IMPROVING COAL SALES PROFIT BY ALTERNATIVE BLENDING PROCESSES

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A Thesis Submitted in Partial Fulfillment of the Requirements

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การปรับปรุงผลกำไรของการขายถ่านหิน โดยพิจารณาทางเลือกในกระบวนการผสมถ่านหิน

นายวรุตม์ วรามิตร

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิศวกรรมศาสตรมหาบัณฑิต
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วรุตม์ วรามิตร : การปรับปรุงผลกำไรของการขายถ่านหิน โดยพิจารณาทางเลือกในกระบวนการผสมถ่านหิน (IMPROVING COAL SALES PROFIT BY ALTERNATIVE BLENDING PROCESSES) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: รศ. จิรพัฒน์ เงาประเสริฐวงศ์ , 107 หน้า.

งานวิจัยนี้มีจุดประสงค์เพื่อปรับปรุงผลกำไรของการขายถ่านหิน โดยพิจารณาทางเลือกในกระบวนการผสมถ่านหิน จุดประสงค์หลักของงานวิจัยนีเ พื่อคำนวนหาแผนการผสมถ่านหินจากเหมืองถ่านหินสองแห่ง เพื่อเพิ่มผลกำไรในการขายให้มีมูลค่าเพิ่มขึ้นมากที่สุดจากแผนการผสมถานหินเดิม

การศึกษาได้แบ่งขั้นตอนออกเป็นสองขั้นตอน คือ ขั้นตอนที่หนึ่งการเก็บข้อมูลและวางแผนวางแผน และ ขั้นตอนที่สอง การคำนวนหาทางเลือกที่ดีที่สุดในการผสมถ่านหิน งานในขั้นตอนการวางแผนนั้นจะเป็นการเก็บข้อมูลที่จำเป็น ศึกษาการเปลี่ยนแปลงของรายได้และค่าใช้จ่ายในทางเลือกใหม่ของกระบวนการผสมถ่านหิน การกำหนดข้อจำกัดของการคำนวนและข้อจำกัดของคุณภาพของถ่านหินหลังจากการผสม รวมถึงการเตรียมการสำหรับการคำนวนอัตราส่วนในการผสมถ่านหิน

ขั้นตอนที่สองคือ ขั้นตอนการคำนวนหาทางเลือกที่ดีที่สุดในการผสมถ่านหินระหว่างเหมืองสองแห่ง ในขั้นตอนนี้จะทำการกำหนดตัวแทนของคุณภาพถ่านหินที่จะใช้ในการผสมจากเหมืองแต่ละแห่ง และทำการกำหนดแผนการในการคำนวนอัตราส่วนในการผสมถ่านหินเพื่อหาทางเลือกที่ดีที่สุดและได้ผลกำไรเพิ่มขึ้นมากที่สุด นอกจากนี้ยังทำการคำนวนผลกำไรที่เปลี่ยนแปลงไปแปรผันตามราคาถ่านหินและราคาน้ำมันที่เปลี่ยนแปลง

ผลลัพธ์จาการศึกษาที่ได้จากการวิจัยนี้ ปรากฏว่า บริษัทมีกำไร 42.3 ล้านเหรียญสหรัฐ ซึ่งสูงกว่าแผนปัจจุบันที่มีกำไร 33.7 ล้านเหรียญสหรัฐ หรือคิดเป็ นกำไรที่เพิ่มขึ้น 25 เปอร์เซนต์ จากการผสมถ่านหินระหว่างเหมืองถ่านหินสองแห่ง และจากการคำนวนการเปลี่ยนแปลงผลกำไรตามตัวแปรสำคัญพบว่า ถึงแม้จะมีการเปลี่ยนแปลงของราคาถ่านหินที่ต่ำลงราคาน้ำมันสูงขึ้นถึง 50 เปอร์เซนต์แต่ผลกำไรจากทางเลือกใหม่ในการผสมถ่านหินยังคงมีกำไรสูงกว่าแผนปัจจุบัน

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The purpose of this research is to improve coal sales profit by alternative coal blending process. The main objective of this research is to improve operational profit of the company by developing alternative coal blending process across 2 coal mines from various raw coal qualities to get coal products to be matched with customers' requirement.

The study consists of two main parts that are the planning part and the calculation of alternative blending part. The planning part begins with gathering all information, classifying coal quality, identifying limitation, and creating blending model. The second stage is calculation of alternative blending part starts from assessing impacts of revenue and cost from changing operation process, preparing new blending calculation model for new blending plan, and then study of sensitivity of main factors, coal price and oil price.

The result of best blending plan show the profit from new blending is 42.3 million US$ which higher than profit of original plan which is 33.7 million US$. The company can get more profit about 25.6 percent compared with profit from original plan. Moreover, the result sensitivity study of coal price and oil price has confirmed that profit from alternative blending process is higher than original plan even though these two factors are changed up to 50 percent.

Department: Regional Centre for Manufacturing Systems Engineering
Student's Signature .....
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1. CHAPTER I

INT RODUCTION

1.1 Background of the research

According to high business competition in coal business and the extremely decreasing of coal price since 2011, all coal companies have been suffering from low profit and entering into surviving mode. Some companies have to shut down the operation because of no profit margin but there are some companies still be able to operate with low profit margin. In this critical business situation, every company needs to maximise the profit in order to survive by applying cost reduction program, performance improvement, lean operation, cash flow maximization, and sale product improvement plan, etc.

In order to improve company profit margin, there are two sides of important factors, which are external factors and internal factors. The external factors are unable to control by the company such as coal price, which is one of the most important factors and is changing by global economics, GDP, electricity demand, oil price and the growing of other substitute energy sources. On the other hand, the internal factors can be controlled and performed by the company.

Figure 1-1: Newcastle index Coal price 2006-2016

Coal is the commodity product; therefore, the price reference of coal trading in Asia is dominated by Newcastle Index (NEWC). The NEWC is updated and announced on a daily basis, which is calculated from the average of real trading price of main customers at Newcastle port in Australia. The Figure 1 above shows that the price of coal has been fluctuated from time to time. It is difficult to predict and unable to control. So, the company can only keep price monitoring and adjust company strategy based on the coal price fluctuations.

The internal factors such as cost reduction program, performance improvement program and product quality improvement program by alternative blending process can be controlled and changed by the company. The cost reduction program is the first priority to lean down cost of operation, reduce unnecessary expense, and negotiate with sub-contractor to reduce mining cost. The second priority is the performance improvement program in order to reduce equipment down time, improve equipment productivity, and apply advanced operational techniques. In addition, product quality improvement program by coal blending process is one of the major programs that can increase profit margin to the company. The best coal blending process could improve product quality and reduce cost. However, the

alternative blending plan must maintain customer satisfaction and ensure delivered products meet committed specification. The coal blending process to increase profit margin can be performed in two ways, including coal quality improvement and processing cost reduction.

The calculation of coal price is based on two main coal qualities, calorific value and ash content; therefore, improving coal quality is the direct way to increase coal price. Higher calorific value can be sold at a higher price while higher ash content would reduce the coal price. Calorific value is the natural property of coal that cannot be changed but can be blended with raw coal from other sources in order to meet product quality as customer's requirement. On the other hand, ash content is the percentage of impurity dirt in coal by volume. Coal washing process is the method to reduce ash content that can separate high ash coal from low quality coal. After the washing process, high ash coal will be rejected and treated as waste material, but low ash coal will be sold at higher price.

The studied company has two coal mines in Indonesia. Its initial plan is to produce two coal products from two different mines. The coal product from the 1st mine has an average calorific value at 5,000 kcal/kg with ash content 15.8%, and the coal product from the 2nd mine has an average calorific value at 5,400 kcal/kg with Ash 5.5%. The initial production plan of both mines is to individually produce and sell coal separately without blending coal across two mine sites. However, after considering information of raw coal qualities from both mines, the raw coal qualities show the range of calorific value between 4,200 – 6,100 kcal/kg, and ash content varies from 4.9% to 25%. Since raw coal qualities vary from low to high qualities, there is the possibility to separate raw coal type and determine the best alternative blending process.

There is the opportunity to study the integrated blending plan of raw coal from two mine sites that could increase company's profit and reduce cost of washing coal process. However, the blending process across two locations has the additional transportation cost and unloading cost.

As a result of the factors mentioned above, the blending opportunity needs to be studied in four parts as follows;

- What is the proper blending ratio across 2 mine sites to maximize the overall company profit?
- How to reduce processing cost from new integrated blending plan?
- How much the company profit can be improved compared with the initial plan?

In summary, the company should study and explore opportunities of alternative coal blending processes which could help company to have better blending plan and to improve profitability that make company survive in this tough situation. Therefore, the purposes of this study are to 1) explore and develop new coal blending plan across two mine sites in order to compare between increased benefits and additional cost 2) to determine the best blending portion between different coal locations and control coal qualities to be matched with the customers' requirement 3) to compare net profit margin between the initial plan and the new blending plan.

1.2 Objective

The main objective of this research is to improve operational profit of the company by developing alternative coal blending process across 2 coal mines from various raw coal qualities to get coal products to be matched with customers' requirement.

1.3 Scopes and Assumptions

The alternative coal blending process is developed to support operational improvement during the downturn in coal market and to maintain long-term company profit. The study consists of two main parts that are the planning part and the calculation of alternative blending part. The planning part begins with gathering all information, identifying limitation, and creating blending model. The second stage is calculation of alternative blending part starts from classifying coal quality, assessing impacts of revenue and cost from changing operation process, preparing new blending calculation model for new blending plan, and then study of sensitivity of main factors, coal price and oil price.

The planning part begins with the study of existing individual coal blending process and collects required information and assumption such as coal quality and quantity information, breakdown processing cost, transportation cost, and coal price formula. Calculation target, limitation, and alternative coal blending process should be set up in the next process. Then, next steps are to classify raw data and prepare calculation model. Furthermore, all information and assumption should be used as an input into the blending model and calculation. The result of alternative blending model will be compared with the initial blending plan in order to consider and select the best alternative blending process for further implementation.

The calculation of alternative blending part is to determine the best alternative blending plan. This stage needs to foresee the impacts, and sensitivity of main factors that might possibly change after selecting new blending process. This part

starts from identifying the additional process of alternative blending process and then assessing the potential additional revenue and cost from the additional activities. Next steps are to calculate blending model. Final step is to study of sensitivity of coal price and oil price, and identify overall benefit from this study.

The scope of this research mainly involves coal blending operation planning during fiscal year 2016. This research focus on increasing profit from alternative blending process across two coal mines. The scopes are the blending at crushing plant or transhipment and blending quality from raw coal stock through coal vessel. Calorific value (CV) and ash content percentage (ASH) are main qualities of coal which are included in coal blending quality, but sulphur and moisture are not included in the calculation. Moreover, the information related to operation cost in all process and margin of all related activities are also required to be a part of profit calculation. Weighted average method will be applied for the calculation of products in blending process with the assumption that all blending coals are homogeneous at all locations. Besides, external information such as coal price assumption is based on sale and marketing department forecast.

The main scopes of this research are listed as follows:

- To compare gross profit between the original blending plan and new alternative blending plan during the operation fiscal year 2016.
- To increase the profit from blending coal across two mines
- Blending coal by focus on representative Calorific value (CV) from each mine site and control Ash content (ASH) not excess the customer limitation.
- To define blending ratio and to deliver final coal product quality to meet customers' requirements

In order to focus on the target of the study, the assumptions and limitations have to be identified to develop alternative blending process and determine the best blending ration between two coal mines. This list of assumptions and limitations are as follows:

- Fixed annual coal sale volume, and coal quality
- Blending calculation using weight average method and assuming all coal blending is homogeneous
- Processing cost, blending cost, and transportation cost and all costs in all activities assumed to be known
- Maximum limit of blending permit volume assumed to be known
- Customer's coal quality requirement assumed to be known
- Mining cost for each coal quality type assumed to be known
- Coal price for each coal quality type assumed to be known

1.4 Research procedure

The study of developing new blending process consists of many steps. The first step is starting the literature review of necessary theory or research related to this study and gathering all necessary information such as all processing cost, coal price assumption, production schedule and etc. Next step is to set up the goal and limitation of the study and then put all required information into the blending model.

After running the blending model, the calculated outcome of the new blending process should be compared with the initial plan. Then, the potential impacts and risks of the new blending process should be identified, following by the preparation of new operation procedure and implementation. The details of research procedure are listed below;

1. Review theory or study on related research – literature review

2. Study existing process and collect necessary information
3. Set up study target and limitation of blending calculation
4. Input information into calculation model and run blending model
5. Summarize result of the model and select the best blending Alternatives
6. Compare result of alternative blending process with the initial blending plan
7. Sensitivity study of changing coal price and oil price.

1.5 Expected benefits

The target of this study is to improve company profits from alternative coal blending processes and identify coal qualities to be blended between two mines. In addition, the result of this study is to select the best blending Alternatives across two mines, to maximize the profit, and to study on sensitivity of changing coal price and oil price.

2. CHAPTER II

PROBLEM ANALYSIS

The information in Chapter II is to explain the problems in the existing coal operation of the studied company. The first part of this chapter provides general information on the studied company, Sakari Resources Group. The second part shows the current situation of coal business in Indonesia and the performance of the company. The last part consists of problem analysis of Sakari Resources Group and the solution of the study.

2.1 Company Overview

2.1.1 Background of the studied company

Sakari Resources Group (SAR) was established and listed in SGX (Singapore Stock Market) in November 2006 with total share value 2.7 billion Singapore dollar at the end of 2009. However, after SAR was acquired 95% by PTT Group from Thailand, it was delisted from stock market in 2013.

There are four mining concession in Mongolia and Indonesia which belong to Sakari. These four assets are in both exploitation stage and exploration stage. The mining concession of Sakari has detail as below;

1. Jembayan Mine concession, owned 100% by Sakari in exploitation stage, location in East Kalimantan, Indonesia.
2. Sebuku Mine cocession, owned 100% by Sakari in exploitation stage, lacation in East Kalimantan, Indonesia.

3. Xanadu mine concession is 15% owned by Sakari, license in Exploration stage, location in Mongolia.
4. Luang Mine concession is 80% owned by Sakari, license in exploration stage and located in Central Kalimantan, Indonesia.

This research will study in only 2 mine concessions in Indonesia which are Jembayan Mine and Sebuku Mine.

Tiger Energy Trading (TET) is based in Singapore and is the one of subsidiary company which 100% owned by Sakari Resources and responsible to sell all coal products from both mine site in Indonesia. The Sakari corporate office is located in Singapore where main office of CEO and CFO is. All technical function of Sakari is based in Balikpapan city, the main hub city of east Kalimantan which easiest place to service of both mine location. Jembayan and Sebuku mine concession are located in east and south Kalimantan. The external relation, legal and government relation office are located in capital city of Indonesia. Figure 2-1: Sakari office and mine site location map.

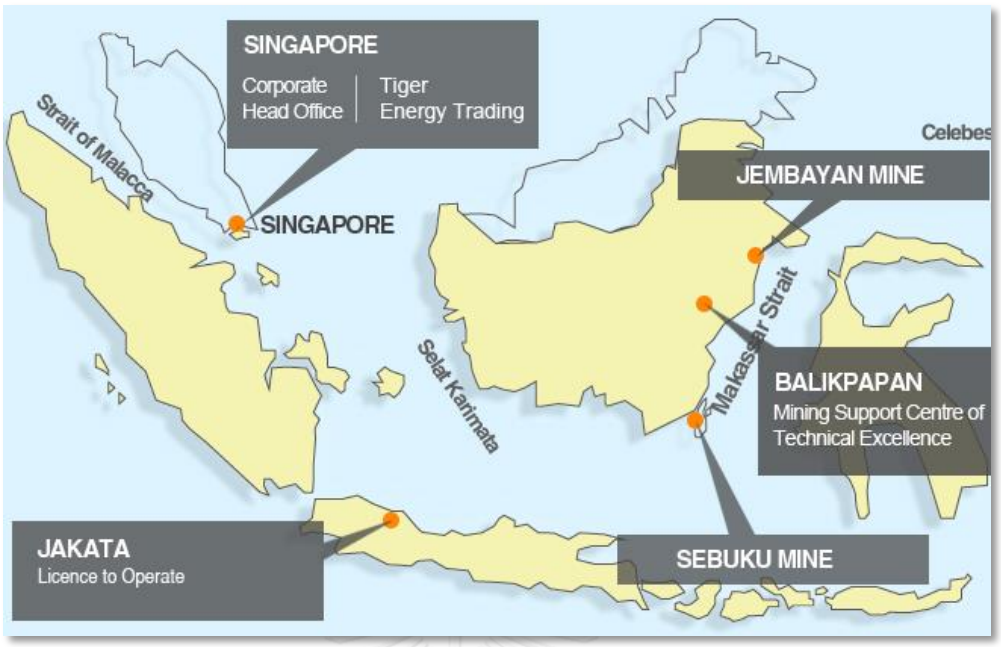

Figure 2-1: Sakari office and mine site location map

2.1.2 SAR's organisation structure

SAR has operations and offices in several locations with different local environments both in Singapore and Indonesia. The organization structures are designed to comply with local regulations and to follow the directions of the group in order to get the best organization structure to support company's growth.

Sakari employ about 850 staffs which categorize as mid to large company size. It is about 70% of total employee has been employed from local. Sakari has been set up the organization following Strategic Business Unit. There are four main departments under CEO of Sakari which are Operation, Financial, Business Development and Tiger Energy Trading. Sakari also created Delegate Authorization Structure (DAS) to delegate power of decision down to each work function.

All mining operations of both Jembayan and Sebuku are controlled by Chief Operation Officer (COO) which responsible to produce coal products following mine plan and customer requirement.

Finance, Tax and accounting function are under Chief Financial Officer (CFO) who takes care for optimising cash flow in the company.

The growth of Sakari Resources is responsible by Business Development. Business development team has duty to seek for new asset opportunity or joint operation with neighbour mine.

Tiger Energy Trading responsible to take care sells process, logistics and marketing for all coal products from Sakari Group. Moreover, TET takes care for all export document and export permit.

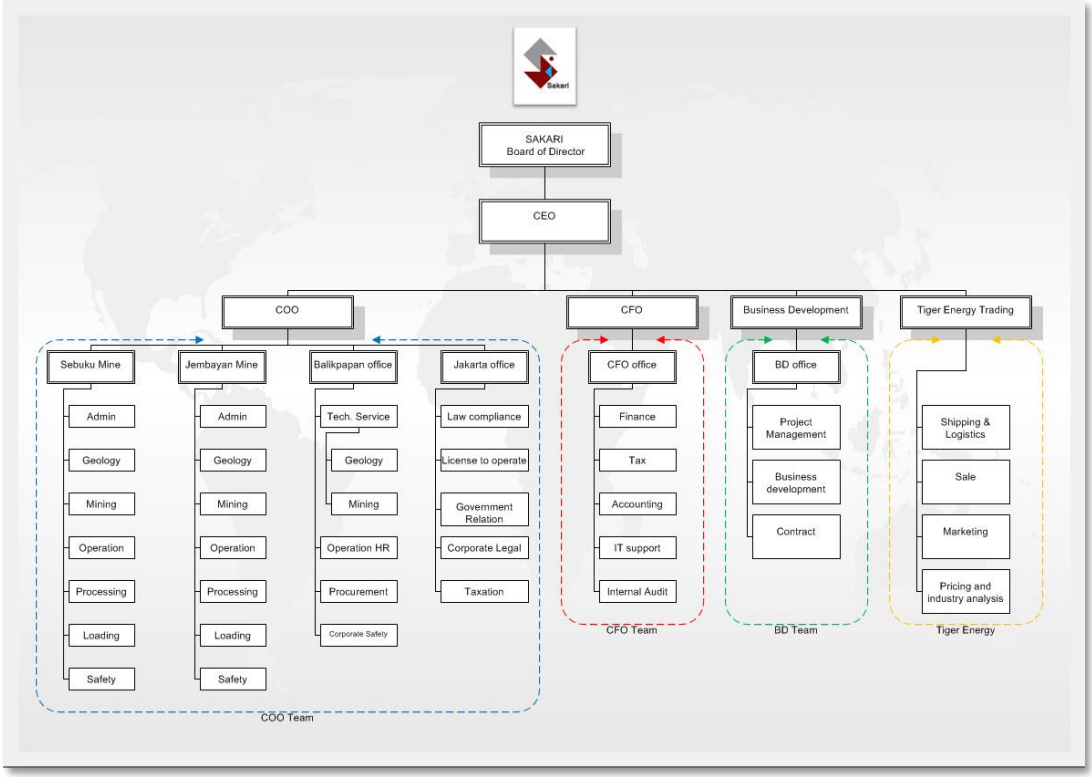

Figure 2-2: Organization Chart of Sakari Resources

2.1.3 Sakari Operation

In this chapter will explain about detail of both mine sites because to improve company operation, it needs to understand both mine sites information. Jembayan and Sebuku are located in difference location but in the same Kalimantan Island.

Sebuku mine is located in Sebuku Island, on the south east of Kalimantan Island. The island area is approximate 350 square kilometre which about 35 km from North to South and about 10 km from east to west.

The First production from Sebuku has produced at 1.7 million ton in 1998 and then ramp up to 4.2 million tons in 2008 as highest production rate. The mining area in Sebuku Island is along the west side of Island, while, the coal processing facility located in middle of the Island and coal loading facility is located in the south of Island.

After 2008, Sebuku's production has decreased because of run out of the coal reserve within the permitted area. However, Legal and government relation team are processing for more mining area approval from mining department of Indonesia. The company expected to get more area permit within 2018 and plan to ramp up production to 5 million ton per year.

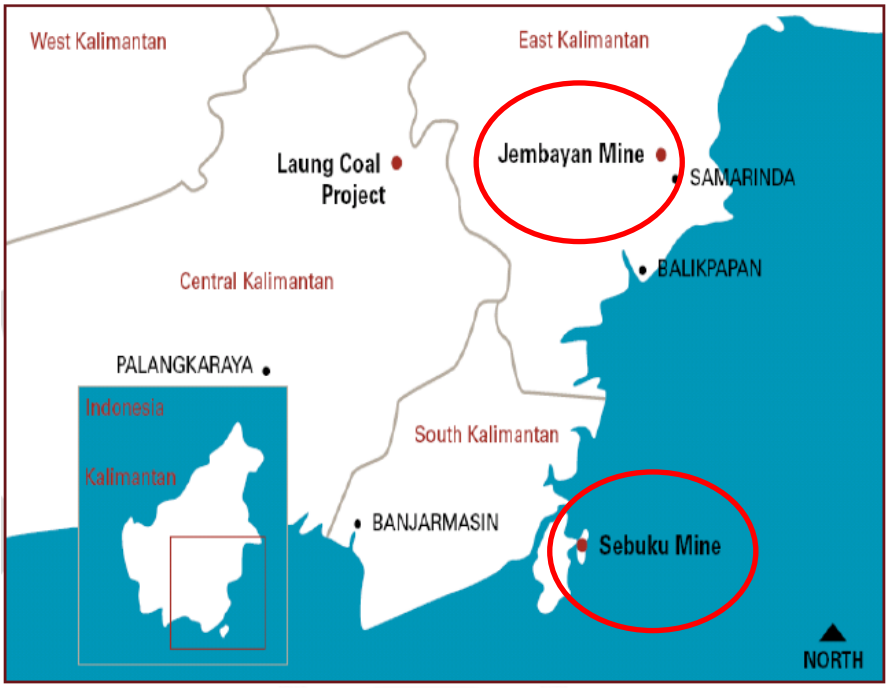

Figure 2-3: Jembayan and Sebuku location Map

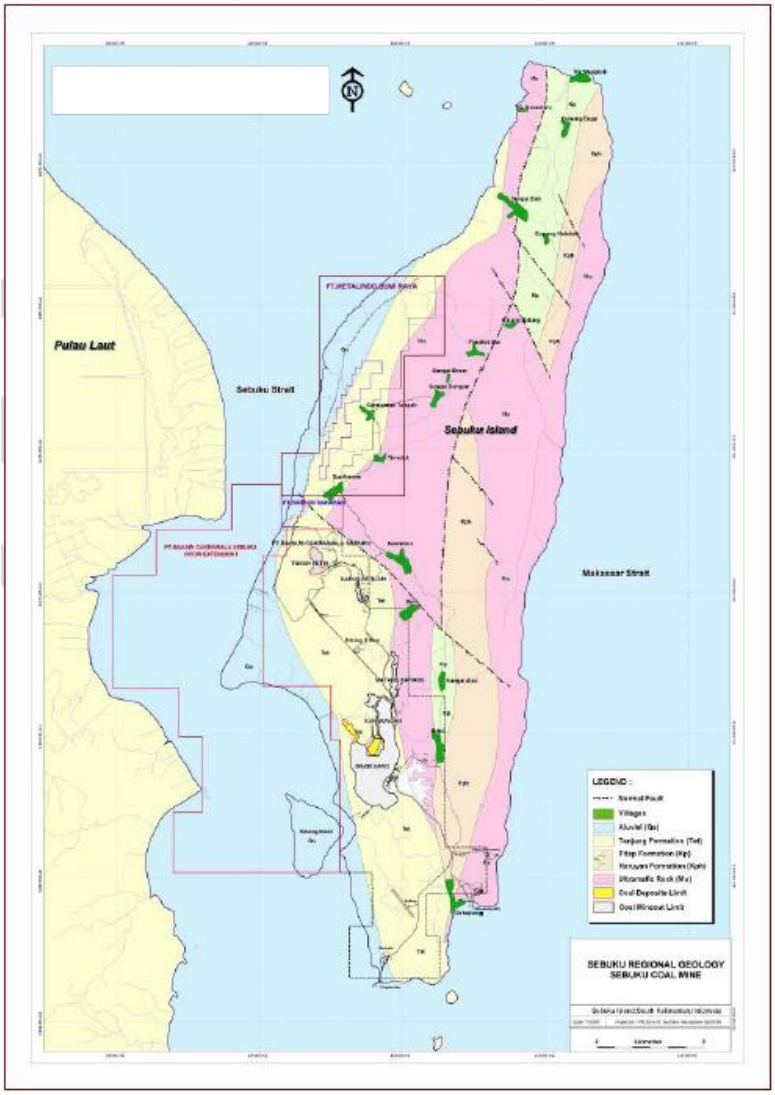

Figure 2-4: Sebuku Island Map

Jembayan Mine is located close to Samarinda City in East Kalimantan province. The distance from Samarinda to mine site is 50 km and takes about one and half hour by car. Jembayan mine has first started by local owner in and acquired by Sakari Resources in 2007. In 2008, Jembayan has sold coal about 5 million tons and ramp up to 9.2 Million tons in 2010.

Total area of Jembayan Mine concession is about 12,800 hectares which has the south border nearby Mahakam River, the main river in East Kalimantan. Beside

of this river, the company has constructed coal crushing and coal loading facility which has maximum capacity 12 million ton per annum.

Raw coal from mine is hauled by coal truck via coal hauling road to stock pile in front of the coal crusher and then load to crusher by dozer or wheel loader. The crusher will reduce coal size to be 50 mm as standards customer specification. There is many coal sampling points in the processing plant to collect sample for Laboratory to determine final coal quality before deliver to customer by loading into barge.

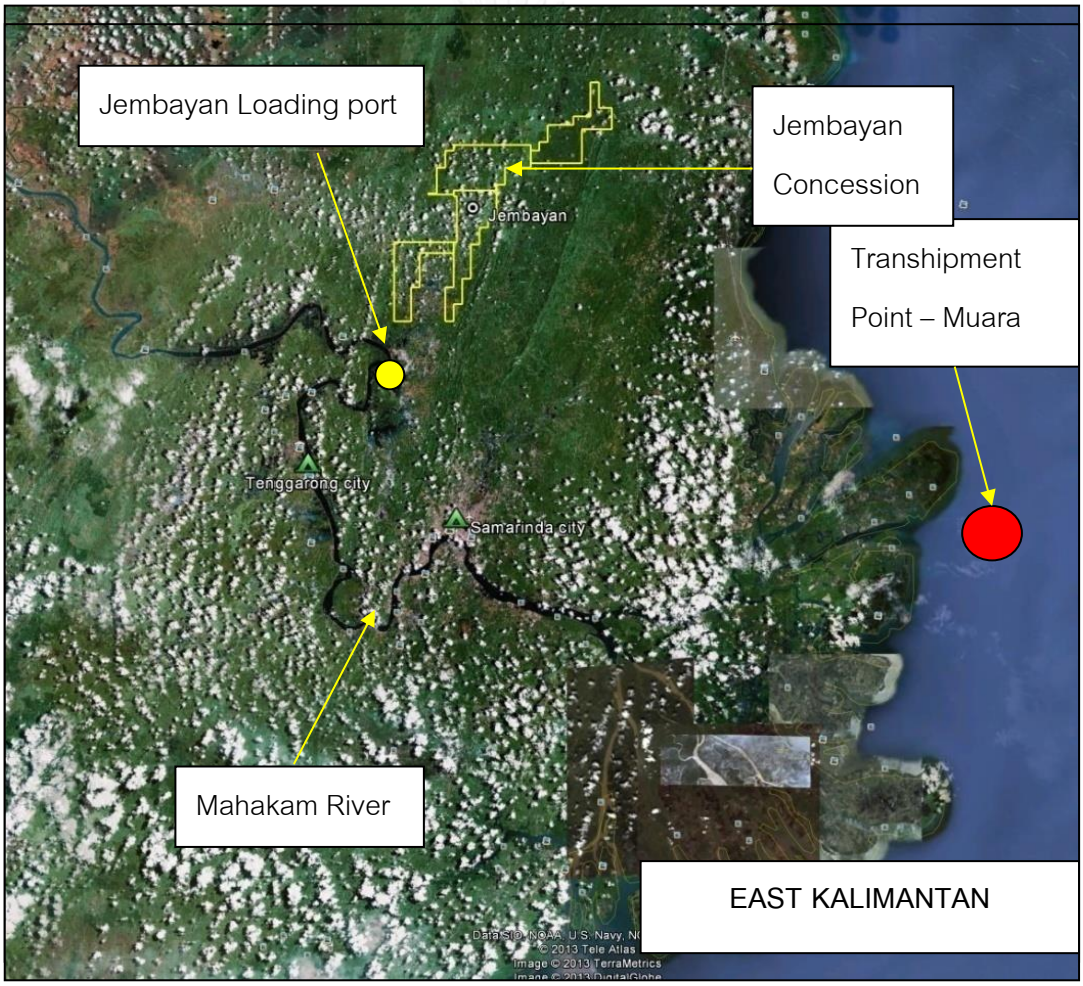

Figure 2-5: Map of Jembayan

2.1.4 Coal Operational Process

This chapter explain about mining activities in both mines. The mining activities is started at mine pit, there are several steps to digging raw coal, clearing and grabbing the surface area is the first activities after located the boundary of pit. Next, overburden removal and coal digging by excavator and transport by dump truck, raw coal will transport to Run of Mine Stock pile in front of the coal crusher.

At coal stockpile, coal quality will be separated by type, and coal samples were daily taken from each stock pile to make sure that the quality is met before feeding into the processing plan. After coal from stock piles is fed into the processing plant, the crusher will reduce coal size to the standard size of coal product at around 50 mm. In the meantime, the blending ratio of each coal quality is controlled by processing team to get the coal quality product as customer need. After coal is blended, the quality of samples will be analysed by laboratory before piling at sale stockpile and waiting for barge loading.

Both SAR's mine have the similar coal operation process which are shown in the Figure below.

Figure 2-6: Coal mining operation process

2.1.5 SAR Product Type

Coal is naturally formed; therefore, coal qualities can be different even come from same mine pit. Coal in the same deposit can be varied from low to high quality. Therefore, coal specification depends on monthly, quarterly and annually operational plan. The coal sale specifications in each mine site are different.

In existing processing process, there are two points for blending coal; the first point is crusher when loading raw coal to crusher. The second point at loading conveyor belt which load coal from product stock pile. Both mine sites must pay very high attention in the quality control because penalty of miss quality is very high. This penalty can make company loses and less creditability.

Coal sale product type of Jembayan and Sebuku are listed below.

SEBUKU	QUALITY COMPARISON	JEMBAYAN
5,600	Gross Calorific Value (kcal/kg GAR) (NEWS 6,300)	5,400
15	Total Moisture (%GAR) (NEWSC Max 15)	20
9.0	Ash (%AD) (NEWC Max 14)	9.0
0.68	Sulphur (%AD) (NEWC Max 0.75)	0.70

Figure 2-7: Coal sale Specification of Sakari

The coal product from both mine sites is categorized in thermal coal which mainly use for electric generator or power plant. Therefore, the main customers of Sakari Resources are power plant in Asia which is Taiwan, Japan, and India combined at > 65% from total sale volume in 2015. Figure below show percentage of main customer by country.

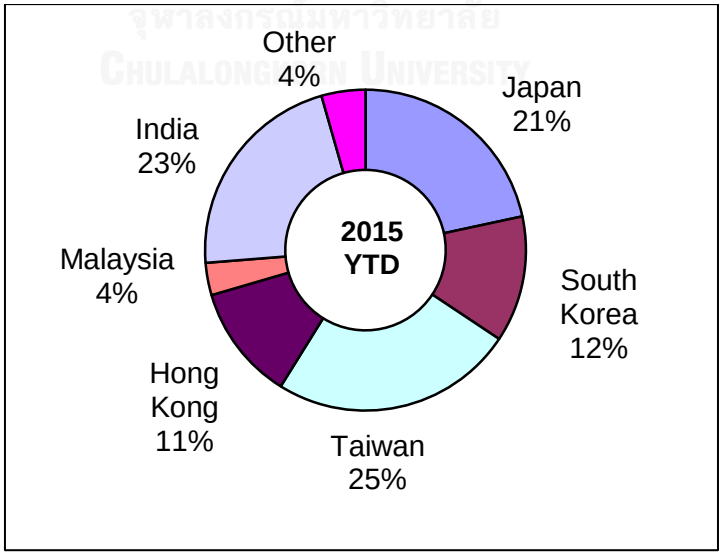

Figure 2-8: Sakari's customer 2015

2.2 Current situation of coal business in Indonesia

2.2.1 Coal Business Situation

The situation of coal business during past 10 years was hardly predictable because the demand of coal consumption extremely fluctuated from the growth of economy in China during 2007 to 2012. As a commodity product, coal price is a major factor that represents coal market situation. To understand coal business situation, coal price factor can be elaborated as follows.

Coal Price

Newcastle Index is a main coal price index for Indonesia coal market, which is dominated by Australian coal exporter association. The price index is calculated from the demand of main customers such as China and Japan and is updated on a daily basis.

The coal price factor is unpredictable, but what the coal company can do is to maximize profit by understanding its coal market trend and customer demand. As a result, the company is able to produce the right coal specification and deliver to customers as scheduled.

Newcastle Index coal price has standard coal qualities which are Calorific value 6,322 kcal/kg (net as received basis), Ash content 14% and Sulphur 0.75%. In order to calculate price of coal from each company, the price will be calculated proportionally from calorific value by using based price from Newcastle Index and then apply penalty from exceed ash % and Sulphur %. In addition, company reputation, company image and size of company will also be factors to calculate premium or discount of coal price.

There is various coal qualities sold from Indonesia market. The standard range of heating value that power plant customer accepted is between 5,000 – 6,000 kcal/kg. Customer's requirement also varies by their own power plant design. For example, power plants in Japan are normally old technology which requires high heating value coal of more than 6,000 kcal/kg, but China power plants are newer technology which can use lower grade coal of about 5,000-5,500 kcal/kg. Figure 2-9 shows the fluctuation of coal price at Newcastle index in the last ten years.

Figure 2-9: Newcastle index Coal price 2006-2016

The Figure above shows that coal price was dramatically jump in year 2007-2008 due to the increasing of electricity demand in China because of high economic growth. Then, the price rapidly dropped at the end of year 2009, but the price was continually climbed up to the second peak in 2010. Because of the 2nd peak in 2010, all Indonesian coal producers increase their production by 10-20% in each mine in order to get more margins. However, China's economic growth was not as high as forecasted after 2010, so imported coal volume was continually dropped from 130 USD per ton in 2010 to 50 USD per ton in early 2016. The continually drop of coal price also came from the production boost up since 2010, resulting in coal market oversupply.

There are several main sub-factors that affect mining business in both short and long terms which are listed as follows;

- **Oil Price:** due to coal is substitute material to produce electricity and the oil price is floated by global economy and industrial growth. There is correlation between oil price and coal price but very difficult to predicted.
- **Gross Domestic Product (GDP):** growth of country economy consume more electricity and it impact to coal demand as main electricity source of material. Mostly, GDP of each country is predicted by Ministry of Financial but sometime the predicted number has been changed by many factors.
- **Global coal consumption:** Coal is one of the major sources of global energy that consumes about 4 billion ton oil equivalent in 2014 and continually increases. Coal is cheap and simple to extract, ship, and burn. It is abundant with the proven coal reserves for about 109 years based on the current consumption.

As commodity product, coal business has been dominated by global energy demand and supply. The long term forecast of global coal demand is continually increased in every year due to the depletion of oil reserve. Moreover, the long term forecast stated that 30% of global energy source came from coal in 2010 and will be a major global energy source with 50% portion in 2030. In Figure 2-10 below shows the proportion of global energy source in 2010 and forecasted for 2030. BP statistical review of world energy 2015 has explained in the report about Figure 2-10 which can be revised every year depends on changing of energy technologies and global trend.

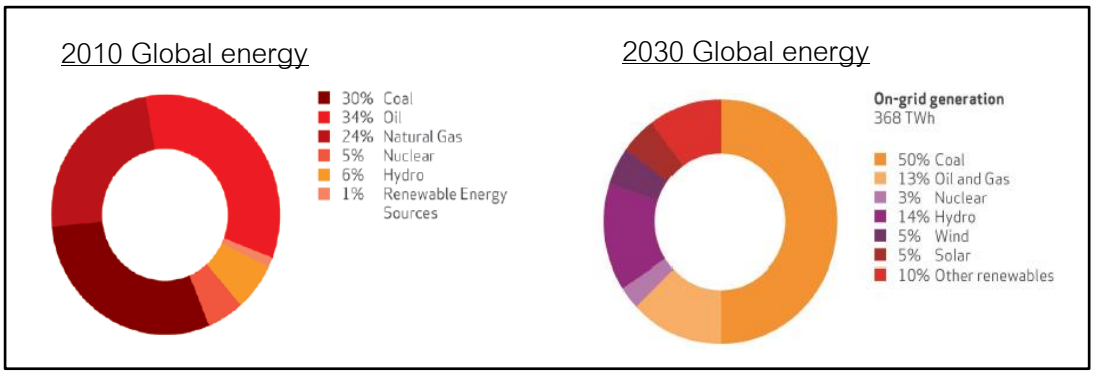

Figure 2-10: Global energy source by type 2010 and forecast for 2030

Source: BP statistical review of world energy 2015

However, the medium term forecast shows that coal market is continuing oversupply until 2025 because most coal producers has increased production since high coal price in 2010. In the meantime, China has decreased imported coal volume because of the slowdown in economic growth. This is the main reason to impact the downturn in coal price and the decline of coal market.

2.2.2 The company situation

According to the downturn of coal market situation, all coal companies have suffered from low profit margin, and some companies have to shut down the business because of no profit. The decline of coal market and the reducing in coal price mostly impact to company revenue and has the direct effect to company's cash flow.

SAR loss $178.8 million after taxation in 2015 (2014: $7 million profit), including a very substantial non-cash impairment charge of $149.3 million and tax expense of $49.3 million which is arising from prior year tax assessment. In terms of performance of the underlying business, the company achieved a gross profit of $42.5 million (2014: $66.4 million) despite a $231.2 million reduction in revenue, resulting from lower average selling price. Table 2-1 shows five years financial performance of the company.

FIVE YEAR SUMMARY					
Y/E 31 Dec ($M)	**2011**	**2012**	**2013**	**2014**	**2015**
Coal sales volume (Mt)	*10.7*	*10.8*	*11.2*	*9.8*	*7.3*
Coal revenue	1,010.4	924.0	811.2	632.7	401.5
Other revenue	3.1	3.2	1.7	2.2	4.1
COGS	(696.7)	(759.9)	(746.0)	(568.5)	(363.1)
Gross profit	316.8	167.3	66.9	66.4	42.5
Other operating income/(expense)	13.1	6.2	(7.6)	4.6	(153.6)
Administrative, Corp & Technical	(57.2)	(31.0)	(27.4)	(21.7)	(14.3)
Operating profit	**272.8**	**142.5**	**31.9**	**49.3**	**(125.4)**
Financial expenses	(13.4)	(13.5)	(11.9)	(8.2)	(4.1)
PBT	259.4	129.0	20.0	41.1	(129.5)
Tax	(69.1)	(20.5)	(10.6)	(34.2)	(49.3)
Net profit	**190.3**	**108.5**	**9.4**	**7.0**	**(178.8)**
Dividend	**(114.2)**	(65.1)	-	(1.7)	-
Dividend Payout %	*60%*	*60%*	*0%*	*25%*	*0%*
EBITDA	321.2	230.4	187.5	145.7	77.2

Table 2-1: Five years financial performance of SAKARI

In response to the oversupply situation, the company reduced its production volume in 2015, particularly in H2 2015. Compared to 2014, the average selling price in 2015 was lower due to the reduction in international coal prices. The poor market condition and the strategic decision to reduce production resulted in 36% revenue dropped from 2014. The company decided to cut production by 21% from 10.0 Million ton in 2014 to 7.9 Million ton in 2015.

The decision to cut production was one of the most difficult decisions that the company faced. However, it was necessary as demand from customers could not guarantee high level of production since the stock level has been running at historically high levels. Aside from the cost of holding stock, high stock levels involve operational problems such as spontaneous combustion risk, which is also the additional cost. During H2 2015, the company sought to reduce stocks rather than maintain production levels. Table 2-2 shows reduction of production volume in 2015.

Kt	Year Ended 31 December	
Sebuku	**2015**	**2014**
Coal mined	**2,568**	3,568
Product coal	**1,928**	3,132
Own coal sales	**1,849**	3,074
Jembayan		
Coal mined	**5,354**	6,636
Product coal	**5,956**	6,882
Own coal sales	**5,287**	6,779
Total		
Coal mined	**7,922**	10,204
Product coal	**7,884**	10,014
Own coal sales	**7,136**	9,853

Table 2-2: 2014-2015 SAR coal production and sale.

Despite the reduction in production volume, the company has reduced average mining cost by $8.25 or 16% per ton. The reduction in production cost is mainly derived from the past and on-going cost improvement initiatives across the entire value chain from pit to ship. In addition, the drop in fuel cost has also contributed to the lower production cost.

SAR's gross profit margin was 11%, the same as in 2014 despite the pressure of lower coal prices. Since 2014, the company reduced overheads by 34% and finance costs by 50%. SAR decided to cut staffs significantly at the head office, relocate technical support office out of Balikpapan, and reduce headcount in the site administration offices. This cost cut helped to reduce administrative and technical support costs to $14.3 million in 2015 (2014: $ 21.7 million). The benefit of these decisions will also be seen in 2016 and beyond.

In summary, the coal market trend is difficult to predict because its trend depends on global economic growth, oil price situation, and coal demand and supply. In long term, coal is forecasted to be main energy source for the next 15 years;

however, coal market will be oversupply in the medium term and have slow growth in the next 3-5 years. Therefore, most of coal producer must focus on cost reduction and operation optimization program to maximize the profit in order to survive during poor coal market situation.

The company truly believe that thermal coal will remain a primary energy source for decades and the current oversupply situation that has persisted for so many years will come to an end in the foreseeable future. Since the producers in major supply countries are cutting back production volumes and reducing their exports in 2015, this lower production will help to bring the international markets back into balance more quickly and end the current oversupply that is the cause of the pressure on coal prices.

2.3 SAR Problem Analysis

The company has concluded the budget plan for 2016 with the targeted coal sales volume of about 8.5 million ton with the gross profit margin of 33.7 million US$, which is only about 8.5% compared with 11% in 2015. Table 2-3 below show detail of 2016 original plan

SAKARI ORIGINAL PLAN 2016				
Cost Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**Total**
Coal Quality (CV)	Kcal/Kg	5,600	5,400	
Coal Quality (Ash)	%	8.00	5.55	
Coal Price	US$ per ton	47.83	46.12	46.50
Sale product	Million Ton	1.88	6.63	8.51
Reject	Million Ton	0.58		
Sale Revenue	**Million US$**	**89.91**	**305.64**	**395.55**
Mining Cost	Million US$	65.73	175.60	241.32
Crushing cost	Million US$	2.71	9.94	12.65
Washing cost	Million US$	11.08	-	11.08
Reject cost	Million US$	0.58	-	0.58
Transportation cost	Million US$	1.50	8.61	10.12
Barging cost	Million US$	2.26	15.24	17.50
Transhipment cost	Million US$	2.07	7.29	9.36
Blending cost	Million US$	-	-	-
Royalty	Million US$	4.70	15.24	19.94
Admin & Sale cost	Million US$	4.70	11.93	16.63
Site support	Million US$	9.40	13.25	22.65
Total cost	**Million US$**	**104.72**	**257.10**	**361.82**
Gross Profit	Million US$	- 14.80	48.54	**33.73**
Margin	%	-16.47%	15.88%	**8.53%**

Table 2-3: SAKARI Resources Original Plan 2016

The company's existing plan is to sell only 2 coal products in 2016 which are;

2016 Sale Specification

Sebuku : calorific value 5,600 kcal/kg with ash 9%

Jembayan : calorific value 5,400 kcal/kg with ash 9%

However, raw coal qualities from both mines have the calorific value vary from 4,200 – 6,100 kcal/kg and ash content percentage varies from 5% to 25%. Average raw coal qualities of each mine are shown as follows;

Raw coal quality

Sebuku : calorific value 5,074 kcal/kg with ash 15.8%

Jembayan : calorific value 5,404 kcal/kg with ash 5.6%

As raw coal and sale specification are shown above, the problem of both mines are listed as follows:

Statement of problem

Sebuku : in order to sell coal from Sebuku mine to meet customer specification, raw coal has to be washed in order to separate high ash coal from low ash coal. 25% of coal volume will be lost as waste from the separation of low ash coal. In addition, the washing process increases operation cost by $4.5 per ton.

Jembayan: even though ash content in raw coal quality is better than sale specification, there is no premium. Therefore, Jembayan mine sell too good coal quality to customer without any premium.

As a consequence, there are opportunities to create new integrated blending plan across 2 mine sites to improve company's profit and reduce cost of washing coal. The main concept to improve operational profit is to search for integrated blending coal formula across 2 mines. The formula will identify appropriate and profitable coal quality and quantity proportion from each mine site.

To determine proper blending formula in order to improve company profit, cost and revenue need to be considered and calculated by the incremental profit from the original plan. 2016 company's budget was set up as the base line cost and margin assumption, which is separated by activity. The original revenue and cost are shown in table 2-3 above.

The **Existing** coal process flow from mines to customer of this company is shown in figure 2-11 below.

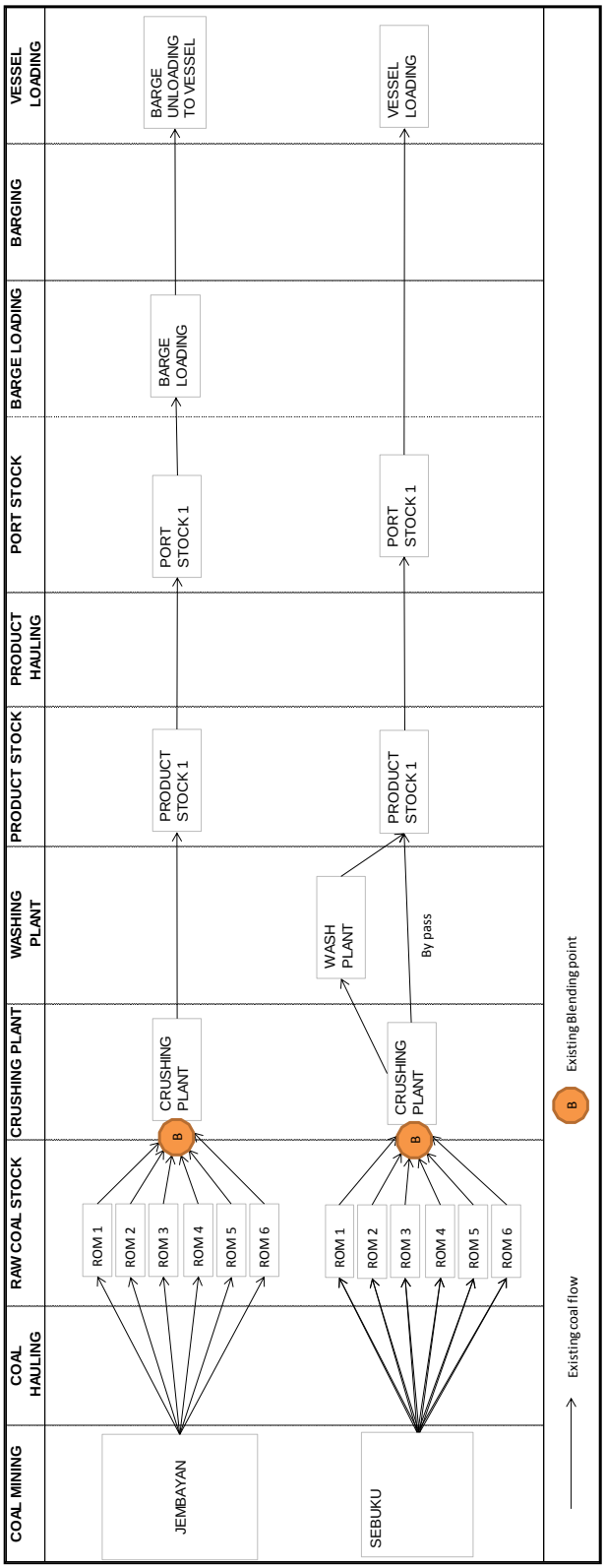

Figure2-11: Original plan of SAR's Coal Flow Diagram

The **Alternative** of coal process flow from mines to customer of this company is shown in figure 2-12 below.

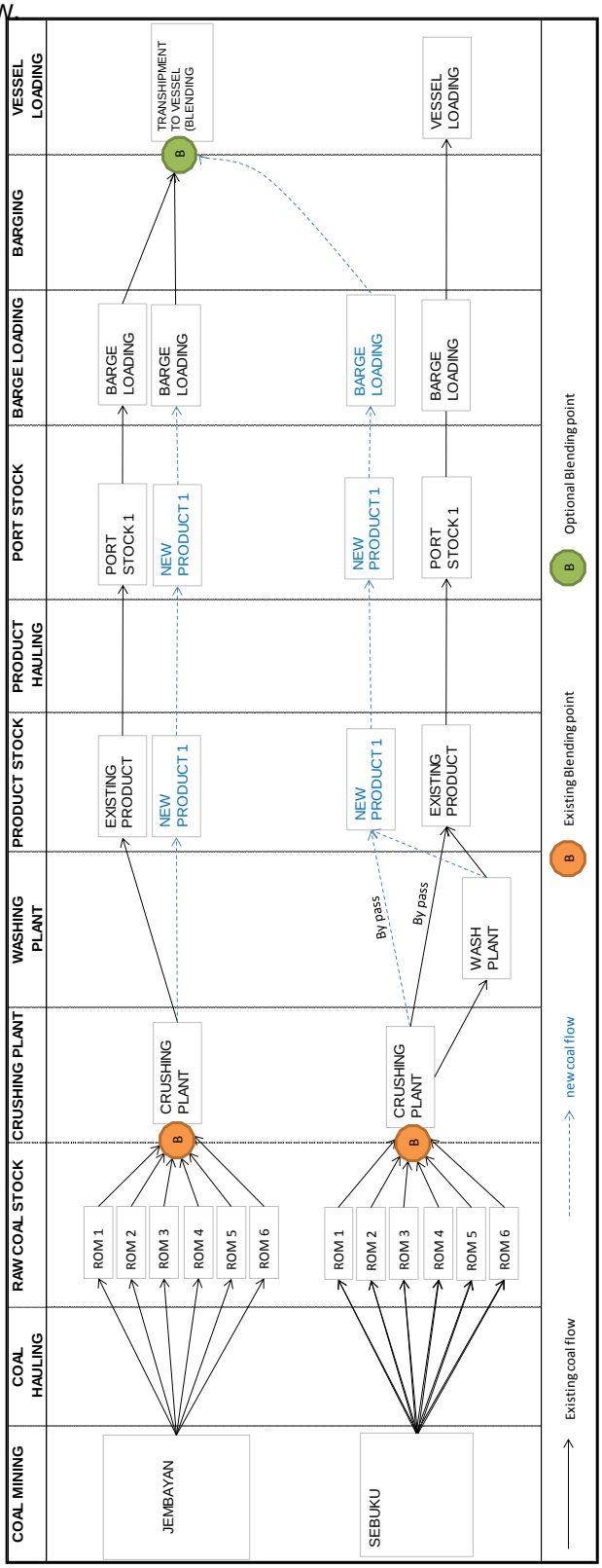

Figure 2-12: Alternative Coal Flow Diagram

3. CHAPTER III

RELATED LITERATURE REVIEW

The information in Chapter III explains about the related theory and result from other research which are related with this study. This chapter consists of three parts; the first part is related literature surveys which explain overview of all reviewed research and theory. The second part is coal blending theory and the last part is about cost benefits analysis.

3.1 Literature survey

James G. Speight, 2013 has studied on research about technology and chemistry which related to coal. The research has explained about impurity in coal, parting of shale that increasing ash content percentage into coal. Moreover, the study also mentioned about preparation of coal which is about crushing plant, washing plant and also studied about theory how to separate ash from coal by separation process. Moreover, the research of James G. Speight has stated about transportation of coal on many ways, for example train, coal barge, truck, ocean transport.

Guo Xi-jin, Chen Ming, Wu Jia-wei has studied research about coal blending and coal preparation production process which has proposed to determine the lowest coating material and the highest profit by determine minimum percentage of high quality coal to and maximise percentage of low-quality coal.

A.Rushdi. A. Sharma, R. Gupta, 2003 has done research about an impact on as deposition to coal blending, the research stated about comparison of result of both

blended coal and non-blended coal that shows the blending behaviour and their potential result from ash deposits.

David A. Tillman, Dao N. B. Duong and N.Stanley Harding, 2012 has studied on solid fuel blending which included of coal-coal blending. This study has objective to give information on the issues of solid blending and principles, practices and problem associated. This paper also explained about examining the blending of coal on coal, coal chemistry of blending, blending system and critical issues.

Stephanie R. C. and James E.K. have done research about CBA (Cost and Benefit Analysis) and CEA (Cost effectiveness analysis) are tools for evaluate the project. Both methods are about comparing benefits that would get from every dollar cost spending and also take indirect benefits into account as well.

H.B. Vuthaluru and D.K. Zhang have done research about impact from coal blending to combustion system. The research explains about problem in burning blending coal which has difference ash content. Ash components such as Sodium, Calcium and organically bound sulphur in low-quality coal transform to the surface of inert bed particles during burning in combustion zone.

H. Abou-Chakra, and U. Tuzun have done research about impact of high ash coal to transportation cost and impact to economic of power generation. From the study shown that the best operation performance of power plant is related to ash content and the maximum ash content should not over than 20%. The result of study explained that higher ash content impact to lower overall efficiency and profit of the power plant.

3.2 Operation Strategy Tools

3.2.1 Puttick Grid

Andrian W, 2014 has explained that one of operation strategic tools to identify the product market segment is Puttick's grid; it helps in understand the complexity degree and level of uncertainty in the company. The difference of product market segment requires difference of operation strategy to cope with the problem.

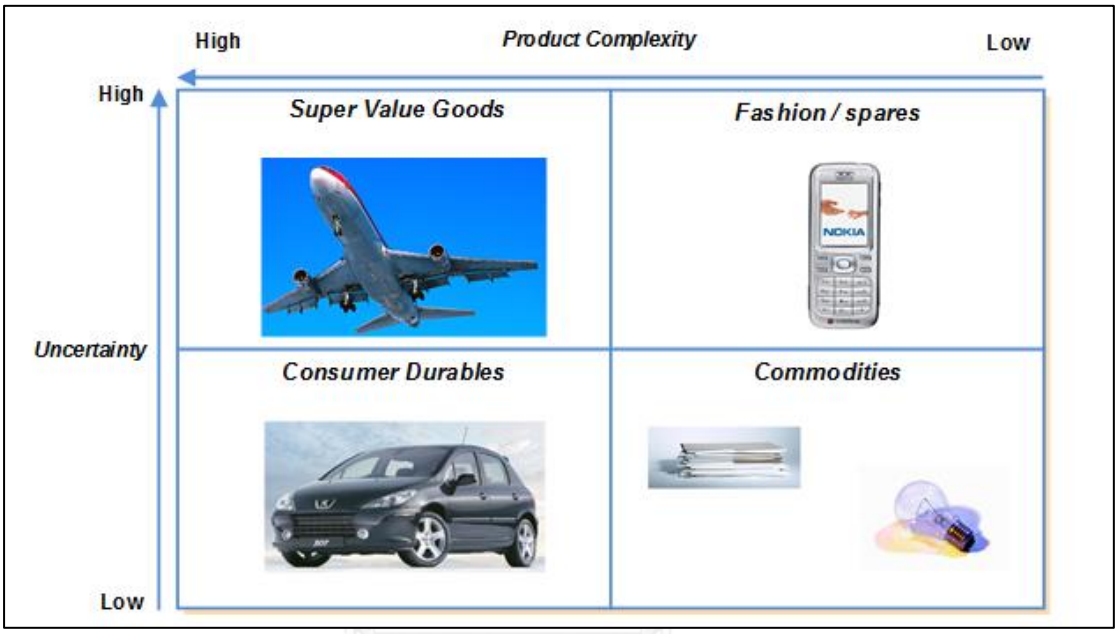

Figure 3-1: Puttick's Grid

John Puttick has developed Puttick Grid and published in 1995. The Puttick Grid is one of methodology that the company can apply for operational strategy which helps to deliver product as per customer. The company can be understand the customer point of view to the product and how the customer given value to the company product.

The Product in Puttick Grid has four categories:

- Super Value Goods
- Products/Services with time-limited windows of opportunity
- Consumer Durables
- Commodities

3.3 Coal Blending Theory

3.3.1 Coal Quality Blending Calculation

David A. Tillman, Dao N. B. Duong and N.Stanley Harding, 2012 explained that one of the global energy sources is coal which is helping quickly growing economy of Chinese and for other emerging countries in Asia. Coal is also used to main fuel source in Europe, especially Russia, Germany, Poland, and the former USSR nations, and others. Also, it is the main energy source of the Republic of South Africa, where not only used to generate electricity but also converted coal into liquid fuels.

There are two main coal quality analysis basis which are proximate and ultimate analysis and the calorific value of high CV or low CV are calculated by linear. These coal properties impact to the weighted average quality of the composition of the blended coal.

To determine blended coal qualities are calculated by using the weighted average method, two sources of raw coal quality is shown as i and j:

$$V_{ij} = x_{ib}V_i + (1 - x_{ib})V_j$$

Vij is the quality of blended coal which calculated by weighted average of any parameter or value (V), and xib is the blending ratio of coal i.

The other quality can be calculated by weighted average of the components of each element of the blend. Also, it includes of proximate and ultimate analysis and heating value. The composite of Ash and other metals compositions are not linear calculation by the weighted average.

3.3.2 Coal Quality Sampling

James G. Speight has explained how to measure coal qualities for coal producer and coal buyer. At the loading point, joint coal sampling is taken out by the representatives of the coal producer and the coal customer, by mutually agreed methodology by both parties. Depend on the coal purchasing agreement, it will mention the point of sampling coal for representative quality. Some cases, average of coal quality sample of both loading at origin and unloading at final destination will be used as transaction quality. Moreover, the purchasing term always stated about penalty and bonus of upper and lower quality. Therefore the tolerance of coal specification is very important factor to be considered when conduct quality control process.

Also, James G. Speight stated that there are several sampling points in coal operations, such as in-pit sampling the raw coal, sampling the reject coal after washing, to find out washing plant efficiency and know the real reject quality , sampling the clean coal product to the coal quality which will be delivered to customer. The coal sampling machine can be set up to collect the sample based on tons per hr, meter per minute and top of the coal product on the conveyor belt. After collect sample from the processing system, then it is separated, crushed, and transported to a coal quality laboratory to determine coal quality where the results will be separated into two parts for the buyer and producer. The buyers in some occasions will also sampling the coal again to double check the results.

Once the coal sample has been taken, the sample is crushed. And, then the sample will be separated into four parts and delivered to an outside laboratory for testing where the results will be submitted to both the buyer and coal producer. In some cases, the coal buyer may ask to have the second analysis by another

laboratory in order to ensure the quality data. Continuous measurement of ash, moisture, calorific value (Kcal/kg), sulphur, nitrogen, and other elemental constituents of the coal is reported

3.3.3 Coal Quality Analysis

The study of James G. Speight on coal quality analysis has begun from the coal laboratory where the samples are received. The results of coal analysis can be reported in many ways, depending on the condition of the coal samples when delivered to the laboratory and the purpose of the testing. Some coal samples are delivered to Laboratory in an insitu condition, the sample will be delivered suddenly after taken. The testing results of these analysis samples are classified on an “as-received” basis. On the other hand, some coal samples are dried out because of long distance transportation, long time storage, or mishandling. The analyses result will be reported on a “dry” basis. The opposite conditions called “moist” basis if the sample arrives in wet condition.

The proximate analysis of coal was widely used as a standard of quality analysis in order to determine the quality of coal products by testing calorific value of coal under a set of standard conditions. This analysis has been used as the coal testing quality basis for coal product characterization. The proximate analysis of coal was considered as the standardize of the general properties of coal and is, in reality, the testing of ash yield, volatile matter content , moisture content, and fixed carbon. On the other hand, the ultimate coal quality analysis provides the elemental composition testing.

The coal quality analysis can be tested in several bases which difference purpose of use as follow:

• As received basis (AR) is the most common in testing quality of coal in the coal market. This basis is analysed all item as is when received the coal sample.

• Air Dry basis (AD) is the quality basis after gets rid of surface moisture and test the quality when the sample has only inherent moisture.

• Dry Basis (DB) burn out all moistures out and test the coal quality

• Dry Ash Free (DAF) the coal quality without ash content.

Calorific value is one of very important coal quality which normally use in coal business. This quality factor is represented the heating value of coal product and can be analysed by many basis. The main analysis basis in the market is proximate analysis which is testing of calorific value, ash content, sulphur, moisture, and other. However, calorific value is the most important in coal quality evaluation because it is used for product price calculation and it is main quality factor in coal purchase agreement.

3.3.4 Cost Benefit Analysis

Following study from Stephanie R. C. and James E. K. have stated that both technics of CBA and CEA are important tools to evaluate the project. The first tool, CEA is one of a technic which identify the major cost of the project and it is the key for the project outcome or the project benefits.

The second tool, CBA is further step to identify the relationship of costs and benefits of the project. This tool can be used for any point of time in the project and it helps decision making on any point of decision. However, in order to set up both tools into the project need to work in detail of cost and benefits item and also it needs to set up it as the main target of the project.

CEA and CBA tools are used for identify the benefits value compare with the cost of the project. Basically, the net benefits came from total benefits minus by cost items.

Net Benefits = Total Benefits−Total Cost

The above formula to calculate ne benefits is looks very simple but the important pint is how to estimate accurate cost and benefits in long term. All assumption of the cost and benefits in the project needs to be identified and it usually should be able to review and revise by any changing situation.

10 Typical Steps of Cost - Effectiveness and Cost - Benefit Analysis have listed as follows:

1. Conduct the analysis Framework
2. Identify which is main cost and benefit item
3. Categorize costs and benefits item
4. Forecast the cost and benefit through whole life of project
5. Cost monetization
6. Identify the effectiveness benefits or Benefit monetization.
7. Calculate net present value of cost and benefits
8. Determine cost effectiveness ratio or overall net present value
9. Conduct sensitivity analysis
10. Conduct recommendation

Spreadsheet software such as Microsoft Excel can be used for complexity project evaluation and would be recommended for analyst to compare multiple assumptions on the valuation of costs and benefits.

4. CHAPTER IV:

ALTERNATIVE COAL BLENDING PROCESS

This Chapter IV explains the study of product category which related to operational strategy to cope with the company problem. After that, explained about the study of existing coal processing system to understand all activities of coal production, including coal blending process to create alternative blending process across two mine sites and to identify additional activities. The limitation and assumption of alternative blending process include coal sale quality limitation, blending limitation, and assumption for blending calculation. The study of coal qualities and quantities distribution from each mine is to identify main type of coal to be delivered to blending in order to reduce blending Alternatives.

Next step in this Chapter is to prepare blending calculation model and then input all assumption and necessary information to determine best blending portion of each Alternative. The result of each Alternative will be compared and selected for the best Alternative to study into detail and then continue with sensitivity study.

4.1 Product Category and operational strategy

The company coal product was classified as commodity product, so it located on the bottom right of market segment in Puttick's grid. The bottom right segment normally represents High volume of product sold and less complexity product.

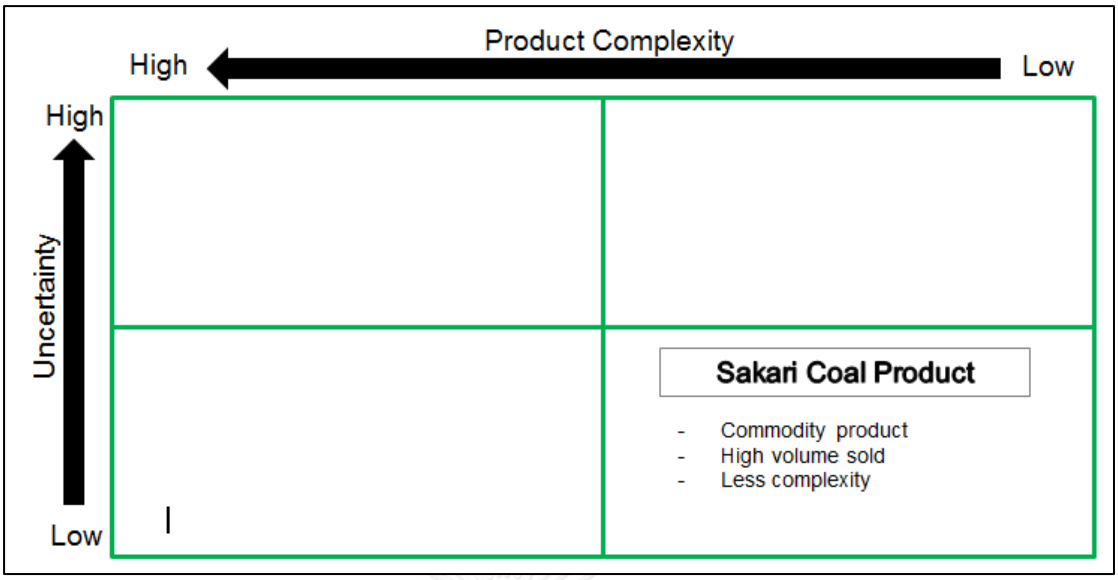

Figure 4-1: Sakari product category in Puttick Grid

According to Sakari coal product has sold at high volume at one time and less complexity. Therefore, the strategy to improve operation has been studied by Harinder S. J., Attracta B. and Jimmie B., 2004 that the commodity producer can improve by several areas as follow below;

- Concentration to be lower cost producer and price competitive.
- Set up the standard range of simple product

Therefore, Sakari operation strategy will continue focus on cost reduction and increase operational profit by improve operational process, re-consideration the blending process and re-consider on reject coal from washing process back to blend with other coal quality.

4.2 Study existing coal production process

To study new alternative coal blending process, it needs to understand current coal production system. Both mines have similar coal production process, but each mine has different coal qualities; therefore, there is some different process to treat coal before delivery to customer. The study will focus from Run of Mine (ROM) to processing facility and then transport to customer. Figure 4-1 shows existing coal production process of Jembayan and Sebuku Mine.

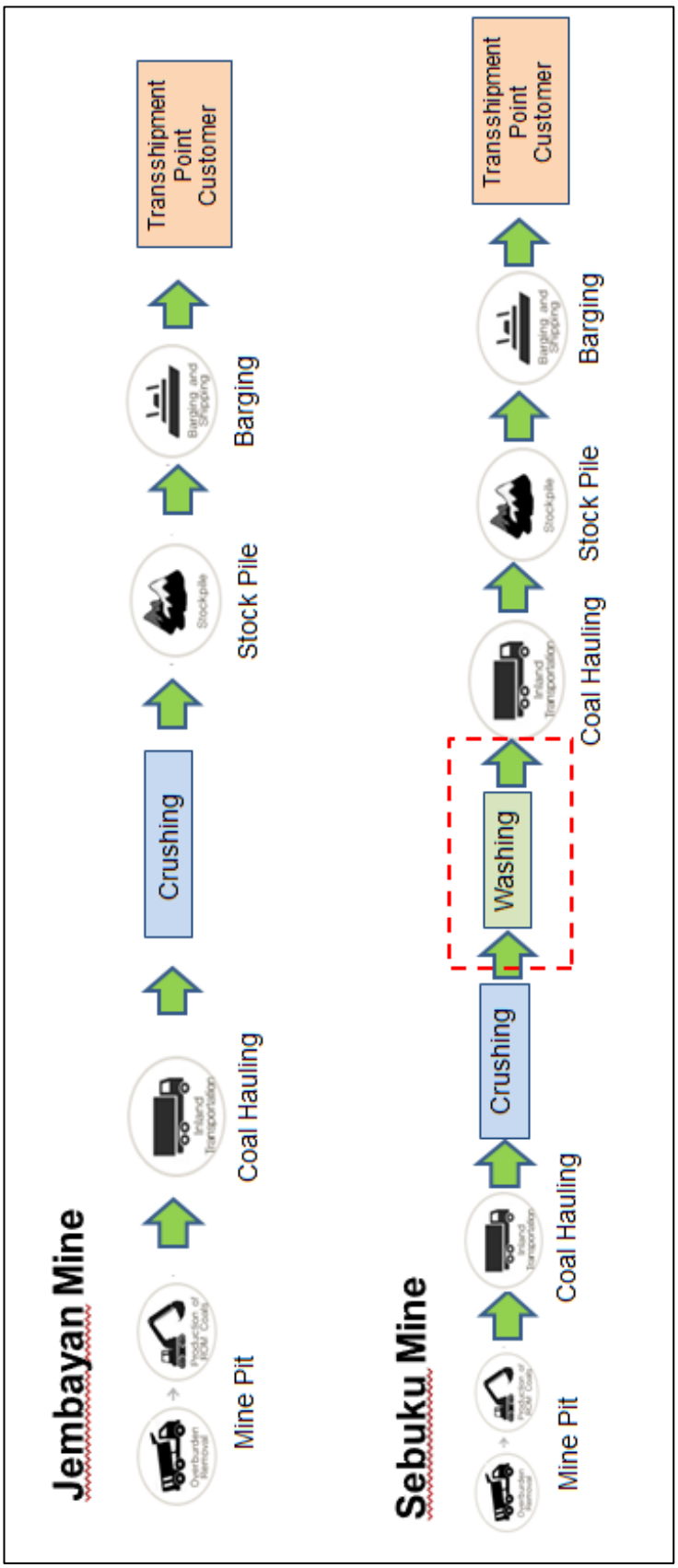

Figure 4-2: Existing Coal production process of Jembayan and Sebuku Mine.

Jembayan mine operation system begins with digging coal at mine pit, transporting to crushing plant in order to reduce coal size to smaller than 50 mm, piling up at coal stock pile near loading port, and waiting for loading to coal barge before transporting to transhipment point. The transhipment point is the place where coal is transferred from barge to customer vessel by floating crane, which is the end of the production system. Details of Jembayan coal hauling distance and barging distance are listed below.

- Coal hauling from pit to Crusher & Port distance 27 km
- Barging from port to transhipment distance 240 km

Sebuku mine operation system is similar to Jembayan mine. It starts from coal mine pit, transports by truck to crush it to 50 mm, and then reduces ash content by washing plant. The washing plant will separate high ash coal from low ash coal by specific gravity. The process use magnetite powder mixed with water to planned specific gravity and use as mixed fluid to separate the coal in hydro cyclone. The output from hydro cyclone is the rejected coal which has high ash content and low calorific value and is dumped to waste area by truck. Whilst, good coal has higher calorific value and low ash content will be transported to port stock pile by truck. Then, the coal product at port stock pile is loaded to coal barge and is transported to Transhipment point nearby in order to transfer to customer shipment. Details of Sebuku coal hauling distance and barging distance are listed below.

- Coal hauling from pit to crusher distance 13 km
- Coal hauling from Crusher & wash plant to port distance 7 km
- Barging from port to transhipment distance 20 km

The main different process between two mines is the washing plant in Sebuku mine since it has to reduce ash content by washing plant because raw coal quality

has ash content higher than customer specification. There is the additional processing cost at washing plant and the loss of rejected coal volume at this point. The loss of rejected coal volume is one of the main impacts to higher operating cost.

In order to compare the profit of alternative coal blending process with current coal process, we need to understand each activity cost. Most activities are operated by contractor except crushing plant, washing plant and stock pile and port loading facility. Each activity cost which is operated by contractor has contractual price. The contractual rate is calculated on per ton coal basis, while other facility costs are summarized the total cost and divided by ton of coal. Table 4-1 contains cost per ton of existing coal production process.

2016 COST OF EXISTING PRODUCTION PROCESS				
Cost Item	**Unit**	**JEMBAYAN**	**SEBUKU**	**Total**
Coal Quality (CV)	Kcal/Kg	5,400	5,600	
Coal Quality (Ash)	%	5.55	8.00	
Sale product	Million Ton	6.63	1.88	8.51
Reject	Million Ton		0.58	
Mining Cost	US$ per ton	26.50	26.70	26.54
Crushing cost	US$ per ton	1.50	1.10	1.41
Washing cost	US$ per ton	-	4.50	0.99
Reject cost	US$ per ton	-	1.00	0.22
Transportation cost	US$ per ton	1.30	0.80	1.19
Barging cost	US$ per ton	2.30	1.20	2.06
Transhipment cost	US$ per ton	1.10	1.10	1.10
Blending cost	US$ per ton		-	-
Royalty	US$ per ton	2.30	2.50	2.34
Admin & Sale cost	Million US$	11.93	4.70	16.63
Site support	Million US$	13.25	9.40	22.65

Table 4-1 contains cost per ton of existing coal production process.

Cost information in Table 4-1 above is based on 2016 original production plan, which has Jembayan coal sale volume at 6.63 million ton, Sebuku coal sale volume at 1.88 million ton and rejected coal volume at 0.58 million ton. The original

plan of both mines is standalone and sells coal product individually. Main operation cost, mining cost, crushing cost, washing cost, reject cost, transportation cost, barging cost, transhipment cost and royalty are variable cost by ton of coal. While, admin & sale cost and site support cost are fixed cost. Cost of existing production process in Table 4-1 will be used as base case to calculate incremental cost for alternative coal blending process in each Alternative.

4.3 Alternative coal blending process

The quality of Jembayan raw coal is very low ash content at 5.5%, which is lower than sale specification at 9%. However, there is no bonus price for ash content lower than sale specification. While, the quality of Sebuku raw coal is high ash content at 15.8%, which exceed sale specification. Therefore, Sebuku coal needs to be reduced ash content by washing coal with the additional processing cost. Therefore, there is an opportunity to blend raw coal without washing across two mine sites in order to get coal product with ash content to match with sale specification.

The study of alternative coal blending process across two mine sites is to define new process to blend coal from 2 mines. Also, it needs to define the proper blending point which has 2 choices of locations as below. The distance between 2 options is about 350 km.

- 1st option: Transhipment point near Sebuku mine
- 2nd option: Transhipment point at Muara Berau near Jembayan mine.

After considering both options above, the 2nd option is selected to be the blending point due to less coal volume need to be transported by barge from Sebuku so that the overall cost is lower. Therefore, the blending point for alternative coal blending process is Muara Berau. Figure 4-2 shows two location options of blending point.

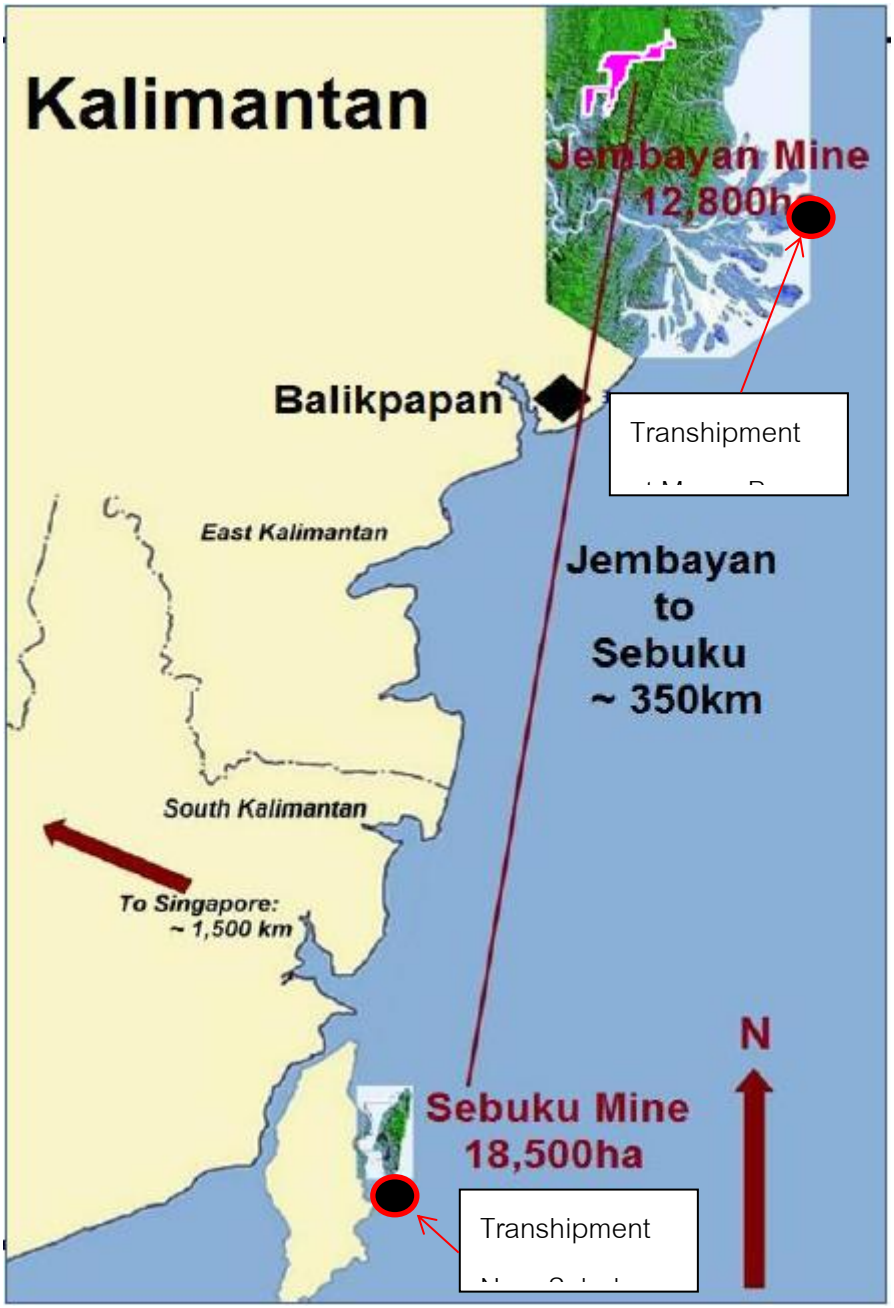

Figure 4-3 two options of blending point at transhipment point.

As selected blending point at Muara Berau, raw coal from Sebuku will be transported by barge to the blending point; therefore, the barging cost of Sebuku coal will be increased by longer transportation distance. In the meantime, Sebuku could decrease washing cost by delivering high ash raw coal directly to blend with Jembayan low ash raw coal.

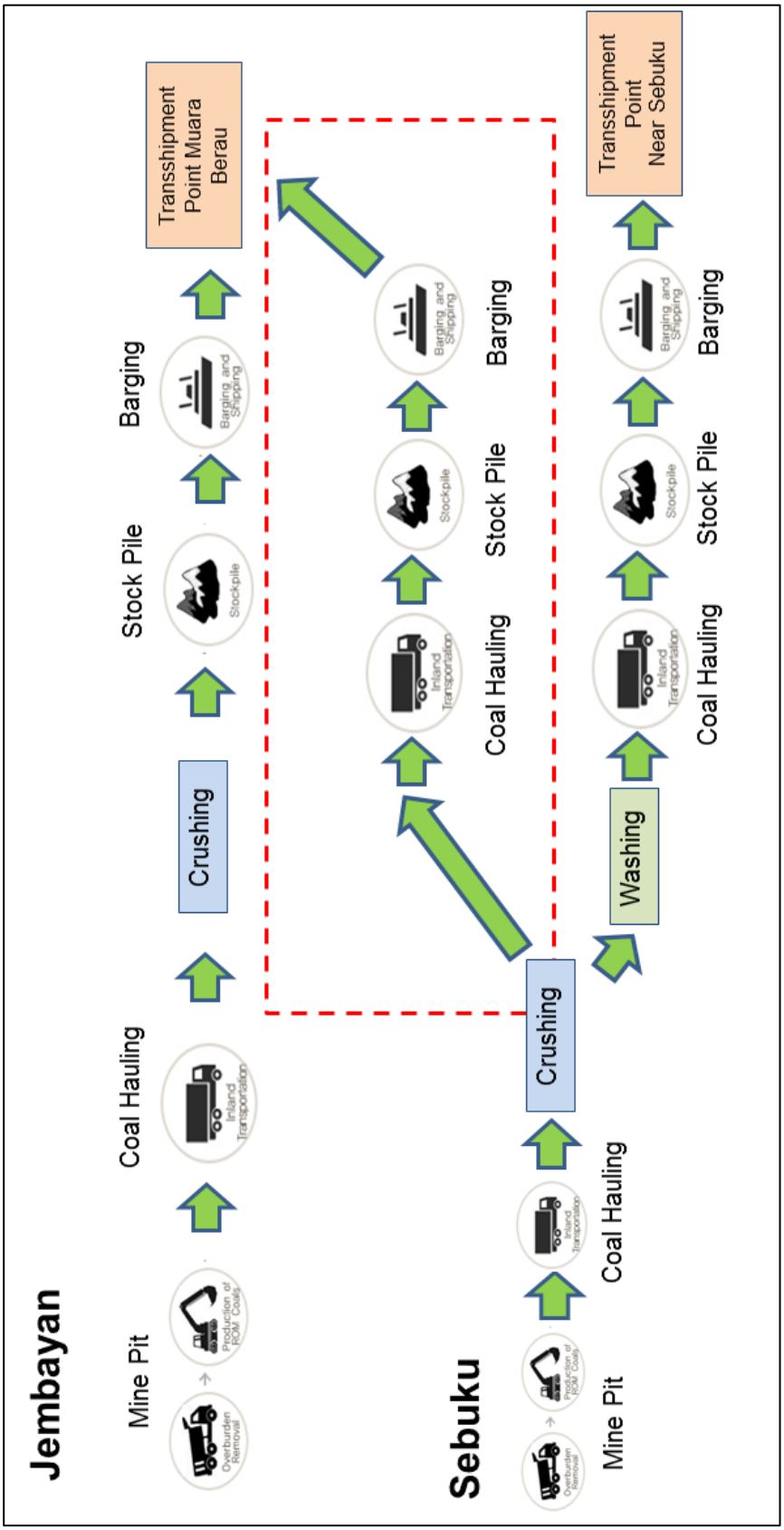

Figure 4-4 show alternative coal blending process to blend at Muara Berau.

The additional processes from alternative coal blending processes are mostly in Sebuku operation since it will divide high ash raw coal to crush and transport by truck to the loading port, load into barge, and transport long distance to Muara Berau. The rest of high ash raw coal will be washed and transported to customer via port of Sebuku. The additional processes are shown in doted red square in Figure 4-3 above. Jembayan low ash raw coal will also be prepared to blend with high ash raw coal from Sebuku with the proper blending ratio. And, the rest of Jembayan raw coal will be crushed and delivered to customer as normal.

Changing of blending processes has the impact to operating cost such as barging cost of high ash coal from Sebuku, washing cost, blending cost, and rejected cost. The details of changing operating cost are shown below;

- Increase: Barging cost from Sebuku to Muara Berau, 7 US$ per ton.
- Increase: Blending cost at Muara Berau, 0.15 US$ per ton.
- Decrease: Washing cost for raw coal from Sebuku, 4.5 US$ per ton.
- Decrease: Rejected cost for raw coal from Sebuku, 1.0 US$ per ton.

4.4 Assumption and limitation

4.4.1 Sale Price Assumption

The operation revenue is calculated from volume of sale and coal price. Jembayan and sebuku sale volume are fixed from annual mine plan, but coal price changes is fluctuated based on the global coal commodity price. Demand and supply of global coal are main factors to impact coal commodity price which is fluctuated and difficult to predict. Even though the price is difficult to predict, there are independent intelligent advisor company who has summarized demand and supply information to

forecast future situation of global coal market. Figure 4-4 show historical global coal demand and forecast separated by importer 2008-2035.

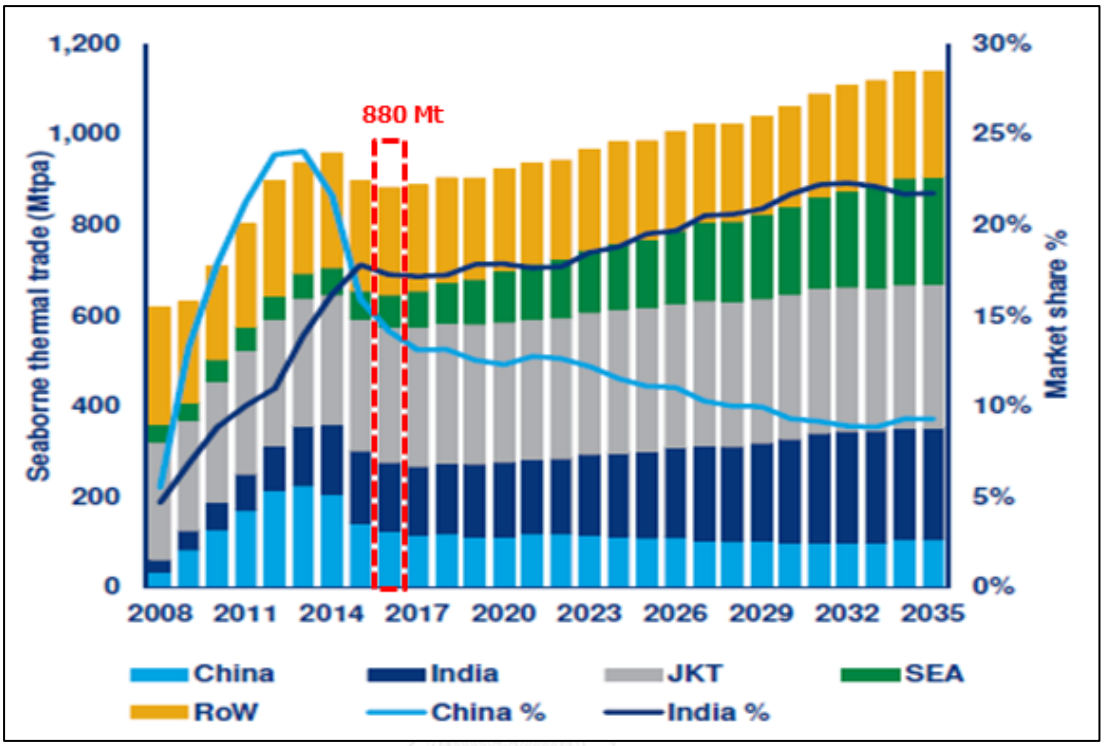

Figure 4-5 Historical of global coal demand and forecast 2008-2035.

Follow Figure 4-4, Seaborne thermal coal market will be lowering to 880 million ton per annum in 2016. Consulting firm has forecasted that the market continues to grow but will not resume back at 2014 level until 2020. China and India are main key importers. Since China starts to increase domestic supply, imported demand is continuing to drop. However, India demand is increasing as the country is developing more coal fire power plant.

Moreover, global coal supply forecast is one of many factors to predict future coal price. The supply forecast is estimated from long term coal mine production plan which is announced from each coal company. The coal supply data is collected and summarized by the independent advisor and will be changed and updated according to all coal mine production plan and the progress of new coal mine project schedule. Figure 4-5 below shows global coal supply separated by exporter.

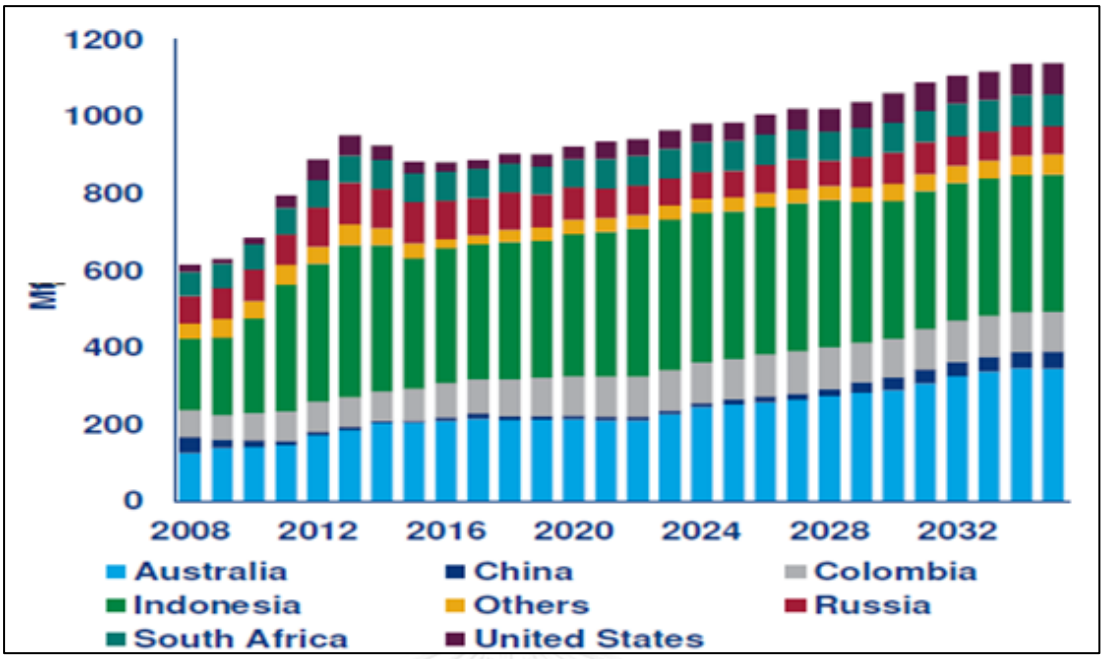

Figure 4-6 Global coal supply separated by exporter. (2008-2035)

According to forecasted global coal demand and supply information, the estimated future coal price will slightly increase from now until 2025 due to the oversupply of coal market situation will slowly get back into the balance and will continue to rise until 2035 driven by global long term demand.

Figure 4-6 below show graph of historical and forecast of coal price with demand vs. supply 2008-2035. The graph shows that coal market will continue to be oversupply until 2025, and it is expected to reach equilibrium by 2025 supporting by currencies appreciation and rising oil prices. The coal in the graph based on Newcastle index, Australia which is main commodity index for South East Asia.

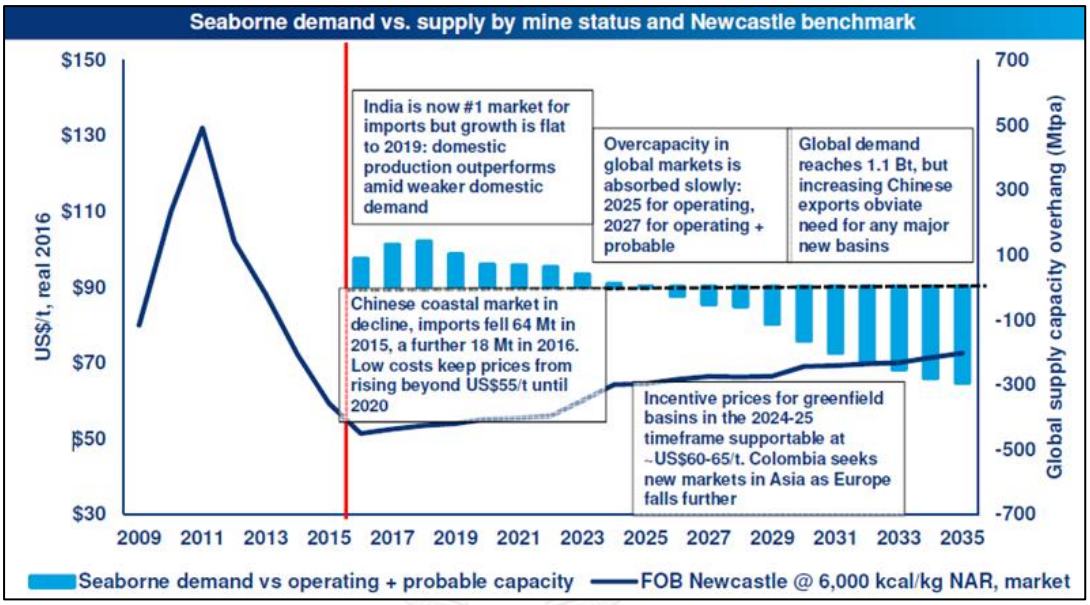

Figure 4-7: Historical and forecast of coal price with demand vs. supply 2008-2035.

According to coal market trend and information of market above, the coal price outlook for 2016 has been estimated based on historical coal price and forecasted future demand from main importers, China and India. By collecting all information of coal market, SAR has forecasted coal price for long term business plan from 2016-2035 as shown in Figure 4-7.

- SAR 2016 outlook coal price = 54 US$ per ton.

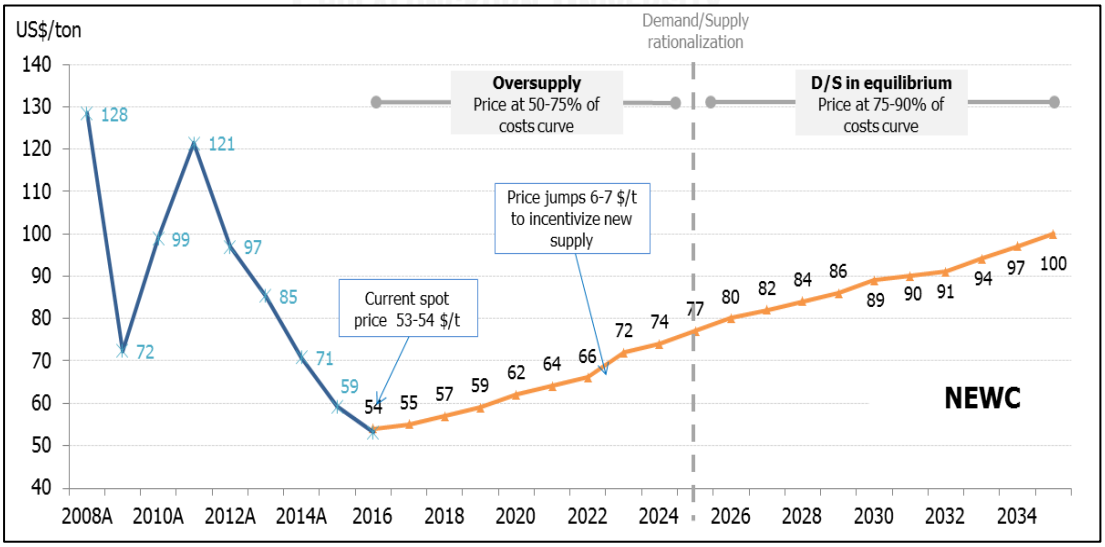

Figure 4-8: SAR Coal Price Forecast Graph

4.4.2 Sale Specification

Coal sale specification of SAR product is based on the customer requirement. Most customers are electricity producers who concern more on calorific value and ash content. Calorific value is the main coal quality to calculate coal price, and ash content is another quality that always mention in the coal buying agreement. If the delivered calorific value is lower than rejection limit or ash content is above rejection limit, the customer will reject the coal and the penalty will be applied.

Typical coal specification of SAR is listed below;

- Calorific value range 5,000 – 5,600 kcal/kg, reject if >300 kcal/kg lower than the commitment.
- Ash content maximum 9%, Reject if ash content > 10%.

4.4.3 Blending Permit

The blending permit is the license awarded from the government of Indonesia to allow the company to blend coal before selling to customer. The purpose of this permit is to control source of coal material from legally mine.

- SAR blending permit allow blending coal from other mines with the maximum of 30%.

4.4.4 Annual production plan

The annual production plan is created from mine planning, including mine pit design, contractor plan, material movement plan, waste dump plan, transportation plan, processing plan, and sale plan. This study will focus on the coal volume to the

processing plant and sale coal volume. Details of 2016 annual production plan are listed below;

- Jembayan :
  - Raw coal production: 6.63 million ton.
  - Coal Sale: 6.63 million ton.
- Sebuku :
  - Raw coal production : 2.46 million ton
  - Coal sale : 1.88 million ton
  - Rejected coal : 0.58 million ton

4.5 Raw Coal Quality and Quantity

To study alternative coal blending process, we need to understand raw coal quality of each coal mine in order to seek opportunity to blending across two mines and reduce blending Alternatives. The raw coal quality and quantity of each coal mine are calculated from grid geological model and summarized into groups by calorific value every 100 kcal/kg. The group of raw coal quality will show the distribution of quantity of every band of 100 kcal/kg calorific value.

Table 4-2 and 4-4 are explaining the distribution of raw coal quality and quantity from Jembayan and Sebuku for 2016 production plan. Moreover, the data of quality and quantity in the table will help to scope down the range of targeted coal type to blending between 2 mines. The table for Jembayan shows calorific value, ash content and raw coal ton, while Sebuku table shows calorific value, ash content, raw coal ton, product coal ton and washing yield. Sebuku product ton and washing yield are the result after washing raw coal to reduce ash content to 8%.

JEMBAYAN		
CV	**Ash**	**Raw coal(Ton)**
4400	6.55	844
4700	6.25	53,607
4800	6.15	69,157
4900	6.04	254,644
5000	5.96	167,087
5100	5.84	195,412
5200	5.75	474,399
5300	5.64	1,203,872
5400	5.55	1,533,808
5500	5.46	1,037,446
5600	5.35	814,568
5700	5.26	373,709
5800	5.16	335,663
5900	5.05	64,794
6000	4.97	36,904
6100	4.89	10,434
Total/Average		
5404	5.55	6,626,347

80% volume of Jembayan raw coal has calorific value 5000-5600 kcal/kg

Table 4-2: Jembayan raw coal quality and quantity distribution

Table 4-2 above shown Jembayan raw coal quality and quantity, which has the lowest calorific value of 4,400 kcal/kg, the highest calorific value of 6,100 kcal/kg, and the average calorific value of 5,404 kcal/kg. The ash content varies from 4.9% to 6.6% with the average ash content of 5.55%. Total Jembayan raw coal volume for 2016 production plan is 6.6 million ton, 80% of the volume has calorific value range 5,000-5,600 kcal/kg and ash content 5.4% to 5.9%. As 80% of raw coal volume is represented by calorific value range 5,000-5,600 kcal/kg, the selected quality from Jembayan to blending is defined within this range of quality. The representative coal calorific value will be defined range in every 200 kcal/kg follows tolerance of standards customer contract which allow CV quality has tolerance within 200 kcal/kg. The selected quality and the maximum volume to blend are shown in Table 4-3 below.

Jembayan	Raw coal Type	CV(kcal/kg)	ASH(%)	Volume (Ton)
1	5,000	5,048	5.90	1,215,150
2	5,200	5,261	5.68	3,952,829
3	5,400	5,404	5.55	6,626,347
4	5,600	5,615	5.34	2,673,518

Table 4-3: Jembayan selected raw coal quality to blending.

Four types of Jembayan raw coal have been selected to blending in alternative blending process. Those types of raw coal will be calculated in blending model in order to seek the best alternative for the study.

According to Sebuku raw quality, it has to be washed to reduce ash content to meet the customer specification. The data of raw coal quality and quantity distribution will help to define selected coal type from Sebuku to blending with Jembayan. The data from Sebuku also shows the washing yield and product volume. Table 4-4: below shown Sebuku raw coal quality and quantity distribution.

SEBUKU				
CV	Ash	Raw coal(Ton)	Product (Ton)	Wash Yield %
4200	24.98	469	324	69.01%
4300	24.24	2,774	1,931	69.61%
4400	21.96	6,082	4,344	71.43%
4500	21.60	6,086	4,365	71.72%
4600	21.62	16,511	11,839	71.70%
4700	19.85	99,922	73,062	73.12%
4800	18.95	102,340	75,568	73.84%
4900	17.71	367,887	275,302	74.83%
5000	16.90	451,142	340,529	75.48%
5100	15.32	580,465	445,458	76.74%
5200	14.62	332,375	256,931	77.30%
5300	12.73	393,088	309,805	78.81%
5400	13.12	79,262	62,226	78.51%
5500	13.96	21,476	16,716	77.84%
5600	17.65	1,762	1,319	74.88%
Total/Average				
5074	15.80	2,461,641	1,879,718	76.36%

80% volume of Sebuku raw coal has calorific value 4900-5300 kcal/kg

Table 4-4: Sebuku raw coal quality and quantity distribution.

Table 4-4 above shows Sebuku raw coal quality and quantity distribution, which has the lowest calorific value of 4,200 kcal/kg, the highest calorific value of 5,600 kcal/kg, and the average calorific value of 5,074 kcal/kg. The raw coal ash content varies from 17.7% to 24.9% with the average ash content of 15.80%. The production volume of coal after washed is 1.88 million ton with 76.4% washing yield.

Total Sebuku raw coal volume for 2016 raw coal production plan is 2.4 million ton, 80% of the volume has calorific value range 4,900-5,300 kcal/kg and ash content 12.7% to 17.7%. As 80% of raw coal volume is represented by calorific value range 4,900-5,300 kcal/kg. The representative coal calorific value will be defined range in every 200 kcal/kg follows tolerance of standards customer contract which allow CV quality has tolerance within 200 kcal/kg. The selected quality and the maximum volume to blending is shown in Table 4-5 below.

Sebuku	Raw coal Type	CV(kcal/kg)	ASH(%)	Volume (Ton)
1	4,800	4,829	18.50	602,071
2	5,000	5,074	15.80	2,461,641
3	5,200	5,203	14.29	1,408,428

Table 4-5: Sebuku selected raw coal quality to blending.

Sebuku has selected three types of raw coal to blending with Jembayan in the alternative blending process. The volume of each coal type is the maximum volume that can be delivered to blend with Jembayan. The rest of raw coal production will be washed and sold as normal product of Sebuku.

4.6 Blending model

Based on the selected 4 types of raw coal from Jembayan and 3 types of raw coal from Sebuku, there are 12 coal blending alternatives to identify blending portion between two mines and determine the best alternative with the highest operation profit. The limitation of this study is coal specification and blending permit. Both limitations will be used to control the result of blending.

The coal product limitations for blending calculation are shown below

- Sale product has CV 5,000 – 5,600 kcal/kg
- Sale product has the maximum ash content of 9%. However, in blending model, it will include some contingency to blending. Therefore, the maximum ash content to blending is 8.5%.
- Blending portion from Sebuku has the maximum of 30%

The blending plan has 12 alternatives to combine Jembayan and Sebuku coal type. The blending portion from Sebuku is limited with the maximum of 30% because it is the maximum portion that the blending permit has allowed.

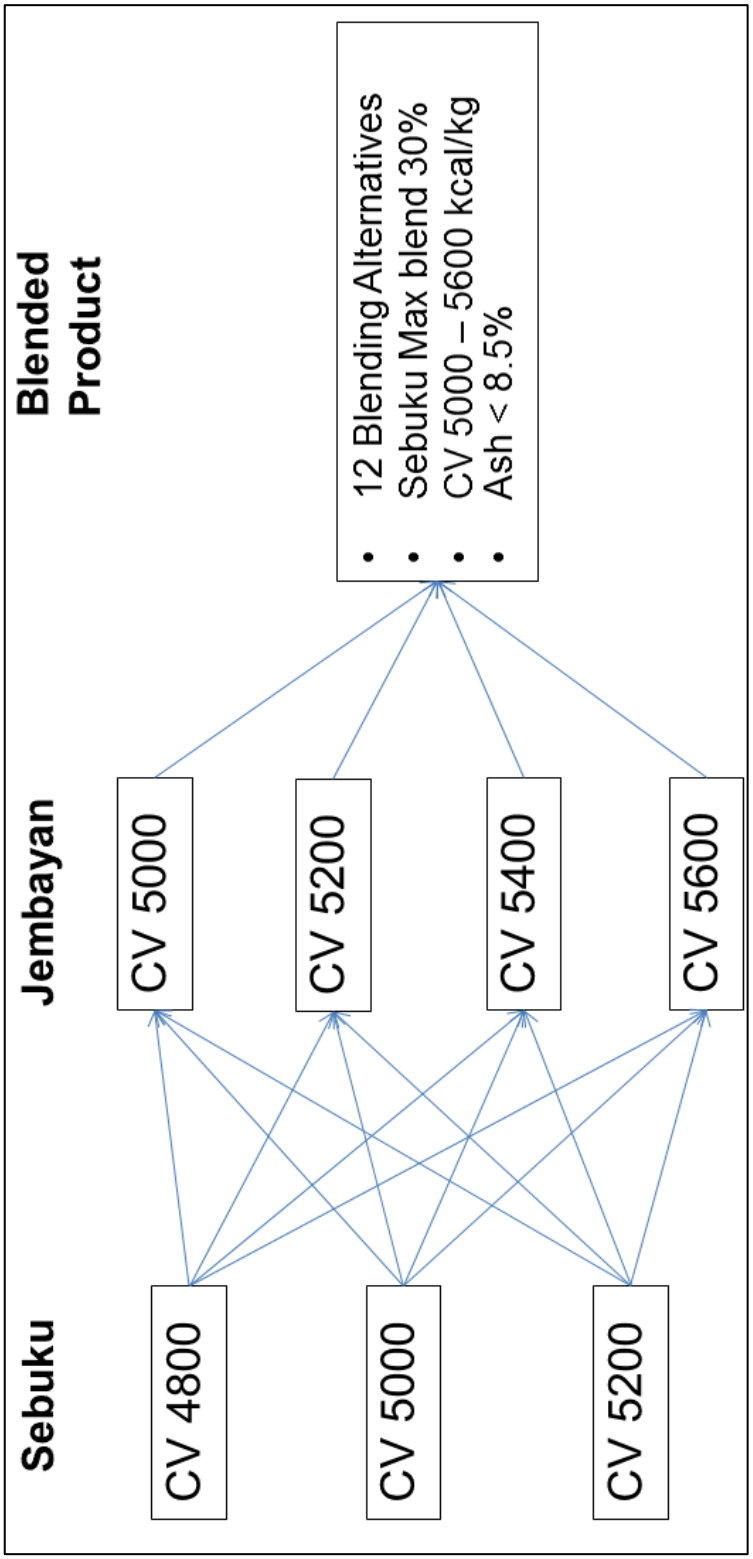

Figure 4-9: Blending model alternatives and coal product limitations.

The details of 12 blending alternative nos are listed below:

- Alternative 1: Sebuku CV 4,800 + Jembayan CV 5,000
  - Sebuku raw coal Ash 18.50%
  - Sebuku max raw coal volume 602,071 Tons
  - Jembayan raw coal Ash 5.90%
  - Jembayan max raw coal volume 1,215,150 Tons
- Alternative 2: Sebuku CV 4,800 + Jembayan CV 5,200
  - Sebuku raw coal Ash 18.50%
  - Sebuku max raw coal volume 602,071 Tons
  - Jembayan raw coal Ash 5.68%
  - Jembayan max raw coal volume 3,952,829 Tons
- Alternative 3: Sebuku CV 4,800 + Jembayan CV 5,400
  - Sebuku raw coal Ash 18.50%
  - Sebuku max raw coal volume 602,071 Tons
  - Jembayan raw coal Ash 5.55%
  - Jembayan max raw coal volume 6,626,347 Tons
- Alternative 4: Sebuku CV 4,800 + Jembayan CV 5,600
  - Sebuku raw coal Ash 18.50%
  - Sebuku max raw coal volume 602,071 Tons
  - Jembayan raw coal Ash 5.34%
  - Jembayan max raw coal volume 2,673,518 Tons
- Alternative 5: Sebuku CV 5,000 + Jembayan CV 5,000
  - Sebuku raw coal Ash 15.80%
  - Sebuku max raw coal volume 2,461,641 Tons
  - Jembayan raw coal Ash 5.90%
  - Jembayan max raw coal volume 1,215,150 Tons

- Alternative 6: Sebuku CV 5,000 + Jembayan CV 5,200
  - Sebuku raw coal Ash 15.80%
  - Sebuku max raw coal volume 2,461,641 Tons
  - Jembayan raw coal Ash 5.68%
  - Jembayan max raw coal volume 3,952,829 Tons
- Alternative 7: Sebuku CV 5,000 + Jembayan CV 5,400
  - Sebuku raw coal Ash 15.80%
  - Sebuku max raw coal volume 2,461,641 Tons
  - Jembayan raw coal Ash 5.55%
  - Jembayan max raw coal volume 6,626,347 Tons
- Alternative 8: Sebuku CV 5,000 + Jembayan CV 5,600
  - Sebuku raw coal Ash 15.80%
  - Sebuku max raw coal volume 2,461,641 Tons
  - Jembayan raw coal Ash 5.34%
  - Jembayan max raw coal volume 2,673,518 Tons
- Alternative 9: Sebuku CV 5,200 + Jembayan CV 5,000
  - Sebuku raw coal Ash 14.29%
  - Sebuku max raw coal volume 1,408,428 Tons
  - Jembayan raw coal Ash 5.90%
  - Jembayan max raw coal volume 1,215,150 Tons
- Alternative 10: Sebuku CV 5,200 + Jembayan CV 5,200
  - Sebuku raw coal Ash 14.29%
  - Sebuku max raw coal volume 1,408,428 Tons
  - Jembayan raw coal Ash 5.68%
  - Jembayan max raw coal volume 3,952,829 Tons

- Alternative 11: Sebuku CV 5,200 + Jembayan CV 5,400
  - Sebuku raw coal Ash 14.29%
  - Sebuku max raw coal volume 1,408,428 Tons
  - Jembayan raw coal Ash 5.55%
  - Jembayan max raw coal volume 6,626,347 Tons
- Alternative 12: Sebuku CV 5,200 + Jembayan CV 5,600
  - Sebuku raw coal Ash 14.29%
  - Sebuku max raw coal volume 1,408,428 Tons
  - Jembayan raw coal Ash 5.34%
  - Jembayan max raw coal volume 2,673,518 Tons

To determine the best blending alternatives in order to improve operational profit, the company need to consider the incremental cost and revenue which will be calculated by the incremental from existing processes cost and coal sale revenue. The base line cost and revenue assumption was set up in 2016 company's budget plan, which is separated by activity. The activities are shown in Table 4-1.

The incremental cost analysis was calculated from the total of increasing or decreasing cost of each process activity, for example cost of crushing plant, cost of washing plant, cost of reject, cost of coal transportation by truck, cost of coal barging, cost of blending and cost of transhipment. All increment cost analysis will be calculated and summarized in US$ and all increment cost of all process activities will be summarised as "Δ Cost"

Δ Cost = Incremental of

- Washing cost
- Crushing cost
- Transportation cost
- Barging cost
- Blending cost
- Transhipment cost
- Other

The incremental revenue analysis will be the information that is used to determine the appropriate blending coal formula. The incremental revenue was calculated from the result of blended coal quality. There are opportunities to create positive incremental revenue from low ash content coal from Jembayan mine, which normally has no bonus, by blending it with high ash coal from Sebuku mine. The incremental revenue (Δ revenue) will be calculated directly from the incremental sale volume multiply by new quality of coal compared with the standard coal product quality.

Δ revenue =

- Increase price from higher calorific value
- Decrease price from lower calorific value
- Saving cost of washing
- Increase revenue from volume take back of no wash coal.

The result of the incremental cost (Δ cost) and incremental revenue (Δ revenue) from above method will be used to determine the incremental profit (Δ profit) of each blending alternative. The selection of the appropriate blending formula will be considered from the incremental profit (Δ profit).

Δ profit of each blending plan = Σ (Δ cost and Δ Revenue)

The highest Δ profit is the best blending alternative no to improve company's operational profit.

4.7 Alternative Coal Blending Result

In order to calculate the incremental profit of each blending alternative, the company requires base point to compare whether profit result is positive or negative. The base point or base information to compare with all alternatives is SAR 2016 original plan. The 2016 original plan has conducted based on the individual coal sale without any blending across mines. Table 4-6 has shown the details of SAR 2016 original plan.

SAR 2016 original plan has shown that the company sell 2 types of coal products, Sebuku coal product with CV 5,600 and Jembayan coal product with CV 5,400. Total coal sale in 2016 is 8.51 million tons in which from Sebuku 1.88 million ton and Jembayan 6.63 million ton. Coal price is calculated proportional by NEWC index price which has the average of 54 US$ per ton in 2016. Total sale revenue is calculated from sale volume multiply by coal price. The total sale revenue 2016 is 395.6 million US$.

Total operating cost of SAR in 2016 is 361.8 million US$, which has the mining cost as major cost of 241 million US$. There are two types of cost as shown in Table 4-6, which are variable cost and fixed cost. Variable cost consists of mining cost, processing cost, reject cost, transportation cost, barging cost, transhipment cost, blending cost and royalty; on the other hand, fixed costs are admin & sale cost and site support cost. The table is clearly shown that Sebuku is operating at loss of 14.8 million US$ and Jembayan has the profit of 48.5 million US$. The gross profit margin for 2016 is only 8.5% of revenue or 33.73 million US$.

2016 SAKARI RESOURCES ORIGINAL PLAN				
Cost Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**Total**
Coal Quality (CV)	Kcal/Kg	5,600	5,400	5,444
Coal Quality (Ash)	%	8.00	5.55	6.09
Coal Price	US$ per ton	47.83	46.12	46.50
Sale product	Million Ton	1.88	6.63	8.51
Reject	Million Ton	0.58		0.58
Sale Revenue	**Million US$**	**89.91**	**305.64**	**395.55**
Mining Cost	Million US$	65.73	175.60	241.32
Crushing cost	Million US$	2.71	9.94	12.65
Washing cost	Million US$	11.08	-	11.08
Reject cost	Million US$	0.58	-	0.58
Transportation cost	Million US$	1.50	8.61	10.12
Barging cost	Million US$	2.26	15.24	17.50
Transhipment cost	Million US$	2.07	7.29	9.36
Blending cost	Million US$	-	-	-
Royalty	Million US$	4.70	15.24	19.94
				-
Admin & Sale cost	Million US$	4.70	11.93	16.63
Site support	Million US$	9.40	13.25	22.65
Total cost	**Million US$**	**104.72**	**257.10**	**361.82**
Gross Profit	Million US$	- 14.80	48.54	**33.73**
Margin	%	-16.47%	15.88%	**8.53%**

Table 4-6: SAR original plan 2016

This study will use the data of SAR 2016 original plan as base information to calculate the incremental revenue (Δ revenue), incremental cost (Δ cost), and the incremental profit (Δ profit). This study will focus on the comparison of the Δ profit or the sum of incremental gross profit margin.

Next step is to input all information into blending model and run all 12 blending alternative nos. The number in each alternative table is the result of the incremental calculation method.

The result of Blending alternative no 1-12 which blend Sebuku CV 4,800, 5,000, and 5,200 with Jembayan CV 5,000, 5,200, 5,400 and 5,600 has shown in Table 4-7 to 4-18 below

BLENDING ALTERNATIVE 1						
Plan : Blend Sebuku 4800 Jembayan 5000						
	Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total/Avg.**
Real Data	Sebuku Blending Ratio				17%	17%
	Coal Quality (CV)	Kcal/Kg	5,600	5,484	5,012	5,427
	Coal Quality (Ash)	%	8.00	5.47	7.98	6.40
	Coal Price	US$ per ton	47.83	46.84	42.81	46.35
	Sale product	Million Ton	1.70	5.41	1.46	8.56
	Reject	Million Ton	0.53			0.53
Incremental data	**Sale Revenue**	**Million US$**	**(8.77)**	**(52.17)**	**62.30**	**1.36**
	Mining Cost	Million US$	(6.41)	(32.20)	38.61	-
	Crushing cost	Million US$	(0.26)	(1.82)	2.09	-
	Washing cost	Million US$	(1.08)	-	-	(1.08)
	Reject cost	Million US$	(0.06)	-	-	(0.06)
	Transportation cost	Million US$	(0.15)	(1.58)	1.77	0.05
	Barging cost	Million US$	(0.22)	(2.79)	4.48	1.46
	Transhipment cost	Million US$	(0.20)	(1.34)	1.60	0.06
	Blending cost	Million US$	-	-	0.22	0.22
	Royalty	Million US$	(0.46)	(2.79)	3.35	0.09
	Admin & Sale cost	Million US$	(1.46)	(2.19)	3.65	-
	Site support	Million US$	(2.92)	(2.43)	5.35	-
	Total cost	**Million US$**	**(13.22)**	**(47.15)**	**61.11**	**0.74**
	Incremental Gross Profit Margin	**Million US$**	**4.45**	**(5.02)**	**1.19**	**0.62**

Table 4-7: Result of Blending alternative no 1

To calculate the blending ratio for Alternative 1 has to consider representative coal quality from each mine, chapter 4.5 has shown the necessary information such as exactly representative quality and quantity from each mine site as below;

- Sebuku CV 4,800 kcal/kg, raw coal Ash 18.50%, raw coal volume 602,071 Tons
- Jembayan CV 5,000 kcal/kg, raw coal Ash 5.90%, raw coal volume 1,215,150 Tons

Next, determine blending ratio by increasing percentage of raw coal from Sebuku and limit the result of ash content to be about 8% because limitation of ash content is 8.5%. The alternative 1 shown the blending ratio from Sebuku is 17% and total blended volume is 1.46 million ton which came from Sebuku 240,000 tons and Jembayan 1,215,000 tons. Therefore, individual sale product from each site will be decreased from split some raw coal to blending.

In the top of table 4-7 shown the coal sale qualities from Sebuku , Jembayan, and Blended quality. Sebuku sale quality after washed has CV 5,600 kcal/kg and 8% ash content, Jembayan sell product without washing at CV 5,484 kcal/kg and ash content 5.5 percent. Whilst, alternative 1 shown result of blended quality CV 5,012 kcal/kg and ash content 7.98%.

Incremental of sale revenue is calculated by alternative 1 sale revenue minus original plan 2016 revenue. While, Alternative 1 sale revenue was calculated by coal price multiply with sale volume. The coal price was calculated proportional to New Castle Index at 54 US$ per ton as show calculation formula as below

Sale Coal price = 54US$ x (Sale CV / 6322)

Example: Incremental of Sebuku revenue – Alternative 1

- Sale coal price of individual Sebuku = 54 x (5,600 / 6322) = 47.83 US$/t
- Sale volume of Sebuku = 1.7 million ton
- Total revenue of Sebuku = 1.7 million ton x 47.83 US$ = 81.31 million US$
- Original plan 2016 Sebuku revenue = 89.91 million US$ (Table 4-6)
- Incremental of Sebuku revenue = 81.31-89.91 = (8.77) million US$

The incremental of operation cost is also calculated from different of alternative 1 cost and cost from original plan 2016. Each cost item was calculated from cost per unit (Table 4-1) multiply by Coal production volume. Example of calculation is shown as below; each cost item was calculated follow detail below;

- Mining cost = Cost per unit x Coal production volume
- Crushing cost = Cost per unit x Coal production volume
- Washing cost = Cost per unit x Coal production volume
- Reject cost = Cost per unit x Reject volume
- Transportation cost = Cost per unit x sale volume
- Barging cost = Cost per unit x sale volume
- Transhipment cost = Cost per unit x sale volume
- Blending cost = Cost per unit x Blend volume
- Royalty = Cost per unit x sale volume
- Admin & Sale cost = Fixed cost
- Site support = Fixed cost

Example: Incremental mining cost of Sebuku Blending Alternative 1

- Mining cost per unit = 26.50 US$ per ton (Table 4-1)
- Coal production volume = Sale volume of Sebuku + Reject volume
- Coal production volume = 1.7 + 0.53 = 2.23 million tons (Table 4-7)
- Total Sebuku mining cost = 26.50 x 2.23 = 59.31 million US$
- Original plan 2016:Total Sebuku mining cost = 65.73 million US$ (Table 4-6)
- Incremental Sebuku mining cost = 45.05-59.31 = (6.41) million US$

The incremental gross profit margin was calculated from incremental of revenue minus by incremental of cost. Alternative 1 shown incremental revenue

decrease 8.77 million US$ but increment of cost also decrease 13.22 million US$. Therefore, Sebuku incremental gross profit revenue = (8.77)-(13.22) = 4.45 million US$, it means alternative blending 1 Sebuku has gross profit margin increased 4.45 million US$. In order to consider how much benefit from Alternative blending 1 has to combine incremental of gross profit margin from Sebuku, Jembayan and Blended coal.

	BLENDING ALTERNATIVE 2					
	Plan : Blend Sebuku 4800 Jembayan 5200					
	Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total/Avg.**
Real Data	Sebuku Blending Ratio				18%	18%
	Coal Quality (CV)	Kcal/Kg	5,600	5,537	5,184	5,410
	Coal Quality (Ash)	%	8.00	5.47	7.99	6.86
	Coal Price	US$ per ton	47.83	47.29	44.28	46.21
	Sale product	Million Ton	1.42	3.88	3.34	8.65
	Reject	Million Ton	0.44			0.44
Incremental data	**Sale Revenue**	**Million US$**	**(21.99)**	**(121.98)**	**148.10**	**4.13**
	Mining Cost	Million US$	(16.08)	(72.68)	88.76	-
	Crushing cost	Million US$	(0.66)	(4.11)	4.78	-
	Washing cost	Million US$	(2.71)	-	-	(2.71)
	Reject cost	Million US$	(0.14)	-	-	(0.14)
	Transportation cost	Million US$	(0.37)	(3.57)	4.05	0.11
	Barging cost	Million US$	(0.55)	(6.31)	10.52	3.66
	Transhipment cost	Million US$	(0.51)	(3.02)	3.68	0.16
	Blending cost	Million US$	-	-	0.50	0.50
	Royalty	Million US$	(1.15)	(6.31)	7.69	0.24
	Admin & Sale cost	Million US$	(1.99)	(4.94)	6.93	-
	Site support	Million US$	(3.98)	(5.49)	9.46	-
	Total cost	**Million US$**	**(28.13)**	**(106.42)**	**136.37**	**1.82**
	Incremental Gross Profit Margin	**Million US$**	**6.14**	**(15.56)**	**11.73**	**2.31**

Table 4-8: Result of Blending alternative no 2

BLENDING ALTERNATIVE 3						
Plan : Blend Sebuku 4800 Jembayan 5400						
	Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total/Avg.**
Real Data	Sebuku Blending Ratio				19%	19%
	Coal Quality (CV)	Kcal/Kg	5,600	5,404	5,295	5,396
	Coal Quality (Ash)	%	8.00	5.55	8.01	6.85
	Coal Price	US$ per ton	47.83	46.16	45.23	46.09
	Sale product	Million Ton	1.42	4.06	3.17	8.65
	Reject	Million Ton	0.44			0.44
Incremental data	**Sale Revenue**	**Million US$**	**(21.99)**	**(118.25)**	**143.31**	**3.07**
	Mining Cost	Million US$	(16.08)	(68.02)	84.09	-
	Crushing cost	Million US$	(0.66)	(3.85)	4.51	-
	Washing cost	Million US$	(2.71)	-	-	(2.71)
	Reject cost	Million US$	(0.14)	-	-	(0.14)
	Transportation cost	Million US$	(0.37)	(3.34)	3.82	0.11
	Barging cost	Million US$	(0.55)	(5.90)	10.12	3.66
	Transhipment cost	Million US$	(0.51)	(2.82)	3.49	0.16
	Blending cost	Million US$	-	-	0.48	0.48
	Royalty	Million US$	(1.15)	(5.90)	7.29	0.24
	Admin & Sale cost	Million US$	(1.99)	(4.62)	6.61	-
	Site support	Million US$	(3.98)	(5.13)	9.11	-
	Total cost	**Million US$**	**(28.13)**	**(99.59)**	**129.51**	**1.79**
	Incremental Gross Profit Margin	**Million US$**	**6.14**	**(18.66)**	**13.80**	**1.28**

Table 4-9: Result of Blending alternative no 3

BLENDING ALTERNATIVE 4						
Plan : Blend Sebuku 4800 Jembayan 5600						
	Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total/Avg.**
Real Data	Sebuku Blending Ratio				20%	20%
	Coal Quality (CV)	Kcal/Kg	5,600	5,261	5,458	5,385
	Coal Quality (Ash)	%	8.00	5.68	7.97	6.86
	Coal Price	US$ per ton	47.83	44.94	46.62	46.00
	Sale product	Million Ton	1.42	4.22	3.01	8.65
	Reject	Million Ton	0.44			0.44
Incremental data	**Sale Revenue**	**Million US$**	**(21.99)**	**(116.08)**	**140.34**	**2.27**
	Mining Cost	Million US$	(16.08)	(63.82)	79.89	-
	Crushing cost	Million US$	(0.66)	(3.61)	4.27	-
	Washing cost	Million US$	(2.71)	-	-	(2.71)
	Reject cost	Million US$	(0.14)	-	-	(0.14)
	Transportation cost	Million US$	(0.37)	(3.13)	3.61	0.11
	Barging cost	Million US$	(0.55)	(5.54)	9.75	3.66
	Transhipment cost	Million US$	(0.51)	(2.65)	3.31	0.16
	Blending cost	Million US$	-	-	0.45	0.45
	Royalty	Million US$	(1.15)	(5.54)	6.92	0.24
	Admin & Sale cost	Million US$	(1.99)	(4.33)	6.32	-
	Site support	Million US$	(3.98)	(4.82)	8.79	-
	Total cost	**Million US$**	**(28.13)**	**(93.44)**	**123.34**	**1.77**
	Incremental Gross Profit Margin	**Million US$**	**6.14**	**(22.63)**	**17.00**	**0.50**

Table 4-10: Result of Blending alternative no 4

BLENDING ALTERNATIVE 5						
Plan : Blend Sebuku 5000 Jembayan 5000						
	Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total/Avg.**
Real Data	Sebuku Blending Ratio				19%	19%
	Coal Quality (CV)	Kcal/Kg	5,600	5,484	5,041	5,429
	Coal Quality (Ash)	%	8.00	5.47	7.92	6.39
	Coal Price	US$ per ton	47.83	46.84	43.06	46.37
	Sale product	Million Ton	1.66	5.41	1.50	8.57
	Reject	Million Ton	0.51			0.51
Incremental data	**Sale Revenue**	**Million US$**	**(10.41)**	**(52.17)**	**64.60**	**2.02**
	Mining Cost	Million US$	(7.61)	(32.20)	39.81	-
	Crushing cost	Million US$	(0.31)	(1.82)	2.14	-
	Washing cost	Million US$	(1.28)	-	-	(1.28)
	Reject cost	Million US$	(0.07)	-	-	(0.07)
	Transportation cost	Million US$	(0.17)	(1.58)	1.81	0.05
	Barging cost	Million US$	(0.26)	(2.79)	4.79	1.73
	Transhipment cost	Million US$	(0.24)	(1.34)	1.65	0.07
	Blending cost	Million US$	-	-	0.23	0.23
	Royalty	Million US$	(0.54)	(2.79)	3.45	0.11
	Admin & Sale cost	Million US$	(1.53)	(2.19)	3.71	-
	Site support	Million US$	(3.05)	(2.43)	5.48	-
	Total cost	**Million US$**	**(15.07)**	**(47.15)**	**63.07**	**0.85**
	Incremental Gross Profit Margin	**Million US$**	**4.66**	**(5.02)**	**1.53**	**1.17**

Table 4-11: Result of Blending alternative no 5

	BLENDING ALTERNATIVE 6					
	Plan : Blend Sebuku 5000 Jembayan 5200					
	Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total/Avg.**
Real Data	Sebuku Blending Ratio				21%	21%
	Coal Quality (CV)	Kcal/Kg	5,600	5,615	5,209	5,381
	Coal Quality (Ash)	%	8.00	5.34	7.96	7.17
	Coal Price	US$ per ton	47.83	47.96	44.49	45.96
	Sale product	Million Ton	1.08	2.67	5.00	8.75
	Reject	Million Ton	0.33			0.33
Incremental data	**Sale Revenue**	**Million US$**	**(38.38)**	**(177.41)**	**222.62**	**6.83**
	Mining Cost	Million US$	(28.06)	(104.75)	132.81	-
	Crushing cost	Million US$	(1.16)	(5.93)	7.09	-
	Washing cost	Million US$	(4.73)	-	-	(4.73)
	Reject cost	Million US$	(0.25)	-	-	(0.25)
	Transportation cost	Million US$	(0.64)	(5.14)	5.98	0.20
	Barging cost	Million US$	(0.96)	(9.09)	16.45	6.39
	Transhipment cost	Million US$	(0.88)	(4.35)	5.50	0.27
	Blending cost	Million US$	-	-	0.75	0.75
	Royalty	Million US$	(2.01)	(9.09)	11.51	0.41
	Admin & Sale cost	Million US$	(2.64)	(7.12)	9.76	-
	Site support	Million US$	(5.29)	(7.91)	13.19	-
	Total cost	**Million US$**	**(46.61)**	**(153.37)**	**203.03**	**3.05**
	Incremental Gross Profit Margin	**Million US$**	**8.23**	**(24.04)**	**19.59**	**3.78**

Table 4-12: Result of Blending alternative no 6

	BLENDING ALTERNATIVE 7					
	Plan : Blend Sebuku 5000 Jembayan 5400					
	Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total/Avg.**
Real Data	Sebuku Blending Ratio				24%	24%
	Coal Quality (CV)	Kcal/Kg	5,600	5,404	5,325	5,334
	Coal Quality (Ash)	%	8.00	5.55	8.01	8.01
	Coal Price	US$ per ton	47.83	46.16	45.48	45.56
	Sale product	Million Ton	0.28	-	8.72	9.00
	Reject	Million Ton	0.09			0.09
Incremental data	**Sale Revenue**	**Million US$**	**(76.43)**	**(305.64)**	**396.57**	**14.50**
	Mining Cost	Million US$	(55.87)	(175.60)	231.47	-
	Crushing cost	Million US$	(2.30)	(9.94)	12.24	-
	Washing cost	Million US$	(9.42)	-	-	(9.42)
	Reject cost	Million US$	(0.49)	-	-	(0.49)
	Transportation cost	Million US$	(1.28)	(8.61)	10.29	0.40
	Barging cost	Million US$	(1.92)	(15.24)	29.89	12.73
	Transhipment cost	Million US$	(1.76)	(7.29)	9.59	0.54
	Blending cost	Million US$	-	-	1.31	1.31
	Royalty	Million US$	(3.99)	(15.24)	20.05	0.82
	Admin & Sale cost	Million US$	(4.16)	(11.93)	16.09	-
	Site support	Million US$	(8.32)	(13.25)	21.58	-
	Total cost	**Million US$**	**(89.52)**	**(257.10)**	**352.50**	**5.89**
	Incremental Gross Profit Margin	**Million US$**	**13.08**	**(48.54)**	**44.06**	**8.61**

Table 4-13: Result of Blending alternative no 7

BLENDING ALTERNATIVE 8						
Plan : Blend Sebuku 5000 Jembayan 5600						
	Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total/Avg.**
Real Data	Sebuku Blending Ratio				25%	25%
	Coal Quality (CV)	Kcal/Kg	5,600	5,261	5,480	5,397
	Coal Quality (Ash)	%	8.00	5.68	7.96	6.93
	Coal Price	US$ per ton	47.83	44.94	46.81	46.10
	Sale product	Million Ton	1.20	3.95	3.56	8.72
	Reject	Million Ton	0.37			0.37
Incremental data	**Sale Revenue**	**Million US$**	**(32.55)**	**(128.00)**	**166.85**	**6.31**
	Mining Cost	Million US$	(23.79)	(70.85)	94.64	-
	Crushing cost	Million US$	(0.98)	(4.01)	4.99	-
	Washing cost	Million US$	(4.01)	-	-	(4.01)
	Reject cost	Million US$	(0.21)	-	-	(0.21)
	Transportation cost	Million US$	(0.54)	(3.48)	4.19	0.17
	Barging cost	Million US$	(0.82)	(6.15)	12.39	5.42
	Transhipment cost	Million US$	(0.75)	(2.94)	3.92	0.23
	Blending cost	Million US$	-	-	0.53	0.53
	Royalty	Million US$	(1.70)	(6.15)	8.20	0.35
	Admin & Sale cost	Million US$	(2.41)	(4.81)	7.22	-
	Site support	Million US$	(4.82)	(5.35)	10.17	-
	Total cost	**Million US$**	**(40.04)**	**(103.73)**	**146.25**	**2.48**
	Incremental Gross Profit Margin	**Million US$**	**7.49**	**(24.26)**	**20.60**	**3.82**

Table 4-14: Result of Blending alternative no 8

BLENDING ALTERNATIVE 9						
Plan : Blend Sebuku 5200 Jembayan 5000						
	Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total/Avg.**
Real Data	Sebuku Blending Ratio				25%	25%
	Coal Quality (CV)	Kcal/Kg	5,600	5,484	5,087	5,430
	Coal Quality (Ash)	%	8.00	5.47	8.00	6.41
	Coal Price	US$ per ton	47.83	46.84	43.45	46.38
	Sale product	Million Ton	1.57	5.41	1.62	8.60
	Reject	Million Ton	0.49			0.49
Incremental data	**Sale Revenue**	**Million US$**	**(14.79)**	**(52.17)**	**70.40**	**3.44**
	Mining Cost	Million US$	(10.81)	(32.20)	43.02	-
	Crushing cost	Million US$	(0.45)	(1.82)	2.27	-
	Washing cost	Million US$	(1.82)	-	-	(1.82)
	Reject cost	Million US$	(0.10)	-	-	(0.10)
	Transportation cost	Million US$	(0.25)	(1.58)	1.90	0.08
	Barging cost	Million US$	(0.37)	(2.79)	5.63	2.46
	Transhipment cost	Million US$	(0.34)	(1.34)	1.78	0.11
	Blending cost	Million US$	-	-	0.24	0.24
	Royalty	Million US$	(0.77)	(2.79)	3.73	0.16
	Admin & Sale cost	Million US$	(1.70)	(2.19)	3.89	-
	Site support	Million US$	(3.40)	(2.43)	5.83	-
	Total cost	**Million US$**	**(20.01)**	**(47.15)**	**68.29**	**1.13**
	Incremental Gross Profit Margin	**Million US$**	**5.22**	**(5.02)**	**2.11**	**2.31**

Table 4-15: Result of Blending alternative no 9

	BLENDING ALTERNATIVE 10					
	Plan : Blend Sebuku 5200 Jembayan 5200					
	Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total/Avg.**
Real Data	Sebuku Blending Ratio				27%	27%
	Coal Quality (CV)	Kcal/Kg	5,600	5,615	5,246	5,396
	Coal Quality (Ash)	%	8.00	5.34	8.01	7.16
	Coal Price	US$ per ton	47.83	47.96	44.81	46.09
	Sale product	Million Ton	0.80	2.82	5.22	8.84
	Reject	Million Ton	0.25			0.25
Incremental data	**Sale Revenue**	**Million US$**	**(51.44)**	**(170.46)**	**233.73**	**11.82**
	Mining Cost	Million US$	(37.61)	(100.91)	138.52	-
	Crushing cost	Million US$	(1.55)	(5.71)	7.26	-
	Washing cost	Million US$	(6.34)	-	-	(6.34)
	Reject cost	Million US$	(0.33)	-	-	(0.33)
	Transportation cost	Million US$	(0.86)	(4.95)	6.08	0.27
	Barging cost	Million US$	(1.29)	(8.76)	18.62	8.57
	Transhipment cost	Million US$	(1.18)	(4.19)	5.74	0.37
	Blending cost	Million US$	-	-	0.78	0.78
	Royalty	Million US$	(2.69)	(8.76)	12.00	0.55
	Admin & Sale cost	Million US$	(3.16)	(6.85)	10.02	-
	Site support	Million US$	(6.33)	(7.62)	13.94	-
	Total cost	**Million US$**	**(61.34)**	**(147.75)**	**212.95**	**3.86**
	Incremental Gross Profit Margin	**Million US$**	**9.90**	**(22.72)**	**20.77**	**7.95**

Table 4-16: Result of Blending alternative no 10

	BLENDING ALTERNATIVE 11					
	Plan : Blend Sebuku 5200 Jembayan 5400					
	Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total/Avg.**
Real Data	Sebuku Blending Ratio				22%	22%
	Coal Quality (CV)	Kcal/Kg	5,600	5,404	5,360	5,390
	Coal Quality (Ash)	%	8.00	5.55	7.47	7.16
	Coal Price	US$ per ton	47.83	46.16	45.78	46.04
	Sale product	Million Ton	0.80	1.63	6.40	8.84
	Reject	Million Ton	0.25			0.25
Incremental data	**Sale Revenue**	**Million US$**	**(51.44)**	**(230.27)**	**293.09**	**11.38**
	Mining Cost	Million US$	(37.61)	(132.33)	169.93	-
	Crushing cost	Million US$	(1.55)	(7.49)	9.04	-
	Washing cost	Million US$	(6.34)	-	-	(6.34)
	Reject cost	Million US$	(0.33)	-	-	(0.33)
	Transportation cost	Million US$	(0.86)	(6.49)	7.62	0.27
	Barging cost	Million US$	(1.29)	(11.49)	21.34	8.57
	Transhipment cost	Million US$	(1.18)	(5.49)	7.04	0.37
	Blending cost	Million US$	-	-	0.96	0.96
	Royalty	Million US$	(2.69)	(11.49)	14.72	0.55
	Admin & Sale cost	Million US$	(3.16)	(8.99)	12.15	-
	Site support	Million US$	(6.33)	(9.99)	16.32	-
	Total cost	**Million US$**	**(61.34)**	**(193.75)**	**259.13**	**4.04**
	Incremental Gross Profit Margin	**Million US$**	**9.90**	**(36.52)**	**33.96**	**7.34**

Table 4-17: Result of Blending alternative no 11

BLENDING ALTERNATIVE 12						
Plan : Blend Sebuku 5200 Jembayan 5600						
	Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total/Avg.**
Real Data	Sebuku Blending Ratio				29%	29%
	Coal Quality (CV)	Kcal/Kg	5,600	5,261	5,496	5,402
	Coal Quality (Ash)	%	8.00	5.68	7.94	6.93
	Coal Price	US$ per ton	47.83	44.94	46.94	46.15
	Sale product	Million Ton	1.05	3.95	3.77	8.76
	Reject	Million Ton	0.32			0.32
Incremental data	**Sale Revenue**	**Million US$**	**(39.89)**	**(128.00)**	**176.76**	**8.88**
	Mining Cost	Million US$	(29.16)	(70.85)	100.00	-
	Crushing cost	Million US$	(1.20)	(4.01)	5.21	-
	Washing cost	Million US$	(4.91)	-	-	(4.91)
	Reject cost	Million US$	(0.26)	-	-	(0.26)
	Transportation cost	Million US$	(0.67)	(3.48)	4.35	0.21
	Barging cost	Million US$	(1.00)	(6.15)	13.79	6.64
	Transhipment cost	Million US$	(0.92)	(2.94)	4.14	0.28
	Blending cost	Million US$	-	-	0.56	0.56
	Royalty	Million US$	(2.08)	(6.15)	8.66	0.43
	Admin & Sale cost	Million US$	(2.70)	(4.81)	7.52	-
	Site support	Million US$	(5.41)	(5.35)	10.75	-
	Total cost	**Million US$**	**(48.31)**	**(103.73)**	**154.99**	**2.95**
	Incremental Gross Profit Margin	**Million US$**	**8.42**	**(24.26)**	**21.76**	**5.92**

Table 4-18: Result of Blending alternative no 12

Tables 4-7 to 4-18 above have shown the details of Alternative blending calculation of 12 alternatives, including all detailed coal blending quality, incremental revenue, cost and profit. Each table has been separated into two parts. The first part contains real data which divided into 3 columns, including Sebuku data, Jembayan data and Blended data. The data in each column represents coal sale information in each area. For example, blend column shows blending ratio, blended quality, and sale volume after blended, and coal price. Moreover, Sebuku column shows coal quality after washed, volume of washed coal, coal price and volume of rejected coal.

The second part of each table shows the incremental data of revenue, cost and gross profit. The incremental data is calculated by the different values from SAR 2016 original plan as shown in Table 4-6. The incremental result is calculated by numbers from Blending alternative nos minus the number from SAR 2016 original plan. If the result is negative, it will show in bracket. The incremental revenue is shown as the first row of the incremental data and then followed by cost item of each operation activity.

Some of the incremental cost items have been shown as zero number because the cost of that activity has not been changed, for example, the incremental mining cost and crushing cost. Moreover, the incremental admin & sale cost and site support cost are shown as zero as no change in the new blending process. On the other hand, some incremental cost has been reduced such as incremental washing cost and rejected cost because coal volume is reduced at the washing process. Barging cost is the main incremental cost that is the most increased since Sebuku coal has to be transported by barge a lot longer distance to the transshipment point near Jembayan mine.

The bottom line of the incremental data is gross profit margin which has been calculated from the total of incremental revenue minus by the total incremental cost. The number of the incremental gross profit margin is the factor to determine the best alternative of alternative coal blending process.

To compare all 12 alternatives of alternative blending plan, the result can be seen in Table 4-19 below. The table has combined the results of all alternatives in one table to see which alternatives should be selected to be the new blending plan. The table shown that Alternative number 7 has the highest incremental increasing gross profit margin at 8.6 million US$ and the second highest is Alternative number 10 which improve the profit of 7.9 million US$.

Table 4-19 combined result of 12 Alternatives of alternative blending process

	Item	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 9	Alternative 10	Alternative 11	Alternative 12
Real data	Sebuku Blending Ratio	17%	18%	19%	20%	19%	21%	24%	25%	25%	27%	22%	29%
	Coal Quality (CV)	5,427	5,410	5,396	5,385	5,429	5,381	5,334	5,397	5,430	5,396	5,390	5,402
	Coal Quality (Ash)	6.40	6.86	6.85	6.86	6.39	7.17	8.01	6.93	6.41	7.16	7.16	6.93
	Coal Price	46.35	46.21	46.09	46.00	46.37	45.96	45.56	46.10	46.38	46.09	46.04	46.15
	Sale product	8.56	8.65	8.65	8.65	8.57	8.75	9.00	8.72	8.60	8.84	8.84	8.76
	Reject	0.53	0.44	0.44	0.44	0.51	0.33	0.09	0.37	0.49	0.25	0.25	0.32
Incremental data	**Sale Revenue**	**1.36**	**4.13**	**3.07**	**2.27**	**2.02**	**6.83**	**14.50**	**6.31**	**3.44**	**11.82**	**11.38**	**8.88**
	Mining Cost	-	-	-	-	-	-	-	-	-	-	-	-
	Crushing cost	-	-	-	-	-	-	-	-	-	-	-	-
	Washing cost	(1.08)	(2.71)	(2.71)	(2.71)	(1.28)	(4.73)	(9.42)	(4.01)	(1.82)	(6.34)	(6.34)	(4.91)
	Reject cost	(0.06)	(0.14)	(0.14)	(0.14)	(0.07)	(0.25)	(0.49)	(0.21)	(0.10)	(0.33)	(0.33)	(0.26)
	Transportation cost	0.05	0.11	0.11	0.11	0.05	0.20	0.40	0.17	0.08	0.27	0.27	0.21
	Barging cost	1.46	3.66	3.66	3.66	1.73	6.39	12.73	5.42	2.46	8.57	8.57	6.64
	Transhipment cost	0.06	0.16	0.16	0.16	0.07	0.27	0.54	0.23	0.11	0.37	0.37	0.28
	Blending cost	0.22	0.50	0.48	0.45	0.23	0.75	1.31	0.53	0.24	0.78	0.96	0.56
	Royalty	0.09	0.24	0.24	0.24	0.11	0.41	0.82	0.35	0.16	0.55	0.55	0.43
		-	-	-	-	-	-	-	-	-	-	-	-
	Admin & Sale cost	-	-	-	-	-	-	-	-	-	-	-	-
	Site support	-	-	-	-	-	-	-	-	-	-	-	-
	Total cost	**0.74**	**1.82**	**1.79**	**1.77**	**0.85**	**3.05**	**5.89**	**2.48**	**1.13**	**3.86**	**4.04**	**2.95**
		-	-	-	-	-	-	-	-	-	-	-	-
	Incremental Gross Profit Margin	**0.62**	**2.31**	**1.28**	**0.50**	**1.17**	**3.78**	**8.61**	**3.82**	**2.31**	**7.95**	**7.34**	**5.92**

The results from 12 blending alternatives show that total coal sale volume in all alternatives are higher than 8.51 million tons from SAR 2016 original plan because the volume of unwashed coal from Sebuku mine has been added to sale volume. The incremental total sale volume vary from 0.05 to 0.49 million tons. The alternative number 7 has the highest incremental increasing in sale volume at 0.49 million tons. The incremental of total sale volume from all alternatives has shown in Table 4-20 below.

Incremental Sale volume (M.Ton)		Sebuku Raw Coal Quality					
		4800		5000		5200	
Jembayan Raw Coal Quality	5000	1	0.05	5	0.06	9	0.09
	5200	2	0.14	6	0.24	10	0.33
	5400	3	0.14	7	0.49	11	0.33
	5600	4	0.14	8	0.21	12	0.25

1 Alternative number

Table 4-20: Incremental of total sale volume (Million Ton)

According to all alternatives of blending, overall coal product quality has been changed. By mixing high ash coal from Sebuku, the calorific value of the new product is decreased. Thus, the changing of CV has the direct impact to the decreasing in sale price. Alternative number 7 is the most decreasing price at 0.95 US$ per ton, while alternative number 9 has the least decreasing price at 0.12 US$ per ton. Table 4-21 below has shown the incremental sale price of all 12 blending alternatives.

Incremental Sale Price (US$/Ton)		Sebuku Raw Coal Quality					
		4800		5000		5200	
Jembayan Raw Coal Quality	5000	1	-0.15	5	-0.13	9	-0.12
	5200	2	-0.29	6	-0.54	10	-0.41
	5400	3	-0.41	7	-0.95	11	-0.46
	5600	4	-0.50	8	-0.40	12	-0.36

Table 4-21: Incremental of sale price (US$ per Ton)

The incremental revenue has shown in Table 4-22 below, which can be seen that all blending alternatives has increased revenue to the company. The highest increasing of revenue is 14.5 Million US$ in blending Alternative number 7, and the second highest is alternative number 10 which has increased 11.8 Million US$. The increasing of revenue is the major factor to impact gross profit margin. However, in order to calculate incremental gross profit margin, it also needs to be considered the incremental cost in each alternative.

Incremental Revenue (M.US$)		Sebuku Raw Coal Quality					
		4800		5000		5200	
Jembayan Raw Coal Quality	5000	1	1.36	5	2.02	9	3.44
	5200	2	4.13	6	6.83	10	11.82
	5400	3	3.07	7	14.50	11	11.38
	5600	4	2.27	8	6.31	12	8.88

Table 4-22: Incremental of total Revenue (Million US$)

The incremental operating cost is mostly impacted by the decreasing in washing cost and increasing in barging cost. Table 4-23 below has shown that the highest incremental increasing cost is alternative number 7 because this alternative

has the highest blending volume from Sebuku with long distance of barging transportation.

Incremental Total Cost (M.US$)		Sebuku Raw Coal Quality					
		4800		5000		5200	
Jembayan Raw Coal Quality	5000	1	0.74	5	0.85	9	1.13
	5200	2	1.82	6	3.05	10	3.86
	5400	3	1.79	7	5.89	11	4.04
	5600	4	1.77	8	2.48	12	2.95

Table 4-23: Incremental of total cost (Million US$)

In summary, the best Alternative Blending plan is alternative number 7 which blends CV 5,000 raw coal quality from Sebuku with CV 5,400 from Jembayan. Alternative number 7 can improve company gross profit at 8.6 million US$, increasing by 25.5% from 33.7 million US$ in the company 2016 original plan to 42.3 million US$. This alternative sell the highest coal volume at 9.0 million ton which is increased about half million ton of coal sale. Even though this alternative has the highest increasing in operating cost from barging cost since higher coal volume has to be transported long distance, this alternative has also the highest increasing in sale revenue. This study has selected the blending alternative number 7 as the best alternative coal blending process.

4.8 Sensitivity Study

Blending alternative no 7 has been selected to be the potential new blending plan for SAR; however, the blending result is calculated based on many assumptions that can be changed by external and internal factors. The external factors cannot be controlled by the company such as coal price and fuel price, which are fluctuated by the commodity price. The changing of coal price and fuel price has opposite impact

to profit margin. Coal price is the direct impact to sale revenue, while the increasing of fuel price is the direct impact to the operating cost.

Incremental Profit (Million.US$)	Sensitivity of Coal Price										
Sensitivity of Oil Price	-50%	-40%	-30%	-20%	-10%	0%	10%	20%	30%	40%	50%
50%	1.51	1.61	1.72	1.82	1.92	2.02	2.12	2.22	2.32	2.43	2.53
40%	2.98	3.08	3.19	3.29	3.39	3.49	3.59	3.69	3.79	3.90	4.00
30%	4.38	4.48	4.58	4.68	4.78	4.88	4.99	5.09	5.19	5.29	5.39
20%	5.70	5.80	5.90	6.00	6.10	6.20	6.30	6.41	6.51	6.61	6.71
10%	6.94	7.04	7.14	7.24	7.35	7.44	7.55	7.65	7.75	7.85	7.95
0%	8.10	8.21	8.31	8.41	8.51	**8.61**	8.71	8.82	8.92	9.02	9.12
-10%	9.20	9.30	9.40	9.50	9.60	9.70	9.81	9.91	10.01	10.11	10.21
-20%	10.21	10.32	10.42	10.52	10.62	10.72	10.82	10.92	11.03	11.13	11.23
-30%	11.15	11.26	11.36	11.46	11.56	11.66	11.76	11.87	11.97	12.07	12.17
-40%	12.02	12.12	12.22	12.32	12.43	12.52	12.63	12.73	12.83	12.93	13.03
-50%	12.81	12.91	13.01	13.11	13.21	13.31	13.42	13.52	13.62	13.72	13.82

Table 4-24: Result of incremental profit from sensitivity study of changing coal price and oil price.

Even though it is difficult to predict, the sensitivity study of the impact from those 2 factors can help the company to monitor and forecast the result of new alternative blending process. Table 4-24 above has shown sensitivity study of coal price and fuel price. The number in the table is the incremental profit calculated by the changing in coal price and fuel price.

The sensitivity study is based on alternative 7 which has the highest profit from 12 alternatives of alternative blending plan. The sensitivity of coal price has been increased and decreased from the based coal price of 54 US$ per ton as the average coal price assumption of 2016, using the increasing and decreasing in every 10 percent up to the maximum of 50% in both directions. The sensitivity of fuel price impact to only some cost components such as barging cost which has 85 percent impact and transportation cost with 60 percent impact. Moreover, sensitivity of fuel has increased and decreased every 10% up and down to the maximum of 50% in both directions.

The result from the sensitivity study has shown in Table 4-24, which is the incremental profit of alternatives 7 compared to SAR 2016 original plan. The changing of coal price every 10 percent in both directions up and down have the average impact to the incremental profit about 0.10 million US$. While, the changing of increasing fuel prices every 10 percent has the average impact to the decreasing in profit of about 1.21 million US$.

Gross Profit (Million US$)	**Sensitivity of Coal Price & Oil Price**										
	-50%	-40%	-30%	-20%	-10%	0%	10%	20%	30%	40%	50%
Original plan	(174.52)	(132.87)	(91.22)	(49.57)	(7.92)	33.73	75.38	117.03	158.68	200.33	241.98
Alternative No 7	(173.00)	(129.78)	(86.64)	(43.57)	(0.57)	42.34	85.19	127.95	170.65	213.26	255.80
Incremental	1.51	3.08	4.58	6.00	7.35	8.61	9.81	10.92	11.97	12.93	13.82

Table 4-25: Gross profit of Original plan compare with Alternative 7 from changing coal price and oil price

Table 4-24 shows that all cases of sensitivity of both coal price and oil price, ranging from the increasing of 50% to the decreasing 50%, show the positive incremental profit. It means that even though coal price drop by 50% and oil price increase by 50%, the profit is still increased 1.51 million US$ from SAR 2016 original plan. However, table 4-25 shows that real gross profit margin of alternative 7 has negative profit since both coal price and oil price drop by 10%. Therefore, the company should reconsider whether to continue running operation at loss or stop operation and wait for the next upturn of coal business.

5. CHAPTER V

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study proposes to seek opportunity of alternative coal blending process across two mine sites in studied company to increase profit margin compare with original plan of 2016. This research is study in blending plan between two mine sites which have original plan to standalone blending and sell product. There is opportunity to blend low ash coal from Jembayan mine with Sebuku mine, it gives benefits to reduce ash content without washing process which can reduce cost of washing but there is additional transportation cost from longer distance barging.

The alternatives for alternative blending plan has been created between 4 coal types from Jembayan and 3 coal types from Sebuku which creates 12 blending alternatives. There are many factors in the blending calculation which has been controlled scope of result by three limitations, Calorific value of coal product, maximum ash content of product, and maximum portion of blending. The result of 12 alternatives is calculated by compare gross profit margin with the company original plan 2016 which has profit 33.7 million US$ from sell product 8.5 million ton of two mines combined.

The best blending plan is alternative 7 which blended CV 5,000 from Sebuku with CV 5,400 from Jembayan that can creates profit margin 42.3 million US$ from sell product 9.0 million ton, the profit higher than original plan 25.6 percent and increase 0.5 million ton coal product. Main factors that increase profit are increasing of coal product that creates more revenue by 14.5 million US$, reducing cost of washing process and reject cost by 9.9 Million US$. However, there are increasing

cost from barging cost, blending cost and transhipment cost, total increase cost from new blending plan is 15.8 million US$. Therefore, net increase profit from alternative new blending alternative 7 is 8.6 million US$.

Moreover, this research also studies on sensitivity of main factors that impact to profit of new blending plan which are sensitivity of coal price and oil price. Result of impact from coal price every 10 percent up and down is change profit 0.1 million US$. While, changing of increasing fuel price every 10 percent has average impact about decreasing 1.21 million US$ of profit. This sensitivity study has vary those 2 factors up and down to 50% of changing but result of incremental profit still shown as positive, it means that the blending alternative no 7 creates more profit even coal price down 50% and oil price is increase by 50%.

5.2 Recommendations

To consider all aspect and ensure the alternative blending plan will creates more profit to company, It also recommends further study that helps this research is successful in reality.

5.2.1 Study of new coal product price

According to alternative coal blending process give new coal product quality, the new product has calorific value 5,325 kcal/kg and ash content 8% which difference from originally product at CV 5,400 kcal/kg. The price calculation in blending model is based on proportional from NEWC price, therefore the study of new coal price can help to ensure benefits of this research. To study the new coal price can do by contact to customer and study on the feedback from market.

5.2.2 Risk Assessment

As the alternative blending plan have several activities that difference from normal blending process, so the changing of process can creates operational risk that could impact to company profit. Risk assessment is method to understand possibility of impact in each changing activity and foresee the risk of new blending process. Moreover, to creates Risk mitigation plan which can help to reduce possibility of risk.

5.2.3 Quality control procedure

The alternative blending process proposed to get benefit from quality blending from two mine sites and the best alternative 7 will blend 24% of high ash coal from Sebuku mine with low ash coal from Jembayan. Target coal blended quality must has ash content not more than 8% which has to control by blending ratio of coal from two sources, therefore the raw quality from each source must be known by laboratory testing. So, it needs to create the procedure to control and ensure that raw coal quality from sites is follows the plan and also quality control at blended product is also very important. The study of new procedure must be in place before start the alternative blending process.

5.2.4 Monthly blending plan

According to the blending model is calculated based on annual production volume which not yet considered about monthly production scheduling. Normally, monthly production schedule is changing follow seasonal and some working factors, such as raining hours and holiday. Therefore, it needs more study on monthly blending raw coal that foresees the impact from miss-match production schedule from each source and be able to further adjust monthly production plan.

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APPENDIX

APPENDIX A: Blending Calculation model

Table A-1: Blending alternative no 1

BLENDING ALTERNATIVE 1					
Plan : Blend Sebuku 4800 Jembayan 5000					
Cost Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total**
Sebuku Blending Ratio				17%	17%
Coal Quality (CV)	Kcal/Kg	5,600	5,484	5,012	
Coal Quality (Ash)	%	8.00	5.47	7.98	
Coal Price	US$ per ton	47.83	46.84	42.81	46.35
Sale product	Million Ton	1.70	5.41	1.46	8.56
Reject	Million Ton	0.53			
Sale Revenue	**Million US$**	**81.14**	**253.47**	**62.30**	**396.91**
Mining Cost	Million US$	59.31	143.40	38.61	241.32
Crushing cost	Million US$	2.44	8.12	2.09	12.65
Washing cost	Million US$	10.00	-	-	10.00
Reject cost	Million US$	0.53	-	-	0.53
Transportation cost	Million US$	1.36	7.03	1.77	10.16
Barging cost	Million US$	2.04	12.45	4.48	18.96
Transhipment cost	Million US$	1.87	5.95	1.60	9.42
Blending cost	Million US$	-	-	0.22	0.22
Royalty	Million US$	4.24	12.45	3.35	20.03
					-
Admin & Sale cost	Million US$	3.24	9.74	3.65	16.63
Site support	Million US$	6.48	10.82	5.35	22.65
Total cost	**Million US$**	**91.50**	**209.95**	**61.11**	**362.56**
Gross Profit Margin	**Million US$**	**(10.35)**	**43.52**	**1.19**	**34.35**

Table A-2: Blending alternative no 2

BLENDING ALTERNATIVE 2					
Plan : Blend Sebuku 4800 Jembayan 5200					
Cost Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total**
Sebuku Blending Ratio				18%	18%
Coal Quality (CV)	Kcal/Kg	5,600	5,537	5,184	
Coal Quality (Ash)	%	8.00	5.47	7.99	
Coal Price	US$ per ton	47.83	47.29	44.28	46.21
Sale product	Million Ton	1.42	3.88	3.34	8.65
Reject	Million Ton	0.44			
Sale Revenue	**Million US$**	**67.92**	**183.66**	**148.10**	**399.68**
Mining Cost	Million US$	49.65	102.91	88.76	241.32
Crushing cost	Million US$	2.05	5.83	4.78	12.65
Washing cost	Million US$	8.37	-	-	8.37
Reject cost	Million US$	0.44	-	-	0.44
Transportation cost	Million US$	1.14	5.05	4.05	10.23
Barging cost	Million US$	1.70	8.93	10.52	21.16
Transhipment cost	Million US$	1.56	4.27	3.68	9.51
Blending cost	Million US$	-	-	0.50	0.50
Royalty	Million US$	3.55	8.93	7.69	20.18
					-
Admin & Sale cost	Million US$	2.71	6.99	6.93	16.63
Site support	Million US$	5.42	7.77	9.46	22.65
Total cost	**Million US$**	**76.59**	**150.68**	**136.37**	**363.64**
Gross Profit Margin	**Million US$**	**(8.67)**	**32.98**	**11.73**	**36.04**

Table A-3: Blending alternative no 3

BLENDING ALTERNATIVE 3					
Plan : Blend Sebuku 4800 Jembayan 5400					
Cost Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total**
Sebuku Blending Ratio				19%	19%
Coal Quality (CV)	Kcal/Kg	5,600	5,404	5,295	
Coal Quality (Ash)	%	8.00	5.55	8.01	
Coal Price	US$ per ton	47.83	46.16	45.23	46.09
Sale product	Million Ton	1.42	4.06	3.17	8.65
Reject	Million Ton	0.44			
Sale Revenue	**Million US$**	**67.92**	**187.39**	**143.31**	**398.62**
Mining Cost	Million US$	49.65	107.58	84.09	241.32
Crushing cost	Million US$	2.05	6.09	4.51	12.65
Washing cost	Million US$	8.37	-	-	8.37
Reject cost	Million US$	0.44	-	-	0.44
Transportation cost	Million US$	1.14	5.28	3.82	10.23
Barging cost	Million US$	1.70	9.34	10.12	21.16
Transhipment cost	Million US$	1.56	4.47	3.49	9.51
Blending cost	Million US$	-	-	0.48	0.48
Royalty	Million US$	3.55	9.34	7.29	20.18
					-
Admin & Sale cost	Million US$	2.71	7.31	6.61	16.63
Site support	Million US$	5.42	8.12	9.11	22.65
Total cost	**Million US$**	**76.59**	**157.51**	**129.51**	**363.61**
Gross Profit Margin	**Million US$**	**(8.67)**	**29.88**	**13.80**	**35.01**

Table A-4: Blending alternative no 4

BLENDING ALTERNATIVE 4					
Plan : Blend Sebuku 4800 Jembayan 5600					
Cost Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total**
Sebuku Blending Ratio				20%	20%
Coal Quality (CV)	Kcal/Kg	5,600	5,261	5,458	
Coal Quality (Ash)	%	8.00	5.68	7.97	
Coal Price	US$ per ton	47.83	44.94	46.62	46.00
Sale product	Million Ton	1.42	4.22	3.01	8.65
Reject	Million Ton	0.44			
Sale Revenue	**Million US$**	**67.92**	**189.56**	**140.34**	**397.82**
Mining Cost	Million US$	49.65	111.78	79.89	161.43
Crushing cost	Million US$	2.05	6.33	4.27	8.37
Washing cost	Million US$	8.37	-	-	8.37
Reject cost	Million US$	0.44	-	-	0.44
Transportation cost	Million US$	1.14	5.48	3.61	6.62
Barging cost	Million US$	1.70	9.70	9.75	11.41
Transhipment cost	Million US$	1.56	4.64	3.31	6.20
Blending cost	Million US$	-	-	0.45	-
Royalty	Million US$	3.55	9.70	6.92	13.25
					-
Admin & Sale cost	Million US$	2.71	7.59	6.32	10.30
Site support	Million US$	5.42	8.44	8.79	13.86
Total cost	**Million US$**	**76.59**	**163.66**	**123.34**	**363.59**
Gross Profit Margin	**Million US$**	**(8.67)**	**25.90**	**17.00**	**34.24**

Table A-5: Blending alternative no 5

BLENDING ALTERNATIVE 5					
Plan : Blend Sebuku 5000 Jembayan 5000					
Cost Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total**
Sebuku Blending Ratio				19%	19%
Coal Quality (CV)	Kcal/Kg	5,600	5,484	5,041	
Coal Quality (Ash)	%	8.00	5.47	7.92	
Coal Price	US$ per ton	47.83	46.84	43.06	46.37
Sale product	Million Ton	1.66	5.41	1.50	8.57
Reject	Million Ton	0.51			
Sale Revenue	**Million US$**	**79.50**	**253.47**	**64.60**	**397.57**
Mining Cost	Million US$	58.12	143.40	39.81	201.51
Crushing cost	Million US$	2.39	8.12	2.14	10.51
Washing cost	Million US$	9.79	-	-	9.79
Reject cost	Million US$	0.51	-	-	0.51
Transportation cost	Million US$	1.33	7.03	1.81	8.36
Barging cost	Million US$	1.99	12.45	4.79	14.44
Transhipment cost	Million US$	1.83	5.95	1.65	7.78
Blending cost	Million US$	-	-	0.23	-
Royalty	Million US$	4.16	12.45	3.45	16.60
					-
Admin & Sale cost	Million US$	3.17	9.74	3.71	12.91
Site support	Million US$	6.35	10.82	5.48	17.17
Total cost	**Million US$**	**89.65**	**209.95**	**63.07**	**362.67**
Gross Profit Margin	**Million US$**	**(10.14)**	**43.52**	**1.53**	**34.90**

Table A-6: Blending alternative no 6

BLENDING ALTERNATIVE 6					
Plan : Blend Sebuku 5000 Jembayan 5200					
Cost Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total**
Sebuku Blending Ratio				21%	21%
Coal Quality (CV)	Kcal/Kg	5,600	5,615	5,209	
Coal Quality (Ash)	%	8.00	5.34	7.96	
Coal Price	US$ per ton	47.83	47.96	44.49	45.96
Sale product	Million Ton	1.08	2.67	5.00	8.75
Reject	Million Ton	0.33			
Sale Revenue	**Million US$**	**51.53**	**128.23**	**222.62**	**402.38**
Mining Cost	Million US$	37.67	70.85	132.81	108.52
Crushing cost	Million US$	1.55	4.01	7.09	5.56
Washing cost	Million US$	6.35	-	-	6.35
Reject cost	Million US$	0.33	-	-	0.33
Transportation cost	Million US$	0.86	3.48	5.98	4.34
Barging cost	Million US$	1.29	6.15	16.45	7.44
Transhipment cost	Million US$	1.19	2.94	5.50	4.13
Blending cost	Million US$	-	-	0.75	-
Royalty	Million US$	2.69	6.15	11.51	8.84
					-
Admin & Sale cost	Million US$	2.06	4.81	9.76	6.87
Site support	Million US$	4.11	5.35	13.19	9.46
Total cost	**Million US$**	**58.11**	**103.73**	**203.03**	**364.87**
Gross Profit Margin	**Million US$**	**(6.58)**	**24.49**	**19.59**	**37.51**

Table A-7: Blending alternative no 7

BLENDING ALTERNATIVE 7					
Plan : Blend Sebuku 5000 Jembayan 5400					
Cost Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total**
Sebuku Blending Ratio				24%	24%
Coal Quality (CV)	Kcal/Kg	5,600	5,404	5,325	
Coal Quality (Ash)	%	8.00	5.55	8.01	
Coal Price	US$ per ton	47.83	46.16	45.48	45.56
Sale product	Million Ton	0.28	-	8.72	9.00
Reject	Million Ton	0.09			
Sale Revenue	**Million US$**	**13.48**	**-**	**396.57**	**410.05**
Mining Cost	Million US$	9.86	-	231.47	9.86
Crushing cost	Million US$	0.41	-	12.24	0.41
Washing cost	Million US$	1.66	-	-	1.66
Reject cost	Million US$	0.09	-	-	0.09
Transportation cost	Million US$	0.23	-	10.29	0.23
Barging cost	Million US$	0.34	-	29.89	0.34
Transhipment cost	Million US$	0.31	-	9.59	0.31
Blending cost	Million US$	-	-	1.31	-
Royalty	Million US$	0.70	-	20.05	0.70
					-
Admin & Sale cost	Million US$	0.54	-	16.09	0.54
Site support	Million US$	1.08	-	21.58	1.08
Total cost	**Million US$**	**15.20**	**-**	**352.50**	**367.70**
Gross Profit Margin	**Million US$**	**(1.72)**	**-**	**44.06**	**42.34**

Table A-8: Blending alternative no 8

BLENDING ALTERNATIVE 8					
Plan : Blend Sebuku 5000 Jembayan 5600					
Cost Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total**
Sebuku Blending Ratio				25%	25%
Coal Quality (CV)	Kcal/Kg	5,600	5,261	5,480	
Coal Quality (Ash)	%	8.00	5.68	7.96	
Coal Price	US$ per ton	47.83	44.94	46.81	46.10
Sale product	Million Ton	1.20	3.95	3.56	8.72
Reject	Million Ton	0.37			
Sale Revenue	**Million US$**	**57.36**	**177.64**	**166.85**	**401.86**
Mining Cost	Million US$	41.93	104.75	94.64	146.68
Crushing cost	Million US$	1.73	5.93	4.99	7.66
Washing cost	Million US$	7.07	-	-	7.07
Reject cost	Million US$	0.37	-	-	0.37
Transportation cost	Million US$	0.96	5.14	4.19	6.10
Barging cost	Million US$	1.44	9.09	12.39	10.53
Transhipment cost	Million US$	1.32	4.35	3.92	5.67
Blending cost	Million US$	-	-	0.53	-
Royalty	Million US$	3.00	9.09	8.20	12.09
					-
Admin & Sale cost	Million US$	2.29	7.12	7.22	9.40
Site support	Million US$	4.58	7.91	10.17	12.48
Total cost	**Million US$**	**64.68**	**153.37**	**146.25**	**364.30**
Gross Profit Margin	**Million US$**	**(7.32)**	**24.27**	**20.60**	**37.55**

Table A-9: Blending alternative no 9

BLENDING ALTERNATIVE 9					
Plan : Blend Sebuku 5200 Jembayan 5000					
Cost Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total**
Sebuku Blending Ratio				25%	25%
Coal Quality (CV)	Kcal/Kg	5,600	5,484	5,087	
Coal Quality (Ash)	%	8.00	5.47	8.00	
Coal Price	US$ per ton	47.83	46.84	43.45	46.38
Sale product	Million Ton	1.57	5.41	1.62	8.60
Reject	Million Ton	0.49			
Sale Revenue	**Million US$**	**75.12**	**253.47**	**70.40**	**398.99**
Mining Cost	Million US$	54.91	143.40	43.02	198.31
Crushing cost	Million US$	2.26	8.12	2.27	10.38
Washing cost	Million US$	9.25	-	-	9.25
Reject cost	Million US$	0.49	-	-	0.49
Transportation cost	Million US$	1.26	7.03	1.90	8.29
Barging cost	Million US$	1.88	12.45	5.63	14.33
Transhipment cost	Million US$	1.73	5.95	1.78	7.68
Blending cost	Million US$	-	-	0.24	-
Royalty	Million US$	3.93	12.45	3.73	16.37
					-
Admin & Sale cost	Million US$	3.00	9.74	3.89	12.74
Site support	Million US$	6.00	10.82	5.83	16.82
Total cost	**Million US$**	**84.70**	**209.95**	**68.29**	**362.95**
Gross Profit Margin	**Million US$**	**(9.58)**	**43.52**	**2.11**	**36.04**

Table A-10: Blending alternative no 10

BLENDING ALTERNATIVE 10					
Plan : Blend Sebuku 5200 Jembayan 5200					
Cost Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total**
Sebuku Blending Ratio				27%	27%
Coal Quality (CV)	Kcal/Kg	5,600	5,615	5,246	
Coal Quality (Ash)	%	8.00	5.34	8.01	
Coal Price	US$ per ton	47.83	47.96	44.81	46.09
Sale product	Million Ton	0.80	2.82	5.22	8.84
Reject	Million Ton	0.25			
Sale Revenue	**Million US$**	**38.47**	**135.17**	**233.73**	**407.37**
Mining Cost	Million US$	28.12	74.69	138.52	102.81
Crushing cost	Million US$	1.16	4.23	7.26	5.39
Washing cost	Million US$	4.74	-	-	4.74
Reject cost	Million US$	0.25	-	-	0.25
Transportation cost	Million US$	0.64	3.66	6.08	4.31
Barging cost	Million US$	0.97	6.48	18.62	7.45
Transhipment cost	Million US$	0.88	3.10	5.74	3.98
Blending cost	Million US$	-	-	0.78	-
Royalty	Million US$	2.01	6.48	12.00	8.49
					-
Admin & Sale cost	Million US$	1.54	5.07	10.02	6.61
Site support	Million US$	3.07	5.64	13.94	8.71
Total cost	**Million US$**	**43.38**	**109.35**	**212.95**	**365.68**
Gross Profit Margin	**Million US$**	**(4.91)**	**25.82**	**20.77**	**41.69**

Table A-11: Blending alternative no 11

BLENDING ALTERNATIVE 11					
Plan : Blend Sebuku 5200 Jembayan 5400					
Cost Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total**
Sebuku Blending Ratio				22%	22%
Coal Quality (CV)	Kcal/Kg	5,600	5,404	5,360	
Coal Quality (Ash)	%	8.00	5.55	7.47	
Coal Price	US$ per ton	47.83	46.16	45.78	46.04
Sale product	Million Ton	0.80	1.63	6.40	8.84
Reject	Million Ton	0.25			
Sale Revenue	**Million US$**	**38.47**	**75.37**	**293.09**	**406.93**
Mining Cost	Million US$	28.12	43.27	169.93	71.39
Crushing cost	Million US$	1.16	2.45	9.04	3.61
Washing cost	Million US$	4.74	-	-	4.74
Reject cost	Million US$	0.25	-	-	0.25
Transportation cost	Million US$	0.64	2.12	7.62	2.77
Barging cost	Million US$	0.97	3.76	21.34	4.72
Transhipment cost	Million US$	0.88	1.80	7.04	2.68
Blending cost	Million US$	-	-	0.96	-
Royalty	Million US$	2.01	3.76	14.72	5.77
					-
Admin & Sale cost	Million US$	1.54	2.94	12.15	4.47
Site support	Million US$	3.07	3.27	16.32	6.34
Total cost	**Million US$**	**43.38**	**63.35**	**259.13**	**365.86**
Gross Profit Margin	**Million US$**	**(4.91)**	**12.02**	**33.96**	**41.07**

Table A-12: Blending alternative no 12

BLENDING ALTERNATIVE 12					
Plan : Blend Sebuku 5200 Jembayan 5600					
Cost Item	**Unit**	**SEBUKU**	**JEMBAYAN**	**BLEND**	**Total**
Sebuku Blending Ratio				29%	29%
Coal Quality (CV)	Kcal/Kg	5,600	5,261	5,496	
Coal Quality (Ash)	%	8.00	5.68	7.94	
Coal Price	US$ per ton	47.83	44.94	46.94	46.15
Sale product	Million Ton	1.05	3.95	3.77	8.76
Reject	Million Ton	0.32			
Sale Revenue	**Million US$**	**50.03**	**177.64**	**176.76**	**404.43**
Mining Cost	Million US$	36.57	104.75	100.00	141.32
Crushing cost	Million US$	1.51	5.93	5.21	7.44
Washing cost	Million US$	6.16	-	-	6.16
Reject cost	Million US$	0.32	-	-	0.32
Transportation cost	Million US$	0.84	5.14	4.35	5.98
Barging cost	Million US$	1.26	9.09	13.79	10.35
Transhipment cost	Million US$	1.15	4.35	4.14	5.50
Blending cost	Million US$	-	-	0.56	-
Royalty	Million US$	2.61	9.09	8.66	11.71
					-
Admin & Sale cost	Million US$	2.00	7.12	7.52	9.11
Site support	Million US$	3.99	7.91	10.75	11.90
Total cost	**Million US$**	**56.41**	**153.37**	**154.99**	**364.77**
Gross Profit Margin	**Million US$**	**(6.38)**	**24.27**	**21.76**	**39.65**

APPENDIX B: Sensitivity Study

Table B-1: Sensitivity of Coal Price and Oil Price of Original Plan 2016 (M.US$)

2016 Original plan (Million US$)	Sensitivity of Coal Price										
Sensitivity of Oil Price	-50%	-40%	-30%	-20%	-10%	0%	10%	20%	30%	40%	50%
50%	(174.52)	(134.96)	(95.41)	(55.85)	(16.30)	23.26	62.81	102.37	141.92	181.48	221.03
40%	(172.42)	(132.87)	(93.31)	(53.76)	(14.20)	25.35	64.91	104.46	144.02	183.57	223.13
30%	(170.33)	(130.77)	(91.22)	(51.66)	(12.11)	27.45	67.00	106.56	146.11	185.67	225.22
20%	(168.23)	(128.68)	(89.12)	(49.57)	(10.01)	29.54	69.10	108.65	148.21	187.76	227.32
10%	(166.14)	(126.58)	(87.03)	(47.47)	(7.92)	31.64	71.19	110.75	150.30	189.86	229.41
0%	(164.04)	(124.49)	(84.93)	(45.38)	(5.82)	**33.73**	73.29	112.84	152.40	191.95	231.51
-10%	(161.95)	(122.40)	(82.84)	(43.28)	(3.73)	35.83	75.38	114.94	154.49	194.05	233.60
-20%	(159.86)	(120.30)	(80.75)	(41.19)	(1.64)	37.92	77.47	117.03	156.58	196.14	235.69
-30%	(157.76)	(118.21)	(78.65)	(39.10)	0.46	40.01	79.57	119.12	158.68	198.23	237.79
-40%	(155.67)	(116.11)	(76.56)	(37.00)	2.55	42.11	81.66	121.22	160.77	200.33	239.88
-50%	(153.57)	(114.02)	(74.46)	(34.91)	4.65	44.20	83.76	123.31	162.87	202.42	241.98

Table B-2: Sensitivity of Coal Price and Oil Price of Blending Process Alternative 7 (M.US$)

Scenario 7 (Million US$)		Sensitivity of Coal Price										
		-50%	-40%	-30%	-20%	-10%	0%	10%	20%	30%	40%	50%
Sensitivity of Oil Price	50%	(173.00)	(133.35)	(93.69)	(54.03)	(14.38)	25.28	64.94	104.59	144.25	183.91	223.56
	40%	(169.44)	(129.78)	(90.13)	(50.47)	(10.81)	28.84	68.50	108.16	147.81	187.47	227.13
	30%	(165.95)	(126.29)	(86.64)	(46.98)	(7.32)	32.33	71.99	111.65	151.30	190.96	230.62
	20%	(162.54)	(122.88)	(83.22)	(43.57)	(3.91)	35.74	75.40	115.06	154.72	194.37	234.03
	10%	(159.20)	(119.54)	(79.89)	(40.23)	(0.57)	39.08	78.74	118.40	158.05	197.71	237.37
	0%	(155.94)	(116.28)	(76.63)	(36.97)	2.69	**42.34**	82.00	121.66	161.31	200.97	240.63
	-10%	(152.75)	(113.10)	(73.44)	(33.78)	5.87	45.53	85.19	124.84	164.50	204.16	243.81
	-20%	(149.64)	(109.99)	(70.33)	(30.67)	8.98	48.64	88.30	127.95	167.61	207.27	246.92
	-30%	(146.61)	(106.95)	(67.29)	(27.64)	12.02	51.67	91.33	130.99	170.65	210.30	249.96
	-40%	(143.65)	(103.99)	(64.34)	(24.68)	14.98	54.63	94.29	133.95	173.60	213.26	252.92
	-50%	(140.77)	(101.11)	(61.45)	(21.80)	17.86	57.52	97.17	136.83	176.49	216.14	255.80

VITA

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