



FINAL PROJECT – TI 184833

**SELECTION OF COAL TRANSPORTATION MODE FOR PT X
USING FEASIBILITY STUDY, FINANCIAL ANALYSIS AND
RISK MANAGEMENT METHOD**

RANDY LUKITO SUSANTO

NRP 02411240000072

Supervisor:

Yudha Andrian Saputra, S.T., M.B.A.

NIP. 19820312 200501 1002

DEPARTMENT OF INDUSTRIAL ENGINEERING

Faculty of Industrial Technology

Institut Teknologi Sepuluh Nopember

Surabaya 2019



TUGAS AKHIR – TI 184833

**PEMILIHAN METODE TRANSPORTASI BATU BARA
UNTUK PT X DENGAN METODE ANALISA FINANSIAL,
ANALISA KELAYAKAN, DAN MANAJEMEN RESIKO**

RANDY LUKITO SUSANTO

NRP 02411240000072

Dosen Pembimbing:

Yudha Andrian Saputra, S.T., M.B.A.

NIP. 19820312 200501 1002

DEPARTMENT OF INDUSTRIAL ENGINEERING

Faculty of Industrial Technology

Institut Teknologi Sepuluh Nopember

Surabaya 2019

LEMBAR PENGESAHAN

PEMILIHAN METODE TRANSPORTASI BATU BARA UNTUK PT X DENGAN METODE ANALISA FINANSIAL, ANALISA KELAYAKAN, DAN MANAJEMEN RESIKO

TUGAS AKHIR

Diajukan untuk Memenuhi Salah Satu Syarat Memperoleh Gelar Sarjana Teknik
pada

Program Studi S-1 Jurusan Teknik Industri

Fakultas Teknologi Industri

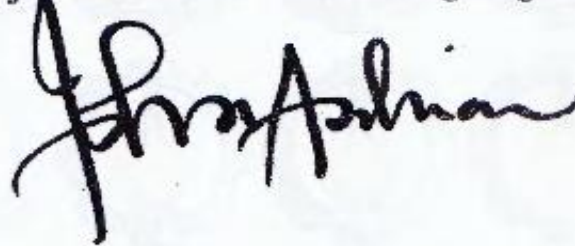
Institut Teknologi Sepuluh Nopember

Oleh:

RANDY LUKITO SUSANTO

NRP 02411240000072

Disetujui oleh Dosen Pembimbing Tugas Akhir:



Yudha Andrian Saputra, S.T., MBA

NIP. 19820312-200501 1002



SELECTION OF COAL TRANSPORTATION MODE FOR PT X USING FEASIBILITY STUDY, FINANCIAL ANALYSIS AND RISK MANAGEMENT METHOD

Name : Randy Lukito Susanto
NRP : 02411210000072
Departement : Teknik Industri
Supervisor : Yudha Andrian Saputra, S.T., MBA

ABSTRACT

PT X is a coal mining company that's based at Kalimantan. Currently they operate 100 tons truck as method of coal transportation. The problem here is a proposal from PT Y to invest in substituting truck with *Lori Listrik Otomatis* (LLO). PT Y state that substituting truck with LLO will significantly reduce operational cost of PT X and give more profit. However, LLO investment require huge amount of capital and PT X only have mining concession time until 2031. The purpose of this research is to find out whether alternative offered by PT Y is better than current coal transportation method or not. Additionally, whether there is another possible alternative that can give better result compared to current condition of using 100 tons truck and alternative offered by PT Y.

Financial feasibility analysis from proposed alternative require implementing risk to find whether it will shift feasibility value or not. Risk Management is done through ISO 31000: 2018 as standard. Based on the result, LLO is the best alternative in coal transportation method with NPV of \$246,219,007 and IRR of 31.64%. If include risk factor, the NPV become \$233,627,722.81 with IRR of 37.07%. Based on risk and non-risk, LLO stand as the best transportation method. However, if there are another factor other than financial factor such as operational risk, it's not impossible to use hybrid instead.

Keyword: Decision Making Analysis, Financial Analysis, Risk Management, Incremental Analysis, Monte Carlo Simulation

(This page is emptied on purpose)

PEMILIHAN METODE TRANSPORTASI BATU BARA UNTUK PT X DENGAN METODE ANALISA FINANSIAL, ANALISA KELAYAKAN, DAN MANAJEMEN RESIKO

Nama : Randy Lukito Susanto
NRP : 02411210000072
Departemen : Teknik Industri
Pembimbing : Yudha Andrian Saputra, S.T., MBA

ABSTRAK

PT X adalah perusahaan pertambangan yang berbasis di Kalimantan. Saat ini mereka menggunakan truk berkapasitas 100 tons untuk melakukan transportasi batu bara. Permasalahan yang dihadapi oleh PT X adalah adanya proposal dari PT Y untuk melakukan investasi penggantian truk sebagai transportasi batu bara dengan Lori Listrik Otomatis (LLO). PT Y menyatakan bahwa penggantian truk dengan LLO dapat mengurangi biaya operasional PT X secara signifikan dan memberikan keuntungan lebih. Hanya saja investasi LLO cukup mahal dan PT X hanya memiliki izin pertambangan hingga tahun 2031. Tujuan dari laporan tugas akhir ini adalah untuk mengetahui apakah alternatif yang ditawarkan PT Y lebih baik dari pada kondisi saat ini. Pertanyaan lebih lanjut adalah apakah ada kemungkinan alternatif yang dapat memberikan keuntungan lebih baik dari pada kondisi saat ini menggunakan truk 100 tons dan proposal yang diberikan PT Y.

Analisa kelayakan finansial dari alternatif yang ada perlu mempertimbangkan resiko-resiko yang dapat menggeser nilai kelayakan. Pengelolaan resiko dilakukan berdasarkan ISO 31000: 2018 sebagai standar. Hasil dari laporan ini menyatakan bahwa LLO sebagai pilihan terbaik dalam pemilihan transportasi batu bara dengan NPV \$246,219,007 dan IRR 31.64 %. Jika mempertimbangkan factor resiko, NPV untuk LLO menjadi \$233,627,722.81 dengan IRR 37.07%. Berdasarkan kedua pertimbangan itu, LLO menjadi pilihan alternatif transport terbaik. Walaupun begitu, alternative penggunaan hybrid tetap terbuka jika ada operasi LLO terhalang dengan operational risk.

Kata Kunci: *Decision Making Analysis, Analisa Finansial, Manajemen Risiko, Analisa Incremental, Simulasi Monte Carlo*

(This page is emptied on purpose)

FOREWORD

Thank you from the writer toward the God Almighty who has bestowed all his grace and blessing so that the writer can complete this thesis report with the title **“Selection of Coal Transportation Mode for PT X Using Feasibility Study, Financial analysis, and Risk Management Method”** with all his capability and skill.

In the writing of this report, the writer receives a lot of helps and guidance from many people and party. For this reason, writer use this opportunity to show his thanks and gratitude to:

1. Yudha Andrian Saputra, S.T., MBA as the supervisor who have guide and help writer in this arduous journey in making this report.
2. PT Y and PT X who have provided data required in research and writing of the report.
3. Diesta Iva Maftuhah S.T., M.T and Effi Latiffianti, S.T., M.Sc. as proposal examiner.
4. Stefanus Eko Wiratno, S.T., M.T and Nurhadi Siswanto, S.T., M.S.I.E., Ph.D as thesis trial examiner.
5. Prof. Ir. Joni Hermana, M.ScES., PhD. as Rector of Institut Teknologi Sepuluh Nopember.
6. Dr. Bambang Lelono Widjiantoro, S.T., M.T as Dean of Industrial Technology Faculty.
7. Nurhadi Siswanto, S.T., MSIE., Ph.D as Department Head of Industrial Engineering.
8. Dr. Maria Anityasari, S.T., M.E and Anny Mariyani, S.T., M.T as Adviser who help and encourage writer to finish this report.
9. Ellif Nurfiana as Head of Industrial Engineering Library who help and support writer in the research.
10. Father, Mother, Sister, and other family member who through all this time pray, help, and encourage writer to finish the writing of this report.
11. Laurentius Grady, Vincentia Erika, and Aldi Tri Yatno as fellow student, friend, and researcher which help on the making of this report.

12. Friends from ITS and outside ITS who give support and encouragement all this year

13. Other party that can't be mention one by one which support writer all this time.

Writer realize that this thesis report is far from perfection. For those purpose, writer expect and accept critic and suggestion for perfecting this report. Writer hope that this research beneficial for future research and development.

Surabaya, January 2019

Writer

TABLE OF CONTENT

Abstract.....	ii
Abstrak.....	iv
Foreword.....	vi
Table of Content	viii
List of Figures.....	xii
List of Tables	xiv
CHAPTER 1 Introduction	1
1.1 Background.....	1
1.2 Problem Formulation	6
1.3 Objectives	6
1.4 Benefits	7
1.5 Research Scope.....	7
1.5.1 Boundaries	7
1.5.2 Assumptions.....	7
1.5.3 Methodology.....	8
CHAPTER 2 Literature Review	11
2.1 Project.....	11
2.1.1 Project Management	12
2.1.2 Project Life Cycle	13
2.1.3 Project Success Parameter	14
2.2 Logistic and Supply Chain Management Concept	14
2.2.1 Cycle Time	15
2.2.2 Calculate Required Number of Transport	16
2.3 Feasibility Study	17
2.3.1 Net Present Value.....	19
2.3.2 Internal Rate of Return.....	20
2.3.3 Payback Period.....	20

2.4	Financial Analysis.....	21
2.4.1	Capital Expenditure.....	22
2.4.2	Operational Expenditure.....	22
2.4.3	Income Statement	23
2.4.4	Balance Sheet	23
2.4.5	Cash Flow Report	23
2.4.6	Return of Investment	24
2.4.7	Inflation	24
2.5	Incremental Analysis	25
2.6	Sensitivity and Risk Management	26
2.6.1	Time, Cost, and Market uncertainty	29
2.6.2	Sensitivity Analysis	30
CHAPTER 3 Methodology.....		31
3.1	Flowchart	31
3.1.1	Problem Formulation and Objective	33
3.1.2	Create Alternative.....	33
3.1.3	Macroeconomics.....	34
3.1.4	Feasibility Study.....	35
3.1.5	Financial Analysis	35
3.1.6	Incremental Analysis	35
3.1.7	Risk Management and Sensitivity analysis	36
3.1.8	Conclusion and Suggestion	36
CHAPTER 4 Alternative Financial Analysis.....		37
4.1	Route Distance	37
4.2	Cycle Time.....	38
4.3	Number of Vehicle for each Alternative.....	39
4.4	Capital Expenditure	41

4.5	Operational Expenditure.....	43
4.6	Cash Flow	45
4.7	Net Present Value	59
4.8	Internal Rate of Return	61
4.9	Payback Period	62
4.10	Return of Investment	62
CHAPTER 5 Risk Management and Sensitivity Analysis		65
5.1	Deciding Scope, Context, and Criteria	65
5.2	Risk Identification	66
5.2.1	Capacity	67
5.2.2	Production	67
5.2.3	Electricity Consumption	67
5.2.4	Electricity Price Increase	68
5.2.5	Inflation Uncertainty	68
5.2.6	Drive Station Tire Cost	69
5.2.7	Equipment Maintenance Cost	69
5.2.8	Track Maintenance Cost	69
5.2.9	Operational Cost	69
5.2.10	Support Equipment	69
5.3	Risk Analysis.....	69
5.3.1	Deciding Likelihood of Risk for LLO	70
5.3.1.1	Distribution Fitting.....	70
5.3.1.2	Goal Seek Analysis	76
5.3.1.3	Likelihood Calculation.....	80
5.3.2	Deciding Consequence of Risk for LLO.....	85
5.3.3	Risk Mapping.....	86
5.4	Risk Treatment	88
5.5	Sensitivity Analysis	88

5.6	Operational Risk	91
CHAPTER 6 Conclusion and Suggestion		95
6.1	Conclusion	95
6.2	Suggestion.....	96
Reference		99
Attachment.....		101

LIST OF FIGURES

Figure 1.1 Indonesia Coal Production and Consumption (MTOE).....	1
Figure 1.2 Indonesia Energy Consumption by Fuel Type (MTOE).....	2
Figure 1.3 Coal Logistic Flow	4
Figure 1.4 CAT 777G 100 Tons Truck	5
Figure 2.1 Atkinson's Project Iron Triangle	13
Figure 2.2 Incremental Analysis.....	26
Figure 3.1 Research Methodology Flow Chart (1).....	31
Figure 3.2 Research Methodology Flow Chart (2).....	32
Figure 4.1 Route Distance for Each Alternative.....	37
Figure 4.2 Yearly Cost Saving	51
Figure 4.3 Net Cash Flow	51
Figure 4.4 Yearly Total Cash Flow	52
Figure 4.5 Net Cash Flow per Alternative.....	58
Figure 4.6 Total Yearly Cash Flow	58
Figure 4.7 Net Present Value.....	60
Figure 5.1 Cost Saving Graph	65
Figure 5.2 Inflation Rate.....	68
Figure 5.3 Inflation Fitting	70
Figure 5.4 Coal Production Fitting	71
Figure 5.5 Exchange Value Fitting.....	71
Figure 5.6 Coal Transport Load Fitting.....	72
Figure 5.7 Industrial Electricity Price Fitting.....	72
Figure 5.8 Electricity Consumption Fitting.....	73
Figure 5.9 Drive Station Tyre Cost Fitting.....	73
Figure 5.10 Equipment Maintenance Cost Fitting.....	74
Figure 5.11 Track Maintenance Cost Fitting.....	74
Figure 5.12 Operational Cost Fitting	75
Figure 5.13 Support Equipment Cost Fitting.....	75
Figure 5.14 Production Capacity Goal Seek Analysis	76
Figure 5.15 Inflation Rate Goal Seek Analysis	77

Figure 5.16 Exchange Rate Goal Seek Analysis.....	77
Figure 5.17 Transport Load Capacity Goal Seek Analysis.....	77
Figure 5.18 Electricity Usage Goal Seek Analysis	78
Figure 5.19 Electricity Price Goal Seek Analysis.....	78
Figure 5.20 Drive Station Tyre Cost Goal Seek Analysis	78
Figure 5.21 Equipment Maintenance Cost Goal Seek Analysis	79
Figure 5.22 Track Maintenance Cost Goal Seek Analysis	79
Figure 5.23 Operational Cost Goal Seek Analysis	79
Figure 5.24 Support Equipment Cost Goal Seek Analysis	80
Figure 5.25 Production Capacity Risk Likelihood	80
Figure 5.26 Inflation Rate Risk Likelihood	81
Figure 5.27 Exchange Value Risk Likelihood	81
Figure 5.28 Transport Load Risk Likelihood	82
Figure 5.29 Electricity Usage Risk Likelihood.....	82
Figure 5.30 Electricity Price Risk Likelihood	82
Figure 5.31 Drive Station Tyre Cost Price Risk Likelihood.....	83
Figure 5.32 Equipment Maintenance Cost Risk Likelihood.....	83
Figure 5.33 Track Maintenance Cost Risk Likelihood	83
Figure 5.34 Operational Cost Risk Likelihood	84
Figure 5.35 Support Equipment Cost Risk Likelihood.....	84
Figure 5.36 Tornado Chart.....	89
Figure 5.37 NPV Simulation.....	90
Figure 5.38 IRR Simulation.....	90

LIST OF TABLES

Table 2.1 NPV Decision Making	19
Table 2.2 Incremental Analysis Example.....	26
Table 2.3 Likelihood Grouping	28
Table 2.4 Consequence Grouping	28
Table 2.5 Risk Mapping	28
Table 4.1 Alternative 2 Hybrid Distance Scenario.....	38
Table 4.2 Truck and LLO Specification	38
Table 4.3 Cycle Time Total	39
Table 4.4 Number of Transport for each Alternative (1)	40
Table 4.5 Number of Transport for Each Alternative (2).....	40
Table 4.6 Capital Expenditure	42
Table 4.7 Operational Expenditure.....	44
Table 4.8 Data for Truck-LLO Cash Flow	45
Table 4.9 Data for Truck-Hybrid (25% LLO) Cash Flow.....	45
Table 4.10 Data for Truck-Hybrid (50% LLO) Cash Flow.....	46
Table 4.11 Data for Truck-Hybrid (75% LLO) Cash Flow.....	46
Table 4.12 Incremental Truck-LLO Cash Flow	47
Table 4.13 Incremental Truck-Hybrid (25% LLO) Cash Flow	48
Table 4.14 Incremental Truck-Hybrid (50% LLO) Cash Flow	49
Table 4.15 Incremental Truck-Hybrid (75% LLO) Cash Flow	50
Table 4.17 Data for Hybrid (75% LLO)-LLO.....	52
Table 4.16 Hybrid (75% LLO)-LLO Cash Flow.....	53
Table 4.18 Alternative 1 Truck Cash Flow	55
Table 4.19 Alternative 2 LLO Cash Flow	56
Table 4.20 Alternative 3 Hybrid (75% LLO) Cash Flow	57
Table 4.21 Expense Present Value	59
Table 4.22 MARR and IRR.....	61
Table 4.23 Payback Period	62
Table 4.24 Return of Investment	63
Table 5.1 Risk Identification for LLO.....	66

Table 5.2 Distribution Type for each Risk.....	76
Table 5.3 Risk Likelihood.....	84
Table 5.4 Risk Consequence	85
Table 5.5 Risk Likelihood Category	86
Table 5.6 Risk Consequence Category	86
Table 5.7 Risk Mapping for LLO (1).....	87
Table 5.8 Risk Mapping for LLO (2).....	87
Table 5.9 Risk Treatment.....	88
Table 5.10 Limit Sensitivity Value	89
Table 5.11 Operational Risk	92

CHAPTER 1

INTRODUCTION

This chapter will explain about the background of the research, problem formulation, objectives, benefits, research's scope, and methodology of the research in this report. Each of the part will be explained in each sub chapter thoroughly.

1.1 Background

Indonesia is world's fourth most populous country with population over 261 million (2016), and the largest economic power in Southeast Asia, with over 18,000 islands and GDP of 932.3 billion USD in the year 2016. Indonesia also place as the 5th biggest coal producer after China, USA, Australia, and India with total 268.82 MTOE in year 2017. This is higher than coal produced in 2016 with 268.8 MTOE, but slightly lower than 2015 with 271.98 MTOE. This is caused by drop of coal price in global market.

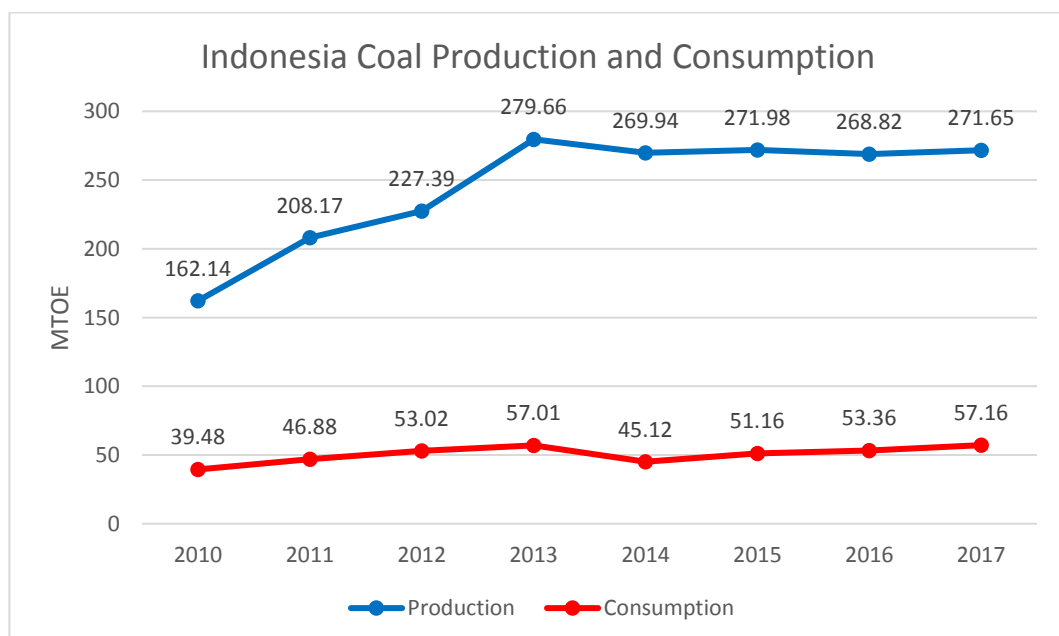


Figure 1.1 Indonesia Coal Production and Consumption (MTOE)

The main reason for price drop in 2016 is because India substituting to high quality coal, compared to Indonesia low quality coal. There is also change in Europe by shifting to more clean energy fuel compared to coal. The coal price drops also cause some low-level miner to cease operation as the coal price no longer enticing. However, the coal price has stabilized ever since from rising coal demand in countries such as Thailand, the Philippines, Malaysia, Vietnam, South Korea and Japan.

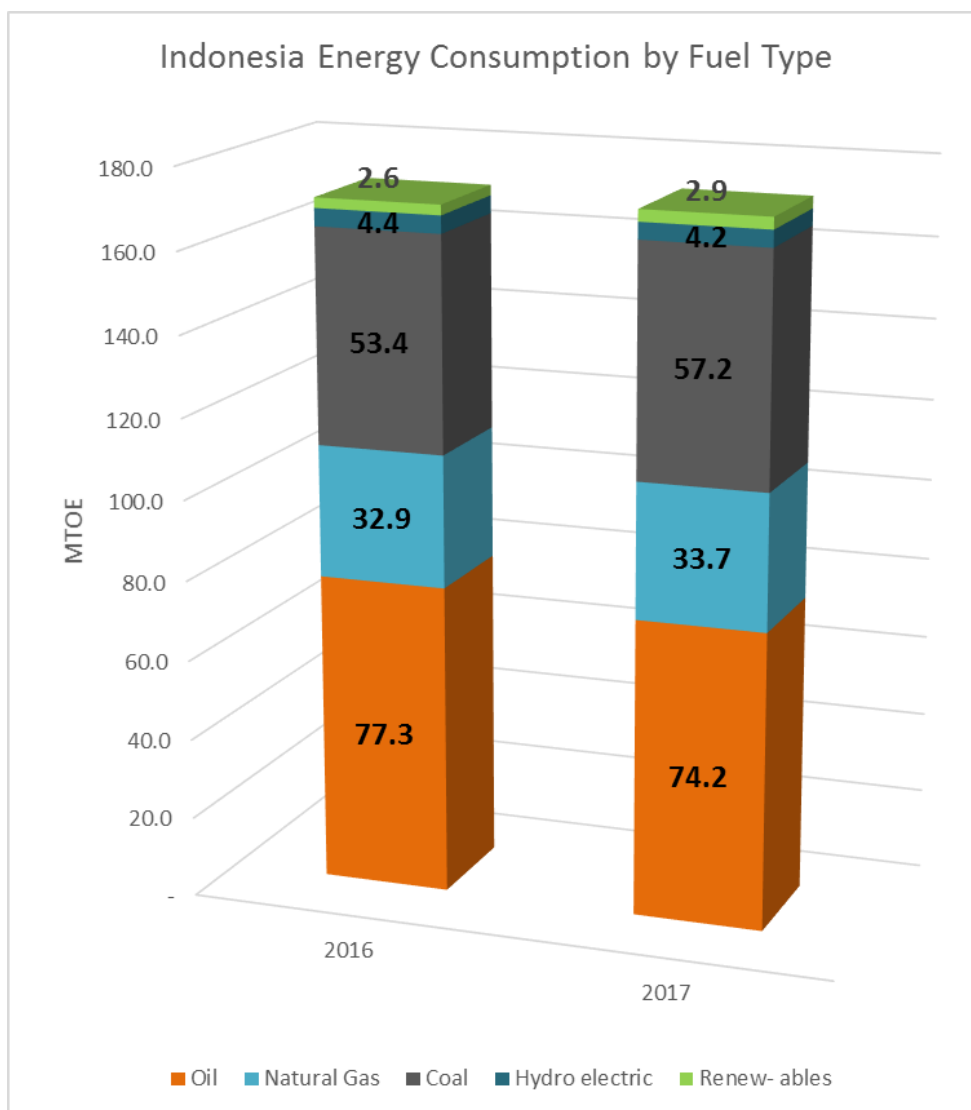


Figure 1.2 Indonesia Energy Consumption by Fuel Type (MTOE)

According to BP PLC (2018), Indonesia consume 57.2 MTOE of coal in the year 2017. This is 7.4% higher compared to previous year of 53.4 MTOE and place

Indonesia as the 9th biggest coal consumer in the world. Indonesia mainly use coal for electricity production as it was the cheapest option and there is plenty of fuel source available in the country. Coal currently sit as 2nd biggest fuel type used in Indonesia for energy production after Oil.

Coal itself as fuel produce high amount of carbon and other pollution which is why there is trend of changing coal to gas fuel. Gas fuel give better heat while produce less pollution compared to coal. However, gas fuel price is more volatile than coal in International Market. Coal also more plenty and easier to transport compared to other type of fuel.

While there are a lot of coal pocket in Indonesia, Indonesia Coal Seam and Coal Bed are mainly centered in South Sumatera Island, South Kalimantan Island, and East Kalimantan Island. PT X is a company based at East Kalimantan. Established in march 2007 witch concession area of 5,650 Hectare, PT X is just one of the many mining coal company in Kalimantan. PT X have a depot at river 70 Km away from the mine location. Later, the coal will be transported from depot at river to port at East Kalimantan using barge. The coal then loads into cargo ship for either export or domestic use.

The process of transporting coal from source, which is the mine, to depot for further transportation can be considered part of Supply Chain. The raw material here is coal with target to be used for other purpose such as power plant fuel, making pottery, household use (Baking food, Boiling water, etc.), cement manufacture, steel production and other usage.

The Supply Chain Management of PT X is regarding how to transport coal from the source at mine, to consumer. Currently there is option to increase efficiency by substitute truck with *Lorry Listrik Otomatis* (LLO) which PT Y sure would reduce overall Operational Expenditure. However, according to PT X permit of IUP No. 5**/K.***a/2009 regarding mining concession time, PT X would have to halt mining operation by 2031. As contract extension is currently undetermined, we based this report with the PT X productivity and profit would stop by the end of the year of 2031.

The Logistic and Supply Chain flow for the coal mined by PT X would be as below:

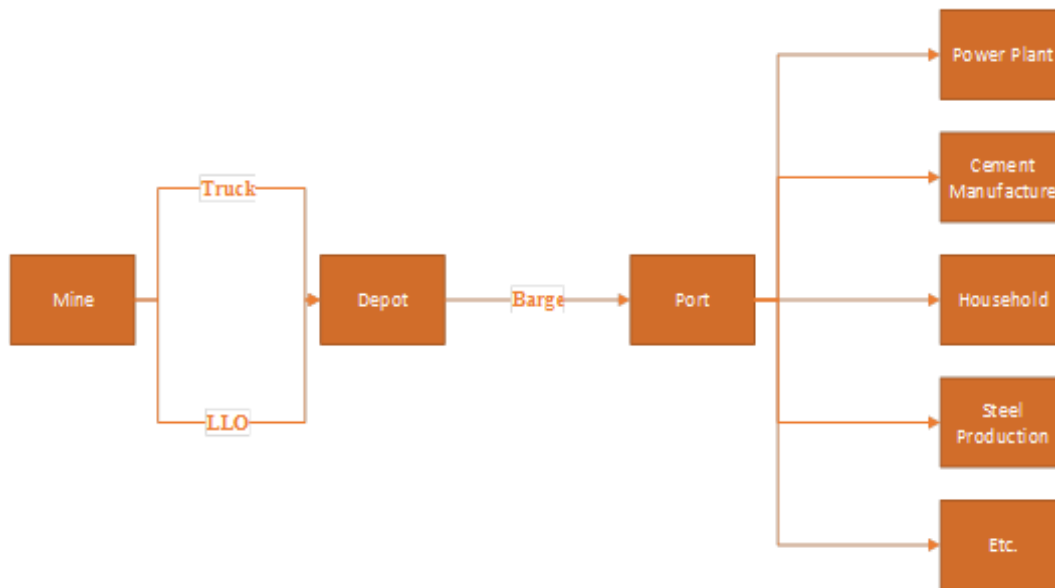


Figure 1.3 Coal Logistic Flow

Currently, PT X have a hauling road constructed by PT Z which finished in the year of 2013. This hauling road around 73 km long between mine and depot. PT X currently use 100 tons truck to transport coal from mine to depot at Mahakam River banks through this road. 100 tons truck can transport coal in huge quantity in 1 big load.

However, there is few problems deducted from current condition of using 100 tons truck as coal transport. As the road already build, there is no need to consider the road construction cost However, the cost to maintain and operate 100 tons truck is pretty questionable as the truck itself is a gas-guzzler and the maintenance needed for truck in such huge size is deem to be expensive and complicated. There is also question about the difficulty to get spare part as the truck very different to normal truck which commonly operated in Indonesia. There are also the wages for experienced driver for the truck.



Figure 1.4 CAT 777G 100 Tons Truck

The current condition of using truck as coal transportation is the alternative number 1 for coal transport method. PT X can choose to keep using Truck or not depend on the result from this research. The truck start operating since 2011 until now. Operating truck only as transportation method doesn't require any more Capital Expenditure (CAPEX) because the Truck is already owned and infrastructure already operational long time ago.

Alternative number 2 is the offer by PT Y. PT Y offer to build LLO as coal transportation method to substitute truck. PT Y sure that changing coal transportation method from current 100 tons truck to LLO will reduce the amount of Operational Expenditure (OPEX) while keeping the same coal load if not more. The LLO track will also going straight instead of detour like the hauling road. However, changing from the current condition from using truck to LLO will require to construct new rail line from Mine to depot. There is also need for construction of support building such as loading-unloading facility, maintenance center, etc. Those new construction will incur substantial CAPEX compared to alternative 1.

Alternative number 3 is Hybrid. This hybrid alternative happens by mixing the combination of LLO and Truck. This is alternative have possibility to use both the advantage of truck and LLO to gain profit. This route is bit different compared to LLO only as it can't go straight between mine and depot. Instead, the LLO track

follow hauling road until certain point before switching transport. The total distance for hybrid is approximately 72 Km in total.

The prospect of doing this could actually produce more revenue as it using the current available asset but mix with the low cost of using LLO with reduced capital cost. The excess truck could also be sold to cover expense necessary for building LLO railway and support building. However, there is additional cost of building transit point compare to alternative 2. As the depot located around high populated area, it's better to start with LLO deliver coal between mine and transit point rather than Truck for construction purpose.

In this report, researcher will analyze which alternative, whether alternative 1, alternative 2, or alternative 3, can give PT X the best benefit and revenue before concession given by government end.

1.2 Problem Formulation

Problem formulated from this research project is to find alternate coal transportation method to deliver coal from mine to depot and in-depth analysis regarding the cost and risk for each alternative to improve PT X profit before their concession time ended.

1.3 Objectives

Bellows is the objective to be achieved by researcher in this report:

1. Discover which alternative is better between alternative 1 Truck and alternative 2 LLO through incremental analysis.
2. Analyze whether hybrid alternative concept is better or not compared to solely use of Truck or LLO alternative.
3. Find and mitigate the possible risk in chosen alternative.
4. Find the limit value for risk factor that have high correlation toward NPV.
5. Find whether other alternative feasible or not if chosen alternative fail.

1.4 Benefits

Bellows is the benefit that can be obtained from this report for both researcher and PT X:

1. Understand project planning concept and criteria involved.
2. Able to create alternative option other than the one proposed.
3. Able to make feasibility study and financial analysis for each alternative.
4. Able to make incremental analysis between alternative.
5. Understand the risk involved in the project and able to create a mitigation plan.
6. Able to give analysis and suggestion to PT X for the best coal transportation method.

1.5 Research Scope

To minimize the complexity of the research, there are several boundaries and assumption used, those are:

1.5.1 Boundaries

Boundaries are used to limit the research scope. Here are the boundaries use in this research:

1. There are three transportation alternatives to be observed for coal transportation between mine to depot 70 km away at Mahakam River banks.
2. Following IUP No. 5**/K.***a/2009, concession contract for mining start in the year of 2009 expired in the year 2031 if there is no extension.
3. Land for LLO track laying is owned by PT X.

1.5.2 Assumptions

Assumptions use to fill blank data necessary for research. However, too many assumptions make result inaccurate. Here are the assumptions use on this research:

1. The truck used is CAT 777G 100 tons truck commonly used for mining operation.

2. Exchange rate between Indonesia Rupiah (IDR) and United States Dollar (USD) is at Rp 15.000,00 based on Indonesia's State Budget for 2019 draft (*Anggaran Pendapatan dan Belanja Negara / APBN*).
3. The inflation rate for Indonesia Rupiah (IDR) based on IMF World Economic Outlook which are 3.4% for Indonesian Rupiah in year 2018.
4. LLO Construction will take 14 months.

1.5.3 Methodology

These are methodology of writing in the process of writing final project report. The purpose is to make the report easily understood and the activity conducted can be explained in detail. Below is the general information for each chapter in the project report:

- **Chapter 1: Introduction**

Chapter 1 explain about the background of the research, determine scope and observation target, problem formulated based on the background, objective of the report, benefit that can be earned, boundaries and assumption used on the writing, and the methodology of the final project report.

- **Chapter 2: Literature Review**

Chapter 2 give information that related with research topic. It consists of the basic information about project, logistic and supply chain management, financial analysis, incremental analysis, and sensitivity and risk assessment.

- **Chapter 3: Research Methodology**

Chapter 3 explain thoroughly about the research methodology. It consists of stages that are needed when conducting research for this report so the report can be done in structured and systematical way.

- **Chapter 4: Alternative Financial Analysis**

Chapter 4 present the financial analysis result which determine best alternative. This include the calculation cycle time for each type of transport, number of each transport type for every alternative, CAPEX for

alternative 2 LLO and alternative 3 hybrid. OPEX for each alternative, Expenditure Present Value (EPV) for each alternative, NPV using truck as benchmark, IRR, Payback Period, and the last is ROI. For incremental analysis, we use alternative 1 truck as benchmark to show how better or worse other alternative is compare to PT X current condition.

- **Chapter 5: Risk Management and Sensitivity Analysis**

Chapter 5 present the risk management and sensitivity analysis from the previously chosen alternative. This include risk identification, risk likelihood, risk consequence, risk mapping, risk mitigation, operational risk, and sensitivity analysis through tornado chart.

- **Chapter 6: Suggestion and Conclusion**

Chapter 6 contain the conclusion and suggestion derived from the Final Project report. This include the solution analyzed by writer as well as the suggestion that can be done to fulfill the objective stated on Chapter 1.

(This page is emptied on purpose)

CHAPTER 2

LITERATURE REVIEW

This chapter explains about the theories and basic concept that used and developed in this research. This literature review is used to justify the suitable method used in the research.

2.1 Project

Project definition is a series of unique activity which interconnectable to achieve certain objective within defined time period (Chase et al., 1998). While according to Kerzner (2009), the definition of project is a series of activity with the purpose to achieve certain criteria, have a clear starting date and end date, funding limit, need resources (human resources, material resources, money, etc.), and have multifunction habit.

According to Project Management Body of Knowledge (PMBOK) Guide (2008), a project has 3 important factors. Those factors are:

1. Temporary: Every project has a clear schedule about when its start and when its end.
2. Unique: Every project has produced different product, solution, service, and output which different compared to other project.
3. Progressive Elaboration: Every project consists of many steps which keep developing until the end of project life. Every step increases the clarity of project objective.

Those 3 criteria are what separated project and routine operation. Operational activity commonly has repetitive and continuous behavior. While project behavior is unique and temporary. The project will end when project goal is accomplished while operational activity will continuously adapt its objective so activity can run continuously.

However, a project can be stop when the project demand is outside capability. This often happen when project can't keep up with the given schedule

or the soaring project cost. The other reason to stop a project might be caused by the consumer itself to stop the project.

Examples of projects include:

1. Developing a new products or service.
2. Effecting a change in the structure, staffing, or style of an organization.
3. Developing or acquiring a new or modified information system.
4. Constructing a building or infrastructure.
5. Implementing a new business process or procedure.

2.1.1 Project Management

Project Management is an application of knowledge, skill, tools, and technique in project activity to meet the project requirement (PMBOK Guide, 2008). Project management is accomplished through the appropriate application and integration of the 42 logically grouped project management processes compromising the 5-process group, which are:

- Initiating.
- Planning.
- Executing.
- Monitoring and Controlling.
- Closing.

Project Manager use 5-process group to achieve approved Iron Triangle.

The iron triangle is criteria that affecting each other in Project Management. (Atkinson, 1999). Those criteria are Time, Cost, and Quality. Time, Cost, and Quality is always a constraint when developing a project as there is a limit for resource is finite. The change in either one of those criteria will change the other as well.

The success of Project Management can be seen based on those triangle's three criteria. First Criteria of Time means the ability project to goes along according to planned schedule. Second Criteria of Cost means the project expense according to allocated funding or not. Third Criteria of Quality means whether the

project performance is according to its given purpose and technical specification or not.

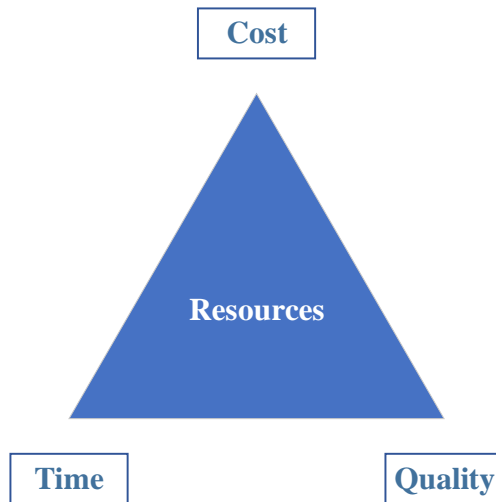


Figure 2.1 Atkinson's Project Iron Triangle

2.1.2 Project Life Cycle

According to A. K. Munns and B.F. Benjamins, there are 6 phases of Project Life Cycle. Those phases are:

1. Concepting Phase

In concepting phase, project manager creates a project idea and feasibility analysis. This phase is done by appointed investor and consultant. If project declare feasible, the project will be handed into contractor for planning and construction.

2. Planning Phase

In planning phase, contractor fabricate elaborate project planning. The plan is conceived by contractor with investor approval.

3. Production Phase

In production phase, the plan converted into physical reality. Investor give funding to project construction while contractor do the physical work. There are 2 activity in this phase, procurement and construction.

4. Handover Phase

In this handover phase, the finished project is handed over to the client for utilization.

5. Commercialization Phase

In this Commercialization phase, the client utilizes the finished project to do the project designed purpose. Also, in this phase the investor gain revenue from project operation.

6. Closedown Phase

In this Closedown phase which occur at the end of project life cycle, the project is dismantled and disposed at the end of its useful life. If there is salvage value, the fund goes into the client cash flow.

2.1.3 *Project Success Parameter*

According to Budi Santosa (2008), project management can be declared as success if it's able to fulfill certain values. If either of this value is not achieved, there is high chance that the client will declare that the project is failure. As such, Project can be classified as success when:

1. Project finish according to given schedule.
2. Project expense is within allocated funding.
3. Project performance and quality as well as it's specification, if not better.
4. Customer accept the project handover from contractor.
5. Did not disturb company main work flow.
6. Minimum changes in scope of work as previously agreed upon.
7. Does not change the positive corporate culture.

2.2 **Logistic and Supply Chain Management Concept**

Supply Chain according to Robert B. Handfield and Ernest L. Nicholas in "Introduction to Supply Chain Management" (1999), encompass all activities associated with flow and transformation of goods from raw materials stage (extraction), through the end user, as well as the associated information flow. They also conclude that Supply Chain Management (SCM) is the integration of these

activities through improved supply chain relationships, to achieve a sustainable competitive advantage.

In the other hand, John T. Mentzer (2001) explain in his book “Defining Supply Chain Management” that Supply Chain Management as systematic, strategic coordination of traditional business function and the tactic across these business function with a particular company and across business within the supply chain, for the purpose of improving the long-term performance of the individual companies and supply chain as whole.

According to Council of Logistic Management, a professional organization of logistic managers, education, and practitioners formed in 1962 with the purpose of continuing education and fostering the interchange ideas, Logistic is that part of supply chain process that plans, implements, and controls the efficient, effective flow and storage of goods, services, and related information from point of origin until the point of consumption in order to meet customer requirement.

To make Financial Analysis of substituting Truck with LLO, its necessary to find the number of Truck that currently operated and the number of LLO needed to be operated later on. For that, it’s important to find Cycle Time for both Truck and LLO.

2.2.1 Cycle Time

Cycle time is the total time from beginning to the end of process. Cycle time includes process time, during which a unit is acted upon to bring it closer to an output, and delay time, during which a unit of work is spent waiting to take the next action.

Delivering coal from mine to depot and then go back to take more coal is counted as 1 process. The process time here is time taken to load coal at mine, time taken to unload coal at depot, travel time from mine to depot, and travel time from depot to mine. Additionally, Delay time here is transport idle time taken to go to loading-unloading area and then travel to their designated destination.

As there is different load between going to mine and going to depot, the speed also differs. There is 2 type of transport, Truck and LLO. The calculation for

Cycle time for both Truck and LLO use the same formula, but the input will be different. Here are the formulas:

$$T_{AB} = V_F \times \text{Distance AB}$$

$$T_{BA} = V_E \times \text{Distance BA}$$

$$\text{Cycle Time} = T_{AB} + T_{BA} + T_i + T_L + T_U$$

With:

1. Cycle Time: Time taken to finish 1 operation which is round trip from Mine (A) to Depot (B) and back in hour.
2. Distance AB: Distance from Mine (A) to Depot (B) in km.
3. Distance BA: Distance from Depot (B) to Mine (A) in km.
4. V_F : Transport velocity when at full load in km/h.
5. V_E : Transport velocity when at empty load in km/h.
6. T_{AB} : Time from Mine (A) to Depot (B) in hour.
7. T_{BA} : Time from Depot (B) to Mine (A) in hour.
8. T_i : Time in idle condition in hour.
9. T_L : Time taken to Load transport in hour.
10. T_U : Time taken to Unload Transport in hour.

2.2.2 Calculate Required Number of Transport

For later calculation of transport cost, which is Capital Expenditure and Operational Expenditure, it is necessary to find the required number of transportations for both LLO and Truck. As Truck and LLO have different capacity, velocity, and cycle time, the required number of transports will also be different. Here is the formula used to calculate required number of Truck and LLO.

First, its important how many tons can Truck and LLO transport within the normal effective working hour of 20 hours a day. The formula to calculate is below:

$$TL_{1/2} = \frac{L_{1/2}}{\text{Cycle Time}}$$

1. $TL_{1/2}$: Transport Load capacity per day for a Truck (1) or LLO (2) in tons.
2. L_1 : Truck Load according to specification in tons.
3. L_2 : LLO Load according to specification in tons.
4. Cycle Time: Time taken to finish 1 operation which is round trip from Mine (A) to Depot (B) and back in hour.

After finding the Transport Load capacity per day, you can find out the necessary number of transports for each type by dividing how many tons of coal need to be transported per day with the Transport Load capacity per day. The formula is as bellow.

$$T_{1/2} = \frac{L_D}{TL_{1/2}}$$

With:

1. $T_{1/2}$: Number of transports required to fulfill daily coal transport target by Truck (1) or LLO (2).
2. L_D : Coal load required to be transported per Day in tons.

2.3 Feasibility Study

Feasibility study is analysis about a project consist of many steps where elements is being arranged and examined to reach a certain decision (Fyffe & Clifton, Jr., 1977). While according to Khoong and Ku (1994), the purpose of feasibility study is to gain comprehension regarding the project that about to be work upon. Also, feasibility study helps to assess the feasibility of Technical, Economical, and Market. Based on those factors, the company able to draw conclusion whether the project is Possible & Feasible or not.

Fyffe and Clifton, Jr. (1977) conclude that feasibility study for every project is unique and depend on the project context. However, the basic pattern for every project is fundamentally similar. The stages of Feasibility study are:

1. Identification stage

The earliest stage for project feasibility study is to declare the objective to be achieved. The idea for objective can be obtained from survey of existing Industry, Resources, Sector, and Market. The purpose of a project usually to answer the requirement for company development framework.

2. Preselection stage

In this stage, researcher decide the object of feasibility study so the boundaries and cost can be estimated. Project Management can also state whether the project is according to company objective, available resources, and possibly, government strategic plan.

3. Analysis stage

In this stage, researcher make in depth analysis about marketing alternative, technology, and other aspect that supported by systematically serve data. Project feasibility study depend on 3 factors, which are:

- Technical factor analysis consists of product, whether physical or service, description, production process, location and building specification, resources availability, legal aspect, environmental aspect, and other technical aspect.
- Financial factor analysis consists of project evaluation with emphasize on financial report. As such, the cost for project funding and revenue projection for the planned project can be observed.
- Market factor consists of market condition & availability, historical data regarding demand and raw material supply, demand estimation in the future, and market share for the project result in the future.

4. Evaluation and decision stage

In this stage, the decision whether to go with the planned project or not is made.

Feasibility study is also a part for constructing financial report. In financial analysis, there is calculation regarding the financial feasibility of the project. The

criteria for making financial feasibility study are Net Present Value, Internal Rate of Return, and Payback period.

2.3.1 Net Present Value

Net Present Value (NPV) whole cash flow that converted into current period value and summed, so the Present value reflect the net value of whole cash flow that occur during project lifetime (Pujawan, 2004). According to Investopedia website, Net Present Value is the difference between the present value of cash inflows and the present value of cash outflows over period of time. The NPV is one of the methods to determine whether a project could deliver profit or not based on the NPV value. Below are decision making table for NPV.

Table 2.1 NPV Decision Making

If	Means	Then
NPV > 0	Investment profitable	Project maybe accepted
NPV < 0	Investment not profitable	Project maybe rejected
NPV = 0	Investment didn't have affect to company profit	Project didn't have monetary value and should be based on other criteria

While the formula used to calculate NPV is:

$$NPV = \sum_{t=1}^T \frac{R_t}{(1+i)^t}$$

With:

1. NPV: Net Present Value.
2. R_t : Net cash inflow during period of t.
3. t: Number of time period.
4. i: Discount rate of return that could be earned in alternative investment.

2.3.2 Internal Rate of Return

The discount rate or interest rate used to achieve balance between income and expense within certain period of time is Rate of Return (ROR). Basically, ROR is the value of discount rate or interest rate that turn NPV=0. While the discount rate or interest rate used to evaluate between alternative is call Minimum Attractive Rate or Return (MARR). MARR is minimum value of interest rate that can be acceptable by investor (Pujawan, 2004).

One of ROR method that can be used to choose investment alternative is Internal Rate of Return (IRR). IRR is the obtained ROR value with assumption that all investment result is re-invested on the project with the same ROR (Pujawan, 2004). As such, IRR must be bigger than MARR.

$$NPV = \sum_{t=1}^T \frac{C_t}{(1+r)^t} - C_0$$

With:

1. NPV: Net Present Value.
2. C_t : Net cash inflow during period of t.
3. C_0 : Initial cost of investment.
4. t: Number of time period.
5. r: Discount rate

2.3.3 Payback Period

Payback Period is basically period needed to return the initial investment cost. Calculation is based on net cash flow per year and the salvage value of the project. The formula used to find Payback Period is:

$$0 = -P_0 + \sum_{t=1}^{N^1} A_t(P/A, i\%, t) + (F/P, i\%, t)$$

With:

1. P_0 : Initial Investment Cost.
2. A_t : Annual cash flow in t period.
3. P: Present Value.
4. F: Future Value.
5. A: Annual cash flow.
6. t: Payback Period.
7. i%: Interest or Discount Rate in %.

2.4 Financial Analysis

According to Investopedia website, Financial analysis is the process of evaluating businesses, projects, budgets and other finance-related entities to determine their performance and suitability. Typically, financial analysis is used to analyze whether an entity is stable, solvent, liquid or profitable enough to warrant a monetary investment. When looking at a specific company, a financial analyst conducts analysis by focusing on the income statement, balance sheet, and cash flow statement.

Financial Analysis usually used to evaluate economic trends, set financial policy, build long-term plans for business activity, and identify the company or project that profitable for investment. This can be done through the analysis of financial number and data. Hence Financial Analysis term came from.

Financial analysis can be conducted in both corporate finance and investment finance. In corporate finance, the objective is to find project that worth executing through analysis of Net Present Value (NPV) and Internal Rate of Return (IRR). While in investment finance, outside financial analyst conducts a financial analysis for investment purpose. Analyst can choose to either conduct top-down or bottom up investment approach.

Top-down approach is to first looks for macroeconomic opportunities such as high performing sector. Then looks for the best companies within that sector. While Bottom-up approach looks at specific company and conducts similar ratio analysis to corporate financial analysis, looking at past performance and expected future performance as investment indicator.

2.4.1 Capital Expenditure

Capital Expenditure or Capital Cost is funds used by company to acquire or upgrade company asset. This include building, equipment, vehicles, or land. It is considered capital expenditure when the assets newly purchased or when the money being used for extending current asset's life. Capital Expenditure is usually one-time cost. Different with Operational Expenditure annual cost.

The Capital Expenditure for PT X will include

1. CE: Total Capital Expenditure.
2. CT_{Ra}: Cost for constructing and installing LLO track including land purchase.
3. CT_{Ro}: Cost for constructing road for truck including land purchase
4. C₁: Cost for purchasing a truck.
5. C₂: Cost for purchasing an LLO.
6. T₁: Number of transports required to fulfill daily coal transport target by Truck.
7. T₂: Number of transports required to fulfill daily coal transport target by LLO.
8. CS₁: Cost for Building and other support equipment needed to operate Truck.
9. CS₂: Cost for Building and other support equipment needed to operate LLO.

Formula for calculating Capital Expenditure:

$$CE = CT_{Ra} + CT_{Ro} + CS_1 + CS_2 + (C_1 \times T_1) + (C_2 \times T_2)$$

2.4.2 Operational Expenditure

Operational Expenditure or Operational Cost is ongoing cost for running a business. This include sales and administration, R&D, employee wages, rent, supplies, attorney and legal fees, insurance, taxes, utilities cost, etc. Often Capital Expenditure can't give output unless Operational Expenditure is involved. On other

word, Operating Expenditure is the sum of a business operating expense for a period of time. This can be month or year.

The Operational Expenditure of PT X will include:

1. OE: Total Operational Expenditure per year.
2. C_{wt} : Wages for both Truck driver and LLO driver per year.
3. C_m : Maintenance cost per year for both Truck and driver.
4. C_{tax} : Company taxes per year.
5. C_u : Utility cost per year.
6. C_{ws} : Wages for other support personnel.
7. C_o : Other cost for unexpected event.

While the formula for calculating Operational Expenditure is:

$$OE = C_{wt} + C_{ws} + C_m + C_u + C_o + C_{tax}$$

2.4.3 *Income Statement*

Income statement (Profit-Loss) is first of the three important financial statements. It's used for reporting company financial performance over period of time. Income statement give the company revenue, expenditure, and income tax report for each period of time.

2.4.4 *Balance Sheet*

Balance sheet is the second of the three important financial statement. Balance sheets reports company assets, liabilities, and shareholder equity at certain period of time. In balance sheets, assets are equal to liabilities plus equity. By analyzing the balance sheet. Investor able to observe assets, liability, and equity from time to time.

2.4.5 *Cash Flow Report*

Cash flow report is the third and last of the three important financial statement. Cash Flow Report state company net cash flow that able to be gained

and recorded within period of time. Cash Flow report structure is separated into 3 part, which are Operational cash flow, Investment cash flow, and Funding cash flow.

Operational cash flow is the cash obtained by company from selling product and service after Operational Expenditure. Investment cash flow related to amount of Capital Expenditure, company investment, acquisition, and long-term asset sales. Funding cash flow is replenishment or payment to investor and debtor. In the end of cash flow report, the company obtain the net cash flow for the period.

2.4.6 *Return of Investment*

Return of Investment (ROI) is average annual profit compared to initial investment cost. The annual profit here is the total income minus total expense. The formula for calculating Rate of Investment is:

$$ROI = \frac{\text{Average Annual Profit}}{\text{Initial Investment Cost}}$$

2.4.7 *Inflation*

Inflation is a condition where there is increase of general price. This include product, service, or production factor (Samuelson, 2004). An economy is having inflation when there is price increase, price increase is general, and the price increase continuously. Indicator commonly used to find inflation is *Indeks Harga Konsumen* (IHK), *Indeks Harga Perdagangan Besar* (IHPB), and GDP deflator. Formula used for calculating inflation is:

$$i = \frac{IHK_n - IHK_{n-1}}{IHK_n} \times 100\%$$

Where:

1. i: Inflation
2. IHK_{n-1} : *Indeks Harga Konsumen tahun n-1*
3. IHK_n : *Indeks Harga Konsumen tahun n*

After obtaining the inflation value, the future value can be calculated using formula:

$$F = P(1 + i)^N$$

Where:

1. F: Future value
2. P: Present value
3. I: Inflation
4. N: Time different between now and future

2.5 Incremental Analysis

According to Investopedia, Incremental analysis is decision making technique used in business to determine the true cost difference between alternative. Incremental analysis used for decision making analysis when there is another alternative. This analysis is solely concerned about the cost when changing alternative over other. If there is any other cost that do not change (sunk cost) when other alternative selected, the that cost is ignored.

Incremental analysis often uses for following analysis:

1. Retain in-house production or outsource it.
2. Retain maintenance personnel or outsource it.
3. To accept one-time order from customer or not. This is usually for low price order.
4. Rebuild assets or replace with new one.
5. Sell product in current condition or keep processing it.

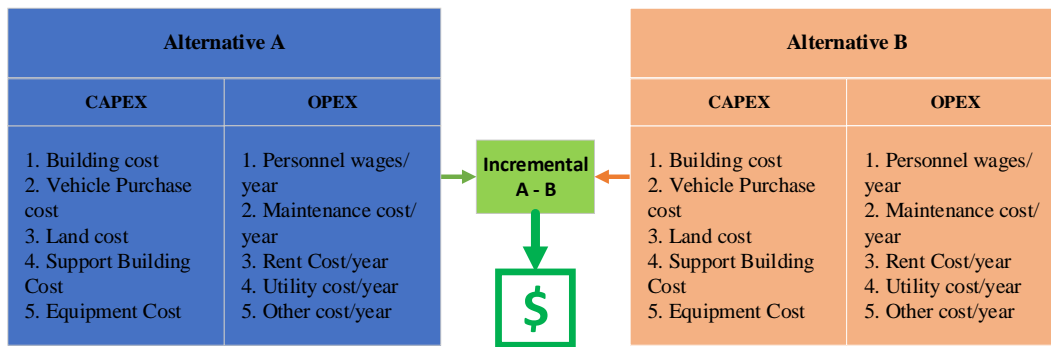


Figure 2.2 Incremental Analysis

The alternative chosen is the one who gave positive value compared to others alternative. If the value of incremental equal, then it means neither alternative better than the other. The decision to make when that happen can be based on other criteria such as social value. Here's the example of Incremental Analysis

Table 2.2 Incremental Analysis Example

Year	Alternative A	Alternative B	Increment (A-B)
1	CAPEX + OPEX Alternative A	CAPEX + OPEX Alternative B	A-B
2			
3			
4			
5			
6			
7			
8			
9			
10			
Total			Total of Increment (A-B)

If A-B value positive, then choose alternative A. However, if A-B value is negative, then choose alternative B.

2.6 Sensitivity and Risk Management

A project is susceptible to event that happen during the project life. This event can be positive or negative but often unpredictable. The butterfly effect from this event might affect company in uncertain way. According to Australian Standard / New Zealand Standard (AS/NZS) 4360: 2004, risk is the possibility of

an event which effect the goal. Risk often define as something negative which should be avoided, or at least, minimized.

To control risk, Risk Management is necessary. Risk Management is a process to identify every variation of risk from every planned activity to maximize opportunity, minimize threat, and improve project output (Australian Standard, 2004a). According to Anityasari and Wessiani (2011), risk management is described in 5 stages. Those stages are

1. Communicate and consult

Communicate and consult with both internal stakeholder and external stakeholder so it's suitable to every stage in risk management process and observe process in whole.

2. Establish the context

In this stage, establish the organization scope, relation between external and internal environment, organization goal, and organization strategy. Then state object scope of risk management which include target, goal, strategy, and activity parameter of organization so the risk management process can go accurately and to the point.

3. Identify Risks

In this stage, identify the possible risk and how the risk might happen. Risk identification can be done by using question of when, where, why, and how regarding event that can delay or impact the objective achievement progress.

4. Analyze Risks

In this stage, analyze the possible risk that can happen. This stage consists of looking for consequence and likelihood value of possible risk. From the risk analysis, it's possible to obtain risk mapping based on level and risk category.

5. Risk Mitigation

The final stage, mitigate the effect of risk starting from the one with highest possible damage.

Table 2.3 and Table 2.4 below show the risk grouping according to AS/NZS standard

Table 2.3 Likelihood Grouping

Likelihood	Possibility of risk to happen
Rare	Possibility of occurring < 5%
Unlikely	Possibility of occurring 5% - 25%
Possible	Possibility of occurring 25% - 50%
Likely	Possibility of occurring 50% - 75 %
Almost Certain	Possibility of occurring > 75%

Table 2.4 Consequence Grouping

Consequence	Risk effect
Insignificant	Low financial loss, no injuries
Minor	First aid treatment, medium financial loss
Moderate	Medical treatment required, high financial loss
Major	Extensive injuries, loss of production capability, major financial loss
Catastrophic	Death, huge financial loss

From likelihood and consequence grouping into risk mapping shown in Table 2.5 below, risk can be categorized into 4.

1. Extreme Risk – Immediate action required.
2. High Risk – Senior management attention required.
3. Medium – Risk management responsibility must be specified.
4. Low Risk – Manage by routine procedure.

Table 2.5 Risk Mapping

Risk Map		Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 6
Almost Certain	5					
Likely	4					
Possible	3					
Unlikely	2					
Rare	1					

Risk Description	Extreme Risk	High Risk	Moderate Risk	Low Risk
------------------	--------------	-----------	---------------	----------

After mapping risk through crossing likelihood and consequence, we go to next stage. There are 3 stages which are:

- Evaluate Risks

Risk evaluation is used for figuring out the handling priority of the risk that happen in the project. Handling category can be handling method for low risk, moderate risk, high risk, or even extreme risk.

- Treat Risks

Treat risks stage is to handle risk that previously identified. Some of risk handling method according AS/NZS 4360/2004 are:

- 1) Avoid Risk.
- 2) Accept Risk.
- 3) Transfer Risk.
- 4) Reduce likelihood.
- 5) Reduce consequence.

- Monitor and Review

Monitor and review is necessary to monitor and improve every stage effectivity in risk management process.

For PT X project, there is need to forecast the profit made for each alternative. The reason is for projecting the NPV, IRR, ROI, and Payback Period for each alternative. However, forecasting isn't an exact data. There might be unpredictable change that occur during the forecasted period which render one of the alternatives to be not-feasible anymore. For those reason, it's necessary to discover the criteria that susceptible to sudden change, how far uncertainty the project is okay with, and the mitigation plan through sensitivity analysis.

2.6.1 Time, Cost, and Market uncertainty

During the duration of project operation, there might be sudden change which cause the uncertainty of the project. The uncertainty happens because we are not sure with operation time, operational cost, and coal price. There might be change in market such as exchange value between Rupiah and Dollar or the

Inflation. History told that sudden spike in exchange value and inflation can happen anytime.

The operational time here refer to PT X time until cease mining operation. There might be extension, however it's uncertain. The extension might make alternative option more interesting compared to current proposed alternative.

The operational cost change refers for the cost for operating chosen alternative. The current projected cost for operation might suddenly spike because certain type of worker wages increases, the cost for part change, or just the fuel price of another alternative become cheaper. As we know, the oil price for truck follow global market and global event often affect it. There might be also the sudden production halt for transport spare part which increase the market price.

The market condition for coal also uncertainty. Increase in coal price might increase PT X coal mining production. The opposite could also happen. The reduce price of coal mining production might lessen the amount of coal mined. As such, this make operating one of the alternatives more feasible compared to current proposed transport alternative.

2.6.2 *Sensitivity Analysis*

Sensitivity analysis is analysis used for checking the sensitivity of investment toward change that happen during the investment period. Sensitivity analysis done by changing un-fixed variable and can affect the current production activity to be able understand how far investment is feasible (Mayasti, 2014). Cash flow itself effected by many factors such as previously in Time, Cost, and Market uncertainty. If one of those factors change, then the overall company cash flow will also change. Sensitivity analysis help to analyze what happen to NPV and IRR if there is change in one of the factors. Sensitivity analysis help to understand what could happen and plan to mitigate it.

CHAPTER 3 METHODOLOGY

This chapter will explain the research methodology used in this report. The purpose from this chapter is to give description and picture of how to conduct the research.

3.1 Flowchart

The research methodology use in this report is describe in flowchart below

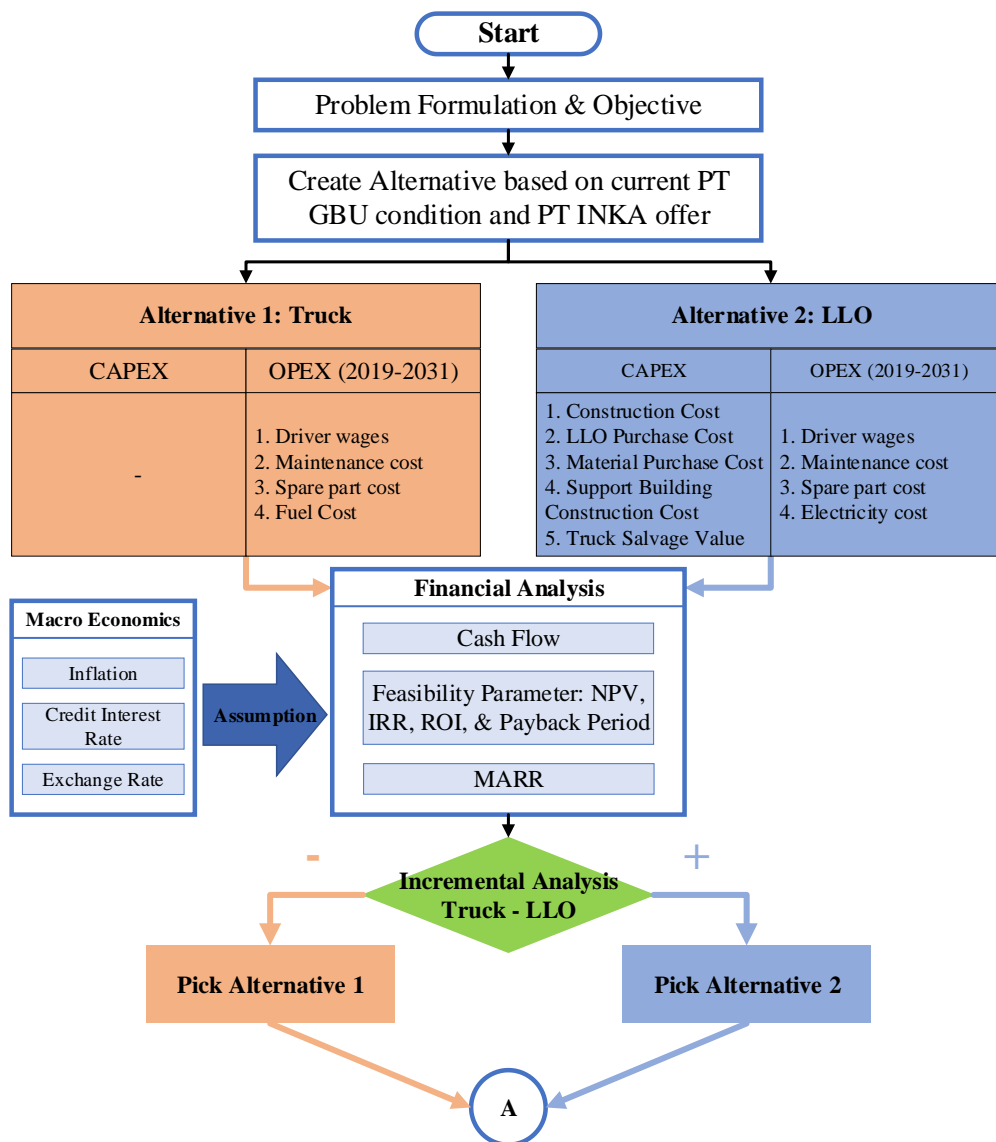


Figure 3.1 Research Methodology Flow Chart (1)

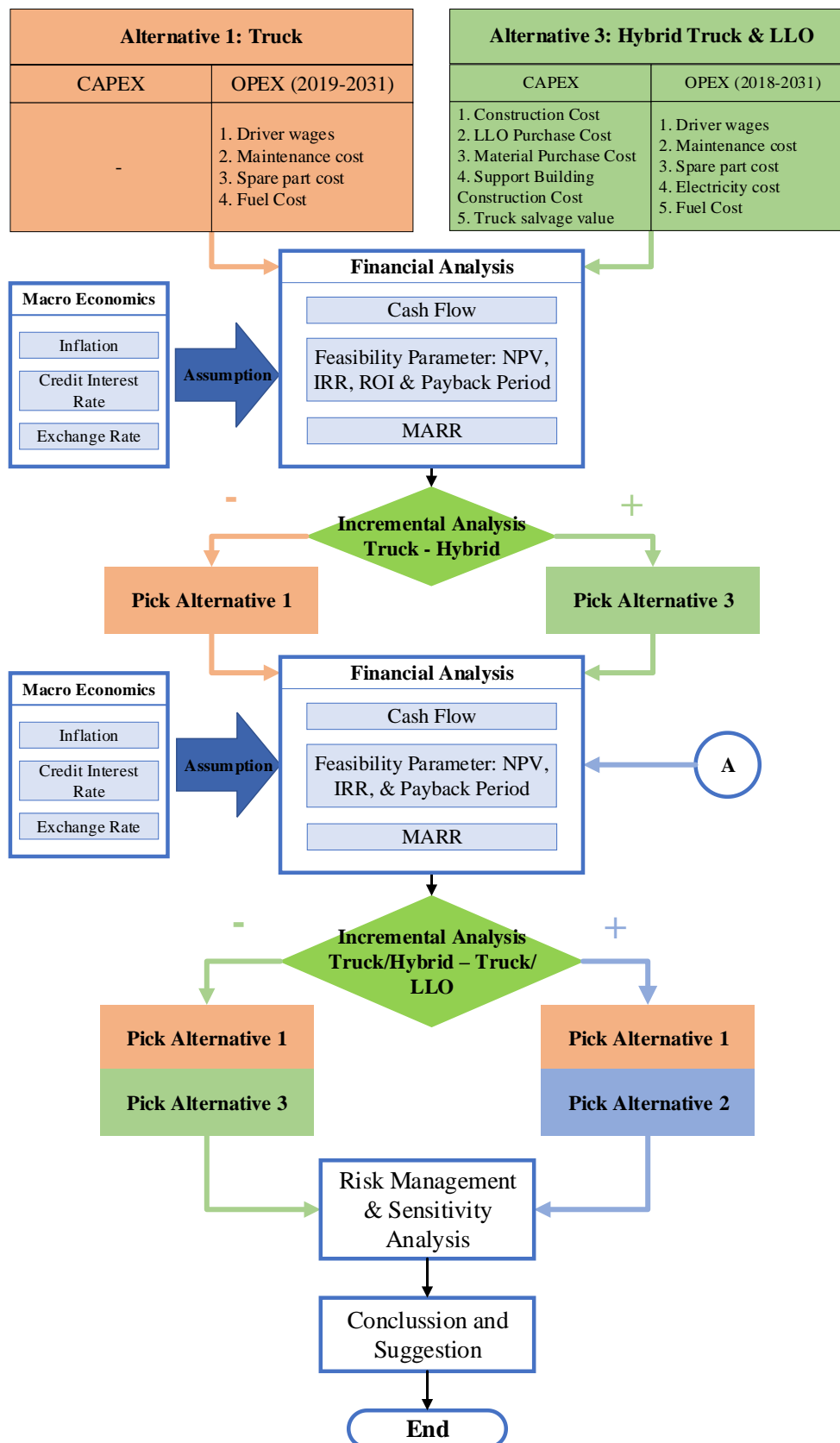


Figure 3.2 Research Methodology Flow Chart (2)

3.1.1 Problem Formulation and Objective

In this stage, researcher formulate problem that occur and analyze PT X objective. The problem that occur in this research is regarding decision making. PT Y make offer of substituting coal transport method from using Truck to LLO. PT Y believe this alternative will highly reduce the operational cost of PT X. However, there is question regarding the high investment cost while their concession time end in 2031. There is another option of hybrid using Truck and LLO to reduce investment while also reducing operational cost. The time limit of 2031 makes this option very attractive as it combines both advantage of using Truck and LLO.

PT X also concerned regarding the risk taken when choosing either alternative. Each alternative has its own risk but also have advantage which the other alternative doesn't have. For example, there is chance that the oil price use to fuel truck would suddenly raise by extreme margin to sudden global event. The usage of electricity seems more stable as there is multiple way to generate electricity.

As such, there is importance to do in-depth analysis regarding these 3 alternatives. The method used here is by making Feasibility Analysis of each alternative. The feasibility of each project then use for further Financial Analysis of each alternative. Later on, Incremental Analysis can be used to compare each alternative data such as NPV, IRR, and even yearly cash flow. Base on the result of Incremental Analysis, researcher can fulfill PT X objective. Which is to achieve maximum profit and benefit before the end of their concession through the choice of these 3 alternatives.

3.1.2 Create Alternative

This stage creates alternatives available for PT X coal transportation. The 2 main alternatives are keep using Truck as PT X condition, or follow PT Y offer and substitute all truck with LLO. Additionally, there is possibility of hybrid between PT X current transport method with PT Y offer. So, all of the alternatives are:

1. Alternative 1 Truck

The current condition of using Truck as sole coal transport is set as Alternative 1. As there is no need for new purchase, the CAPEX for alternative 1 is 0. The OPEX calculated since 2018 until 2031.

2. Alternative 2 LLO

The second alternative is using PT Y offer. The offer is regarding full substitution of Truck with LLO. With this option, there is need for Capital Expenditure such as LLO purchase and the contractor wages. The OPEX for LLO will start from 2019. OPEX 2018 still use Truck OPEX. Until LLO operational, the truck is still on use. However, when LLO start operating, the Truck owned by PT X can be sold to cover expended fund.

3. Alternative 3 Hybrid

The third alternative is hybrid of PT X current Truck transport and PT Y offer. The idea is to use Truck to cover half of distance between mine and depot. While the other half will be using LLO. The advantage here is the reduced amount of Capital Expenditure, Reduced Operational Expenditure compare to using Truck only while sell the unused truck. With PT X concession time end in 2031, the hybrid choice might be better solution compare to solely use Truck or LLO.

3.1.3 *Macroeconomics*

This stage includes what's necessary from Macroeconomics factor. Macroeconomics the part of economy concerned with large-scale or general economic factor. This include interest, exchange rate between currency, inflation, GDP, and many more. Basically, economy part that affect regional, national, and even global. To make Financial Analysis for each alternative, it's required to understand about inflation rate, interest rate, and exchange value between rupiah and dollars.

3.1.4 Feasibility Study

In this stage, feasibility study is conducted. The feasibility study conducted in this research through NPV, IRR, and Payback Period method. The Feasibility study for each alternative is to ensure that the alternative is worth to be considered and help for later Financial Analysis.

3.1.5 Financial Analysis

In this stage, Financial analysis for each alternative is conducted to help propose alternative to PT X. Base on this Financial Analysis, PT X can understand the attractiveness of each alternative base on the profit. This also tell how better an alternative compared to the other. PT X can also see how the cash flow for each period for future planning.

In this stage, researcher include feasibility study previously done, construct cash flow, and MARR.

3.1.6 Incremental Analysis

In this stage, we conduct comparison by subtracting the value between alternative. For this research, we use alternative 1 truck as benchmark for incremental analysis. This is because of research objective of proof if any other alternative can improve current PT X condition. As such, using alternative 1 truck as benchmark is the best solution to show how much worse or better is alternative compared to PT X current condition.

In the first Incremental Analysis, we subtract the financial analysis value between truck and LLO. This value includes CAPEX, OPEX, IRR, NPV, Payback Period, etc. If the value of subtraction positive, then we choose LLO as alternative. If the result is negative then choose alternative 1 truck instead. The winner in this stage, goes for later incremental analysis. The same for incremental analysis between truck and hybrid. The winner on this 2 Incremental Analysis will be the proposed as coal transport alternative for PT X.

If the last incremental between alternative 1 truck against alternative 1 truck, then there are no needs for further incremental. If the last incremental either

between alternative 1 truck and alternative 2 LLO or alternative 1 truck and alternative 3 hybrid, there are no need for further incremental and instead refer to previous incremental result. If the last incremental between alternative 2 LLO and alternative 3 hybrid, the chosen alternative from the result of incremental analysis is deemed as the best solution for increasing PT X profit.

3.1.7 Risk Management and Sensitivity analysis

The resulting chosen alternative then further assess through risk management and sensitivity analysis. The purpose is to find out whether an alternative still feasible or not during certain scenario. Risk Management include Risk Identification, Risk Likelihood, Risk Consequence, Risk Mapping, Risk Mitigation, and Operational Risk. Sensitivity analysis is done through correlation between risk to NPV using tornado chart.

3.1.8 Conclusion and Suggestion

Conclude the result of the conducted research to answer research objective. The research also give suggestion to PT X in choosing which alternative give the best profit and benefit before the end of concession.

CHAPTER 4

ALTERNATIVE FINANCIAL ANALYSIS

Chapter 4 is about data collecting and data processing for the purpose of making financial analysis for each alternative. This chapter consist of calculation of cycle time for each alternative based on the specification of vehicle and requirement based on each alternative. There is also calculation of CAPEX for LLO & hybrid and calculation of OPEX for all of 3 alternatives. For cash flow construction, the period is 13 year until 2031. For this research, the data for financial analysis is gather through secondary source with some data obtained by comparing it to similar project. The purpose of this financial analysis is to rank which out of 3 alternatives can give the best benefit and profit to PT X.

4.1 Route Distance

Each alternative took different route which generate distance. Between alternative 1 and alternative 2, the shortest distance is by using alternative 2 LLO which generate total of 70 Km distance. LLO is shorter from other alternative as it cut through between mine and depot directly. Alternative 3 hybrid have approximated total distance of 62 Km making it the second farthest route. The last alternative with longest route to take is alternative 1 Truck as it has to follow the already existing mining route which slightly detour to south. This give alternative 1 63 km route to take for delivering coal.

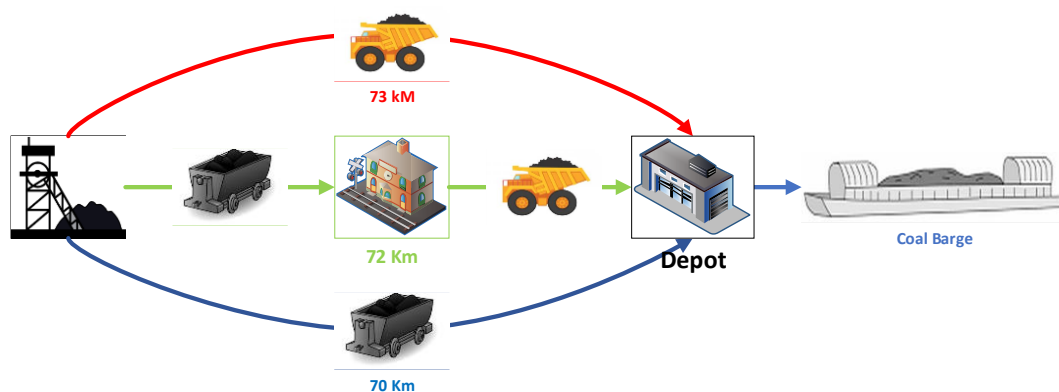


Figure 4.1 Route Distance for Each Alternative

As for alternative 3 hybrid the distance for LLO or Truck are unknown. To find the best combination, few scenarios to be tested. In every combination, the total distance for alternative 3 hybrid is approximately 72 Km while the scenario are 25% LLO, 50% LLO, and 75% LLO of total 62 Km distance. The results are as follow

Table 4.1 Alternative 2 Hybrid Distance Scenario

LLO Coverage of 72 Km	Distance (Km)	
	LLO	Truck
25%	20.5	51.5
50%	36	36
75%	51.5	36

The resulting scenario will be tested to find the best LLO distance percentage for alternative 3 hybrid.

4.2 Cycle Time

Cycle Time is the time required for completing 1 process. The process in this case is time taken to transport coal from mine to depot and then go back to mine. Cycle Time in this report is use for determining the number of required transports for both Truck and LLO so PT X can transport at least 20 million tons of coal per year for the duration of 13 year, starting from 2019. Number of transports also necessary for calculation of CAPEX and OPEX as more transport require more investment and operational cost. The data for truck CAT 777G, which used as alternative 1 Truck, is obtained through the specification of CAT 777G written in the owner manual. The data of LLO in the other hand, is obtained from PT Y proposal. Here is the specification for both Truck and LLO

Table 4.2 Truck and LLO Specification

Specification	Transport		Unit
	Truck (CAT 777G Tier 4)	Lori Listrik Otomatis (LLO)	
Work Day	330	330	Day
Operation Time	24	20	Hour
Capacity	100	482	Tons
Speed (Full Load)	40	25	km/h
Speed (Empty Load)	50	32	km/h
Speed while unload	0	11	km/h

As truck and LLO have different specification such as capacity and speed, and there is also different route taken between alternative, there is different time taken for each transport in each alternative to complete 1 cycle. Cycle time calculated by sum up coal loading duration, coal unloading duration, and tramming time, which is time taken to go from mine to depot and back from depot to mine. Based on Table 4.1, here is the cycle time for every alternative:

Alternative hybrid requires additional stop to transit coal from LLO to truck. For those reason, there is additional loading and unloading time. Based Figure 4.3, the total of cycle time for every alternative is shown in Table 4.2 below.

Table 4.3 Cycle Time Total

Description	Alternative 1	Alternative 2	Alternative 3					
	Truck	LLO	LLO	Truck	LLO	Truck	LLO	Truck
Distance (Km)	73	70	20.5	51.5	36	36	51.5	36
Loading Duration (Min)	3.21	16.67	19.88		19.88		19.88	
Unloading Duration (Min)	5.00	5.56	10.56		10.56		10.56	
Tramming Duration (Min)	154.98	296.30	196.11		228.81		261.51	
Cycle Time (Min)	163.19	318.52	226.54		259.24		291.94	
Cycle Time (Hour)	2.72	5.31	3.78		4.32		4.87	

4.3 Number of Vehicle for each Alternative

After discover the specification of each transport type and the cycle time for each alternative, the number of transports can be calculated. The number of transports can be found by dividing Operation hour per day with cycle time and then rounded down. The result is the number of trips a transport can make per day. Then divide the minimum required volume per day with number of trips and transport specification load to find the required number of transports. The formula to calculate it is basically:

$$\text{Possible Number of Trips} = \text{Rounddown}\left(\frac{\text{Operating hour per day}}{\text{Cycle time}}\right)$$

$$\text{Number of Transport} = \frac{\text{Required tons per day}}{\text{Possible Trips per day} \times \text{Transport Load Spec}}$$

$$\text{Required Number of Trips} = \text{Roundup}\left(\frac{\text{Target Load/Day}}{\text{Load Spec} \times \text{Transport Num}}\right)$$

Using the formula above, the number of transports for each alternative are:

Table 4.4 Number of Transport for each Alternative (1)

Description	Alternative 1	Alternative 2	Alternative 3 (25% LLO)	
	Truck	LLO	LLO	Truck
Distance (Km)	73	70	20.5	51.5
Cycle Time (Min)	163.19	318.52	196.11	
Cycle time (Hour)	2.72	5.31	3.27	
Possible Number of Trip	8	3	11	12
Required Number of Trip	8	3	11	12
Truck Number	76	-	-	12
LLO Number	-	42	51	-

Table 4.5 Number of Transport for Each Alternative (2)

Description	Alternative 3 (50% LLO)		Alternative 3 (75% LLO)	
	LLO	Truck	LLO	Truck
Distance (Km)	36	36	51.5	20.5
Cycle Time (Min)	228.81		291.94	
Cycle time (Hour)	3.81		4.87	
Possible Number of Trip	6	17	4	27
Required Number of Trip	6	17	4	27
Truck Number	-	36	-	23
LLO Number	21	-	32	-

Possible number of trips and required number of trips, while sound similar, are actually different. Possible number of trips is based on how many trips a transport can made based on the operating hour and cycle time resulting number of possible trips can be made

Required number of trips is the minimum amounts of trips required to be made to fulfill daily quota based on target load per day with number of transport and transport load specification.

Another different is between rounding down possible number of trips and rounding up required number of trips. Rounding down for number of trips is

because the number of trips can't exceed the resulted number but also must be integer. Rounding up for required number of trips is because it's not possible to have non-integer result. However, less than result means the daily load quota isn't met either way. As such, the result number of trips need to be rounded up.

For example, number of trips for alternative 1 truck can be discovered by dividing operation hour of 24 hours/day for truck with cycle time of 163.19 minute which result of 8.82 possible trips per day. As it's not possible to have non-integer number of trips and it's not possible to actually have more trip than the resulted calculation, the number of possible trips for alternative 1 truck is rounded down to 8 trips per day.

As for required number of trips, there is 61 available truck for alternative 1 truck and 100 tons truck load specification. Daily target are 60.606 tons of coal. It results with 9.93 number of trips required per day. However, it's not possible to make 9.93 trips per day but below 7.97 trips per day also result of unfulfilled daily quota. As such, the result is rounded up to 8 required number of trips per day per truck to be made with alternative 1.

The other alternatives are calculated with the same method. As LLO can load more coal compared to truck, it requires less number for that type of transport. Alternative 1 truck require the greatest number of transport type as it solely use truck. Alternative 3 hybrid is in the middle with less amount of each type of transport, but in total are more than pure usage of LLO. Alternative 2 LLO require the least number of transport type as it purely LLO based.

4.4 Capital Expenditure

Alternative 2 and alternative 3 require additional expense for investment compare to alternative 1 which already exist prior to the project. This investment is what we call Capital Expenditure or CAPEX. The CAPEX for alternative 2 and alternative 3 estimated to be quite significantly large, however the excess truck not use can be disposed and sold to cover part of CAPEX.

Table 4.6 Capital Expenditure

Description	Unit	Price	Distance (Km)			Hybrid (50% LLO)	Hybrid (75% LLO)
			LLO	Hybrid (25% LLO)	Hybrid (50% LLO)		
			70	20.5	36		51.5
VARIABLE COST							
Track							
a. Rail 122	Km	\$ 185,000	\$ 12,950,000	\$ 3,792,500	\$ 6,660,000	\$ 9,527,500	
b. Anchor and Bolts fastener							
c. Iron Bearing							
d. Fish Plate							
Installation track							
a. Track Installation	Km	\$ 28,000	\$ 1,960,000.00	\$ 574,000.00	\$ 1,008,000.00	\$ 1,442,000.00	
b. Rail Welding							
c. Track Lying							
d. Turnout Installation							
e. Land Price	3 x 1000m	\$ 16,000.00	\$ 1,120,000.00	\$ 328,000.00	\$ 576,000.00	\$ 824,000.00	
Installation drive station	Km	\$ 4,000	\$ 280,000.00	\$ 82,000.00	\$ 144,000.00	\$ 206,000.00	
Communication Cable (FO)	Km	\$ 115,000	\$ 8,050,000	\$ 2,357,500	\$ 4,140,000	\$ 5,922,500	
Drive Station							
a. Motor Gear Box	Pcs	\$ 120,000	\$ 25,800,000.00	\$ 8,280,000.00	\$ 13,800,000.00	\$ 19,320,000.00	
b. Traction Control							
c. Trafo							
d. Tyre							
Cart trains (1 Train Set = 400 Cart)	Cart	\$ 5,000	\$ 84,000,000	\$ 24,000,000	\$ 42,000,000	\$ 64,000,000	
Supporting							
Office	Pcs	\$ 7,692	\$ 15,384.62	\$ 23,076.92	\$ 23,076.92	\$ 23,076.92	
Depo	Pcs	\$ 57,692	\$ 57,692.31	\$ 115,384.62	\$ 115,384.62	\$ 115,384.62	
Mobilization, Demobilization, Vibro Roller	Km	\$ 2,308	\$ 161,538.46	\$ 47,307.69	\$ 83,076.92	\$ 118,846.15	
FIXED COST							
Loading + Unloading							
a. Loading	Lumpsum	\$1,158,550.00	\$ 1,158,550.00	\$ 2,317,100.00	\$ 2,317,100.00	\$ 2,317,100.00	
b. Unloading	Lumpsum	\$838,950.00	\$ 838,950.00	\$ 1,677,900.00	\$ 1,677,900.00	\$ 1,677,900.00	
Commissioning	Lumpsum	\$636,556.25	\$ 636,556.25	\$ 636,556.25	\$ 636,556.25	\$ 636,556.25	
Worker Barracks	Lumpsum	\$19,230.77	\$ 19,230.77	\$ 19,230.77	\$ 19,230.77	\$ 19,230.77	
Asset Disposal (Truck)	unit	\$600,000.00	\$ (45,600,000.00)	\$ (15,000,000.00)	\$ (24,000,000.00)	\$ (31,800,000.00)	
Total CAPEX			\$91,447,902.40	\$29,250,556.25	\$49,200,325.48	\$74,350,094.71	
Total CAPEX (Rp)			Rp1,371,718,536,057.69	Rp438,758,343,750.00	Rp738,004,882,211.54	Rp1,115,251,420,673.08	

Alternative 3 hybrid required additional office depo, and loading & unloading facility compared to alternative 2 LLO. However, alternative 3 hybrid still require less investment compared to alternative 2 LLO. Out of 3 scenarios of alternative 3 hybrid, using 25% LLO require the least investment with only \$ 29,250,556.25 and using 75% LLO require the highest investment out of 3 scenarios with \$ 74,350,094.71 of investment cost. Alternative 3 hybrid with 50% LLO is in the middle with CAPEX of \$49,200,325.48. Alternative 2 LLO require \$ 91,447,902.4 capital investment.

4.5 Operational Expenditure

Operational Expenditure or OPEX is the cost incurred to keep transport operational and give revenue to PT X. The operational expenditure includes Oil cost for truck, electricity price and usage for LLO, tire cost for truck, tire cost for LLO drive station, equipment maintenance cost, road and track maintenance cost, other operational cost, and support equipment cost. As each alternative use different transport and transport combination, the operational cost is also different. However, as some alternative doesn't require certain operational cost, the operational cost for that part can be 0. For each alternative 3 hybrid scenario also require specific OPEX calculation as it have different usage and requirement. Here's the OPEX for each alternative

Table 4.7 Operational Expenditure

Description	Unit	Truck (73 Km)	LLO (70 Km)	Hybrid 73 Km		
				25% LLO	50% LLO	75% LLO
DIRECT COST						
Fuel Cost (Electricity or Oil)	\$	\$38,933,333.33	\$4,358,842.98	\$28,743,184.97	\$21,441,690.68	\$14,140,196.38
Fuel Cost / Tons.Km (Electricity or Oil)	\$/Tons.Km	\$0.03	\$0.00	\$0.02	\$0.02	\$0.017549
Drive Station Tyres Cost	\$	-	\$268,191.00	\$90,169.20	\$143,451.00	\$204,019.20
Drive Station Tyres Cost / Tons.Km	\$/Tons.Km	-	\$0.00	\$0.00	\$0.00	\$0.000198
Truck Tyre Cost	\$	\$351,010.10	-	\$234,006.73	\$165,181.22	\$104,002.99
Truck Tyre Cost / Tons.Km	\$/Tons.Km	\$0.00	-	\$0.00	\$0.00	\$0.000254
Equipment Maintenance Cost	\$	\$4,460,981.95	\$2,496,407.06	\$5,489,960.74	\$4,609,503.78	\$3,846,441.07
Equipment Maintenance Cost / Tons.Km	\$/Tons.Km	\$0.00	\$0.00	\$0.01	\$0.01	\$0.005716
Road-Track Maintenance Cost	\$	\$2,087,301.59	\$2,849,693.00	\$2,307,101.33	\$2,494,910.61	\$2,682,719.88
Road-Track Maintenance Cost / Tons.Km	\$/Tons.Km	\$0.00	\$0.00	\$0.00	\$0.00	\$0.003465
INDIRECT COST						
Operational Cost	\$	\$210,000.00	\$110,046.32	\$250,967.37	\$209,520.00	\$173,598.95
Operational Cost / Tons.Km	\$/Tons.Km	\$0.00	\$0.00	\$0.00	\$0.00	\$0.000262
Support Equipment Cost	\$	\$214,000.00	\$78,872.73	\$222,477.99	\$180,241.15	\$143,635.89
Support Equipment Cost / Tons.Km	\$/Tons.Km	\$0.00	\$0.00	\$0.00	\$0.00	\$0.000235
Total OPEX/Year		\$46,256,626.97	\$10,162,053.09	\$37,337,868.33	\$29,244,498.43	\$21,294,614.37
Total OPEX/Year (Rp)		Rp693,849,404,613.65	Rp152,430,796,279.80	Rp560,068,024,974.88	Rp438,667,476,475.46	Rp319,419,215,509.09

4.6 Cash Flow

Using the previously found CAPEX and OPEX, the construction of cash flow is made possible. Cash Flow is important in determining NPV, IRR, and Payback Period later on. There is 2 tax involved in cash flow construction. Those tax are PPh 22 for 1.5% from CAPEX and PPh Badan for gross income more than Rp 50.000.000.000 with tax of 25%. The PPh Badan tax of 25% is because PT X have estimate gross income of RP 2.94 trillion per year in 2018.

For the construction of cash flow, its necessary to find the Cost Saving between alternative. Cost saving obtained by subtract the different operational cost between alternative. For this research, alternative 1 truck is used as the benchmark basis as it's PT X current condition. Period is the cash flow concession period which start from 2019 until 2031. Tax PPh 22 is tax incurred for BUMN when they purchase something. PPh Badan on the other hand is the tax incurred from gross income.

The cost saving, period, tax, and CAPEX for between alternative, including each scenario of alternative 3, is as follow:

Table 4.8 Data for Truck-LLO Cash Flow

Item	Value	Remarks
Cost Saving	\$ 36,094,574	OPEX Truck-LLO
Concession time	13	year
Purchase Tax (PPh 22)	1.5%	
PPH Badan >Rp. 50	25%	
Inflation	3.8%	
CAPEX	\$ 91,447,902	

Table 4.9 Data for Truck-Hybrid (25% LLO) Cash Flow

Item	Value	Remarks
Cost Saving	\$ 8,918,759	OPEX Truck-Hybrid
Concession time	13	year
Purchase Tax (PPh 22)	1.5%	
PPH Badan >Rp. 50	25%	
Inflation	3.8%	
CAPEX	\$29,250,556.25	

Table 4.10 Data for Truck-Hybrid (50% LLO) Cash Flow

Item	Value	Remarks
Cost Saving	\$ 17,012,129	OPEX Truck-Hybrid
Concession time	13	year
Purchase Tax (PPH 22)	1.5%	
PPH Badan >Rp. 50	25%	
Inflation	3.8%	
CAPEX	\$49,200,325.48	

Table 4.11 Data for Truck-Hybrid (75% LLO) Cash Flow

Item	Value	Remarks
Cost Saving	\$ 24,962,013	OPEX Truck-Hybrid
Concession time	13	year
Purchase Tax (PPH 22)	1.5%	
PPH Badan >Rp. 50	25%	
Inflation	3.8%	
CAPEX	\$74,350,094.71	

From those data, here's the incremental cash flow constructed between Truck-LLO and each scenario for Truck-Hybrid

Table 4.12 Incremental Truck-LLO Cash Flow

Cashflow	0	2019	2020	2021	2022	2023	2024
Cash in							
Cost Saving		\$ 36,094,573.89	\$ 37,466,167.70	\$ 38,889,882.07	\$ 40,367,697.59	\$ 41,901,670.10	\$ 43,493,933.56
Cash out							
Depreciation		\$ (7,034,454.03)	\$ (7,034,454.03)	\$ (7,034,454.03)	\$ (7,034,454.03)	\$ (7,034,454.03)	\$ (7,034,454.03)
Net Cash		\$ 29,060,119.86	\$ 30,431,713.67	\$ 31,855,428.04	\$ 33,333,243.56	\$ 34,867,216.07	\$ 36,459,479.53
Income		\$29,060,119.86	\$30,431,713.67	\$31,855,428.04	\$33,333,243.56	\$34,867,216.07	\$36,459,479.53
Tax		(\$9,447,902.40)	(\$9,023,643.47)	(\$9,722,470.52)	(\$10,091,924.40)	(\$10,475,417.52)	(\$10,873,483.39)
Purchase Tax (PPH 22)		(\$1,371,718.54)					
PPH Badan >Rp. 50 Billion		(\$1,371,718.54)		(\$9,722,470.52)	(\$10,091,924.40)	(\$10,475,417.52)	(\$10,873,483.39)
Revenue		(\$92,819,620.94)	\$20,036,476.39	\$22,132,957.52	\$23,241,319.16	\$24,391,798.54	\$25,585,996.14
Depreciation	\$0.00	\$7,034,454.03	\$7,034,454.03	\$7,034,454.03	\$7,034,454.03	\$7,034,454.03	\$7,034,454.03
Net cashflow	(\$92,819,620.94)	\$27,070,930.42	\$28,099,635.77	\$29,167,411.55	\$30,275,773.19	\$31,426,252.57	\$32,620,450.17
Total Cashflow	(\$92,819,621)	(\$65,748,691)	(\$37,649,065)	(\$8,481,653)	\$21,794,120	\$53,220,373	\$85,840,823
Net Cashflow (Rp)	(Rp1,392,294,314,099)	Rp406,063,956,250	Rp421,494,386,588	Rp437,511,173,278	Rp454,136,597,863	Rp471,393,788,582	Rp489,306,752,548
Total Cashflow (Rp)	(Rp1,392,294,314,099)	(Rp986,230,357,848)	(Rp564,735,971,260)	(Rp127,224,797,982)	Rp326,911,799,881	Rp798,305,588,462	Rp1,287,612,341,010

Cashflow	2025	2026	2027	2028	2029	2030	2031
Cash in							
Cost Saving	\$45,146,703.04	\$46,862,277.75	\$48,643,044.30	\$50,491,479.99	\$52,410,156.23	\$54,401,742.16	\$56,469,008.37
Cash out							
Depreciation	(\$7,034,454.03)	(\$7,034,454.03)	(\$7,034,454.03)	(\$7,034,454.03)	(\$7,034,454.03)	(\$7,034,454.03)	(\$7,034,454.03)
Net Cash	\$38,112,249.00	\$39,827,823.72	\$41,608,590.27	\$43,457,025.96	\$45,375,702.20	\$47,367,288.13	\$49,434,554.34
Income	\$38,112,249.00	\$39,827,823.72	\$41,608,590.27	\$43,457,025.96	\$45,375,702.20	\$47,367,288.13	\$49,434,554.34
Tax	(\$11,286,675.76)	(\$11,715,569.44)	(\$12,160,761.08)	(\$12,622,870.00)	(\$13,102,539.06)	(\$13,600,435.54)	(\$14,117,252.09)
Purchase Tax (PPH 22)							
PPH Badan >Rp. 50 Billion	(\$11,286,675.76)	(\$11,715,569.44)	(\$12,160,761.08)	(\$12,622,870.00)	(\$13,102,539.06)	(\$13,600,435.54)	(\$14,117,252.09)
Revenue	\$26,825,573.25	\$28,112,254.28	\$29,447,829.20	\$30,834,155.96	\$32,273,163.14	\$33,766,852.59	\$35,317,302.24
Depreciation	\$7,034,454.03	\$7,034,454.03	\$7,034,454.03	\$7,034,454.03	\$7,034,454.03	\$7,034,454.03	\$7,034,454.03
Net cashflow	\$33,860,027.28	\$35,146,708.31	\$36,482,283.23	\$37,868,609.99	\$39,307,617.17	\$40,801,306.62	\$42,351,756.28
Total Cashflow	\$119,700,850	\$154,847,558	\$191,329,842	\$229,198,452	\$268,506,069	\$309,307,375	\$351,659,132
Net Cashflow (Rp)	Rp507,900,409,145	Rp527,200,624,692	Rp547,234,248,430	Rp568,029,149,871	Rp589,614,257,566	Rp612,019,599,353	Rp635,276,344,129
Total Cashflow (Rp)	Rp1,795,512,750,155	Rp2,322,713,374,847	Rp2,869,947,623,277	Rp3,437,976,773,148	Rp4,027,591,030,713	Rp4,639,610,630,067	Rp5,274,886,974,195

Table 4.13 Incremental Truck-Hybrid (25% LLO) Cash Flow

Cashflow	0	2019	2020	2021	2022	2023	2024
Cash in							
Cost Saving		\$8,918,758.64	\$9,257,671.47	\$9,609,462.99	\$9,974,622.58	\$10,353,658.24	\$10,747,097.25
Cash out							
Depresiasi		(\$2,250,042.79)	(\$2,250,042.79)	(\$2,250,042.79)	(\$2,250,042.79)	(\$2,250,042.79)	(\$2,250,042.79)
Net Cash							
Income	(\$29,250,556.25)	\$6,668,715.85	\$7,007,628.68	\$7,359,420.20	\$7,724,579.79	\$8,103,615.45	\$8,497,054.46
Tax	(\$438,758.34)	(\$2,229,689.66)	(\$2,314,417.87)	(\$2,402,365.75)	(\$2,493,655.65)	(\$2,588,414.56)	(\$2,686,774.31)
Purchase Tax (PPH 22)		(\$438,758.34)					
PPH Badan >Rp. 50 Billion		(\$2,229,689.66)	(\$2,314,417.87)	(\$2,402,365.75)	(\$2,493,655.65)	(\$2,588,414.56)	(\$2,686,774.31)
Revenue	(\$29,689,314.59)	\$4,439,026.19	\$4,693,210.81	\$4,957,054.45	\$5,230,924.15	\$5,515,200.89	\$5,810,280.15
Depreciation	\$0.00	\$2,250,042.79	\$2,250,042.79	\$2,250,042.79	\$2,250,042.79	\$2,250,042.79	\$2,250,042.79
Net cashflow	(\$29,689,314.59)	\$6,689,068.98	\$6,943,253.60	\$7,207,097.24	\$7,480,966.94	\$7,765,243.68	\$8,060,322.94
Total Cashflow	(\$29,689,314.59)	(\$23,000,245.61)	(\$16,056,992.01)	(\$8,849,894.77)	(\$1,368,927.83)	\$6,396,315.85	\$14,456,638.78
Net Cashflow (Rp)	(Rp445,339,718,906)	Rp100,336,034,729	Rp104,148,804,049	Rp108,106,458,603	Rp112,214,504,030	Rp116,478,655,183	Rp120,904,844,080
Total Cashflow (Rp)	(Rp445,339,718,906)	(Rp345,003,684,177)	(Rp240,854,880,128)	(Rp132,748,421,526)	(Rp20,533,917,496)	Rp95,944,737,686	Rp216,849,581,766

Cashflow	2025	2026	2027	2028	2029	2030	2031
Cash in							
Cost Saving	\$11,155,486.95	\$11,579,395.45	\$12,019,412.48	\$12,476,150.15	\$12,950,243.86	\$13,442,353.12	\$13,953,162.54
Cash out							
Depresiasi	(\$2,250,042.79)	(\$2,250,042.79)	(\$2,250,042.79)	(\$2,250,042.79)	(\$2,250,042.79)	(\$2,250,042.79)	(\$2,250,042.79)
Net Cash							
Income	\$8,905,444.16	\$9,329,352.66	\$9,769,369.69	\$10,226,107.36	\$10,700,201.07	\$11,192,310.34	\$11,703,119.76
Tax	\$8,905,444.16	\$9,329,352.66	\$9,769,369.69	\$10,226,107.36	\$10,700,201.07	\$11,192,310.34	\$11,703,119.76
Income	(\$2,788,871.74)	(\$2,894,848.86)	(\$3,004,853.12)	(\$3,119,037.54)	(\$3,237,560.96)	(\$3,360,588.28)	(\$3,488,290.64)
Purchase Tax (PPH 22)							
PPH Badan >Rp. 50 Billion	(\$2,788,871.74)	(\$2,894,848.86)	(\$3,004,853.12)	(\$3,119,037.54)	(\$3,237,560.96)	(\$3,360,588.28)	(\$3,488,290.64)
Revenue	\$6,116,572.42	\$6,434,503.80	\$6,764,516.57	\$7,107,069.83	\$7,462,640.11	\$7,831,722.06	\$8,214,829.12
Depreciation	\$2,250,042.79	\$2,250,042.79	\$2,250,042.79	\$2,250,042.79	\$2,250,042.79	\$2,250,042.79	\$2,250,042.79
Net cashflow	\$8,366,615.21	\$8,684,546.59	\$9,014,559.36	\$9,357,112.61	\$9,712,682.89	\$10,081,764.84	\$10,464,871.91
Total Cashflow	\$22,823,253.99	\$31,507,800.58	\$40,522,359.94	\$49,879,472.56	\$59,592,155.45	\$69,673,920.29	\$80,138,792.20
Net Cashflow (Rp)	Rp125,499,228,155	Rp130,268,198,825	Rp135,218,390,380	Rp140,356,689,214	Rp145,690,243,404	Rp151,226,472,654	Rp156,973,078,615
Total Cashflow (Rp)	Rp342,348,809,921	Rp472,617,008,745	Rp607,835,399,125	Rp748,192,088,339	Rp893,882,331,744	Rp1,045,108,804,397	Rp1,202,081,883,012

Table 4.15 Incremental Truck-Hybrid (75% LLO) Cash Flow

Cashflow	0	2019	2020	2021	2022	2023	2024
Cash in							
Cost Saving		\$24,962,012.61	\$25,910,569.09	\$26,895,170.71	\$27,917,187.20	\$28,978,040.31	\$30,079,205.84
Cash out							
Depresiasi		(\$5,719,238.05)	(\$5,719,238.05)	(\$5,719,238.05)	(\$5,719,238.05)	(\$5,719,238.05)	(\$5,719,238.05)
Net Cash		\$19,242,774.55	\$20,191,331.03	\$21,175,932.66	\$22,197,949.14	\$23,258,802.26	\$24,359,967.79
Income	(\$74,350,094.71)	\$19,242,774.55	\$20,191,331.03	\$21,175,932.66	\$22,197,949.14	\$23,258,802.26	\$24,359,967.79
Tax	(\$1,115,251.42)	(\$6,240,503.15)	(\$6,477,642.27)	(\$6,723,792.68)	(\$6,979,296.80)	(\$7,244,510.08)	(\$7,519,801.46)
Purchase Tax (PPh 22)	(\$1,115,251.42)						
PPH Badan >Rp. 50 Billion		(\$6,240,503.15)	(\$6,477,642.27)	(\$6,723,792.68)	(\$6,979,296.80)	(\$7,244,510.08)	(\$7,519,801.46)
Revenue	(\$75,465,346.13)	\$13,002,271.40	\$13,713,688.76	\$14,452,139.98	\$15,218,652.34	\$16,014,292.18	\$16,840,166.33
Depreciation	\$0.00	\$5,719,238.05	\$5,719,238.05	\$5,719,238.05	\$5,719,238.05	\$5,719,238.05	\$5,719,238.05
Net cashflow	(\$75,465,346.13)	\$18,721,509.46	\$19,432,926.81	\$20,171,378.03	\$20,937,890.40	\$21,733,530.23	\$22,559,404.38
Total Cashflow	(\$75,465,346.13)	(\$56,743,836.68)	(\$37,310,909.86)	(\$17,139,531.83)	\$3,798,358.57	\$25,531,888.80	\$48,091,293.19
Net Cashflow (Rp)	(Rp1,131,980,191,983)	Rp280,822,641,828	Rp291,493,902,218	Rp302,570,670,502	Rp314,068,355,981	Rp326,002,953,509	Rp338,391,065,742
Total Cashflow (Rp)	(Rp1,131,980,191,983)	(Rp851,157,550,155)	(Rp559,663,647,937)	(Rp257,092,977,435)	Rp56,975,378,547	Rp382,978,332,055	Rp721,369,397,797

Cashflow	2025	2026	2027	2028	2029	2030	2031
Cash in							
Cost Saving	\$31,222,215.67	\$32,408,659.86	\$33,640,188.94	\$34,918,516.12	\$36,245,419.73	\$37,622,745.68	\$39,052,410.01
Cash out							
Depresiasi	(\$5,719,238.05)	(\$5,719,238.05)	(\$5,719,238.05)	(\$5,719,238.05)	(\$5,719,238.05)	(\$5,719,238.05)	(\$5,719,238.05)
Net Cash	\$25,502,977.61	\$26,689,421.81	\$27,920,950.88	\$29,199,278.06	\$30,526,181.67	\$31,903,507.62	\$33,333,171.96
Income	\$25,502,977.61	\$26,689,421.81	\$27,920,950.88	\$29,199,278.06	\$30,526,181.67	\$31,903,507.62	\$33,333,171.96
Tax	(\$7,805,553.92)	(\$8,102,164.97)	(\$8,410,047.23)	(\$8,729,629.03)	(\$9,061,354.93)	(\$9,405,686.42)	(\$9,763,102.50)
Purchase Tax (PPh 22)							
PPH Badan >Rp. 50 Billion	(\$7,805,553.92)	(\$8,102,164.97)	(\$8,410,047.23)	(\$8,729,629.03)	(\$9,061,354.93)	(\$9,405,686.42)	(\$9,763,102.50)
Revenue	\$17,697,423.69	\$18,587,256.84	\$19,510,903.65	\$20,469,649.03	\$21,464,826.74	\$22,497,821.20	\$23,570,069.46
Depreciation	\$5,719,238.05	\$5,719,238.05	\$5,719,238.05	\$5,719,238.05	\$5,719,238.05	\$5,719,238.05	\$5,719,238.05
Net cashflow	\$23,416,661.75	\$24,306,494.90	\$25,230,141.70	\$26,188,887.09	\$27,184,064.80	\$28,217,059.26	\$29,289,307.51
Total Cashflow	\$71,507,954.94	\$95,814,449.83	\$121,044,591.53	\$147,233,478.62	\$174,417,543.42	\$202,634,602.67	\$231,923,910.18
Net Cashflow (Rp)	Rp351,249,926,240	Rp364,597,423,437	Rp378,452,125,528	Rp392,833,306,298	Rp407,760,971,937	Rp423,255,888,871	Rp439,339,612,648
Total Cashflow (Rp)	Rp1,072,619,324,037	Rp1,437,216,747,474	Rp1,815,668,873,002	Rp2,208,502,179,300	Rp2,616,263,151,237	Rp3,039,519,040,108	Rp3,478,858,652,756

Here is chart of cost saving, net cashflow, and yearly total cash flow based on cash flow on Table 4.12, Table 4.13, Table 4.14, and Table 4.15. Based on those charts, the best alternative and scenario can be ranked based on the biggest profit.

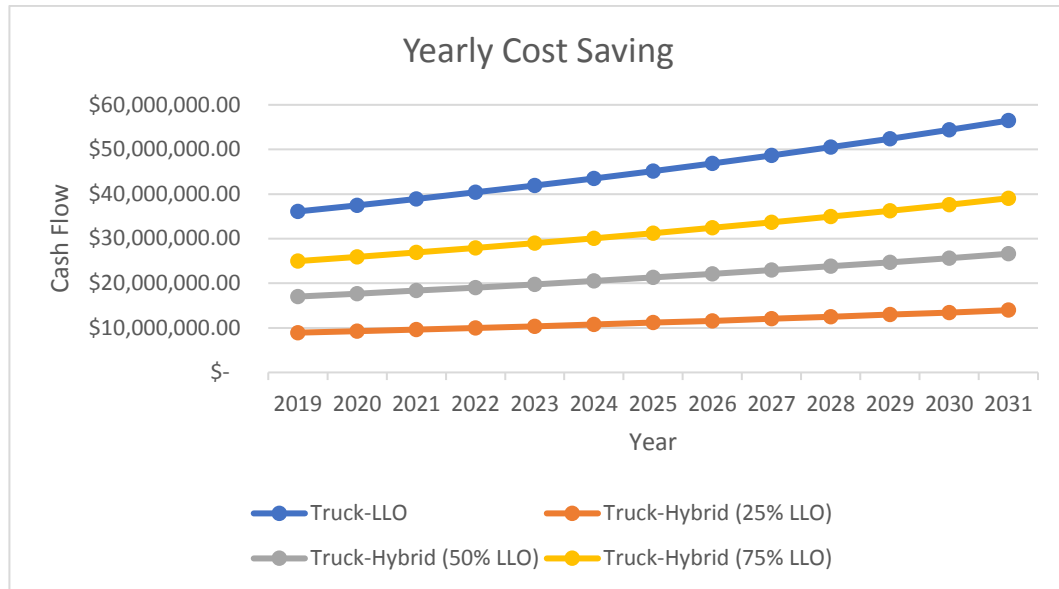


Figure 4.2 Yearly Cost Saving

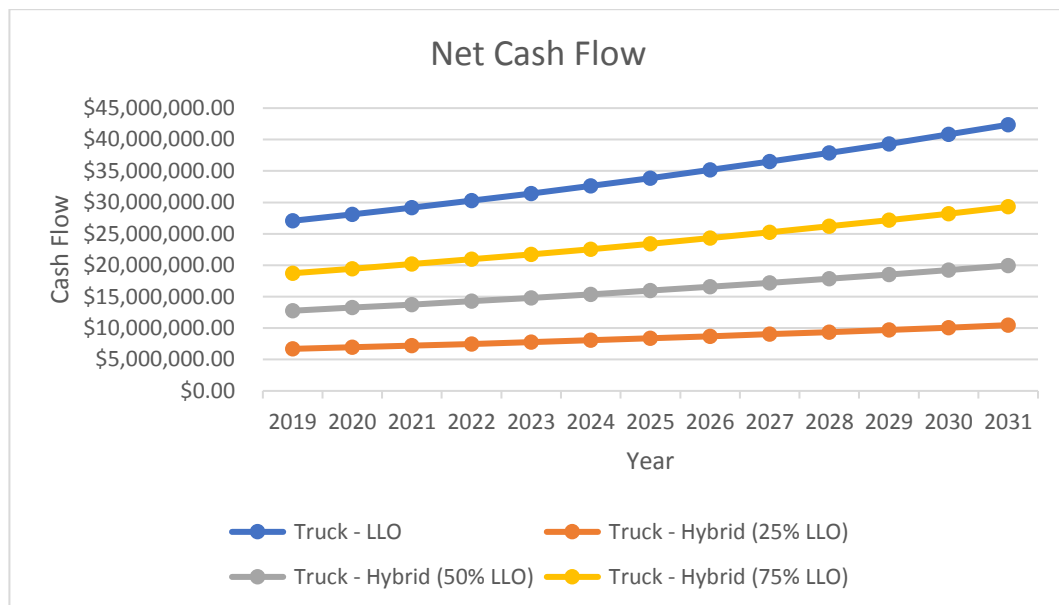


Figure 4.3 Net Cash Flow

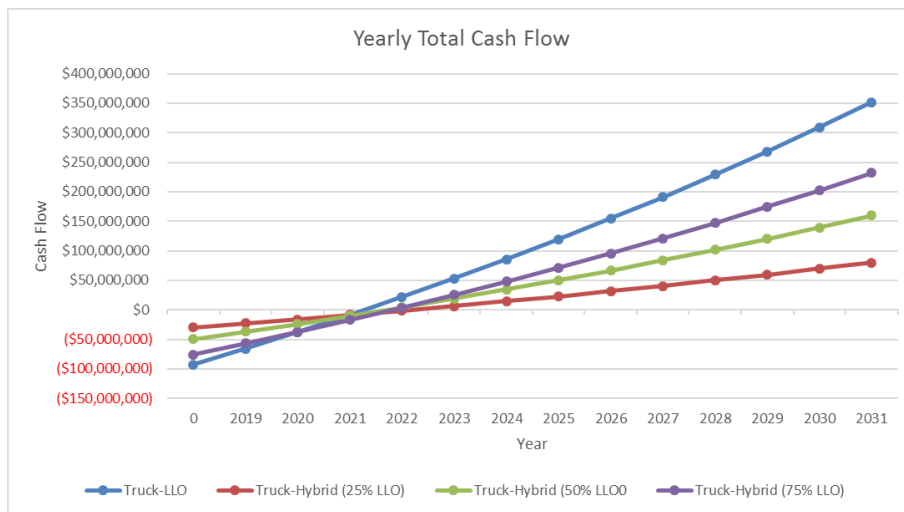


Figure 4.4 Yearly Total Cash Flow

Based on chart above, alternative 2 LLO and each alternative 3 hybrid scenario are better compared to alternative 1 truck. Alternative 2 LLO give the biggest profit with \$351,659,132 followed by alternative 3 hybrid with scenario 75% of total distance using LLO which generate \$231,923,910.18 by the end of year 2031. As such, scenario using 75% LLO for alternative 3 will be the one chosen to be compared with another alternative rather than scenario of alternative 3 hybrid with 25% LLO or 50% LLO.

Because alternative 2 LLO proven to be better than alternative 1 truck and alternative 3 hybrid with scenario of 75% LLO better than alternative 1 truck and other alternative 3 scenario, alternative 2 LLO and alternative 3 hybrid with 75% LLO need incremental cash flow to see how better or worse between those alternatives are. The data for incremental hybrid (75% LLO)-LLO can be seen below while the constructed cash flow for incremental hybrid-LLO can be seen on Table 4.16.

Table 4.16 Data for Hybrid (75% LLO)-LLO

Item	Value	Remarks
Cost Saving	\$ 11,132,561	OPEX Truck-LLO
Concession time	13	year
Purchase Tax (PPh 22)	1.5%	
PPH Badan >Rp. 50	25%	
Inflation	3.8%	
CAPEX Hybrid (75% LLO)	\$74,350,094.71	
CAPEX LLO	\$ 91,447,902	
CAPEX Hybrid-LLO	\$ 17,097,808	

Table 4.17 Hybrid (75% LLO)-LLO Cash Flow

Cashflow	0	2019	2020	2021	2022	2023	2024
Cash in							
Cost Saving		\$11,132,561.28	\$11,555,598.61	\$11,994,711.36	\$12,450,510.39	\$12,923,629.78	\$13,414,727.72
Cash out							
Depresiasi		(\$1,315,215.98)	(\$1,315,215.98)	(\$1,315,215.98)	(\$1,315,215.98)	(\$1,315,215.98)	(\$1,315,215.98)
Net Cash		\$9,817,345.31	\$10,240,382.63	\$10,679,495.38	\$11,135,294.41	\$11,608,413.81	\$12,099,511.74
Income	(\$17,097,807.69)	\$9,817,345.31	\$10,240,382.63	\$10,679,495.38	\$11,135,294.41	\$11,608,413.81	\$12,099,511.74
Tax	(\$256,467.12)	(\$2,783,140.32)	(\$2,888,899.65)	(\$2,998,677.84)	(\$3,112,627.60)	(\$3,230,907.45)	(\$3,353,681.93)
Purchase Tax (PPh 22)	(\$256,467.12)						
PPH Badan >Rp. 50 Billion		(\$2,783,140.32)	(\$2,888,899.65)	(\$2,998,677.84)	(\$3,112,627.60)	(\$3,230,907.45)	(\$3,353,681.93)
Revenue	(\$17,354,274.81)	\$7,034,204.99	\$7,351,482.98	\$7,680,817.54	\$8,022,666.82	\$8,377,506.36	\$8,745,829.81
Depreciation	\$0.00	\$1,315,215.98	\$1,315,215.98	\$1,315,215.98	\$1,315,215.98	\$1,315,215.98	\$1,315,215.98
Net cashflow	(\$17,354,274.81)	\$8,349,420.96	\$8,666,698.96	\$8,996,033.52	\$9,337,882.79	\$9,692,722.34	\$10,061,045.79
Total Cashflow	(\$17,354,274.81)	(\$9,004,853.85)	(\$338,154.89)	\$8,657,878.63	\$17,995,761.42	\$27,688,483.76	\$37,749,529.55
Net Cashflow (Rp)	(Rp260,314,122,115)	Rp125,241,314,422	Rp130,000,484,370	Rp134,940,502,776	Rp140,068,241,882	Rp145,390,835,073	Rp150,915,686,806
Total Cashflow (Rp)	(Rp260,314,122,115)	(Rp135,072,807,693)	(Rp5,072,323,323)	Rp129,868,179,453	Rp269,936,421,334	Rp415,327,256,407	Rp566,242,943,213

Cashflow	2025	2026	2027	2028	2029	2030	2031
Cash in							
Cost Saving	\$13,924,487.37	\$14,453,617.89	\$15,002,855.37	\$15,572,963.87	\$16,164,736.50	\$16,778,996.49	\$17,416,598.35
Cash out							
Depresiasi	(\$1,315,215.98)	(\$1,315,215.98)	(\$1,315,215.98)	(\$1,315,215.98)	(\$1,315,215.98)	(\$1,315,215.98)	(\$1,315,215.98)
Net Cash	\$12,609,271.39	\$13,138,401.91	\$13,687,639.39	\$14,257,747.90	\$14,849,520.52	\$15,463,780.51	\$16,101,382.38
Income	\$12,609,271.39	\$13,138,401.91	\$13,687,639.39	\$14,257,747.90	\$14,849,520.52	\$15,463,780.51	\$16,101,382.38
Tax	(\$3,481,121.84)	(\$3,613,404.47)	(\$3,750,713.84)	(\$3,893,240.97)	(\$4,041,184.13)	(\$4,194,749.12)	(\$4,354,149.59)
Purchase Tax (PPh 22)							
PPH Badan >Rp. 50 Billion	(\$3,481,121.84)	(\$3,613,404.47)	(\$3,750,713.84)	(\$3,893,240.97)	(\$4,041,184.13)	(\$4,194,749.12)	(\$4,354,149.59)
Revenue	\$9,128,149.55	\$9,524,997.44	\$9,936,925.55	\$10,364,506.93	\$10,808,336.40	\$11,269,031.39	\$11,747,232.79
Depreciation	\$1,315,215.98	\$1,315,215.98	\$1,315,215.98	\$1,315,215.98	\$1,315,215.98	\$1,315,215.98	\$1,315,215.98
Net cashflow	\$10,443,365.53	\$10,840,213.42	\$11,252,141.53	\$11,679,722.90	\$12,123,552.38	\$12,584,247.37	\$13,062,448.77
Total Cashflow	\$48,192,895.07	\$59,033,108.49	\$70,285,250.02	\$81,964,972.92	\$94,088,525.30	\$106,672,772.66	\$119,735,221.43
Net Cashflow (Rp)	Rp156,650,482,904	Rp162,603,201,255	Rp168,782,122,902	Rp175,195,843,573	Rp181,853,285,629	Rp188,763,710,482	Rp195,936,731,481
Total Cashflow (Rp)	Rp722,893,426,118	Rp885,496,627,372	Rp1,054,278,750,275	Rp1,229,474,593,848	Rp1,411,327,879,476	Rp1,600,091,589,959	Rp1,796,028,321,439

The result of incremental between Hybrid-LLO resulting in alternative 2 LLO as better choice as its still profitable when incremental with alternative 3 hybrid with 75% LLO. Based on the incremental cash flow of hybrid-LLO substituting to LLO can give total cash flow of \$ 119,735,221.43.

Based on incremental Truck-LLO and Truck-Hybrid cash flow, cash flow for each alternative can be constructed. The necessary data regarding tax is discovered through previous incremental cash flow. For incremental Truck-Hybrid, the scenario for hybrid will be using 75% LLO. Here's the cash flow for each alternative

Table 4.18 Alternative 1 Truck Cash Flow

Cashflow	0	2019	2020	2021	2022	2023	2024
CAPEX	\$0.00						
OPEX		(\$40,853,091.62)	(\$42,405,509.10)	(\$44,016,918.45)	(\$45,689,561.35)	(\$47,425,764.68)	(\$49,227,943.74)
Net Cash Flow	\$0.00	(\$40,853,091.62)	(\$42,405,509.10)	(\$44,016,918.45)	(\$45,689,561.35)	(\$47,425,764.68)	(\$49,227,943.74)
Tax							
Purchase Tax (PPh 22)	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
PPH Badan >Rp. 50 Billion	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Net cashflow	\$0.00	(\$40,853,091.62)	(\$42,405,509.10)	(\$44,016,918.45)	(\$45,689,561.35)	(\$47,425,764.68)	(\$49,227,943.74)
Total Cashflow	\$0.00	(\$40,853,091.62)	(\$83,258,600.72)	(\$127,275,519.17)	(\$172,965,080.52)	(\$220,390,845.20)	(\$269,618,788.94)
Net Cashflow (Rp)	Rp0	(Rp612,796,374,311)	(Rp636,082,636,534)	(Rp660,253,776,723)	(Rp685,343,420,238)	(Rp711,386,470,207)	(Rp738,419,156,075)
Total Cashflow (Rp)	Rp0	(Rp612,796,374,311)	(Rp1,248,879,010,845)	(Rp1,909,132,787,568)	(Rp2,594,476,207,806)	(Rp3,305,862,678,013)	(Rp4,044,281,834,088)

Cashflow	2025	2026	2027	2028	2029	2030	2031
CAPEX							
OPEX	(\$51,098,605.60)	(\$53,040,352.61)	(\$55,055,886.01)	(\$57,148,009.68)	(\$59,319,634.05)	(\$61,573,780.14)	(\$63,913,583.79)
Net Cash Flow	(\$51,098,605.60)	(\$53,040,352.61)	(\$55,055,886.01)	(\$57,148,009.68)	(\$59,319,634.05)	(\$61,573,780.14)	(\$63,913,583.79)
Tax							
Purchase Tax (PPh 22)	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
PPH Badan >Rp. 50 Billion	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Net cashflow	(\$51,098,605.60)	(\$53,040,352.61)	(\$55,055,886.01)	(\$57,148,009.68)	(\$59,319,634.05)	(\$61,573,780.14)	(\$63,913,583.79)
Total Cashflow	(\$320,717,394.54)	(\$373,757,747.15)	(\$428,813,633.17)	(\$485,961,642.85)	(\$545,281,276.90)	(\$606,855,057.04)	(\$670,768,640.83)
Net Cashflow (Rp)	(Rp766,479,084,006)	(Rp795,605,289,198)	(Rp825,838,290,188)	(Rp857,220,145,215)	(Rp889,794,510,733)	(Rp923,606,702,141)	(Rp958,703,756,822)
Total Cashflow (Rp)	(Rp766,479,084,006)	(Rp1,562,084,373,204)	(Rp2,387,922,663,392)	(Rp3,245,142,808,607)	(Rp4,134,937,319,340)	(Rp5,058,544,021,481)	(Rp6,017,247,778,303)

Table 4.19 Alternative 2 LLO Cash Flow

Cashflow	0	2019	2020	2021	2022	2023	2024
CAPEX	(\$73,464,825.48)						
OPEX		(\$9,098,677.28)	(\$9,444,427.01)	(\$9,803,315.24)	(\$10,175,841.22)	(\$10,562,523.18)	(\$10,963,899.07)
Net Cash Flow	(\$73,464,825.48)	(\$9,098,677.28)	(\$9,444,427.01)	(\$9,803,315.24)	(\$10,175,841.22)	(\$10,562,523.18)	(\$10,963,899.07)
Tax	(\$1,101,972.38)						
Purchase Tax (PPh 22)	(\$1,101,972.38)	(\$7,938,330.30)	(\$8,239,986.85)	(\$8,553,106.35)	(\$8,878,124.39)	(\$9,215,493.12)	(\$9,565,681.86)
PPH Badan >Rp. 50 Billion		(\$7,938,330.30)	(\$8,239,986.85)	(\$8,553,106.35)	(\$8,878,124.39)	(\$9,215,493.12)	(\$9,565,681.86)
Net cashflow	(\$74,566,797.86)	(\$17,037,007.57)	(\$17,684,413.86)	(\$18,356,421.59)	(\$19,053,965.61)	(\$19,778,016.30)	(\$20,529,580.92)
Total Cashflow	(\$74,566,797.86)	(\$91,603,805.44)	(\$109,288,219.30)	(\$127,644,640.89)	(\$146,698,606.49)	(\$166,476,622.80)	(\$187,006,203.72)
Net Cashflow (Rp)	(Rp1,118,501,967,945)	(Rp255,555,113,605)	(Rp265,266,207,922)	(Rp275,346,323,823)	(Rp285,809,484,129)	(Rp296,670,244,526)	(Rp307,943,713,818)
Total Cashflow (Rp)	(Rp1,118,501,967,945)	(Rp1,374,057,081,550)	(Rp1,639,323,289,472)	(Rp1,914,669,613,296)	(Rp2,200,479,097,424)	(Rp2,497,149,341,950)	(Rp2,805,093,055,767)

Cashflow	2025	2026	2027	2028	2029	2030	2031
CAPEX							
OPEX	(\$11,380,527.23)	(\$11,812,987.26)	(\$12,261,880.78)	(\$12,727,832.25)	(\$13,211,489.88)	(\$13,713,526.49)	(\$14,234,640.50)
Net Cash Flow	(\$11,380,527.23)	(\$11,812,987.26)	(\$12,261,880.78)	(\$12,727,832.25)	(\$13,211,489.88)	(\$13,713,526.49)	(\$14,234,640.50)
Tax							
Purchase Tax (PPh 22)	(\$9,929,177.77)	(\$10,306,486.52)	(\$10,698,133.01)	(\$11,104,662.06)	(\$11,526,639.22)	(\$11,964,651.51)	(\$12,419,308.27)
PPH Badan >Rp. 50 Billion	(\$9,929,177.77)	(\$10,306,486.52)	(\$10,698,133.01)	(\$11,104,662.06)	(\$11,526,639.22)	(\$11,964,651.51)	(\$12,419,308.27)
Net cashflow	(\$21,309,705.00)	(\$22,119,473.79)	(\$22,960,013.79)	(\$23,832,494.31)	(\$24,738,129.10)	(\$25,678,178.00)	(\$26,653,948.77)
Total Cashflow	(\$208,315,908.71)	(\$230,435,382.50)	(\$253,395,396.29)	(\$277,227,890.60)	(\$301,966,019.70)	(\$327,644,197.71)	(\$354,298,146.47)
Net Cashflow (Rp)	(Rp319,645,574,943)	(Rp331,792,106,790)	(Rp344,400,206,848)	(Rp357,487,414,709)	(Rp371,071,936,468)	(Rp385,172,670,053)	(Rp399,809,231,515)
Total Cashflow (Rp)	(Rp319,645,574,943)	(Rp651,437,681,733)	(Rp995,837,888,581)	(Rp1,353,325,303,290)	(Rp1,724,397,239,758)	(Rp2,109,569,909,811)	(Rp2,509,379,141,326)

Table 4.20 Alternative 3 Hybrid (75% LLO) Cash Flow

Cashflow	0	2019	2020	2021	2022	2023	2024
CAPEX	(\$74,350,094.71)						
OPEX		(\$21,294,614.37)	(\$22,103,809.71)	(\$22,943,754.48)	(\$23,815,617.15)	(\$24,720,610.60)	(\$25,659,993.81)
Net Cash Flow	(\$74,350,094.71)	(\$21,294,614.37)	(\$22,103,809.71)	(\$22,943,754.48)	(\$23,815,617.15)	(\$24,720,610.60)	(\$25,659,993.81)
Tax	(\$966,723.73)	(\$5,722,356.49)	(\$5,939,806.04)	(\$6,165,518.67)	(\$6,399,808.37)	(\$6,643,001.09)	(\$6,895,435.13)
Purchase Tax (PPh 22)	(\$966,723.73)						
PPH Badan >Rp. 50 Billion		(\$5,722,356.49)	(\$5,939,806.04)	(\$6,165,518.67)	(\$6,399,808.37)	(\$6,643,001.09)	(\$6,895,435.13)
Net cashflow	(\$75,316,818.44)	(\$27,016,970.86)	(\$28,043,615.75)	(\$29,109,273.15)	(\$30,215,425.53)	(\$31,363,611.70)	(\$32,555,428.94)
Total Cashflow	(\$75,316,818.44)	(\$102,333,789.30)	(\$130,377,405.05)	(\$159,486,678.19)	(\$189,702,103.72)	(\$221,065,715.42)	(\$253,621,144.36)
Net Cashflow (Rp)	(Rp1,129,752,276,599)	(Rp405,254,562,851)	(Rp420,654,236,239)	(Rp436,639,097,216)	(Rp453,231,382,910)	(Rp470,454,175,461)	(Rp488,331,434,128)
Total Cashflow (Rp)	(Rp1,129,752,276,599)	(Rp1,535,006,839,449)	(Rp1,955,661,075,688)	(Rp2,392,300,172,904)	(Rp2,845,531,555,815)	(Rp3,315,985,731,276)	(Rp3,804,317,165,404)

Cashflow	2025	2026	2027	2028	2029	2030	2031
CAPEX							
OPEX	(\$26,635,073.57)	(\$27,647,206.37)	(\$28,697,800.21)	(\$29,788,316.62)	(\$30,920,272.65)	(\$32,095,243.01)	(\$33,314,862.24)
Net Cash Flow	(\$26,635,073.57)	(\$27,647,206.37)	(\$28,697,800.21)	(\$29,788,316.62)	(\$30,920,272.65)	(\$32,095,243.01)	(\$33,314,862.24)
Tax	(\$7,157,461.67)	(\$7,429,445.21)	(\$7,711,764.13)	(\$8,004,811.17)	(\$8,308,993.99)	(\$8,624,735.76)	(\$8,952,475.72)
Purchase Tax (PPh 22)							
PPH Badan >Rp. 50 Billion	(\$7,157,461.67)	(\$7,429,445.21)	(\$7,711,764.13)	(\$8,004,811.17)	(\$8,308,993.99)	(\$8,624,735.76)	(\$8,952,475.72)
Net cashflow	(\$33,792,535.24)	(\$35,076,651.58)	(\$36,409,564.34)	(\$37,793,127.79)	(\$39,229,266.64)	(\$40,719,978.77)	(\$42,267,337.97)
Total Cashflow	(\$287,413,679.60)	(\$322,490,331.18)	(\$358,899,895.52)	(\$396,693,023.31)	(\$435,922,289.95)	(\$476,642,268.73)	(\$518,909,606.69)
Net Cashflow (Rp)	(Rp506,888,028,625)	(Rp526,149,773,713)	(Rp546,143,465,114)	(Rp566,896,916,789)	(Rp588,438,999,627)	(Rp610,799,681,612)	(Rp634,010,069,514)
Total Cashflow (Rp)	(Rp506,888,028,625)	(Rp1,033,037,802,338)	(Rp1,579,181,267,453)	(Rp2,146,078,184,241)	(Rp2,734,517,183,868)	(Rp3,345,316,865,480)	(Rp3,979,326,934,994)

Based on Table 4.18, Table 4.19, and Table 4.20, here are the net cash flow and total cash flow chart for alternative 1 truck, alternative 2 LLO, and alternative 3 hybrid with 75% LLO:

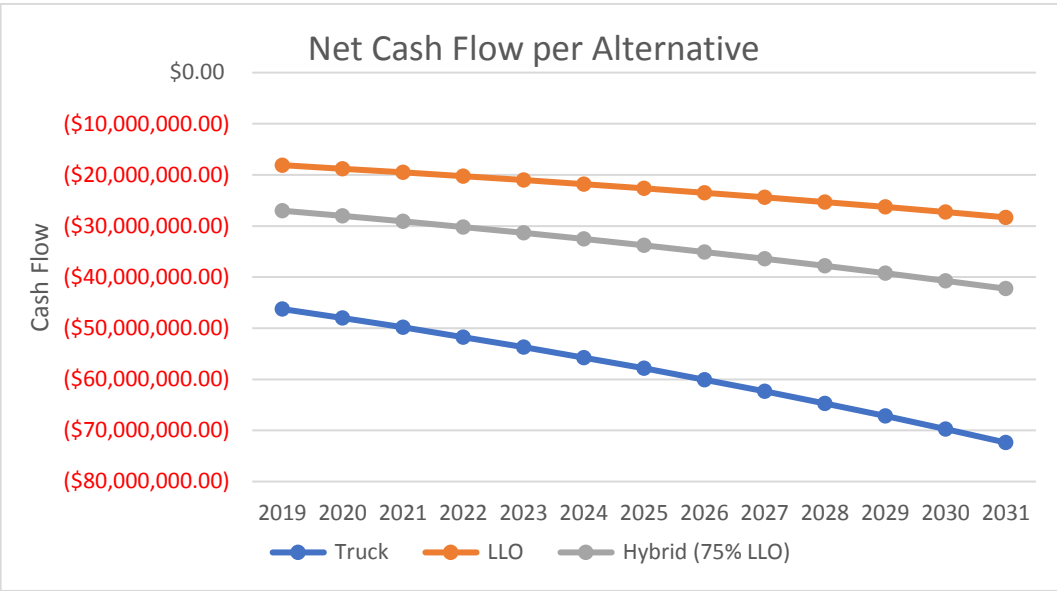


Figure 4.5 Net Cash Flow per Alternative

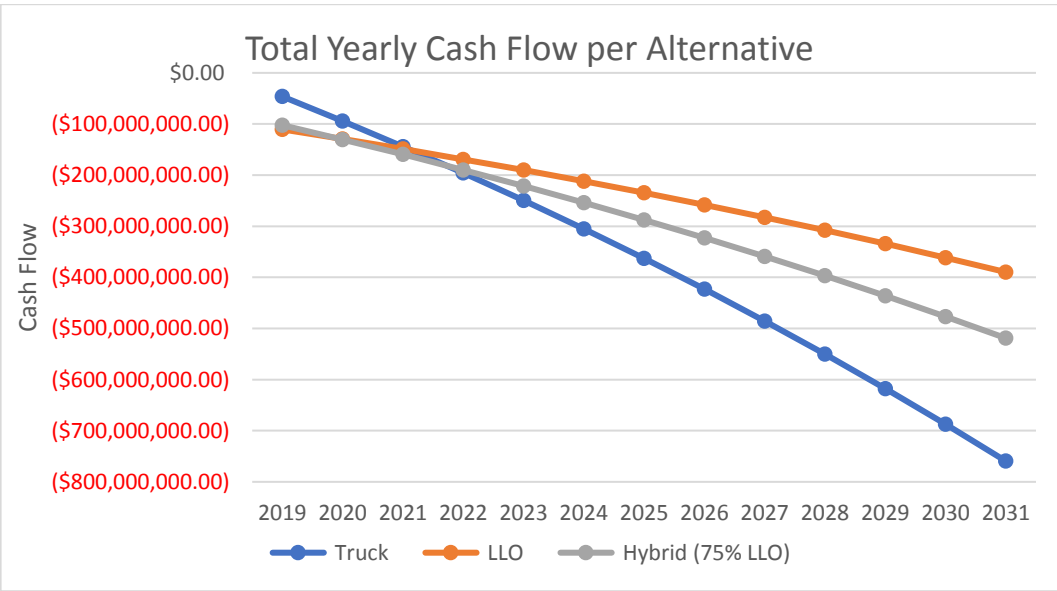


Figure 4.6 Total Yearly Cash Flow

Based on the cash flow and resulting chart, alternative 2 LLO require less total cost with (\$389,740,835.82). Alternative 3 hybrid with 75% LLO follow with

total cost of (\$518,909,606.69). The highest total cost is incurred by alternative 1 truck with total cost of (\$759,489,516.55).

4.7 Net Present Value

Net Present Value or also known as NPV is method for cost calculation by converting the total cost, including forecasted income and expense, in the future into present day value. NPV method can easily show the benefit or harm for investment alternative. The advantage of using NPV method to other financial analysis method is the ability to calculate the advantage and disadvantage of investment in present day money value.

NPV in this research is used to calculate how much the CAPEX and OPEX incurred in each alternative in present day value to help choose which alternative is the best. For this research purpose, there will be 2 type of Present Value. The first are Expenditure Present Value (EPV). As there is no inherent income in this research and instead use cost saving for income, the cash flow for each alternative result in negative value. Using the same formula for NPV, total expense in present day value can be found. The tax for alternative 2 and alternative 3 in EPV use the same tax from incremental NPV. Tax PPh22 based on CAPEX while PPh Badan is depending on income. This mean that truck is not subjected to tax as there is no CAPEX or income obtained from cost saving of OPEX different. The second are NPV by using alternative 1 truck as benchmark to make NPV analysis for LLO and hybrid. Here is the result of EPV for alternative 1 truck, alternative 2 LLO, and alternative 3 hybrid:

Table 4.21 Expense Present Value

Description	Truck	LLO	Hybrid (75% LLO)
Production Capacity	20,000,000	20,000,000	20,000,000
CAPEX	\$0.00	\$ 91,447,902	\$ 74,350,095
OPEX	\$ 46,256,627	\$ 10,162,053	\$ 21,294,614
Distance (Km)	73	70	72
Inflation	3.8%	3.8%	3.8%
PPh 22	0.0%	1.5%	1.5%
PPH Badan >Rp. 50 Billion	0%	25%	25%
EPV	(\$579,321,917.79)	(\$319,240,610.79)	(\$413,679,651.91)
EPV (Rp)	(Rp7,674,713,743,774.64)	(Rp4,319,095,876,296.43)	(Rp5,436,165,442,174.79)

If using incremental NPV with alternative 1 truck as benchmark, here is the NPV:

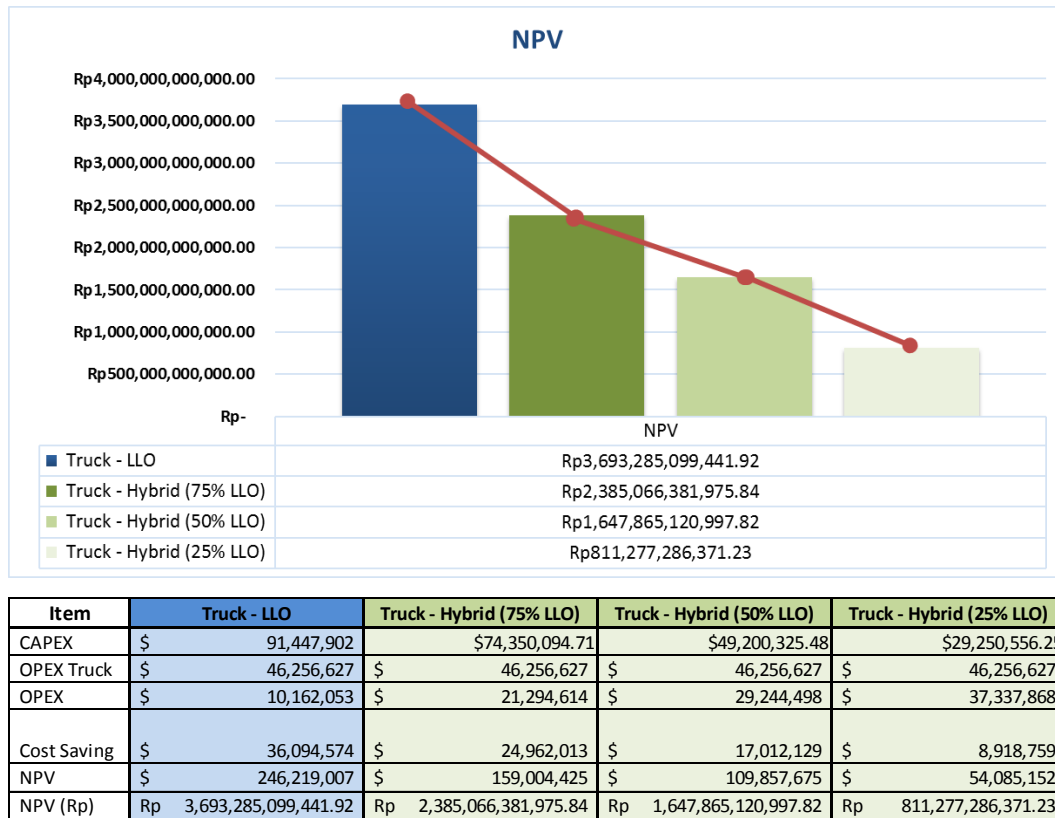


Figure 4.7 Net Present Value

As the calculation of EPV through expenditure instead of income, the bigger the EPV negative value, the less appetizing an alternative is. Based on above result in Table 4.21, Truck alternative have the biggest EPV with **(\$579,321,917.79)** or **(Rp7,674,713,743,774.64)** which make it the least feasible alternative. Second best result is hybrid with EPV of **(\$413,679,651.91)** or **(Rp5,436,165,442,174.79)**. The last is LLO with the least EPV of **(\$319,240,610.79)** or around **(Rp4,319,095,876,296.43)**.

For NPV using alternative 1 truck as benchmark, the bigger the NPV the better alternative it is. However, if NPV value negative, this means that the benchmark used in comparison is better compared to the other alternative. Based on Figure 4.7, Truck-LLO give NPV of \$246,219,007 or Rp3,693,285,099,441.92

while Truck-Hybrid (75% LLO) give NPV of \$159,004,425 or Rp2,385,066,381,975.84.

Based on calculation of both NPV and Incremental NPV, alternative 2 LLO is deem to be the best possible alternative. However as alternative 3 hybrid also result with least EPV compared to alternative 1 truck while also result in positive NPV in Incremental NPV, alternative 3 also deem as feasible choice of transportation method.

4.8 Internal Rate of Return

Internal Rate of Return or IRR is the efficiency of an investment. An investment got go a no go depend whether the IRR is bigger than other investment. IRR also required to be bigger than Minimum Attractive Rate of Return (MARR). For example, if company want at least 10% MARR. Then even if IRR 8% is already generating profit, the company might not accept the project as it deems too much problem or time consuming.

Same as NPV, we use alternative 1 truck as benchmark. If the IRR not found then the alternative 1 is the correct result. PT X require at least 7% of MARR for project to be acceptable. Here's the IRR based on the cash flow of Table 4.12, Table 4.13, Table 4.14, Table 4.15 and Table 4.16.

Table 4.22 MARR and IRR

MARR	Truck - LLO	Truck - Hybrid (25% LLO)
7%	31.64%	24.13%

MARR	Truck - Hybrid (50% LLO)	Truck - Hybrid (75% LLO)
7%	27.61%	26.76%

MARR	Hybrid (75% LLO) - LLO
7%	51.56%

The result is both alternative 2 LLO and alternative 3 Hybrid is better than alternative 1 truck. Both alternative also have bigger percentage than the MARR so it's acceptable investment. Alternative 3 with scenario of 50% LLO have the

biggest IRR compared to the other scenario. However, LLO generate more profit than hybrid with 50% LLO scenario which suggest alternative 2 LLO as the better option. Additionally because NPV of alternative 3 scenario using 75% LLO is bigger compared to scenario using 50% LLO, even with bigger IRR, scenario using 75% LLO is still more preferable.

4.9 Payback Period

Payback period is the period required for company to regain back its money from its investment cost. As seen in Table 4.8 and Table 4.9, Truck-LLO and Truck-Hybrid have different payback period. Based on the cashflow, alternative 2 LLO will only require 3 year to regain back its investment cost in the year 2021. Alternative 3 hybrid will require 3 year instead and regain back its investment cost in the year 2022.

Table 4.23 Payback Period

Cash Flow	0	2019	2020	2021
Truck - LLO	(\$92,819,620.94)	(\$65,748,690.52)	(\$37,649,064.75)	(\$8,481,653.20)
Truck - Hybrid (25% LLO)	(\$29,689,314.59)	(\$23,000,245.61)	(\$16,056,992.01)	(\$8,849,894.77)
Truck - Hybrid (50% LLO)	(\$49,938,330.36)	(\$37,179,233.96)	(\$23,935,291.89)	(\$10,188,080.02)
Truck - Hybrid (75% LLO)	(\$75,465,346.13)	(\$56,743,836.68)	(\$37,310,909.86)	(\$17,139,531.83)
Hybrid (75% LLO) - LLO	(\$17,354,274.81)	(\$9,004,853.85)	(\$338,154.89)	\$8,657,878.63

Cash Flow	2022	2023	2024	Period
Truck - LLO	\$21,794,119.99	\$53,220,372.56	\$85,840,822.73	4Years
Truck - Hybrid (25% LLO)	(\$1,368,927.83)	\$6,396,315.85	\$14,456,638.78	5Years
Truck - Hybrid (50% LLO)	\$4,081,525.90	\$18,893,376.85	\$34,268,078.13	4 Years
Truck - Hybrid (75% LLO)	\$3,798,358.57	\$25,531,888.80	\$48,091,293.19	3 Years
Hybrid (75% LLO) - LLO	\$17,995,761.42	\$27,688,483.76	\$37,749,529.55	2 Years

4.10 Return of Investment

Return of Investment or ROI is the profit gained from investment. As alternative 1 truck doesn't require any investment, the ROI calculation is only for alternative 2 LLO and alternative 3 hybrid. The higher the ROI percentage, the better that alternative. Here's the ROI for alternative 2 and alternative 3

Table 4.24 Return of Investment

Item	LLO	Hybrid (25% LLO)	Hybrid (50% LLO)	Hybrid (75% LLO)
CAPEX	\$ 91,447,902	\$ 29,250,556	\$ 49,200,325	\$ 74,350,095
Annual Income	\$ 45,587,564.36	\$ 11,264,421.21	\$ 21,486,373.75	\$ 31,527,103.21
ROI	49.85%	38.51%	43.67%	42.40%

Based on ROI result, alternative 2 LLO give bigger ROI with 54.59% . The best alternative 3 scenario is with 50% and ROI of 43.67% . However, alternative 2 LLO still have bigger ROI compared to alternative 3 hybrid with 50% LLO. As such, alternative 2 is better compared to alternative 3.

(This page is emptied on purpose)

CHAPTER 5

RISK MANAGEMENT AND SENSITIVITY ANALYSIS

Sensitivity and Risk Management explain regarding scope, context, criteria, risk identification, risk analysis, risk evaluation, and Monte Carlo simulation which calculate the feasibility of alternative. Risk management process is use for because the result of initial feasibility result with investment cost and operational expenditure for each alternative far in the future. This gain uncertain accuracy as a possibility for cost shift to happen. Risk will be analyzed through likelihood and consequences which latter will be plotted in risk mapping. The result will be evaluated through Monte Carlo simulation method. As alternative LLO is overall better alternative compared to other alternative, this chapter will generally do analysis regarding alternative 2 LLO risk.

5.1 Deciding Scope, Context, and Criteria

Based on ISO 31000: 2018, the first step of risk management is by decide the scope, context, and criteria. Scope is about the purpose of risk management. Context explain about the external and internal context faced. The last, Criteria, explain about condition for at risk or not.

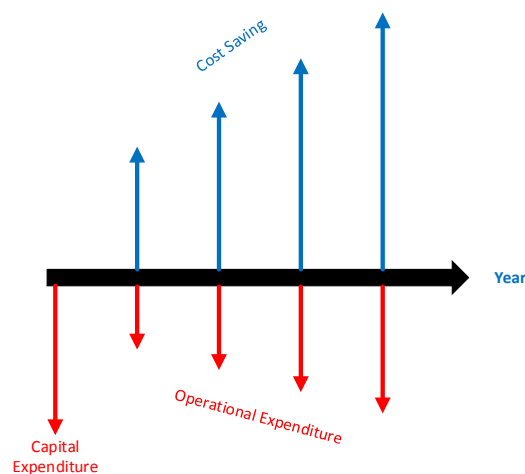


Figure 5.1 Cost Saving Graph

Scope in this research is financial risk that might occur from chosen alternative. A condition categorized as risky when it shifts the feasibility of alternative. The cause of shift can be from investment or operational cost. Scope is visualized like the graph bellow as cash flow.

Context here is the total cost for choosing an alternative which require evaluation by including risk. Risk that require to be analyze are factor that cause the shift in CAPEX and OPEX. Criteria can be tolerated through some financial analysis method such as NPV, IRR, and Payback Period. If there is no significant different then it can be categorized as not at risk.

5.2 Risk Identification

Table 5.1 Risk Identification for LLO

ID	Risk Driver	Failure Potential	Impact Category	Current Control
A	Capacity	Unable to be fully loaded as specified due to terrain or other reason	Revenue	No
B	Production	Reduce in coal production due to regulation or coal price	Revenue	No
C	Electricity consumption	LLO consume more electricity more than it's specified due to load or internal problem	Operational Expenditure	No
D	Increased electricity price	Increase of electricity price due to change in government regulation or other reason	Operational Expenditure	No
E	Inflation Uncertainty	Operational cost increase	Operational Expenditure	No
		Sparepart cost increase	Operational Expenditure	No
		Drive station price increase	Operational Expenditure	No
		Equipment cost increase	Operational Expenditure	No
		Support equipment cost increase	Operational Expenditure	No
F	Dollar exchange value uncertainty	Reduced exchange value	Capital Expenditure	No
G	Drive Station Tyre Cost	Unexpected price increase	Operational Expenditure	No
H	Equipment Maintenance Cost	Unexpected price increase	Operational Expenditure	No
I	Track Maintenance Cost	Unexpected price increase or problem that hinder normal maintenance method	Operational Expenditure	No
J	Operational Cost	Unexpected price increase	Operational Expenditure	No
K	Support Equipment Cost	Unexpected price increase	Operational Expenditure	No

This sub-chapter is to identify a potential of failure in alternative LLO. As the revenue of this research is obtain through cost saving between alternative 1 truck as benchmark with other alternative, the problem in operational cost will affect revenue in general. Here's the result of risk identification

5.2.1 Capacity

Due to terrain or maybe the LLO performance itself, the transport load for LLO might not be up to required standard. This will cause problem such as increased number of LLO to fulfill the capacity gap. However, this solution requires more CAPEX and more density in transport schedule.

5.2.2 Production

Due to government or global regulation, there might sudden cut on coal production. For example, coal produce high amount of pollution, it's likely that United Nation might make regulation of reducing coal mining to reduce pollution. Other factor such as coal price is also high possibility as drop in coal price reduce the Indonesia overall coal production just few years ago. Reduced coal production will reduce overall company revenue even though there is reduce in operational cost too.

5.2.3 Electricity Consumption

Machine is very affected by environment. The specified result based on other environment might differ a lot compared to others environment. The same problem also plagues LLO. The previously specified electricity consumption might actually very different compared to field operation. There is also possibility cause by heavy load and terrain that require more electricity output than previous calculation.

5.2.4 Electricity Price Increase

Indonesia as developing country isn't the most stable economy in global competition. Due to regulation or might even be increase on powerplant fuel, such as oil, coal, and gas, might result in high electricity price. Oil price alone already cause many problems worldwide due to its high demand. However, as there is multiple way to generate electricity, the electricity price increase is generally more stable compare to other fuel type such as oil and gas.

5.2.5 Inflation Uncertainty

Inflation affect cost component of our daily life, not to mention, industry level tools and equipment. Inflation also often increase and decrease sporadically. Here's the Indonesia Inflation since 1981 until 2018.

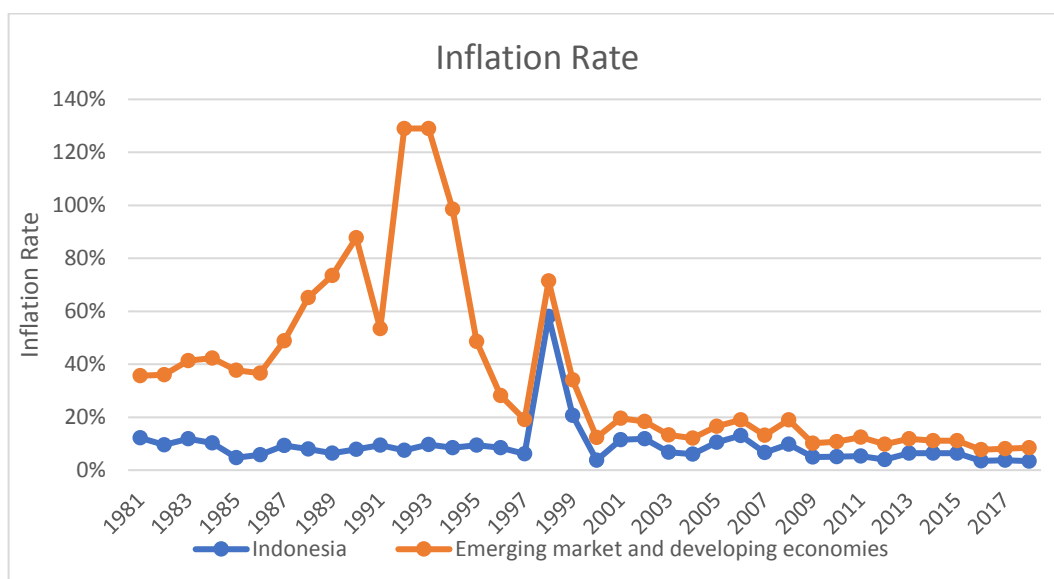


Figure 5.2 Inflation Rate

As seen in chart above, inflation rate is always unstable. This instability is the high reason for inaccuracy. If inflation is higher than the prediction, the cost would also increase. The opposite with reduced inflation could also reduce cost.

5.2.6 Drive Station Tire Cost

Sudden increase of tire price used in LLO drive station. This can be caused by the sudden price increase, embargo, or caused by the company that produce that particular tire closed. This might increase the price to purchase tire as the availability become scarce and others source might be more expensive than current supplier.

5.2.7 Equipment Maintenance Cost

Sudden increase of maintenance cost which can be cause by many reasons such as routine breakdown, increase wages for maintenance crew, increase spare part price, spare part rarity, etc. which lead to increase cost.

5.2.8 Track Maintenance Cost

Increase maintenance cost due to various reason such as maintenance crew wages, track availability, increase track price, increase iron for track production price, track supplier shut down, etc. which lead to increase cost.

5.2.9 Operational Cost

Sudden increase on cost for operating LLO. This correlate with the wages for LLO driver

5.2.10 Support Equipment

Sudden increase of tools and equipment use to support the operation of LLO which lead to overall increase cost in operating LLO.

5.3 Risk Analysis

After risk identification is risk analysis. Risk analysis goal is to discover the value of likelihood and consequence of risk. The value is determined through Monte Carlo simulation based on variability input and risk identification. Based on those, risk mapping can be constructed

5.3.1 Deciding Likelihood of Risk for LLO

Likelihood is the chance of risk to happen. Estimation of risk happen depend on its distribution. For those reason, likelihood very dependent on its distribution and goal seek analysis to determine the percentage of likelihood.

5.3.1.1 Distribution Fitting

Using historical data, we can find the distribution fitting for each risk. Distribution fitting is very important for constructing model later on. Here's the distribution fitting for every risk:

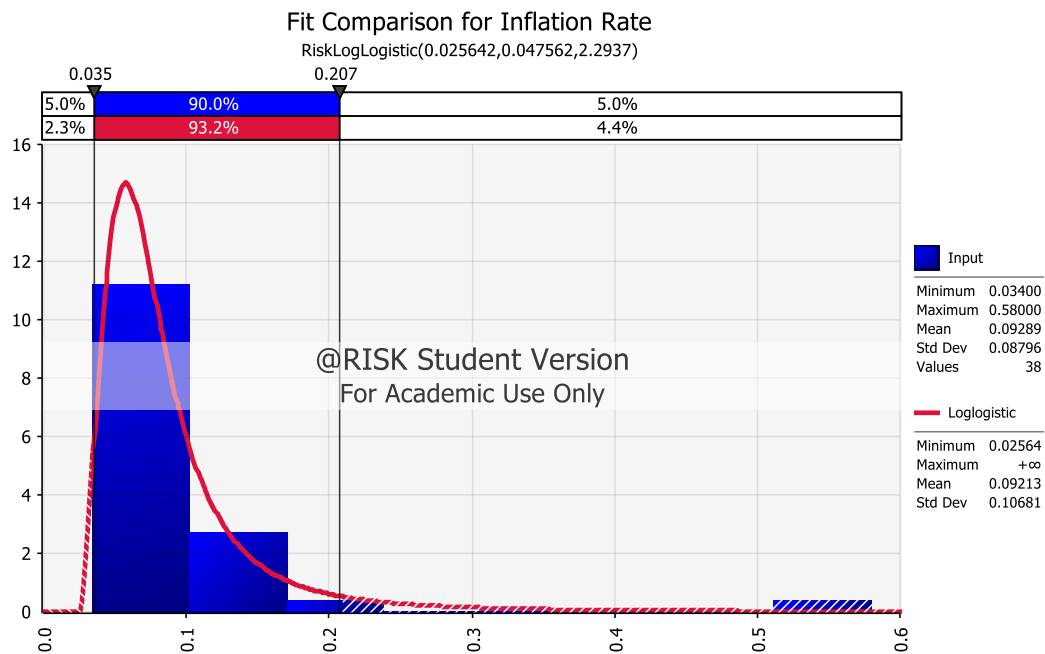


Figure 5.3 Inflation Fitting

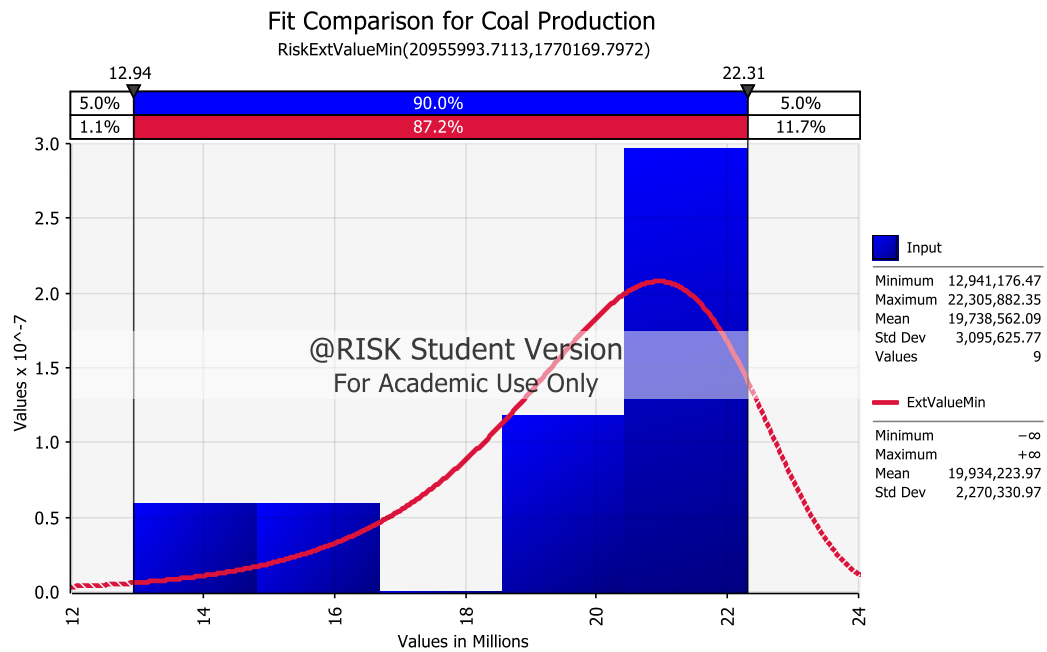


Figure 5.4 Coal Production Fitting

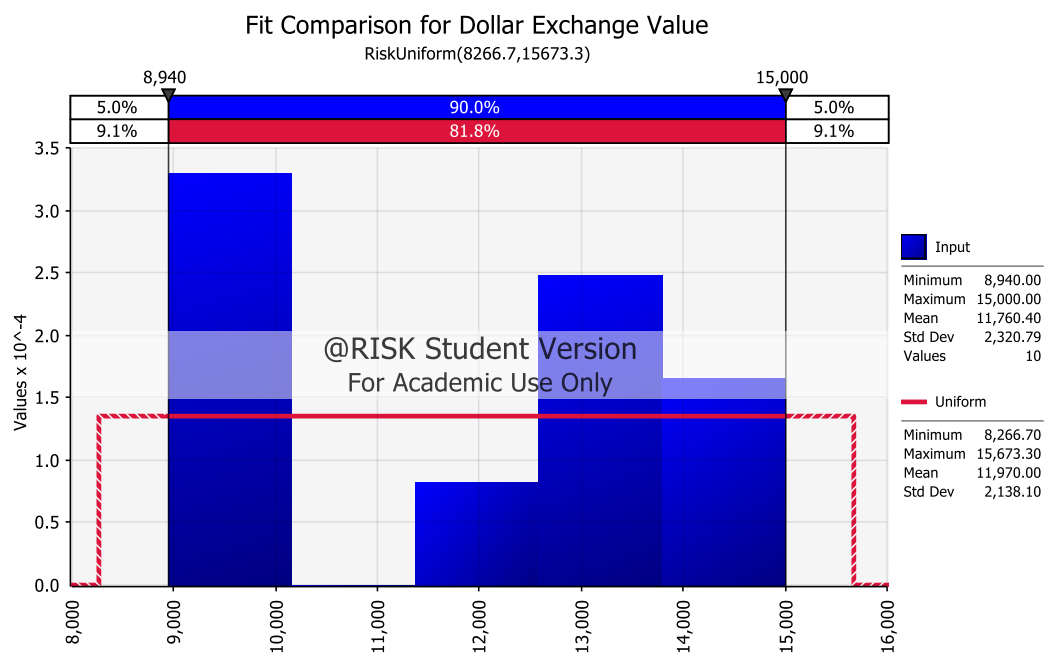


Figure 5.5 Exchange Value Fitting

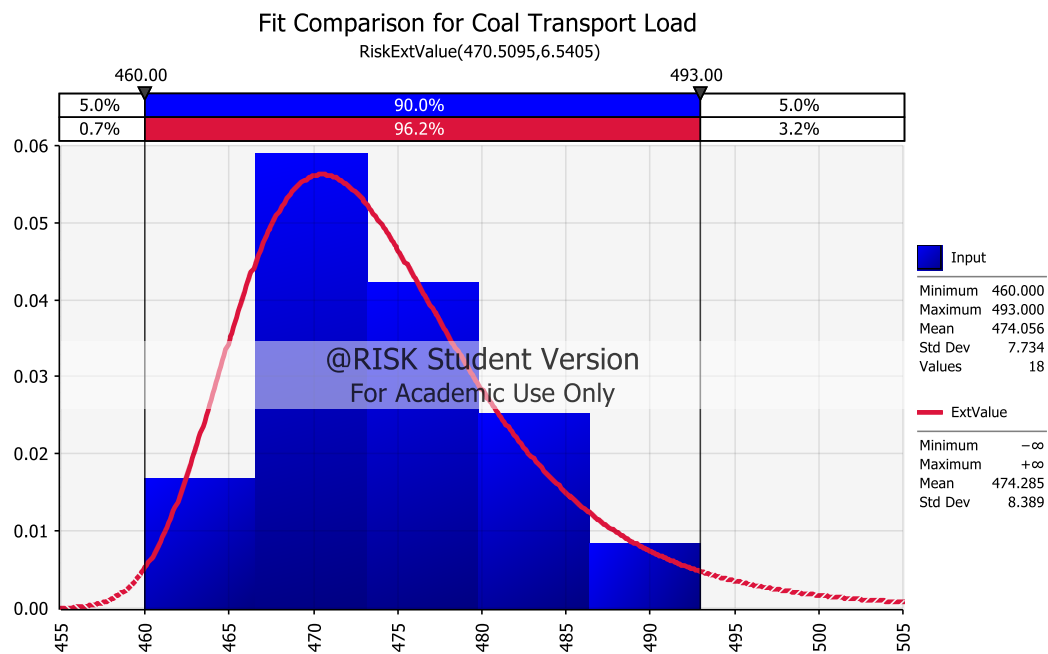


Figure 5.6 Coal Transport Load Fitting

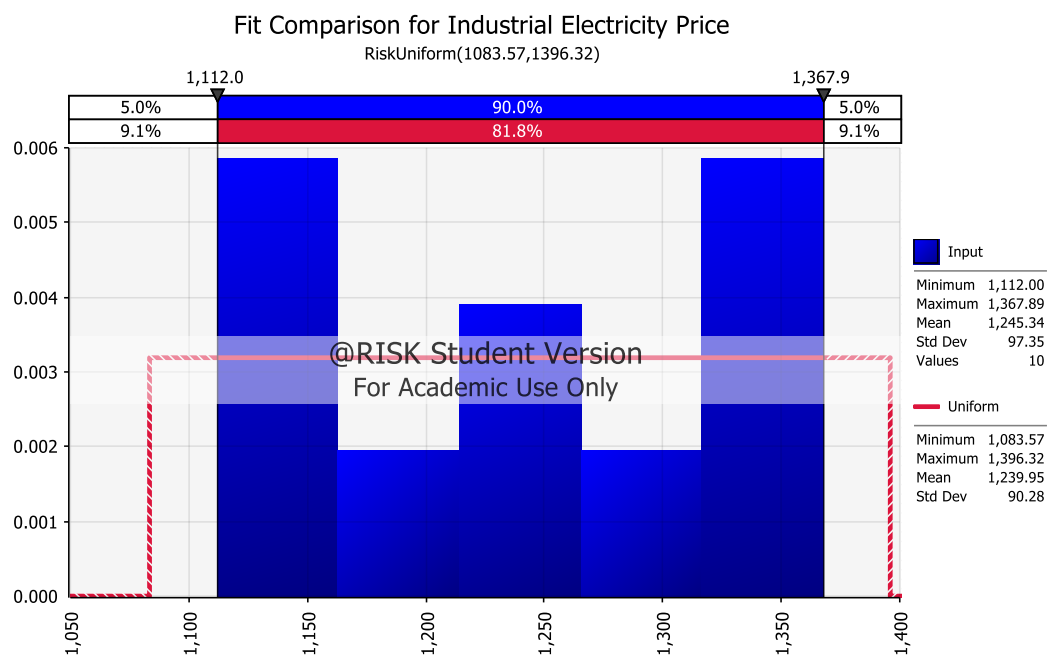


Figure 5.7 Industrial Electricity Price Fitting

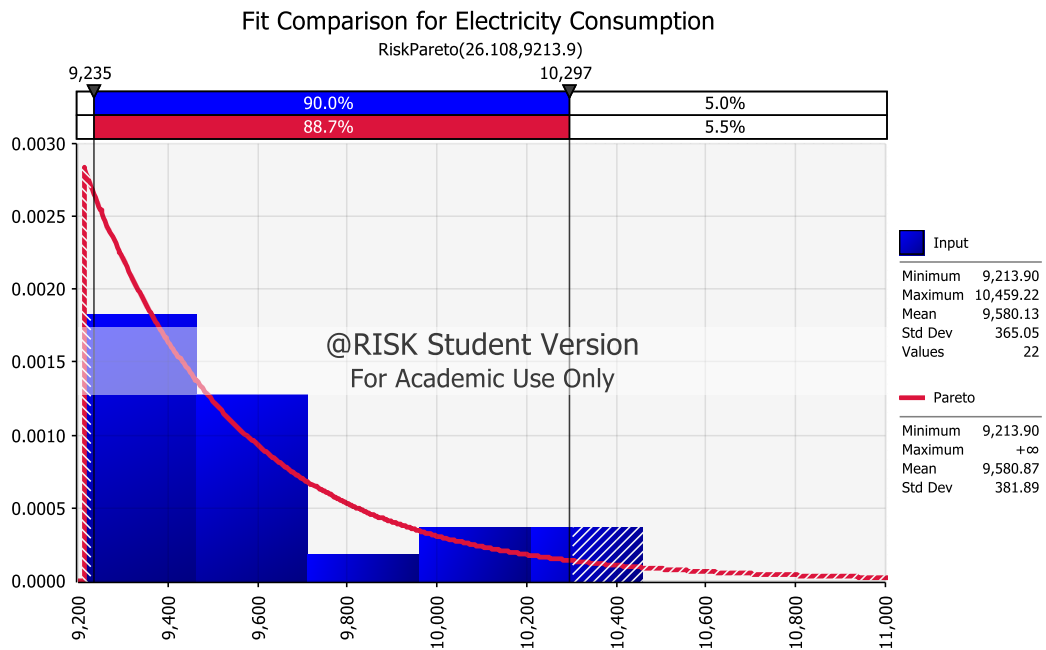


Figure 5.8 Electricity Consumption Fitting

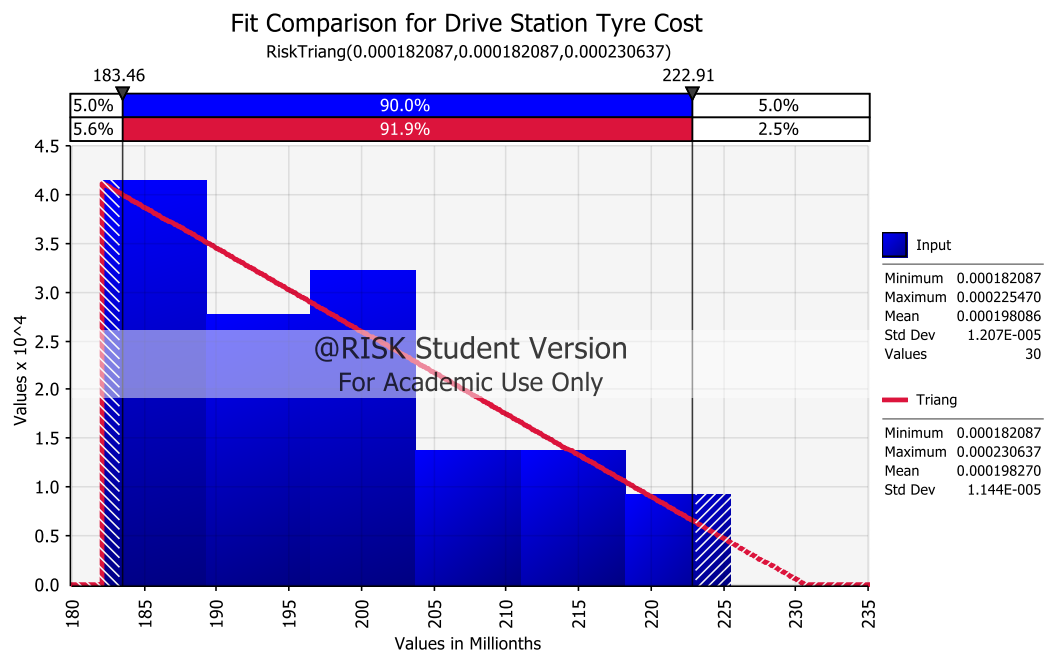


Figure 5.9 Drive Station Tyre Cost Fitting

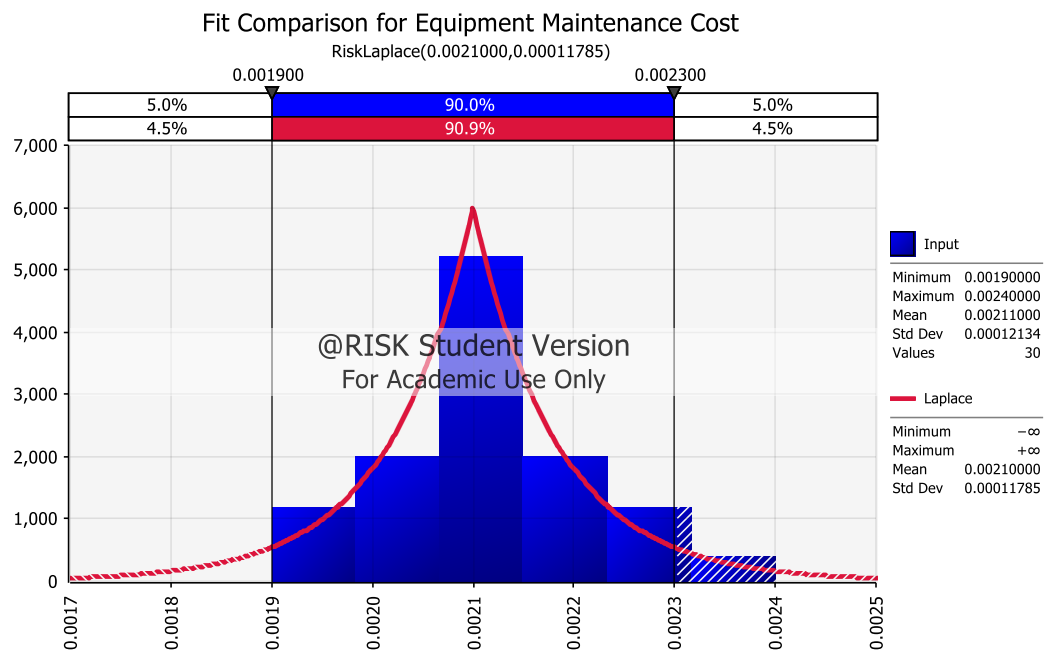


Figure 5.10 Equipment Maintenance Cost Fitting

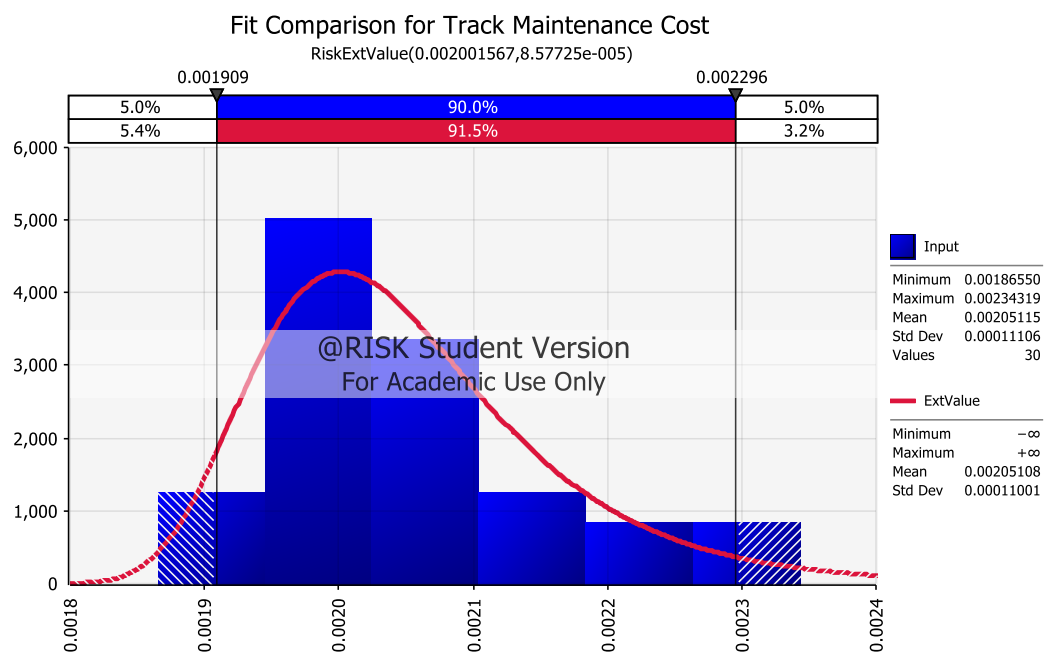


Figure 5.11 Track Maintenance Cost Fitting

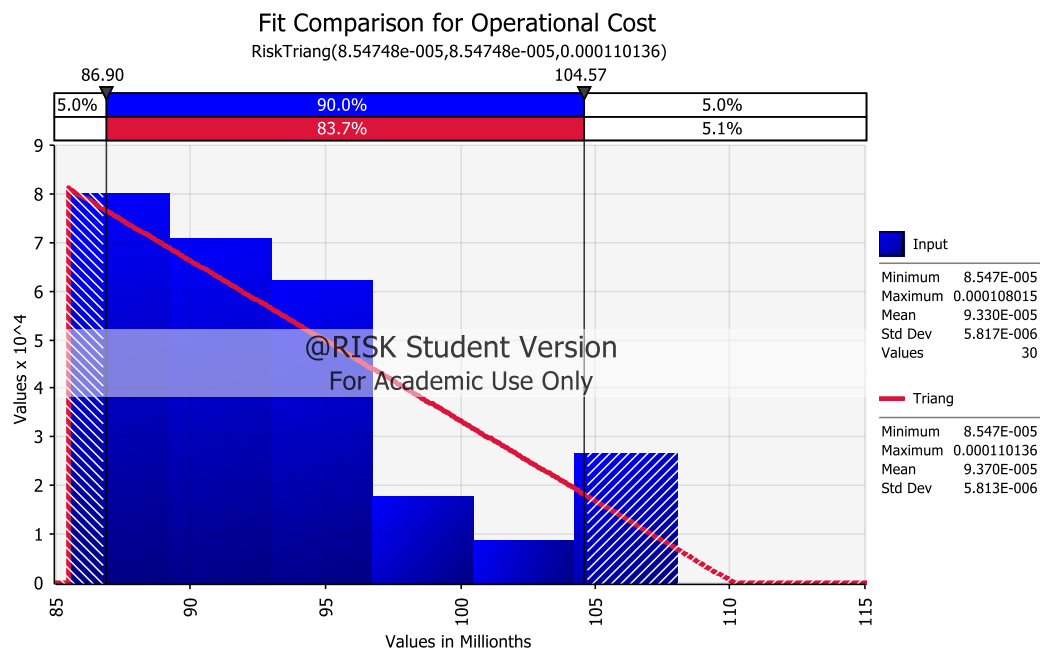


Figure 5.12 Operational Cost Fitting

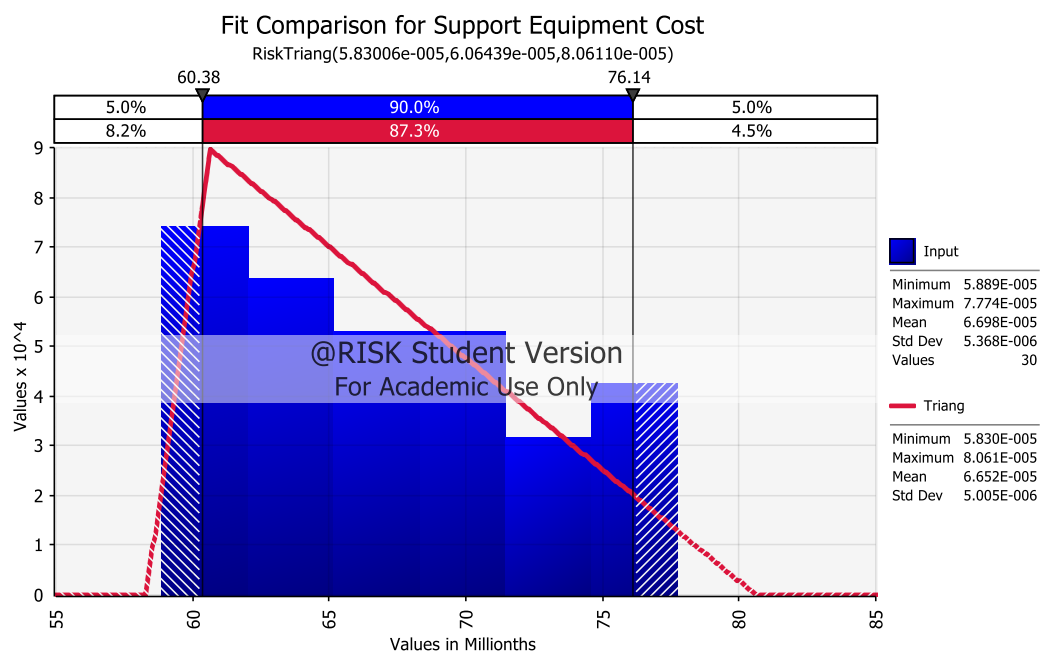


Figure 5.13 Support Equipment Cost Fitting

Based on the result, here's the distribution type, mean, and standard deviation for each risk type.

Table 5.2 Distribution Type for each Risk

Risk	Mean	Stdev	Unit	Distribution Type
Coal Production	19,934,224.00	2,270,331.00	Tons	Ext Value Min
Inflation Rate	9.21	10.68	%	Log Logistic
Dollar Exchange Value	11,970.00	2,138.10	Rupiah	Uniform
Transport Load	474.29	8.39	Tons	Ext Value
Electricity Usage	9,580.87	381.89	Kw	Pareto
Electricity Price	1,239.95	90.28	\$/Kwh	Uniform
Drive Station Tyre Cost	0.000198	0.000011	\$/Tons.Km	Triangular
Equipment Maintenance Cost	0.00	0.00	\$/Tons.Km	Laplace
Track Maintenance Cost	0.00	0.00	\$/Tons.Km	Ext Value
Operational Cost	0.00	0.0000937	\$/Tons.Km	Triangular
Support Equipment Cost	0.00006652	0.000005005	\$/Tons.Km	Triangular

5.3.1.2 Goal Seek Analysis

Goal seek analysis is used to find the limit acceptable within distribution to find the likelihood of a risk. Goal Seek output is estimation output of certain factor. For this report, goal seek output used are NPV of Rp237,988,714.48. This is the NPV value from truck-LLO cash flow analysis without including risk factor. The goal seek analysis is done using @risk software. A case is categorized as at risk if NPV average is below the allowed tolerance. The result of goal seek is point tolerance to find likelihood of risk. Here is the goal seek results for each risk:

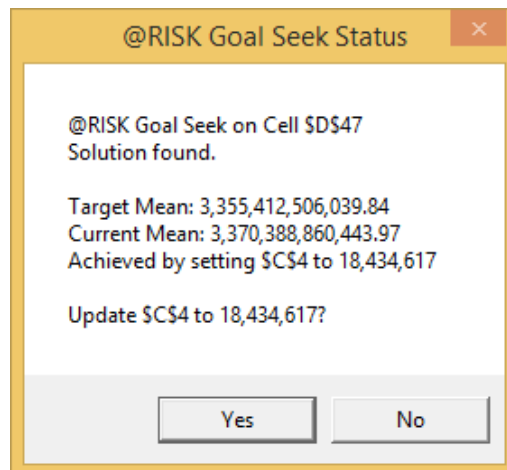


Figure 5.14 Production Capacity Goal Seek Analysis

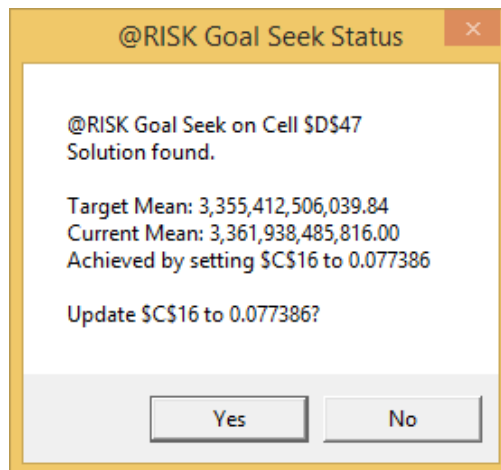


Figure 5.15 Inflation Rate Goal Seek Analysis

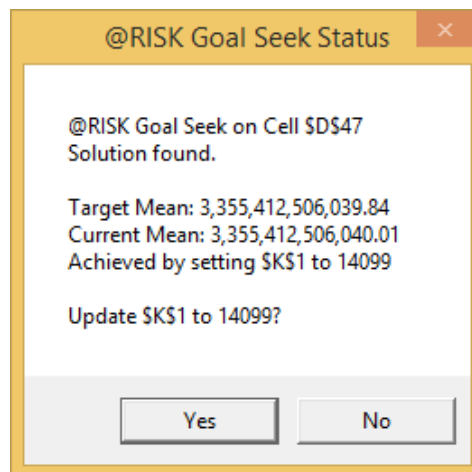


Figure 5.16 Exchange Rate Goal Seek Analysis

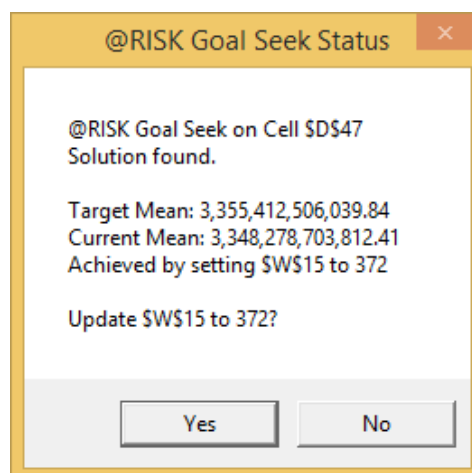


Figure 5.17 Transport Load Capacity Goal Seek Analysis

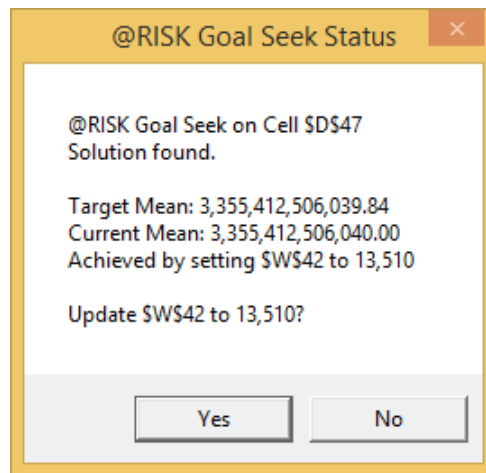


Figure 5.18 Electricity Usage Goal Seek Analysis

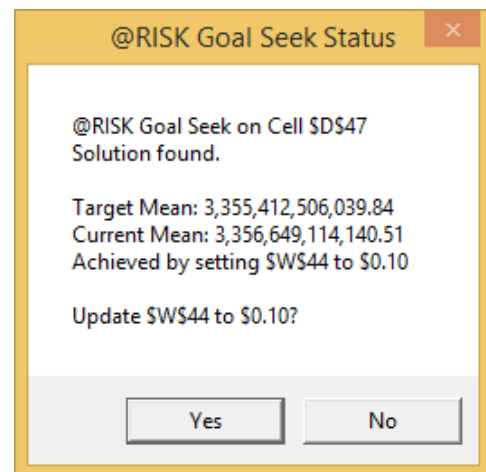


Figure 5.19 Electricity Price Goal Seek Analysis

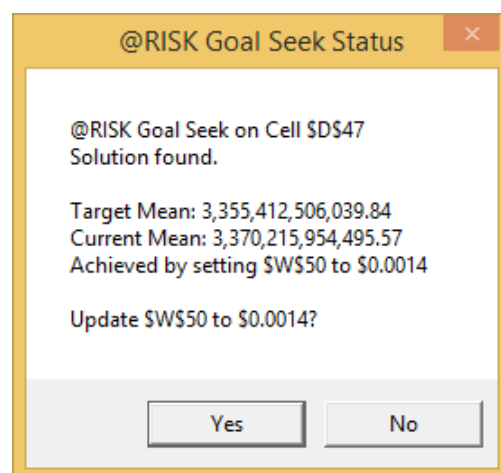


Figure 5.20 Drive Station Tyre Cost Goal Seek Analysis

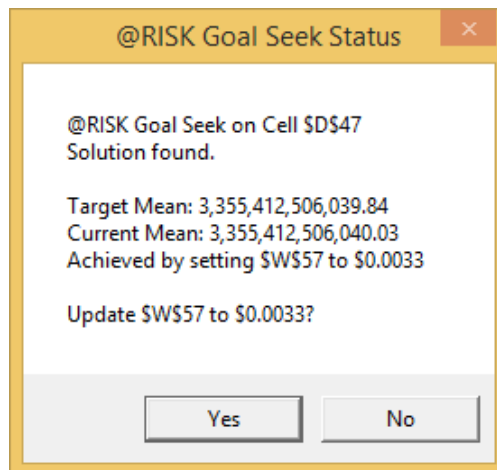


Figure 5.21 Equipment Maintenance Cost Goal Seek Analysis

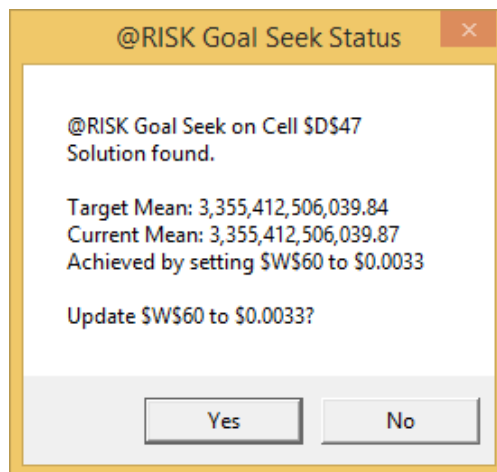


Figure 5.22 Track Maintenance Cost Goal Seek Analysis

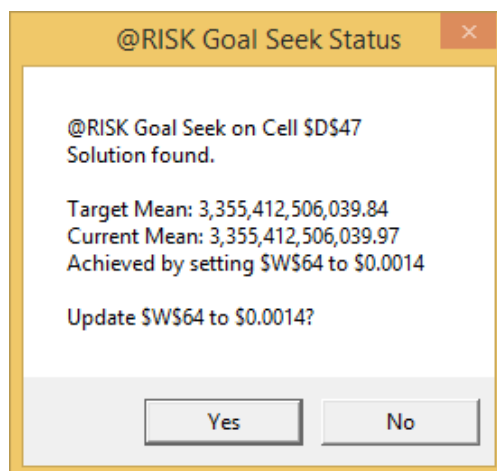


Figure 5.23 Operational Cost Goal Seek Analysis

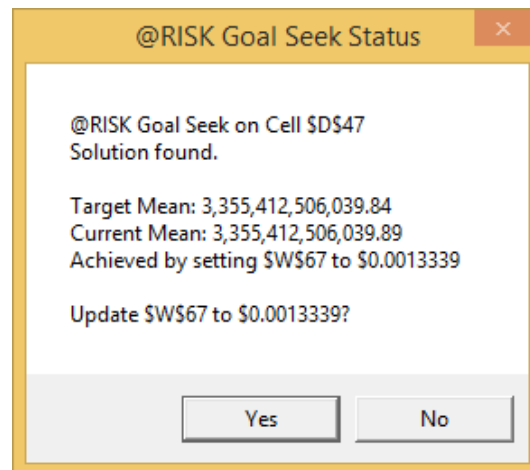


Figure 5.24 Support Equipment Cost Goal Seek Analysis

5.3.1.3 Likelihood Calculation

Based on the result of goal seeking analysis, the point of likelihood can be plotted on the risk distribution. Each risk has different distribution and likelihood percentage. Based on correlation between each risk and NPV, we can determine the risk give positive feedback or negative feedback toward NPV. Below is the risk likelihood calculation for production capacity using @risk software.

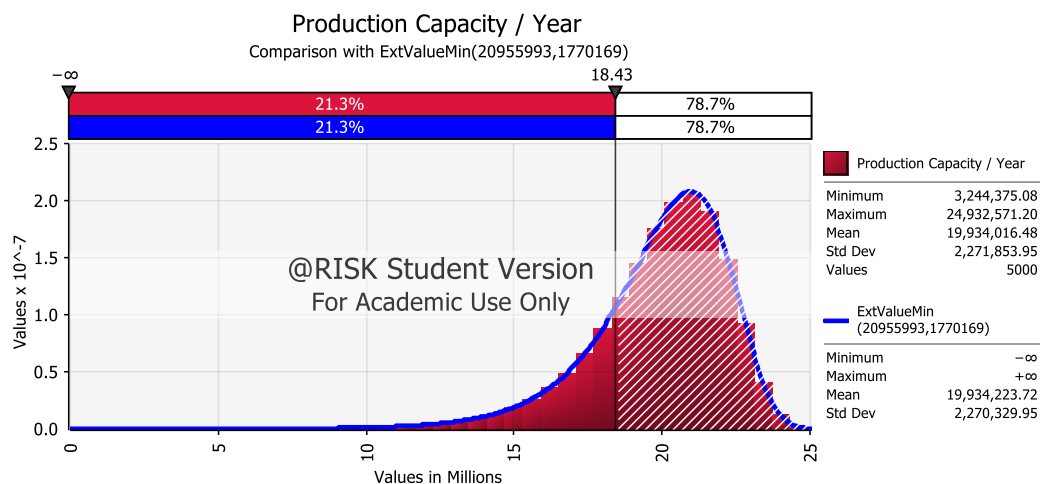


Figure 5.25 Production Capacity Risk Likelihood

For production capacity, the more coal mined, the better company profit is. However, based on goal seek analysis, PT X required to mine minimum 18.43 million tons of coal per year to achieve NPV of Rp3,693,285,099,441.92. NPV

value will be at risk if PT X mine less than that. For those reason, it's necessary to calculate the probability of PT X not able to mine 18.43 million tons at least. Based on Figure 5.15, are 21.3% which is risk likelihood for production capacity not able to fulfill minimum target.

Using the same method, we calculate the likelihood for each alternative. Here is the risk likelihood for each risk:

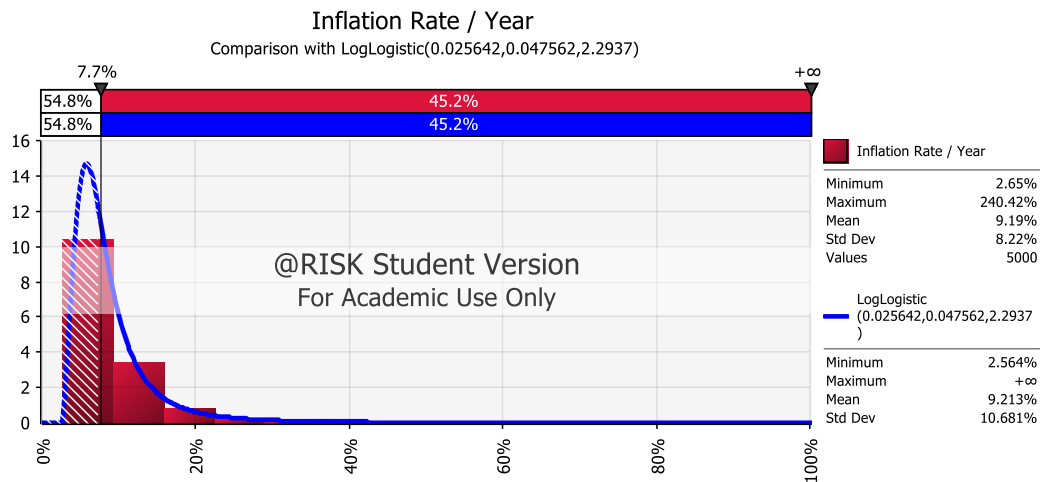


Figure 5.26 Inflation Rate Risk Likelihood

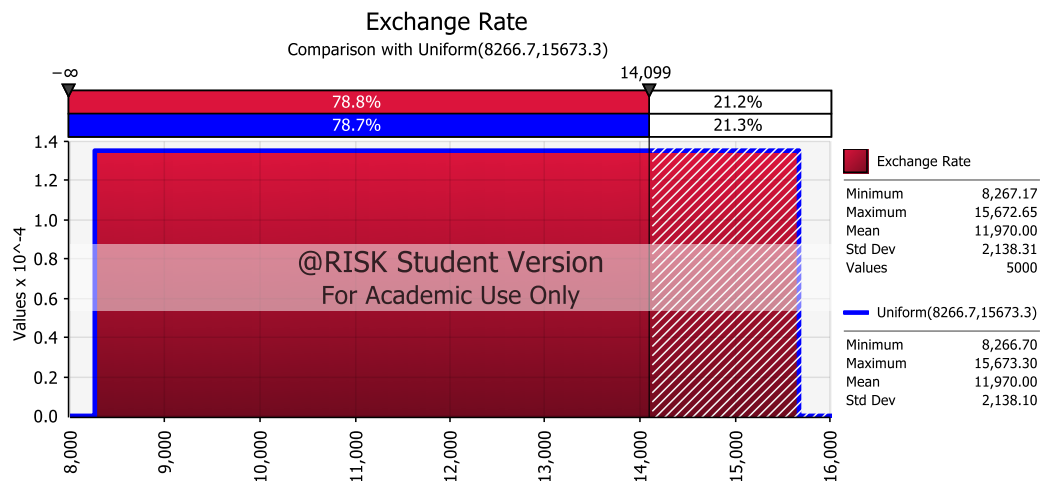


Figure 5.27 Exchange Value Risk Likelihood

The higher the exchange value, the higher the NPV. This is because the income for cash flow is based on cost saving instead of traditional input.

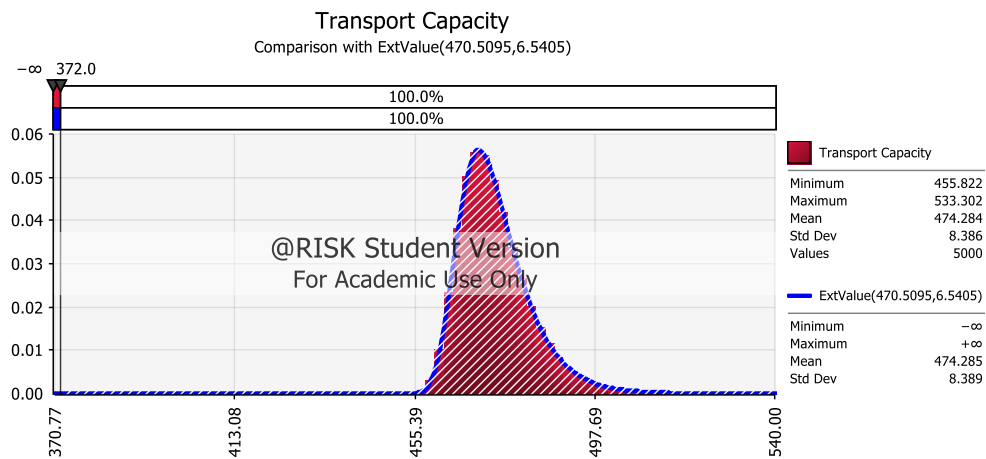


Figure 5.28 Transport Load Risk Likelihood

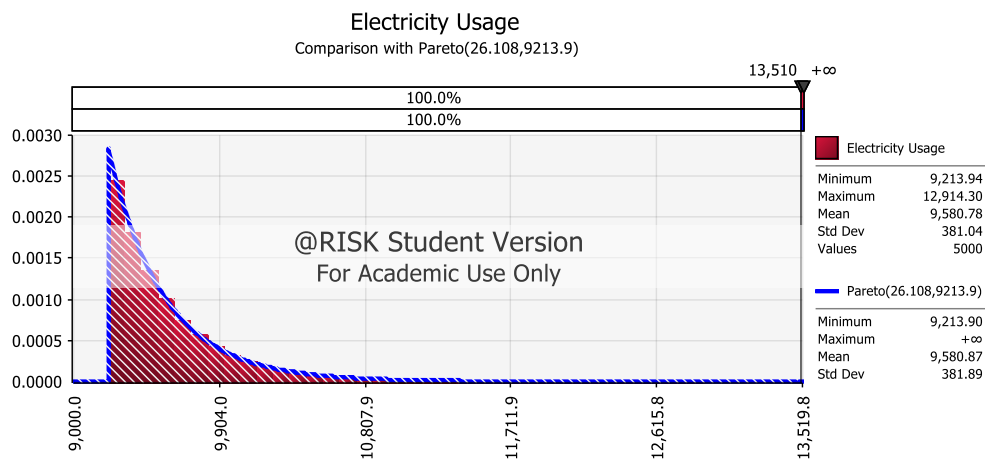


Figure 5.29 Electricity Usage Risk Likelihood

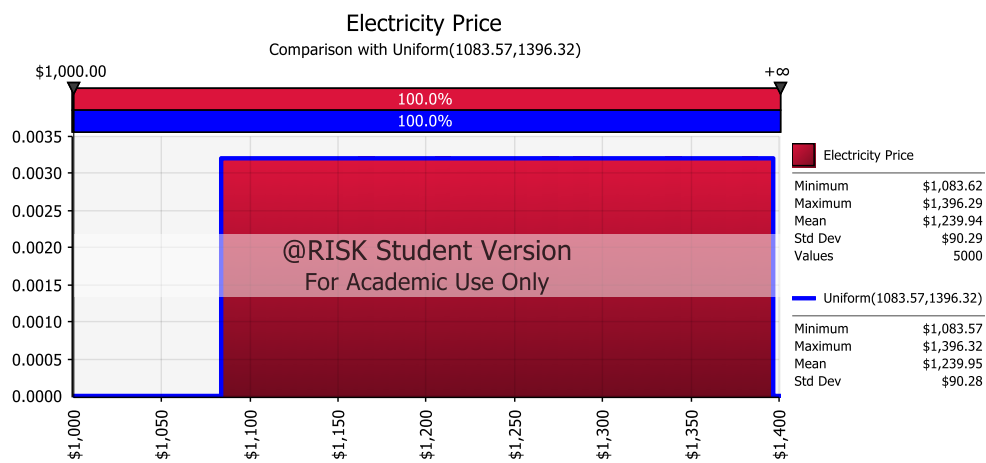


Figure 5.30 Electricity Price Risk Likelihood

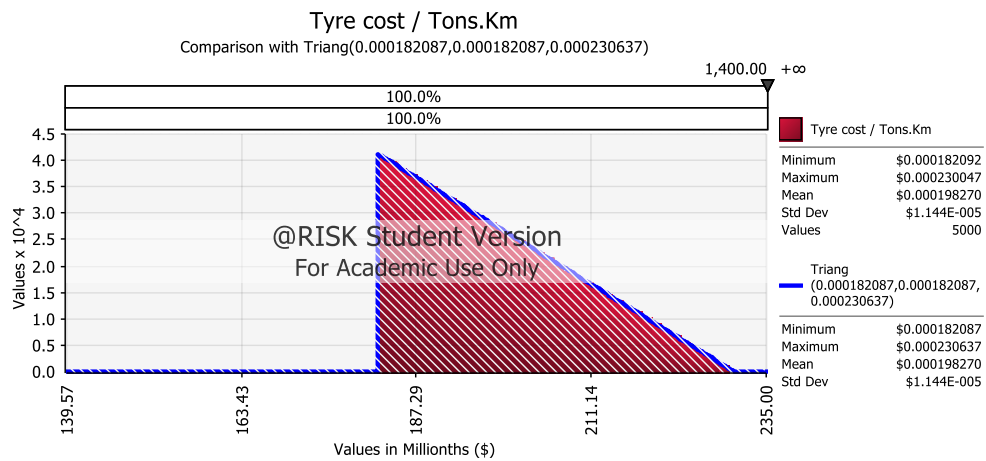


Figure 5.31 Drive Station Tyre Cost Price Risk Likelihood

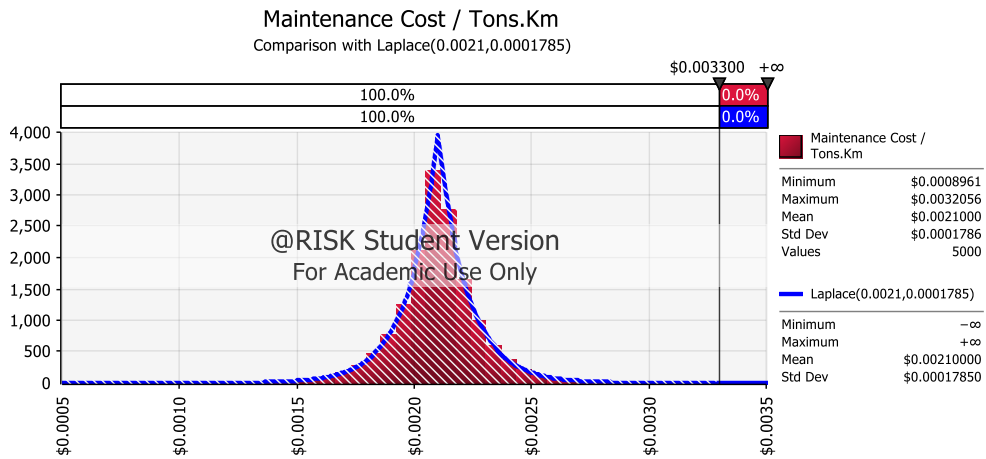


Figure 5.32 Equipment Maintenance Cost Risk Likelihood

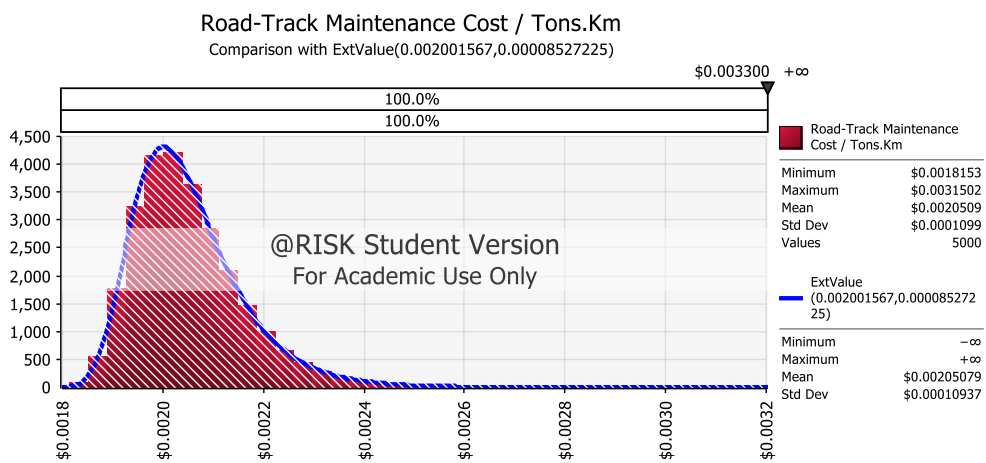


Figure 5.33 Track Maintenance Cost Risk Likelihood

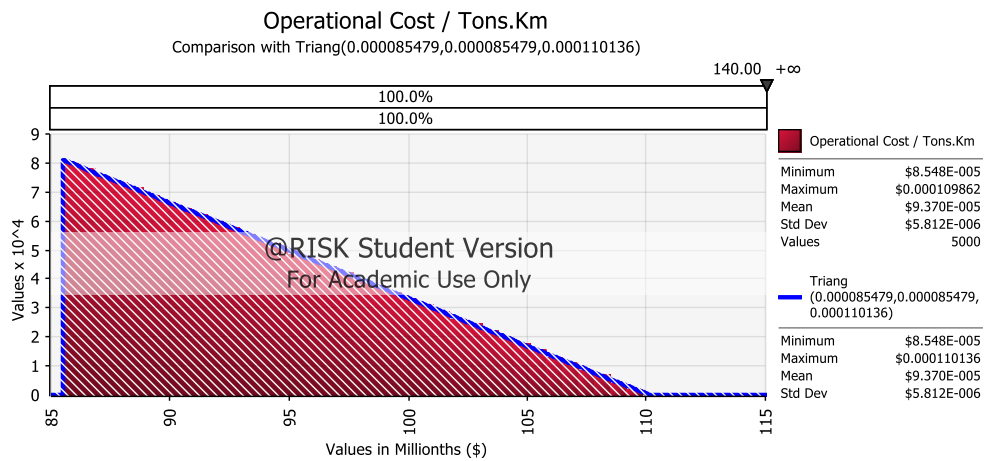


Figure 5.34 Operational Cost Risk Likelihood

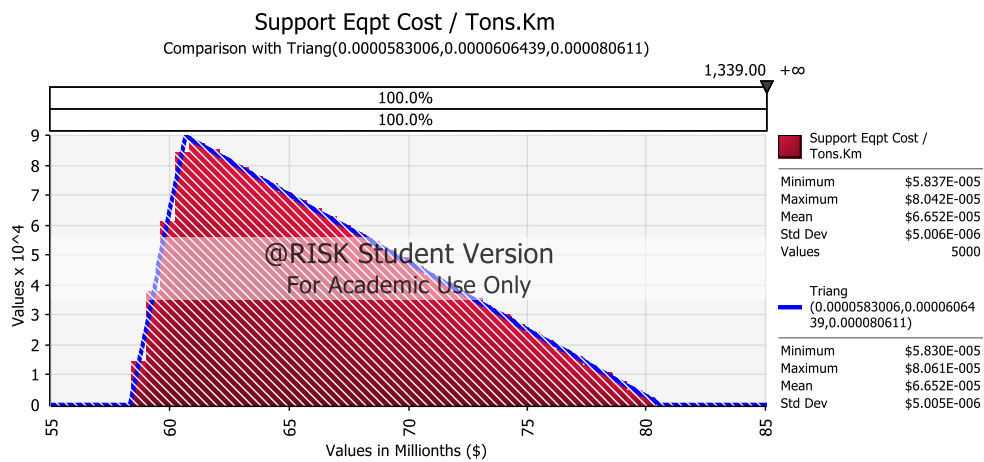


Figure 5.35 Support Equipment Cost Risk Likelihood

The result of calculating risk likelihood is as follow:

Table 5.3 Risk Likelihood

Risk	Parameter	Likelihood
Coal Production	≤ 18,434,617 tons	21.3%
Inflation Rate	≥ 7.7%	45.2%
Dollar Exchange Value	≤ Rp 14,099	78.8%
Transport Load	≤ 372 tons	0%
Electricity Usage	≥ 13,510 Kw	0%
Electricity Price	≥ \$0.10	100%
Drive Station Tyre Cost	≥ \$0.0014	0%
Equipment Maintenance Cost	≥ \$0.0033	0%
Track Maintenance Cost	≥ \$0.0033	0%
Operational Cost	≥ \$0.0014	0%
Support Equipment Cost	≥ \$0.0014	0%

Based on summary at Table 5.3, electricity price is 100% sure to increase. Then it followed by dollar exchange value with likelihood of 78.8%. Inflation follow with likelihood of 45.2%. Coal production follow with likelihood of 21.3%. The others risk has 0% likelihood.

5.3.2 Deciding Consequence of Risk for LLO

Consequence show the impact caused by risk factor. Consequence value can be calculated using stress analysis test using software @risk. Risk used as input in stress analysis are the probability distribution of risk found in risk likelihood calculation. Here is the risk consequence calculation for LLO

Table 5.4 Risk Consequence

Risk	Baseline	Mean	NPV Base	NPV Decrease	NPV Decrease %
Coal Production	0% - 21.3%	Rp2,071,599,611,787.11	Rp3,693,285,099,442	Rp580,323,385,557.27	-15.71%
Inflation Rate	54.8%-100%	Rp2,332,771,747,536.58		Rp1,030,649,912,620.83	-27.91%
Dollar Exchange Value	0% - 21.2%	Rp1,737,367,580,402.63		Rp544,345,983,527.91	-14.74%
Transport Load	0% - 10%	Rp2,472,267,645,216.93		Rp191,231,146,257.11	-5.18%
Electricity Usage	90% - 100%	Rp2,424,464,261,937.42		Rp272,121,214,291.13	-7.37%
Electricity Price	10% - 100%	Rp2,468,325,756,877.90		Rp2,401,735,686,733.76	-65.03%
Drive Station Tyre Cost	90% - 100%	Rp2,472,433,256,875.63		Rp271,687,332,691.18	-7.36%
Equipment Maintenance Cost	90% - 100%	Rp2,432,989,028,606.43		Rp272,139,443,080.30	-7.37%
Track Maintenance Cost	90% - 100%	Rp2,445,731,284,447.45		Rp267,797,837,383.13	-7.25%
Operational Cost	90% - 100%	Rp2,473,835,546,227.54		Rp269,200,370,858.41	-7.29%
Support Equipment Cost	90% - 100%	Rp2,474,037,427,816.23		Rp272,293,792,340.16	-7.37%

Based on the result, the highest consequence is by electricity price with 65.03% NPV decrease. The second highest consequence is by inflation rate with consequence of 27.91% NPV decrease. Followed by coal production with 15.71% NPV decrease. Dollar exchange value is just bit smaller compared to coal production with 14.74% NPV decrease. Electricity usage, equipment maintenance cost, and support equipment cost have similar NPV decrease of 7.37%. Drive station tyre price almost have same NPV decrease of 7.36%. Operational cost has NPV decrease by 7.29% and followed by Track maintenance cost with 7.25% NPV decrease. The smallest decrease is by Transport with 5.18% NPV decrease only.

5.3.3 Risk Mapping

After discover the risk likelihood and risk consequence from previous sub-chapter, risk mapping can be constructed. Likelihood show the chance of risk to happen while consequence show the impact if risk happen. Here is the category for risk likelihood:

Table 5.5 Risk Likelihood Category

Likelihood	Possibility of risk to happen
Rare	Possibility of occurring $< 5\%$
Unlikely	Possibility of occurring $5\% - 25\%$
Possible	Possibility of occurring $25\% - 50\%$
Likely	Possibility of occurring $50\% - 75\%$
Almost Certain	Possibility of occurring $> 75\%$

As seen in Table 5.5, a risk has rare occurrence chance if have probability less than 5%. Risk unlikely to happen if occurrence chance between 5%-25%. Risk possible to happen if it's between 25%-50% chance to occur. Risk have high degree of possibility to happen when it passes 50% probability. 50%-75% chance is categorized as likely. Finally, with more than 75% chance to happen is categorized as almost certainty.

For consequence, its bit similar to likelihood. Here's the category for risk consequence.

Table 5.6 Risk Consequence Category

Consequence	Risk effect
Insignificant	NPV Decrease $\leq 10\%$
Minor	$10\% < \text{NPV Decrease} \leq 25\%$
Moderate	$25\% < \text{NPV Decrease} \leq 50\%$
Major	$50\% < \text{NPV Decrease} \leq 100\%$
Catastrophic	NPV Decrease $> 100\%$

If NPV decrease less than 10%, its categorized as insignificant consequence. If it decreases overall NPV by 10% -25%, its categorized as minor consequence. If it decreases NPV by 25% - 50%, its categorized as moderate consequence. Bigger than 50% until 100% of NPV categorized as major consequence. Lastly, if it decreases NPV by more than 100%, its categorized as catastrophic.

Based on those risk likelihood and consequence, here's the risk mapping for choosing LLO as sole coal transport

Table 5.7 Risk Mapping for LLO (1)

Risk	Likelihood	Consequence	Category
Coal Production	21.3%	-15.71%	Moderate Risk
Inflation Rate	45.2%	-27.91%	High Risk
Dollar Exchange Value	78.8%	-14.74%	High Risk
Transport Load	0%	-5.18%	Low Risk
Electricity Usage	0%	-7.37%	Low Risk
Electricity Price	100%	-65.03%	Low Risk
Drive Station Tyre Cost	0%	-7.36%	Low Risk
Equipment Maintenance Cost	0%	-7.37%	Low Risk
Track Maintenance Cost	0%	-7.25%	Low Risk
Operational Cost	0%	-7.29%	Low Risk
Support Equipment Cost	0%	-7.37%	Low Risk

Table 5.8 Risk Mapping for LLO (2)

Risk Map		Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
Almost Certain	5		Exchange Value		Electricity Price	
Likely	4					
Possible	3			Inflation Rate		
Unlikely	2		Coal Production			
Rare	1	Transport Load Electricity Usage Drive Station Tyre Cost Equipment Maintenance Cost Track Maintenance Cost Operational Cost Support Equipment Cost				

From the result of risk mapping, Electricity Price is categorized as extreme risk. Inflation rate and exchange rate are categorized as high risk. Coal production is categorized as moderate risk. Transport load, electricity usage, drive station tyre cost, equipment maintenance cost, track maintenance cost, operational cost, and

support equipment cost are categorized as low risk as it has low likelihood and low consequences.

5.4 Risk Treatment

Based on risk mapping analyses by combining likelihood and consequence of each risk, inflation rate and exchange rate are categorized as extreme risk. This is very important to be treat. There is also production capacity, transport load, electricity usage, and electricity price which are high risk. For those reason, here are the mitigation plan for each risk.

Table 5.9 Risk Treatment

Risk	Category	Mitigation Type	Risk Treatment
Coal Production	Moderate Risk	Transfer	Create binding contract with government to prepare unexpected event and prevent sudden reduce of coal mining concession quantity and area.
Inflation Rate	High Risk	Mitigation	Stock item and equipment susceptible to inflation Substituting with local component
Dollar Exchange Value	High Risk	Mitigation	Stock imported item and equipment Substituting with local component
Transport Load	Low Risk	Mitigation	Using preventive and scheduled maintenance to keep transport performance
Electricity Usage	Low Risk	Mitigation	Using preventive and scheduled maintenance to keep transport performance
Electricity Price	Extreme Risk	Mitigation	Prepare electricity supplier other than PLN or weight the possibility of making a dedicated power plant
Drive Station Tyre Cost	Low Risk	Mitigation	Stock tyre for emergency use
Equipment Maintenance Cost	Low Risk	Accept	Accept risk because it have low likelihood and consequence
Track Maintenance Cost	Low Risk	Accept	Accept risk because it have low likelihood and consequence
Operational Cost	Low Risk	Accept	Accept risk because it have low likelihood and consequence
Support Equipment Cost	Low Risk	Accept	Accept risk because it have low likelihood and consequence

5.5 Sensitivity Analysis

Using the previously found distribution fitting, we can construct model for simulation. Using monte carlo simulation method, the correlation of each risk toward NPV can be analyzed. Based on the simulation, here's the tornado chart on which risk correlate the most toward NPV.

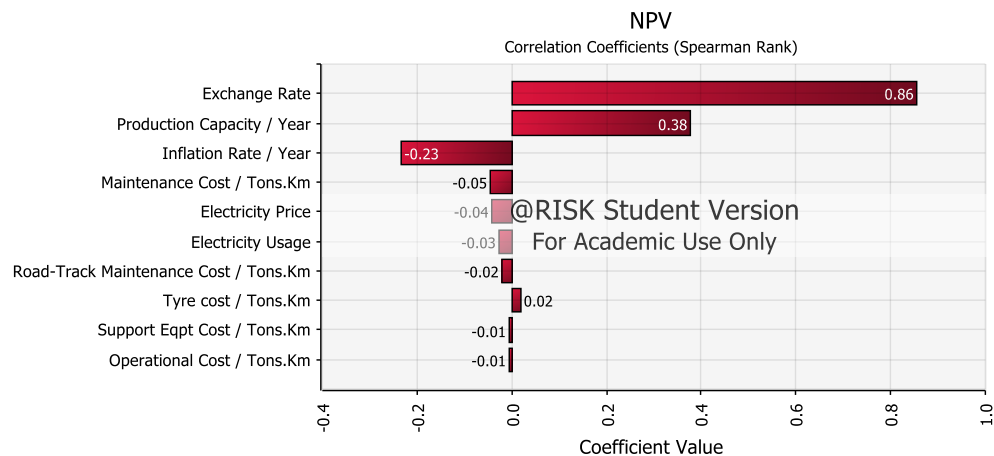


Figure 5.36 Tornado Chart

As can be seen on tornado chart Figure 5.21, exchange rate and production capacity give positive correlation toward NPV. This mean increase in exchange rate or production capacity also increase NPV. Exchange rate have the highest positive correlation. In the other hand, Inflation rate give the highest negative correlation although not as high value as either exchange rate or production capacity. The other negative correlations are maintenance cost, electricity price, electricity usage. Track maintenance cost, tyre cost, support equipment cost, and operational cost all have very small correlation value. As such, those factors are not deemed important and can be neglected.

Based on tornado chart correlation coefficient, its necessary to find out the limit value for exchange rate, production capacity, inflation rate, maintenance cost, electricity price, and electricity usage. Alternative 2 isn't viable option when the NPV value is lower compared to NPV value of NPV alternative 3 hybrid with scenario using 75%. Using goal seek analysis, here are the limit value for each of those correlate risk.

Table 5.10 Limit Sensitivity Value

Risk Factor	Correlation Value	Current Value	Limit	Unit
Exchange Rate	0.86	15,000	$\geq 9,428.2$	Rupiah
Production Capacity	0.38	20,000,000	$\geq 10,300,589$	Tons
Inflation Rate	-0.23	3.80%	$\leq 40\%$	Percent
Maintenance Cost	-0.05	0.0021	≤ 0.0099	\$/Tons.Km
Electricity Price	-0.04	0.074	≤ 0.26	\$/Tons.Km
Electricity Usage	-0.03	9,600	$\leq 33,782$	Kw

If risk factor has positive value, then the risk value must not below those limits and vice versa. For example, exchange value has positive correlation which mean the value must not below Rp9428.20. The opposite for inflation rate with negative correlation. Inflation rate must not be bigger than 40%.

As for the NPV and IRR can be seen on Figure 5.22 and Figure 5.23 below.

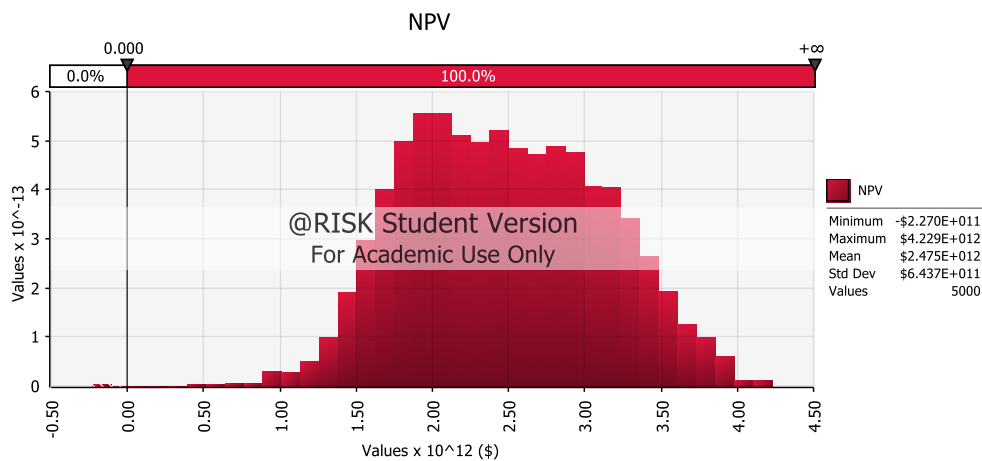


Figure 5.37 NPV Simulation

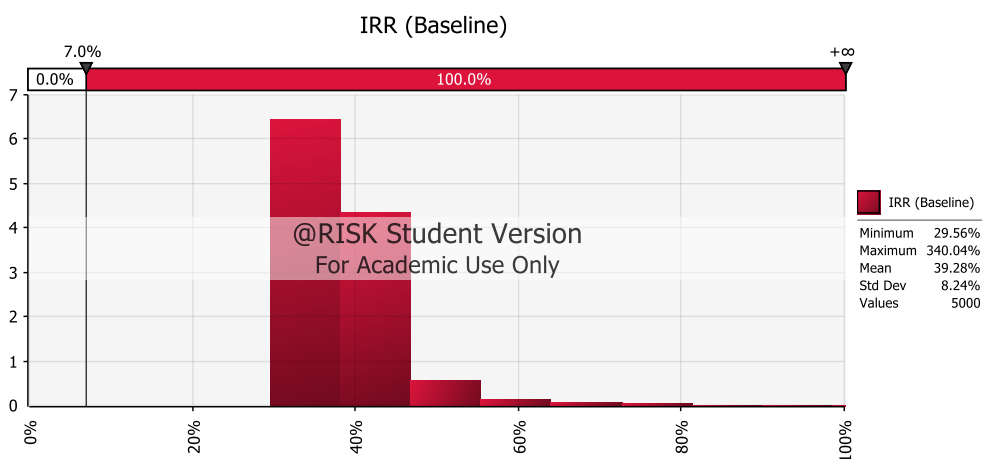


Figure 5.38 IRR Simulation

As can be seen from Figure 5.22 and Figure 5.23, both NPV and IRR are above the required requirement. NPV have 100% probability to be profitable to PT X while IRR have 100% probability to be above MARR 7%. This mean even without risk treatment, alternative 2 LLO is very much profitable.

5.6 Operational Risk

According to Investopedia website, Operational risk is summarizing as risks a company undertakes when it attempts to operate within given field or industry. Operational risk is the risk not inherent in financial or market-wide risk, it's the risk remaining after determining financing and systematic risk and includes risks resulting from breakdown in internal procedures, people, and system.

Operational risk is risk that cause by human factor such as negligent or sabotage. It differs between industry type but important consideration to make when looking at potential investment decision. Less human interaction often has lower operational risk. Operational risk focus on the organization itself. It's often related by company or organization active decision regarding how the organization function and what it prioritize, it can be higher or lower risk depend on various internal management decision. Here's few operational risks related to choosing LLO as alternative:

Table 5.11 Operational Risk

Risk Factor	Description	Compromise
Lack of Capital	Choosing LLO as alternative require additional investment which very costly. Compared to truck which doesn't require anymore investment or hybrid which have lower capital investment, LLO can be a troublesome choice in this situation.	Proposition to slowly substitute to LLO or implement hybrid alternative instead. While hybrid have lower advantage compared to LLO in term of cost saving, hybrid is feasible option as it's still better than solely usage of truck. Hybrid also use the already proven truck as coal transportation method. This also reduce the initial investment cost while give PT GBU back up in case of LLO result in failure.
Lack of Confidence	Choosing LLO compared to already proven situation of using truck can be very doubtful. While on paper LLO give huge advantage over truck, it's not impossible that the actual far from the given specification. The LLO might not even be able to fulfill it's designated purpose due to reason.	
Minor Accident	If there are accident or disaster happen that render LLO to be temporarily inoperable but no major loss or loss of human capital	Consider to have small fleet of truck as emergency option or making contract with transport company for renting truck in case of emergency.
Major Accident	If there are accident or disaster happen that render LLO to be inoperable in long-term and cause major financial loss or loss of human life	Consider the risk to be fixable or not. If the risk are unfixable and constantly give huge loss, consider to substitute with alternative hybrid or change back to truck as coal transportation method.
Lay-off	Substitution of truck with LLO would require not only sell of truck but also massive lay-off from ground crew need to operate truck. There might be massive amount of unemployment and problem from it.	Prepare retirement plan for the lay-off worker and possibly to choose hybrid alternative instead if necessary.

AS can be seen above, those are the operational risk that can happen if PT X choose LLO as coal transport method. Depend on the severity, the company may have big deficit cause by those risk. As such, there is opening for other alternative if LLO can't be implemented because of some reason such as above. If those happen, alternative 3 hybrid can be an excellent choice. Alternative 3, while can't as much profit as alternative 2 LLO, offer more flexibility. There is also existing and proven infrastructure to be use. The truck driver also already available and doesn't require any more training. There is also confident reason as implement alternative 2 LLO, while look good on paper, isn't certain regarding its performance. Alternative 3 instead offer the combine of pre-existing and proven truck with LLO as experiment. If LLO not proven as expected, there is choice to revert back to truck. The opposite can also happen, if LLO proven to be much-much better compared to hybrid, PT X can always switch as some infrastructure already constructed.

(This page is emptied on purpose)

CHAPTER 6

CONCLUSSION AND SUGGESTION

This chapter give conclusion and suggestion based on this research regarding alternative coal transportation for PT X.

6.1 Conclusion

Conclusion from this research is as follow:

1. Based on NPV using Truck as benchmark and EPV. Feasibility result in alternative 2 using LLO as the best alternative for PT X. Without risk analysis, alternative 2 give NPV of \$246,219,007 or Rp 3,693,285,099,441.92 and IRR 31.64%. Second most feasible alternative is alternative 3 hybrid with 75% route covered using LLO with NPV value of \$159,004,425.47 or \$2,385,066,381,975.84 and IRR of 26.76%. Alternative 1 of using truck by far the worst alternative because as benchmark, both alternative 2 LLO and alternative 3 hybrid using 75% LLO scenario have large positive NPV and IRR bigger than MARR of 7%. Based on EPV, alternative 2 LLO also the best alternative with EPV of (\$319,240,611) or (Rp4,788,609,161,903) which is the smallest EPV compared to the other 2 alternatives. Second smallest EPV is alternative 3 with 75% LLO scenario which give EPV of (\$413,679,652) or (Rp6,205,194,778,583). The last and the biggest negative value of EPV is by alternative 1 truck with EPV value of (\$579,321,918) or (Rp8,689,828,766,838) which make the worse alternative. Based on NPV and EPV overall, alternative 2 LLO is by far the best alternative. Second best alternative is alternative 3 hybrid. Alternative 3 hybrid is feasible. In case alternative 2 LLO can't be implemented, alternative 3 is a good back up plan. The worst of the 3 alternative is alternative 1 truck.
2. Based on risk identification, there are 11 risk which affect alternative 2 as optimal choice. Those risk are Production Capacity, Inflation, Exchange Rate between Dollar and Rupiah, LLO Load Capacity, Electricity Usage, Electricity Price, Drive Station Tyre Cost, Equipment Maintenance Cost,

Track Maintenance Cost, Operational Cost, and Support Equipment Cost. Out of those 11 risks, production capacity and exchange rate give positive sensitivity coefficient while maintenance cost, inflation, electricity usage, and electricity price give negative coefficient. The other 5 risk have very low correlation and deem as not important. NPV for alternative 2 LLO have 100% probability to be above 0. IRR also have 100% positive to be above MARR 7%.

3. Alternative 2 LLO deem to be not feasible as coal transport alternative when the value is below another alternative. As the closes value to alternative 2 LLO is by alternative 3 hybrid with 75% LLO scenario, the risk factor of alternative 2 LLO must not make the NPV value of Truck-LLO below Truck-Hybrid (75% LLO). Based on sensitivity analysis with correlation value of 0.86, exchange rate has limit value of 9428.2. The second highest correlation with 0.38 is production capacity with limit of 10,300,589 tons of coal. Inflation rate is the third highest correlation but with negative value. The correlation value is -0.23 with limit of 40%. Maintenance cost have correlation value of -0.05 and limit of \$0.0099/Tons.Km. Electricity Price have correlation value of -0,04 with limit of \$0.26/Tons.Km. The last is electricity usage with correlation value of -0.03 and limit of 33,782 Kw.
4. If Operational Risk occur, it is possible to choose hybrid alternative instead of LLO as alternative 3 hybrid also result of positive NPV and IRR higher than MARR 7%. While hybrid doesn't give return as high as LLO alternative, it offers more flexibility and less initial capital requirement. It also reduced the uncertainty of the project.

6.2 Suggestion

Here's suggestion for PT X in choosing the best alternative

1. Alternative 2 LLO is by large margin the best option compared to others alternative. As such, it's highly recommended to switch from the usage of truck to LLO. Later on, the unused truck can be sold to cover the investment cost in implementing LLO as coal transport.

2. While risk still won't affect the option of alternative 2 LLO as coal transport, it's highly recommended to make mitigation toward inflation risk as it has the highest result of negative coefficient.
3. Alternative 3 hybrid isn't closed as possible alternative because operational risk affects the LLO alternative in non-financial factor. If LLO is impossible to be implemented, then hybrid alternative is the best choice. Alternative 3 hybrid offer better flexibility and familiarity compared to alternative 2 LLO.

(This page is emptied on purpose)

REFERENCE

- Anityasari, M. & Wessianti, N. A., 2011. *Analisa Kelayakan Usaha dilengkapi Kajian Management Resiko*. Surabaya: Guna Widya.
- Atkinson, R., 1999. *International Journal of Project Management* Vol 17, No 6. *Project Management: cost, time, and quality, two best guesses and a phenomenon, itstime to accept other success criteria*, pp. 337-342.
- BP PLC, 2018. *Energy Charting Tool*. [Online]
Available at: <https://www.bp.com/en/global/corporate/energy-economics/energy-charting-tool-desktop.html>
[Accessed 22 November 2018].
- Chandra, A. A., 2018. *Harga Batu Bara Acuan Turun Jadi US\$ 97,9/Ton*. [Online]
Available at: <https://finance.detik.com/energi/d-4289456/harga-batu-bara-acuan-turun-jadi-us-979ton>
[Accessed 3 1 2019].
- Gray, E. W. L. & C. F., 2011. *Project Management, The Managerial Process*. 5th ed. s.l.:The McGraw-Hill Companies, Inc..
- Indonesia Investments, 2018. *Komoditas Batu Bara*. [Online]
Available at: <https://www.indonesia-investments.com/id/bisnis/komoditas/batu-bara/item236>
- Institute of Risk Management, 2018. *A Risk Practitioner Guide to ISO 31000: 2018*, London: Institute of Risk Management.
- International Monetary Funding, 2018. *Indonesia Country Data*. [Online]
Available at: <https://www.imf.org/en/Countries/IDN#countrydata>
- Kendrick, T., 2003. *Identifying and Managing Project Risk*. Bandung: AMACOM.
- Kenton, W., 2018. *Operational Risk*. [Online]
Available at: https://www.investopedia.com/terms/o/operational_risk.asp
[Accessed 9 January 2019].

- Kerzner, H., 2003. *Project Management, A System Approach to Planning, Scheduling, and Controlling*. 8th ed. Hoboken: John Wiley and Sons, Inc..
- Khoong, C. & Ku, Y. W., 1994. A Holistic Feasibility Study Framework for Decision Making. *IEEE Transactions on Systems, Man, and Cybernetics*, 24(1), pp. 100-106.
- Munns, A. K. & Bjerimi, B. F., 1996. International Journal of Project Management Vol 14, No 2. *The role of Project Management in achieving project success*, pp. 81-87.
- Project Management Institute, 2008. *A Guide To The Project Management Body of Knowledge (PMBOK Guide)*. 4th ed. Newtown Square: Project Management Institute, Inc..
- Pujawan, I. N., 2004. *Ekonomi Teknik*. Surabaya: Guna Widya.
- Putra, A. D., 2018. *Resmi, DPR Sahkan UU APBN 2019*. [Online] Available at: <https://ekonomi.kompas.com/read/2018/10/31/133228526/resmi-dpr-sahkan-uu-apbn-2019> [Accessed 2 10 2018].
- Santosa, B., 2009. *Manajemen Proyek*. 1st ed. Yogyakarta: Graha Ilmu.
- Siahaan, S., 2018. *Tarif PPh Badan: Poin Penting dalam Penghitungan Pajak Badan*. [Online] Available at: <https://www.online-pajak.com/tarif-pph-badan> [Accessed 21 January 2019].
- Standard Australia/Standard New Zealand, 2004. *Australia/New Zealand Standard Risk Management*, s.l.: Standard International Australia Ltd. and Standard New Zealand.
- Statista, 2018. *Change in OPEC Crude Oil Price Since 1960*. [Online] Available at: <https://www.statista.com/statistics/262858/change-in-opec-crude-oil-prices-since-1960/> [Accessed 15 November 2018].

ATTACHMENT

Attachment 1 Capital Expenditure	103
Attachment 2 Operational Expenditure Truck & LLO	105
Attachment 3 Operational Expenditure Hybrid	Error! Bookmark not defined.
Attachment 4 Risk consequence Stress Analysis.....	111
Attachment 5 Sensitivity Goal Seek Analysis	113

(This page is emptied on purpose)

CAPEX PRICE														
NO	ITEM	70	20.5	36	51.5	UNIT	UNIT PRICE	70	20.5	36	51.5			
1	Track													
	a. Rel 122													
	b. Penambat & Baut Pengencang					Km	\$ 185,000	\$ 12,950,000	\$ 3,792,500	\$ 6,660,000	\$ 9,527,500			
	c. Bantalan besi													
	d. Fish Plate													
	Installation track													
	a. Pasang Track													
	b. Pengelasan Rel					Km	\$ 28,000	\$ 1,960,000	\$ 574,000	\$ 1,008,000	\$ 1,442,000			
	c. Track Lying													
	d. Pasang Turnout													
	e. Pembebasan tanah					3m x 1000m	\$ 16,000.00	\$ 1,120,000	\$ 328,000	\$ 576,000	\$ 824,000			
						Km	\$ 4,000	\$ 280,000	\$ 82,000	\$ 144,000	\$ 206,000			
3		Installation drive station				Km	\$ 115,000	\$ 8,050,000	\$ 2,357,500	\$ 4,140,000	\$ 5,922,500			
4		Communication Cable (FO)				Km	\$ 115,000	\$ 8,050,000	\$ 2,357,500	\$ 4,140,000	\$ 5,922,500			
5	Drive Station													
	a. Motor Gear Box													
	b. Traction Control	215	69	115	161	Pcs	\$ 120,000	\$ 25,800,000.00	\$ 8,280,000.00	\$ 13,800,000.00	\$ 19,320,000.00			
	c. Trafo													
	d. Tire													
	Car trains (1 Train Set = 400 Car)	16800	4800	8400	12800	Car	\$ 5,000	\$ 84,000,000	\$ 24,000,000	\$ 42,000,000	\$ 64,000,000			
7	Supporting													
	Office	2	3	3	3	Pcs	\$ 7,692	\$ 15,384.62	\$ 23,076.92	\$ 23,076.92	\$ 23,076.92			
	Depo	1	2	2	2	Pcs	\$ 57,692	\$ 57,692.31	\$ 115,384.62	\$ 115,384.62	\$ 115,384.62			
	Mobilization, Demobilization, Vibro Roller					Km	\$ 2,308	\$ 161,538	\$ 47,308	\$ 83,077	\$ 118,846			
TOTAL PRICE VARIABLE COST											\$39,599,769	\$68,549,538	\$101,499,308	
NO	ITEM	QTY (DISTANCE)			UNIT	UNIT PRICE	PRICE (DISTANCE)							
		70	20.5	36	51.5			70	20.5	36	51.5			
1	Loading + Unloading													
	a. Loading	1	2	2	2	Lumpsum	\$1,158,550.00	\$1,158,550	\$2,317,100	\$2,317,100	\$2,317,100			
	b. Unloading	1	2	2	2	Lumpsum	\$838,950.00	\$838,950	\$1,677,900	\$1,677,900	\$1,677,900			
2	Commissioning					Lumpsum	\$636,556.25	\$636,556	\$636,556	\$636,556	\$636,556			
3	Worker Barrack					Lumpsum	\$19,230.77	\$19,231	\$19,231	\$19,231	\$19,231			
TOTAL PRICE FIXED COST											\$2,653,287	\$4,650,787	\$4,650,787	
NO	ITEM	QTY (DISTANCE)			UNIT	UNIT PRICE	PRICE (DISTANCE)							
		70	20.5	36	51.5			70	20.5	36	51.5			
1	Asset Disposal (Truck)					unit	\$600,000	\$45,600,000	\$15,150,000	\$24,000,000	\$31,800,000			
TOTAL PRICE VARIABLE COST + FIXED COST											\$91,447,902	\$29,250,556	\$49,200,325	\$74,350,095
CONVERT PER KM											\$1,306,398.61	\$1,426,856.40	\$1,366,675.71	\$1,443,691.16

(This page is emptied on purpose)

Attachment 2 Operational Expenditure Truck & LLO

DESCRIPTION	Truck	UNIT		LLO
	73 Km			70 Km
1. Data				
Distance	73	Km		70
Operating Days per Annum	330	Days		330
Effective Operation Hour per day	24	Hour		20
Train sets				
Required Minimal number of Transports	76	Truck	Train	42
Train total Lengths - combined	-	Km		42
Train gaps between trains	-	Km		0.13
Cart/Transport	1	Cart/truck	Cart/train	400
Total No. of Cart	76	Cart/truck	Cart/train	16800
Cart capacity	100	Tons/cart		1.204
Transport capacity	100	Tons		482
Total Payload	7600	Tons		20225
No. of Drive Stations	-	loop @ loading		3
	-	loop @ discharge		4
	-	Max 8% grades - Trammig Loaded		206
	-	Max 8% grades - simpang		2
	-	Total		215
Engineering & Construction Period	-	months		14
Operation				
Loading stations	1870	Tons Per Hour (TPH)		1870
	1	Loading points		1
	0	Km/h		3.6
Speed Loaded	50	Km/h		25
Speed Empty	65	Km/h		32
Discharge	0	Km/h		11
Loading Duration	3.21	Min		17
Tramming Duration	155	Min		296
unloading Duration	5	Min		5.6
Trip Duration (cycle time)	163.19	Min		319
Min. required volumes Conveyed / Day	60,606	Tons/day		60,606
Minimum Required Trips / Day (Target per day/transport number.capacity)	8	Trips/day		3
Possible Trips / Day (Work Hour/Cycle Time)	8	Trips/day		3
Capacity / Transport.Day	800	Tons/vehicle.day		1,445
Actual Transported capacity / Day	60,800	Tons/day		60,674
Actual Transported capacity / Year	20,064,000	Tons		20,022,267
2A. OPEX - DIRECT COST				
Electricity Usage	-	Kwh/T.km		0.042
Electricity Usage/month	-	Kw		12,600
Electricity Fixed Cost/month (1-1, 2-14KV)	-	\$		-
Electricity Price (1-1, 2-14KV)	-	\$/Kwh		\$0.074
Fuel Cost / Tons.Km (Electricity or Oil)	\$0.0267	\$/Tons.km		\$0.0031
Tyre qtuantity for drive stations	-	Tyres		430
Tyre Change	-	Hours		1283.3
Tyres Cost / Year	-	per tyre		\$ 268,191
Tyre cost / Tons	-	\$		\$ 0.013
Tyre cost / Tons.Km	-	\$/Tons.km		\$ 0.0002
Truck Tyre price (27.00R49 2* Bridgestone VMTP E4 E2A TL)	\$13,900	\$/Tyre.Truck.6 year		-
Truck Tyre price (4 tyre)	\$55,600	\$/Truck.6 year		-
Truck Tyre price / Year	\$704,266.67	\$/Truck.Year		-
Annual Truck Tyre Maintenance Cost / Tons.Km	\$0.000240	\$/Tons.km		-
Annual Equipment Maintenance	\$4,460,981.95	\$/Year		\$ 2,496,407
Eqpt Maintenance cost / Tons	\$0.22	\$/Tons		\$ 0.12
Maintenance Cost / Tons.Km	\$0.0031	\$/Tons.Km		\$ 0.0018
Annual Road-Track Maintenance Cost	\$2,087,301.59	\$		\$ 2,849,693
Road-Track Maintenance cost / Tons	\$0.10	\$/Tons		\$ 0.14
Road-Track Maintenance Cost / Tons.Km	\$0.0014	\$/Tons.km		\$ 0.0020
2B. OPEX - INDIRECT COST				
Annual Operational Cost	\$210,000	\$		\$ 110,046
Operational cost / Tons	\$0.0105	\$/Tons		\$ 0.01
Operational Cost / Tons.Km	\$0.0001	\$/Tons.km		\$ 0.0001
Annual Support Equipment Cost	\$214,000.00	\$/year		\$ 78,873
Support Equipment Cost	\$0.0107	\$.Tons		\$ 0.00
Support Eqpt Cost / Tons.Km	\$0.00015	\$/Tons.km		\$0.0000563
OPEX COSTS RATE (\$/T.Km)	\$0.0317	\$/Tons.km		\$0.007259
OPEX COSTS RATE	\$46,256,626.97	\$/Year		\$10,162,053.09
OPEX COSTS RATE (\$/T.Km)	Rp475	\$/Tons.km		Rp109
OPEX COSTS RATE	Rp693,849,404,614	\$/Year		Rp152,430,796,280

(This page is emptied on purpose)

Attachment 3 Operational Expenditure Hybrid

DESCRIPTION (25% LLO)	Truck	UNIT		LLO
	51.5 Km			20.5 Km
1. Data				
Distance	51.5	Km		20.5
Operating Days per Annum	330	Days		330
Effective Operation Hour per day	24	Hour		20
Train sets				
Required Minimal number of Transports	51	Truck	Train	12
Train total Lengths - combined	-	Km		12
Train gaps between trains	-	Km		0.13
Cart/Transport	1	Cart/truck	Cart/train	400
Total No. of Cart	51	Cart/truck	Cart/train	4800
Cart capacity	100	Tons/cart		1.204
Transport capacity	100	Tons		482
Total Payload	5100	Tons		5778
No. of Drive Stations	-	loop @ loading		3
	-	loop @ discharge		4
	-	Max 8% grades - Trammimg Loaded		60
	-	Max 8% grades - simpang		2
	-	Total		69
Engineering & Construction Period	-	months		14
Operation				
Loading stations	1870	Tons Per Hour (TPH)		1870
	1	Loading points		1
	0	Km/h		3.6
Speed Loaded	50	Km/h		25
Speed Empty	65	Km/h		32
Discharge	0	Km/h		11
Loading Duration	3.21	Min		17
Tramming Duration	109	Min		87
unloading Duration	5	Min		5.6
Trip Duration (cycle time)	117.55	Min		109
Min. required volumes Conveyed / Day	60,606	Tons/day		60,606
Minimum Required Trips / Day (Target per day/transport number.capacity)	12	Trips/day		11
Possible Trips / Day (Work Hour/Cycle Time)	12	Trips/day		11
Capacity / Transport.Day	1,200	Tons/vehicle.day		5,297
Actual Transported capacity / Day	61,200	Tons/day		63,563
Actual Transported capacity / Year	20,196,000	Tons		20,975,708
2A. OPEX - DIRECT COST				
Electricity Usage	-	Kwh/T.km		0.042
Electricity Usage/month	-	Kw		3,600
Electricity Fixed Cost/month (1-1, 2-14KV)	-	\$		-
Electricity Price (1-1, 2-14KV)	-	\$/Kwh		\$0.074
Fuel Cost / Tons.Km (Electricity or Oil)	\$0.0267	\$/Tons.km		\$0.0031
Tyre qtuantity for drive stations	-	Tyres		138
Tyre Change	-	Hours		1344.4
Tyres Cost / Year	-	per tyre		\$ 90,169
Tyre cost / Tons	-	\$		\$ 0.005
Tyre cost / Tons.Km	-	\$/Tons.km		\$ 0.0002
Truck Tyre price (27.00R49 2* Bridgestone VMTP E4 E2A TL)	\$13,900	\$/Tyre.Truck.6 year		-
Truck Tyre price (4 tyre)	\$55,600	\$/Truck.6 year		-
Truck Tyre price / Year	\$472,600.00	\$/TYear		-
Annual Truck Tyre Maintenance Cost / Tons.Km	\$0.000227	\$/Tons.km		-
Annual Equipment Maintenance	\$2,993,553.68	\$/Year		\$ 2,496,407
Eqpt Maintenance cost / Tons	\$0.15	\$/Tons		\$ 0.12
Maintenance Cost / Tons.Km	\$0.0029	\$/Tons.Km		\$ 0.0061
Annual Road-Track Maintenance Cost	\$1,472,548.38	\$		\$ 834,553
Road-Track Maintenance cost / Tons	\$0.07	\$/Tons		\$ 0.04
Road-Track Maintenance Cost / Tons.Km	\$0.0014	\$/Tons.km		\$ 0.0020
2B. OPEX - INDIRECT COST				
Annual Operational Cost	\$140,921.05	\$		\$ 110,046
Operational cost / Tons	\$0.0070	\$/Tons		\$ 0.01
Operational Cost / Tons.Km	\$0.0001	\$/Tons.km		\$ 0.0003
Annual Support Equipment Cost	\$143,605.26	\$/year		\$ 78,873
Support Equipment Cost	\$0.0072	\$/Tons		\$ 0.00
Support Eqpt Cost / Tons.Km	\$0.00014	\$/Tons.km		\$0.0001924
OPEX COSTS RATE (\$/T.Km)	\$0.0315	\$/Tons.km		\$0.011918
OPEX COSTS RATE	\$32,451,301.78	\$/Year		\$4,886,566.56
OPEX COSTS RATE (\$/T.Km)	Rp473	\$/Tons.km		Rp179
OPEX COSTS RATE	Rp486,769,526,629	\$/Year		Rp73,298,498,346

DESCRIPTION (50% LLO)	Truck	UNIT	LLO
	36 Km		36 Km
1. Data			
Distance	36	Km	36
Operating Days per Annum	330	Days	330
Effective Operation Hour per day	24	Hour	20
Train sets			
Required Minimal number of Transports	36	Truck	21
Train total Lengths - combined	-	Km	21
Train gaps between trains	-	Km	0.13
Cart/Transport	1	Cart/truck	400
Total No. of Cart	36	Cart/truck	8400
Cart capacity	100	Tons/cart	1.204
Transport capacity	100	Tons	482
Total Payload	3600	Tons	10112
No. of Drive Stations	-	loop @ loading	3
	-	loop @ discharge	4
	-	Max 8% grades - Trammimg Loaded	106
	-	Max 8% grades - simpang	2
	-	Total	115
Engineering & Construction Period	-	months	14
Operation			
Loading stations	1870	Tons Per Hour (TPH)	1870
	1	Loading points	1
	0	Km/h	3.6
Speed Loaded	50	Km/h	25
Speed Empty	65	Km/h	32
Discharge	0	Km/h	11
Loading Duration	3.21	Min	17
Trammimg Duration	76	Min	152
unloading Duration	5	Min	5.6
Trip Duration (cycle time)	84.64	Min	175
Min. required volumes Conveyed / Day	60,606	Tons/day	60,606
Minimum Required Trips / Day (Target per day/transport number.capacity)	17	Trips/day	6
Possible Trips / Day (Work Hour/Cycle Time)	17	Trips/day	6
Capacity / Transport.Day	1,700	Tons/vehicle.day	2,889
Actual Transported capacity / Day	61,200	Tons/day	60,674
Actual Transported capacity / Year	20,196,000	Tons	20,022,267
2A. OPEX - DIRECT COST			
Electricity Usage	-	Kwh/T.km	0.042
Electricity Usage/month	-	Kw	6,300
Electricity Fixed Cost/month (1-1, 2-14KV)	-	\$	-
Electricity Price (1-1, 2-14KV)	-	\$/Kwh	\$0.074
Fuel Cost / Tons.Km (Electricity or Oil)	\$0.0267	\$/Tons.km	\$0.0031
Tyre qtuantity for drive stations	-	Tyres	230
Tyre Change	-	Hours	1283.3
Tyres Cost / Year	-	per tyre	\$ 143,451
Tyre cost / Tons	-	\$	\$ 0.007
Tyre cost / Tons.Km	-	\$/Tons.km	\$ 0.0002
Truck Tyre price (27.00R49 2* Bridgestone VMTP E4 E2A TL)	\$13,900	\$/Tyre.Truck.6 year	-
Truck Tyre price (4 tyre)	\$55,600	\$/Truck.6 year	-
Truck Tyre price / Year	\$333,600.00	\$/TYear	-
Annual Truck Tyre Maintenance Cost / Tons.Km	\$0.000229	\$/Tons.km	-
Annual Equipment Maintenance	\$2,113,096.71	\$/Year	\$ 2,496,407
Eqpt Maintenance cost / Tons	\$0.11	\$/Tons	\$ 0.12
Maintenance Cost / Tons.Km	\$0.0029	\$/Tons.Km	\$ 0.0035
Annual Road-Track Maintenance Cost	\$1,029,354.21	\$	\$ 1,465,556
Road-Track Maintenance cost / Tons	\$0.05	\$/Tons	\$ 0.07
Road-Track Maintenance Cost / Tons.Km	\$0.0014	\$/Tons.km	\$ 0.0020
2B. OPEX - INDIRECT COST			
Annual Operational Cost	\$99,473.68	\$	\$ 110,046
Operational cost / Tons	\$0.0050	\$/Tons	\$ 0.01
Operational Cost / Tons.Km	\$0.00	\$/Tons.km	\$ 0.0002
Annual Support Equipment Cost	\$101,368.42	\$/year	\$ 78,873
Support Equipment Cost	\$0.0051	\$/Tons	\$ 0.00
Support Eqpt Cost / Tons.Km	\$0.00014	\$/Tons.km	\$0.0001095
OPEX COSTS RATE (\$/T.Km)	\$0.0315	\$/Tons.km	\$0.009078
OPEX COSTS RATE	\$22,708,474.25	\$/Year	\$6,536,024.18
OPEX COSTS RATE (\$/T.Km)	Rp473	\$/Tons.km	Rp136
OPEX COSTS RATE	Rp340,627,113,766	\$/Year	Rp98,040,362,709

DESCRIPTION (75% LLO)	Truck	UNIT		LLO
	20.5 Km			51.5 Km
1. Data				
Distance	20.5	Km		51.5
Operating Days per Annum	330	Days		330
Effective Operation Hour per day	24	Hour		20
Train sets				
Required Minimal number of Transports	23	Truck	Train	32
Train total Lengths - combined	-	Km		32
Train gaps between trains	-	Km		0.13
Cart/Transport	1	Cart/truck	Cart/train	400
Total No. of Cart	23	Cart/truck	Cart/train	12800
Cart capacity	100	Tons/cart		1.204
Transport capacity	100	Tons		482
Total Payload	2300	Tons		15409
No. of Drive Stations	-	loop @ loading		3
	-	loop @ discharge		4
	-	Max 8% grades - Trammimg Loaded		151
	-	Max 8% grades - simpang		2
	-	Total		161
Engineering & Construction Period	-	months		14
Operation				
Loading stations	1870	Tons Per Hour (TPH)		1870
	1	Loading points		1
	0	Km/h		3.6
Speed Loaded	50	Km/h		25
Speed Empty	65	Km/h		32
Discharge	0	Km/h		11
Loading Duration	3.21	Min		17
Trammimg Duration	44	Min		218
unloading Duration	5	Min		5.6
Trip Duration (cycle time)	51.73	Min		240
Min. required volumes Conveyed / Day	60,606	Tons/day		60,606
Minimum Required Trips / Day (Target per day/transport number.capacity)	27	Trips/day		4
Possible Trips / Day (Work Hour/Cycle Time)	27	Trips/day		4
Capacity / Transport.Day	2,700	Tons/vehicle.day		1,926
Actual Transported capacity / Day	62,100	Tons/day		61,637
Actual Transported capacity / Year	20,493,000	Tons		20,340,081
2A. OPEX - DIRECT COST				
Electricity Usage	-	Kwh/T.km		0.042
Electricity Usage/month	-	Kw		9,600
Electricity Fixed Cost/month (I-1, 2-14KV)	-	\$		-
Electricity Price (I-1, 2-14KV)	-	\$/Kwh		\$0.074
Fuel Cost / Tons.Km (Electricity or Oil)	\$0.0267	\$/Tons.km		\$0.0031
Tyre qtuantity for drive stations	-	Tyres		322
Tyre Change	-	Hours		1303.7
Tyres Cost / Year	-	per tyre		\$ 204,019
Tyre cost / Tons	-	\$		\$ 0.010
Tyre cost / Tons.Km	-	\$/Tons.km		\$ 0.0002
Truck Tyre price (27.00R49 2* Bridgestone VMTP E4 E2A TL)	\$13,900	\$/Tyre.Truck.6 year		-
Truck Tyre price (4 tyre)	\$55,600	\$/Truck.6 year		-
Truck Tyre price / Year	\$213,133.33	\$/TYear		-
Annual Truck Tyre Maintenance Cost / Tons.Km	\$0.000254	\$/Tons.km		-
Annual Equipment Maintenance	\$1,350,034.01	\$/Year		\$ 2,496,407
Eqpt Maintenance cost / Tons	\$0.07	\$/Tons		\$ 0.12
Maintenance Cost / Tons.Km	\$0.0033	\$/Tons.Km		\$ 0.0024
Annual Road-Track Maintenance Cost	\$586,160.03	\$		\$ 2,096,560
Road-Track Maintenance cost / Tons	\$0.03	\$/Tons		\$ 0.10
Road-Track Maintenance Cost / Tons.Km	\$0.0014	\$/Tons.km		\$ 0.0020
2B. OPEX - INDIRECT COST				
Annual Operational Cost	\$63,552.63	\$		\$ 110,046
Operational cost / Tons	\$0.0032	\$/Tons		\$ 0.01
Operational Cost / Tons.Km	\$0.0002	\$/Tons.km		\$ 0.0001
Annual Support Equipment Cost	\$64,763.16	\$/year		\$ 78,873
Support Equipment Cost	\$0.0032	\$/Tons		\$ 0.00
Support Eqpt Cost / Tons.Km	\$0.00016	\$/Tons.km		\$0.0000766
OPEX COSTS RATE (\$/T.Km)	\$0.0320	\$/Tons.km		\$0.007954
OPEX COSTS RATE	\$13,101,846.16	\$/Year		\$8,192,768.20
OPEX COSTS RATE (\$/T.Km)	Rp479	\$/Tons.km		Rp119
OPEX COSTS RATE	Rp196,527,692,437	\$/Year		Rp122,891,523,072

(This page is emptied on purpose)

Attachment 4 Risk consequence Stress Analysis

Name	Stress Analysis	Mean	Min	Max
-	Baseline	2,475,275,558,015	-157,471,128,511	4,204,203,388,854
Production Capacity	0% to 21.30%	2,071,599,611,787	-142,029,033,863	3,454,285,823,087
Inflation Rate	54.80% to 100.00%	2,332,771,747,537	-388,429,800,037	3,986,005,588,945
Exchange Rate	0% to 21.20%	1,737,367,580,403	-160,020,050,452	2,472,497,877,589
Transport Capacity	0% to 10.00%	2,472,267,645,217	-157,471,128,511	4,191,530,932,707
Electricity Usage	90.00% to 100.00%	2,424,464,261,937	-172,736,471,954	4,158,055,485,050
Electricity Price	10.00% to 100.00%	2,468,325,756,878	-157,493,964,356	4,190,220,700,284
Tyre cost	90.00% to 100.00%	2,472,433,256,876	-158,349,991,982	4,198,275,080,325
Maintenance Cost	90.00% to 100.00%	2,432,989,028,606	-168,839,157,254	4,074,182,047,786
rack Maintenance Cost	90.00% to 100.00%	2,445,731,284,447	-166,078,929,449	4,156,149,263,110
Operational Cost	90.00% to 100.00%	2,473,835,546,228	-157,914,911,148	4,202,453,906,088
Support Eqpt Cost	90.00% to 100.00%	2,474,037,427,816	-157,926,597,603	4,201,786,632,994

(This page is emptied on purpose)

Attachment 5 Sensitivity Goal Seek Analysis

@RISK Goal Seek Status

@RISK Goal Seek on Cell \$D\$47
Solution found.

Target Mean: 2,243,802,916,984.47
Current Mean: 2,245,711,467,207.99
Achieved by setting \$C\$4 to 10,300,589

Update \$C\$4 to 10,300,589?

Yes No

@RISK Goal Seek Status

@RISK Goal Seek on Cell \$D\$47
Solution found.

Target Mean: 2,243,802,916,984.47
Current Mean: 2,243,802,916,984.60
Achieved by setting \$K\$1 to 9428.2

Update \$K\$1 to 9428.2?

Yes No

@RISK Goal Seek Status

@RISK Goal Seek on Cell \$D\$47
Solution found.

Target Mean: 2,243,802,916,984.47
Current Mean: 2,249,135,737,671.99
Achieved by setting \$C\$16 to 0.40075

Update \$C\$16 to 0.40075?

Yes No

@RISK Goal Seek Status

@RISK Goal Seek on Cell \$D\$47
Solution found.

Target Mean: 2,243,802,916,984.47
Current Mean: 2,243,802,916,984.64
Achieved by setting \$W\$57 to \$0.0099

Update \$W\$57 to \$0.0099?

Yes

No

@RISK Goal Seek Status

@RISK Goal Seek on Cell \$D\$47
Solution found.

Target Mean: 2,243,802,916,984.47
Current Mean: 2,243,802,916,984.20
Achieved by setting \$W\$44 to \$0.26

Update \$W\$44 to \$0.26?

Yes

No

@RISK Goal Seek Status

@RISK Goal Seek on Cell \$D\$47
Solution found.

Target Mean: 2,243,802,916,984.47
Current Mean: 2,243,802,916,984.15
Achieved by setting \$W\$42 to 33,782

Update \$W\$42 to 33,782?

Yes

No