select functions that contribute to higher value and benefit to the project development. The FAST diagram can be seen as shown in **Figure 3**.

## 5.3. Creativity phase

This phase evaluates the functional analysis in the previous stage by taking into account more detail potential on the project. It will update the previous FAST diagram model by including extended functions and extended processes. The revised concept design is shown in **Figure 4**.

## 5.4. Evaluation phase

The evaluation of the study is conducted by considering the project life cycle cost. The additional function that has been identified has to increase the feasibility, thus attracting private



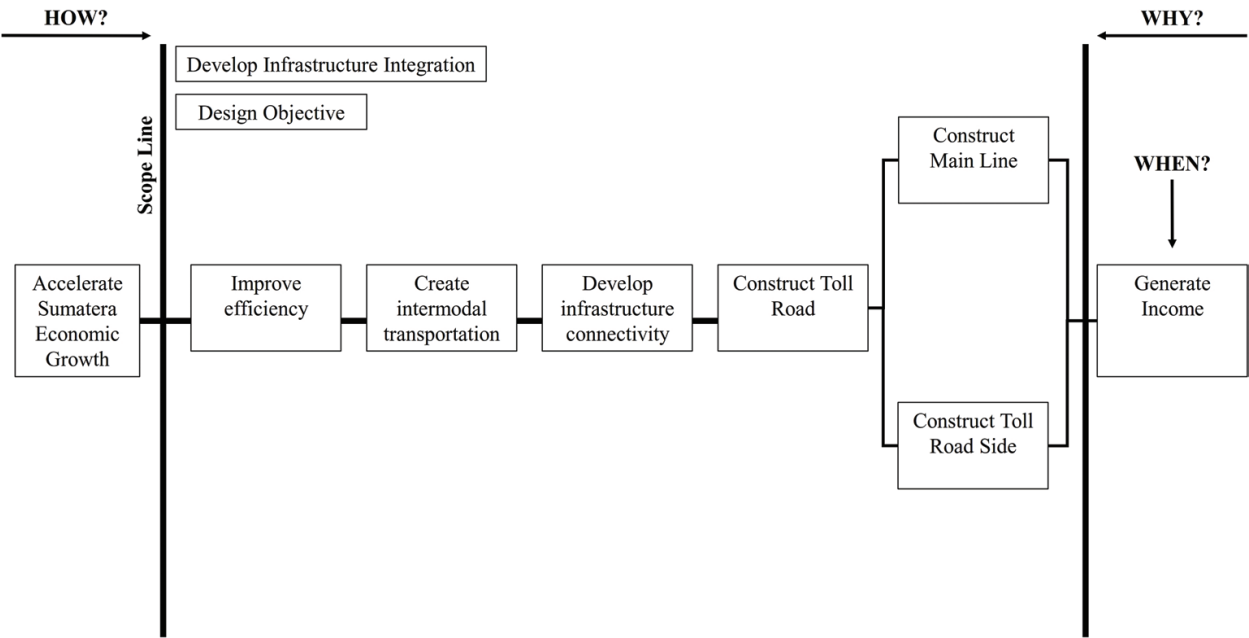


Figure 3. Initial FAST diagram.

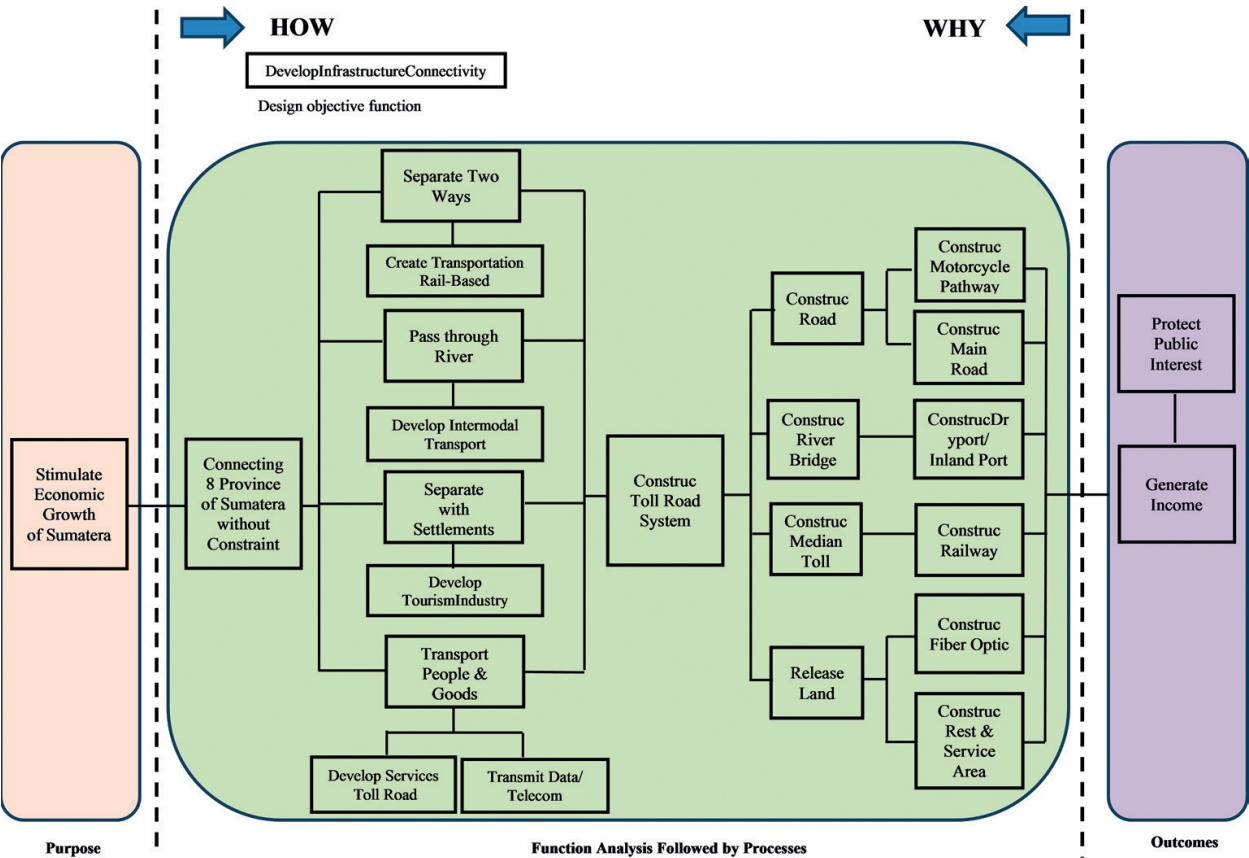


Figure 4. Revised FAST diagram. Source: [28].

investors. When the function was unable to generate financial benefits, the function can be justified through other advantages such as economic growth, job opportunity, and many others. The project life cycle cost is discussed in the following scenario.

## 6. Financial scenario

In evaluating the financial scenario, life-cycle cost approach is used by considering mid scenario for every identified function. It considers initial cost, operational and maintenance cost, and revenue. Several assumptions are proposed for estimation boundary which retrieved from Statistics Indonesia and other reliable sources. The discount rate is about 6.81%, inflation ranging from 1.63 to 5.95% depends on the sector, and project life cycle is about 40 years.

### 6.1. Single function

The new route of highway concept spans about 2527 km consist of 6 corridors and 22 sections. The initial cost is followed by the unit cost from the ministry of public works where the road on lowland is about 106.6 million rupiahs/km, and road on hilly terrain is about 164 million rupiahs/km. Revenue is generated by considering three scenarios of tariff and divided by main and connecting corridors. The scenario is as follows:

- Low scenario tariff: Main corridor = 150 rupiahs/km  
Connecting corridor = 300 rupiahs/km
- Mid scenario tariff: Main corridor = 300 rupiahs/km  
Connecting corridor = 300 rupiahs/km
- High scenario tariff: Main corridor = 300 rupiahs/km  
Connecting corridor = 600 rupiahs/km.

In term of low tariff scenario, 7 out of 22 scenarios generate negative net present value (NPV) that indicates the low internal rate of return (IRR). The average IRR at this scenario is about 7.25%. Middle tariff scenario produces 19 scenarios that show positive NPV. The average is higher than low tariff scenario as about 11.34%. Tebing Tinggi-Lima Puluh section is the lowest IRR about 4.88%. The low figure is caused by a high construction cost in contrast with low projected volume trip during 40 years of the operational stage. High tariff scenario proposes 20 scenarios with a positive NPV. The average IRR at this scenario is about 12.61%. Despite producing higher IRR, the scenario also shows sections with negative NPV such as Tebing Tinggi-Lima Puluh and Sigli-Banda Aceh. As financial engineering was unable to increase the sections into the targeted feasibility, additional functions were further proposed. The detail of the scenario can be seen in **Table 1**.

Highway section	Length	Tariff scenario 1		Tariff scenario 2		Tariff scenario 3	
		NPV	IRR (%)	NPV	IRR (%)	NPV	IRR (%)
<b>Pekanbaru-Medan (main corridor)</b>	<b>547.2</b>	<b>Tariff IDR 150/km</b>		<b>Tariff IDR 300/km</b>		<b>Tariff IDR 300/km</b>	
Bakauheni-Bandar Lampung	85.8	Negative	4.31	Positive	8.55	Positive	8.55
Bandar Lampung-Metro-Kota Bumi	102.3	Positive	11.92	Positive	17.32	Positive	17.32
Kota Bumi-Kayu Agung	185.3	Positive	7.21	Positive	12.32	Positive	12.32
Kayu Agung-Palembang	63.8	Positive	7.67	Positive	13.04	Positive	13.04
Palembang-Pangkalan Balai-Sekayu	110	Positive	11.30	Positive	18.63	Positive	18.63
<b>Palembang-Pekanbaru (main corridor)</b>	<b>494.8</b>	<b>Tariff IDR 150/km</b>		<b>Tariff IDR 300/km</b>		<b>Tariff IDR 300/km</b>	
Sekayu-Meranti Panjang-Jambi	151.5	Negative	2.87	Positive	7.37	Positive	7.37
Jambi-Rengat	184.9	Positive	7.76	Positive	13.17	Positive	13.17
Rengat-Pangkalan Kerinci-Pekanbaru	158.4	Positive	7.03	Positive	11.99	Positive	11.99
<b>Pekanbaru-Medan (main corridor)</b>	<b>581.4</b>	<b>Tariff IDR 150/km</b>		<b>Tariff IDR 300/km</b>		<b>Tariff IDR 300/km</b>	
Pekanbaru-Pematang Duri-Dumai	133.2	Positive	10.22	Positive	16.55	Positive	16.55
Pematang Duri-Rantau Prapat	191	Positive	6.86	Positive	11.99	Positive	11.99
Rantau Prapat-Pematang Siantar-Raya	135	Negative	5.39	Positive	10.35	Positive	10.35
Pematang Siantar-Tebing Tinggi-Medan	93.08	Negative	10.90	Positive	17.60	Positive	17.60
Tebing Tinggi-Lima Puluh	29.12	Negative	1.57	Negative	4.88	Negative	4.88
<b>Banda-Aceh Medan (main corridor)</b>	<b>480.2</b>	<b>Tariff IDR 150/km</b>		<b>Tariff IDR 300/km</b>		<b>Tariff IDR 300/km</b>	
Medan-Langsa	118	Positive	9.68	Positive	16.16	Positive	16.16
Langsa-Lhokseumawe	136.8	Negative	6.72	Positive	12.27	Positive	12.27
Lhokseumawe-Sigli	145.5	Negative	3.61	Positive	8.78	Positive	8.78
Sigli-Banda Aceh	79.9	Negative	2.61	Negative	6.58	Negative	6.58

Highway section	Length	Tariff scenario 1		Tariff scenario 2		Tariff scenario 3	
		NPV	IRR (%)	NPV	IRR (%)	NPV	IRR (%)
<b>Pekanbaru-Padang (connecting corridor)</b>	<b>212.9</b>	<b>Tariff IDR 300/km</b>		<b>Tariff IDR 300/km</b>		<b>Tariff IDR 600/km</b>	
Pekanbaru-Bangkinang	50.4	Positive	7.06	Positive	7.06	Positive	11.96
Bangkinang-Paya Kambuh	72.5	Positive	7.78	Positive	7.78	Positive	12.97
Paya Kambuh-Batusangkar-Padang	90	Positive	12.41	Positive	12.41	Positive	19.65
<b>Palembang-Bengkulu (connecting corridor)</b>	<b>211.1</b>	<b>Tariff IDR 300/km</b>		<b>Tariff IDR 300/km</b>		<b>Tariff IDR 600/km</b>	
Sekayu-Lubuklinggau	116.1	Positive	9.55	Positive	9.55	Positive	15.37
Lubuklinggau-Bengkulu	95	Negative	5.13	Negative	5.13	Positive	9.81
Average IRR		<b>Average IRR</b>	<b>7.25</b>	<b>Average IRR</b>	<b>11.34</b>	<b>Average IRR</b>	<b>12.61</b>

**Table 1.** Life cycle cost analysis of highway function.

## 6.2. Multifunction

The concept integrates highway with other potential function such as dry port, fiber optic, tourism, rest area, and services, as well as railway and motorbike integration. Each function is investigated with the initial cost, operation, and maintenance cost and revenue for 40 years of operation. Rest area and tourism development were identified as the two most contributing functions in term of revenue. It was followed by railway integration, dry port, motorbike integration, and fiber optic. The projected revenue for each additional function can be seen in **Figure 5**.

Compared to the single function, the highway with multifunction concept generates more revenue for the project. Low tariff in multifunction concept produces 200 billion rupiahs in 2060 compared to 160 billion rupiahs for the single function. Moreover, the mid tariff on multifunction concept surpasses the revenue from mid tariff and higher tariff scenario of the single-function concept. It produces 350 billion rupiahs in 2060 compared to 330 billion rupiahs and 290 billion rupiahs, respectively. The projected revenue for multifunction and single function can be seen in **Figure 6**.

Life cycle cost in multifunction simulated through 8 alternative scenarios. Each alternative differed from the active function and elaborated with IRR, NPV, and payback period (PbP). Alternative A recommends including all additional functions, while some others inactivated the additional function. The simulation can be seen in **Table 2**.

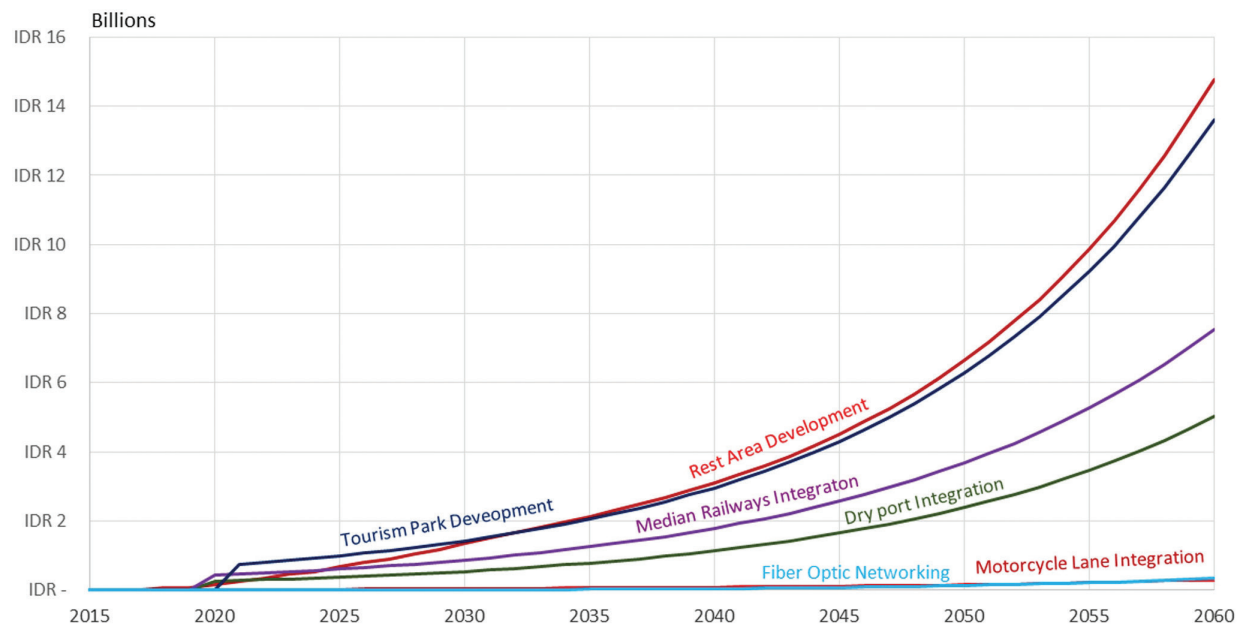


Figure 5. Projected revenue for each additional function on the conceptual design. Source: [28].

In terms of the low tariff, alternative E generates higher IRR with the lowest PbP about 8.30% and 34.39%. Despite lower IRR and higher PbP, alternative A provides more NPV compared to the alternative E. Similar issue also shows for mid and high tariff where alternative E proposes higher IRR and PbP, yet alternative A suggests higher NPV.

Alternative E suggests excluding tourism for the project. However, the tourism acts as one of the highest contributor to project revenue. With such valuable attractiveness, excluding the sector is no longer an option. As a result, alternative A that includes all additional functions is proposed as the best scenario for the project development. The detailed comparison for each alternative in terms of the financial feasibility is shown in **Table 3**.

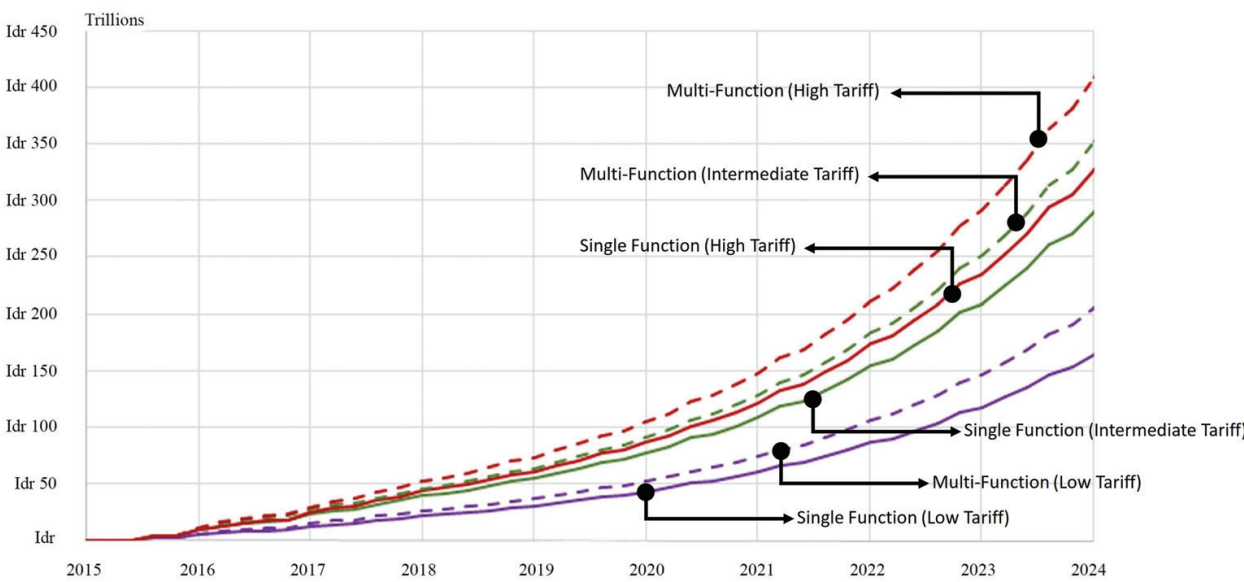


Figure 6. Projected revenue comparison for multifunction and single function. Source: [28].



Alternative	Highway road	Rest area	Tourism	Dry port	Railways	Motorcycle	Fiber optic
A	√	√	√	√	√	√	√
B	√	√	√	√	√	x	x
C	√	√	√	x	x	√	√
D	√	√	√	x	x	x	x
E	√	√	x	√	√	√	√
F	√	x	√	√	√	√	√
G	√	x	x	√	√	x	x
H	√	x	x	x	x	√	√

**Table 2.** Life cycle cost simulation for multifunction conceptual design.

Alt	Low tariff			Intermediate tariff			High tariff		
	NPV (million IDR)	IRR (%)	PBP	NPV (million IDR)	IRR (%)	PBP	NPV (million IDR)	IRR (%)	PBP
A	83,743,843	8.29	34.47	398,199,357	12.71	20.72	501,149,460	13.77	19.62
B	83,609,123	8.29	34.46	397,025,087	12.70	20.45	498,935,639	13.76	18.65
C	76,617,476	8.22	34.76	379,764,988	12.66	20.52	471,407,089	13.63	18.83
D	76,482,757	8.22	34.76	378,590,718	12.65	20.52	469,193,268	13.61	18.88
E	78,811,227	8.30	34.39	380,774,195	12.84	20.22	471,231,753	13.82	18.59
F	72,121,410	8.13	35.27	375,411,362	12.58	20.74	467,195,903	13.57	20.00
G	67,054,074	8.13	35.35	356,811,930	12.71	20.54	435,064,376	13.60	19.02
H	60,062,427	8.04	35.36	339,551,832	12.66	20.59	407,535,826	13.45	19.19

**Table 3.** Scenario on eight alternative for multifunction conceptual design.

## 7. Public-private partnership

The scheme will evaluate division of responsibility between the government and private on the life cycle of the project from initial cost, operational and maintenance cost, as well as revenue. The financing scheme consists of three scenarios:

- Scenario A: Government share 60% and private 40% for the initial cost.
- Scenario B: Government share 50% and private 50% for the initial cost.
- Scenario C: Government share 40% and private 60% for the initial cost.

Each scenario is followed by cost sharing on operational and maintenance cost where the private contributes 60, 50, and 40%. Revenue will also be shared where the private obtains from 80 to 50%.

In evaluating the best scenario, three considerations are being used from the comparison of IRR and MARR, revenue weighting score, and weighting score of operational and maintenance cost. Revenue weighting score for private shall be the lowest. When IRR reach expected MARR with the lowest revenue, calculation using higher revenue is not necessary. A similar scenario is also conducted on the O&M cost. When the highest O&M cost contributes to reaching IRR over MARR, then lower cost is no longer needed.

### 7.1. Scenario A

The scenario A consists of 12 initial scenarios from A.1 to A.12. Firstly, parameter about IRR minimum is conducted, and 6 scenarios are passed. Second, revenue weighting score for private to gain expected MARR (12%) is evaluated, and it generates three available scenarios from A.2, A.6, and A.10. Last, weighting score of operational and maintenance cost produces two most potential scenarios consisting of A.6 and A.10.

Both scenarios regulate private responsibility on initial cost and operational and maintenance cost as well as private's revenue from the project. A.6 scenario produces 12.48% of the internal rate of return (IRR) with a positive NPV. The private on initial cost and operational and maintenance cost shall contribute about 60 and 50%, respectively. In this scenario, private will obtain 70% of revenue from the project. On the other hand, A.10 scenario produces IRR for about 12.31% with a positive NPV. In the scenario, private has different contribution percentage on operational and maintenance cost, that is, about 60%.

### 7.2. Scenario B

The scenario B consists of 12 initial scenarios from B.1 to B.12. Similar treatment was also conducted as scenario A. The scenario generates two most potential scenarios B.7 and B.11.

B.7 scenario produces 12.63% with positive NPV. The scenario suggests that the private contributes 50% of initial cost and operational and maintenance cost. They reserve the right to gain 60% of revenue. Moreover, B.11 scenario produces close IRR to B.7 about 12.43% and a positive NPV. Private obtains 60% of revenue by contributing 50% of the initial cost and 60% of operational and maintenance cost.

### 7.3. Scenario C

The scenario C consists of 12 initial scenarios from C.1 to C.12. Similar treatment was also conducted as scenario A and scenario B. The scenario generates two most potential scenarios C.8 and C.12.

C.8 scenario produces 12.86% with positive NPV. The scenario regulates private responsibility and rights for initial cost, operational and maintenance cost as well as revenue by 40, 50 and 50%, correspondingly. C.12 generates 12.60% of IRR and a positive NPV. The private should invest 40% of initial cost and 60% of operational and maintenance cost. They will gain 50% of revenue from the investment.

#### 7.4. The proposed scenario

As 6 scenarios have been generated, then the most optimal financing scheme by the division of responsibility between government and private shall be conducted. All the scenarios show similar IRR about 12%. The comparison for each scenario can be seen in **Table 4**. It shows the investor responsibility for initial cost to revenue.

From the 6 available scenarios, the C.8 scenario is recommended for the division of responsibility between the public and private partnership. In public perspective, government contributes sunk cost about 60% from the project but gains revenue about 50% which can be used as a capital investment to support other infrastructure projects. For private, they contribute higher operational and maintenance cost compared to other scenarios and share equal income for the revenue. As the initial cost for private is only at 40%, the IRR produces competitive value. The proposed scheme aims to benefit public interest without compromising private income from the project.

Scenario	Initial cost (%)	OM cost (%)	Revenue (%)	IRR (%)
A.6	60	50	70	12.48
A.10	60	60	70	12.31
B.7	50	50	60	12.63
B.11	50	60	60	12.42
C.8	40	50	50	12.86
C.12	40	60	50	12.60

**Table 4.** Comparison for optimal scenario.

#### 8. Institutional scheme

The financing scheme produces an optimum scenario which increases the IRR value from 10.59 to 12.86%. As the project uses more than one function, it is argued that a consortium which accommodates multidiscipline sector should be established. The project is consisted of nine main stakeholders: the joint venture company, investor, consultant, insurance institution, national bank, multilateral bank, contractor, operator, and user.

The joint venture company consists of six different sectors such as transportation, telecommunication, tourism, port, railway, and industry. They should collaborate with the government to institute a business entity which shall manage the project. Investor is supported by a national bank and shares the cost with companies in the joint venture. On the other hand, the multilateral bank shall support government through soft loan. The detail institutional scheme is shown in **Figure 7**.

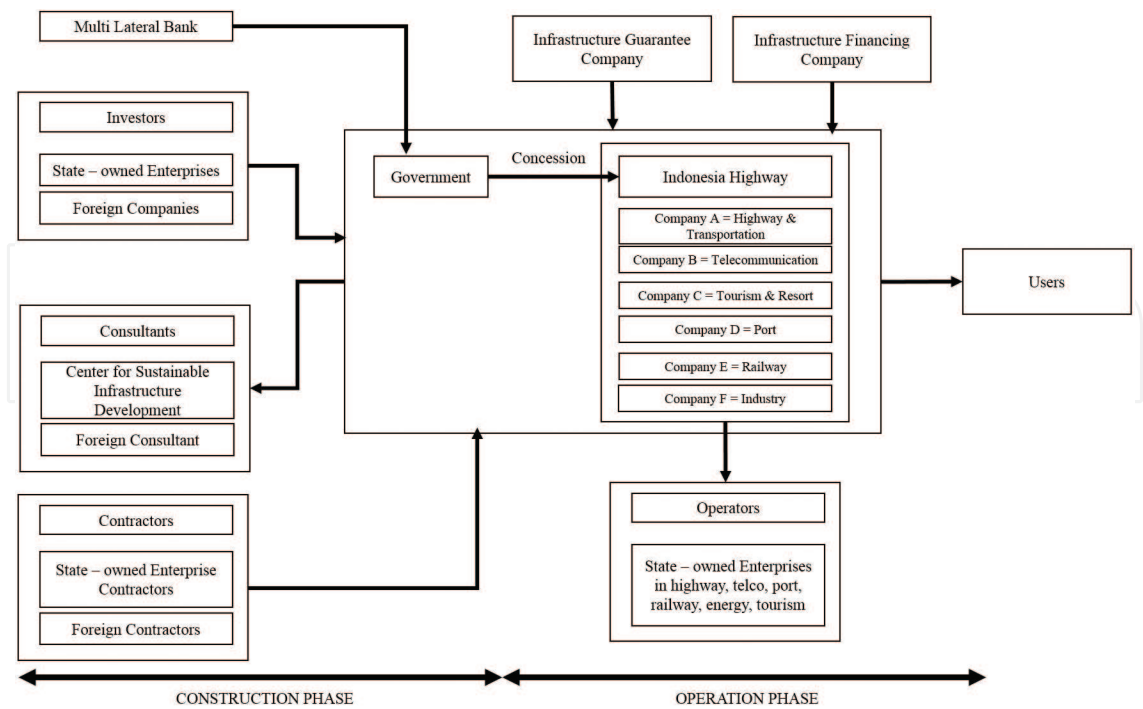


Figure 7. Institutional scheme on the project.

9. Conclusion

Value engineering (VE) has successfully improved the highway project by creating innovation and additional function. Value for money project reaches through the transformation of a single-function project into a multifunction project. The VE process generates dry port, fiber optic, tourism, rest area, and services, as well as railway and motorbike integration to meet the innovative conceptual design of highway development.

Compared to the single function project that produces 7.79%, the multifunction of TSTR project proposes a rate of return of about 10.59%. The study elaborates financing scheme that is suitable for government and business through public-private partnership. The system proposed as build operate sharing transfer (BOST) where government play roles on each project life cycle. Government contributes 59% in the initial stage and 40% in the operational and maintenance stage, and obtains 21% from the projected revenue. The public-private partnership scheme increases rate of return from 10.59 to 12.76% and a positive net present value (NPV). The study also generates institutional scheme that regulates related stakeholders from investors, joint venture structure, consultant, to the contractors for a division of responsibility for the project life cycle.

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