Proposed Solution to Optimize Production Cost in Fulfilling Domestic Market Obligations
(Study Case: Coal Mining Company in Indonesia)

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Abstract

A coal-mining and trading company in Indonesia annually fulfills the demand for Domestic Market Obligations for the public interest power generation industry. The Ministry of Energy and Mineral Resources policy for coal entrepreneurs in Indonesia mandates that Indonesian coal producers meet 25 percent of the annual production plan for the domestic market. This policy has set the selling price of coal for the power generation industry for public use at $70 per metric ton. Indonesian coal business owners must follow the policy if they do not want to be banned from export. Due to higher production costs than the set selling price, this policy is hazardous to the company's bottom line. Losses in the company can be reduced through actions taken by the company. Based on root cause analysis using the Current Reality Tree method, the planning of coal blending was found to be ineffective. Since the user still plans the coal blending using intuition and the user's limited knowledge of methods that can optimize these activities. As a result, companies can reduce production costs by optimizing these plans. The linear programming method is used to solve the problem because it can minimize production costs by allocating the amount of coal mixed from the nine coal types available at the company and considering the buyer's quality requirements. After implementing the linear programming method, the total production cost is optimize and meets all product specifications required by the buyer.

Keywords
Blending Plan, Coal Industry, Domestic Market Obligations, Linear Programming

1. Introduction
Coal is one of the fossil fuels widely used for production processes such as the power generation industry, the cement industry, and other industries. Coal is in demand by businesspeople because of its affordable price, abundant availability, and high heat content. Based on data from BP's Statistical Review of World Energy 2021, the total world coal consumption globally reached 151.42 exajoules in 2020. Coal consumption continues to increase yearly, and the post-pandemic world economic recovery is also one of the causes of growing world coal demand. The high demand for coal has led to increased coal prices since 2021 because many countries are experiencing a coal supply crisis, so coal commodity prices have increased dramatically. The high cost of coal commodities benefits Indonesian coal mining companies that carry out export activities and take advantage of this momentum to increase their export sales. However, on the other hand, Indonesian coal companies must meet domestic coal needs, namely Domestic Market Obligations. Referring to the Decree of the Minister of Energy and Mineral Resources of the Republic of Indonesia 139.K.HK.02/MEM.B/2021 concerning the Fulfillment of Domestic Coal Needs, it is regulated that Indonesian coal companies must first fulfill a Domestic Market Obligation (DMO) of 25% of the planned annual production (general

electricity and non-general electricity) which the government approves. There are provisions regarding the selling price of coal for power generation industries for the public interest, which is USD 70/MT for Freeboard (FOB) Vessels with a calorific value specification of 6,322 kcal/kg GAR, total moisture 8%, total sulfur 0.8%, and ash 15%. Indonesian coal companies suffer losses in meeting Domestic Market Obligations due to the high total cost of production to meet the DMO compared to the selling price, which is too low. Indonesian coal companies must comply with the Domestic Market Obligation policy if they do not want to be subject to sanctions such as fines and a ban on coal export activities. Suppose the company does not address these losses. In that case, they will impact the company's business continuity, so it is necessary to optimize the total production costs to reduce the losses experienced by the company.

1.1 Objectives

This study aims to reduce the losses experienced by one of the Indonesian coal mining companies by optimizing the total production costs to meet the demand for Domestic Market Obligations. This research will focus on minimizing production costs while prioritizing the buyer's desired coal quality. The results of this study are expected to help companies in reducing losses.

2. Literature Review

There are several factors that related in controlling cost in coal company if company does not suffer a loss are product quality, operational, production cost, price, and inventory. Product quality is the essential key for buyers in making decisions because customers want to buy if the products offered have good quality. The company can increase its profitability by increasing customer satisfaction to make customers repeat orders in the future. One way to increase customer satisfaction is to provide quality products according to their wishes. Coal companies have various types of coal, which are grouped based on their quality specifications because usually, the coal is used according to its quality. So, to utilize coal, the quality must first be known. This is because machines or equipment that utilize coal have their specifications. In addition, coal also varies greatly both vertically and horizontally. Due to a large amount of variability, it is necessary to parameterize the quality of coal to facilitate its utilization. In designing machines that use coal as fuel, they must adjust to the quality of the coal so that the machines used can last a long time (Komariah, 2012). As is known, coal generally consists of hydrogen, carbon, oxygen, nitrogen, and sulfur. Then some elements are contained in small amounts in coal, namely tin, and mercury. These two elements will cause air pollution when coal is burned. In meeting the demands of various buyers, company must carry out a process of changing the quality of coal to meet the buyer's desired product specifications. Blending process must be carried out effectively and efficiently to minimize production costs. Theoretically the parameters of the quality of the mixture can be seen in **Equation (1).**

$$KB_c = \frac{(KB1 \times PB1)+(KB2 \times PB2)+\dots +(KBn \times PBn)}{PB_c} \qquad \dots(1)$$

Where:
KB = Coal Quality Parameter
KB_c = Coal Quality Parameters of Blending
PB = Coal Tonnage
PB_c = Coal Tonnage of Blending ($PB_1 + PB_2 + \dots + PB_n$)

Production costs are costs incurred by the company during the manufacturing or management process with the aim of producing products to be sold. Production costs can be used as the cost of goods sold. According to Wiratna (2016), the cost of goods sold are all costs incurred to obtain goods sold or the cost of goods sold. Cost of goods sold is very important to calculate because this figure is the cost incurred by the company to produce coal with the desired specifications. In determining the selling price or buying price of coal for domestic and export needs, PT XYZ refers to the Coal Reference Price (HBA) issued by the Government of Indonesia through the Ministry of Energy and Mineral Resources. This Reference Price is determined based on the international market, so the government routinely issues the Reference Coal Price monthly using US Dollars per Ton. Inventory is the number of company-owned products ready to be traded. The primary function of inventory is to ensure meeting a demand for products according to consumer needs to increase company sales. The essential part of the inventory is to increase the profitability of the company. Inventory must be planned and controlled effectively and efficiently. The procurement of inventory must be considered because it is directly related to the costs incurred by the company to produce it. For some companies, a safe inventory policy is to have large amounts of inventory. Still, this will lead to high costs for storing and purchasing the materials or goods in question. At the same time, excess inventory will also cause a lot of funds to be absorbed in

inventory, making it inefficient. Inventories that are too low will risk a shortage of materials or goods. This will disrupt the production process; besides that, the purchase costs and inventory costs are also getting bigger (Siagian, 2005).

3. Methods

The research was conducted by identifying the business issues that occurred in the company and then developing a conceptual framework. The conceptual framework guides in systematically explaining the theories used in solving problems. After knowing the factors involved in business issues, root cause analysis is conducted using the Current Reality Tree method to find the root causes. It is known the root cause of is current planning of the coal blending process is not optimal, so the next step is to overcome the root cause by using a linear programming optimization method to optimize the planning of blending coal to reduce the company's production costs while still considering the quality specifications desired by the buyer. The linear programming method is suitable to solve problem because this method can achieve the desired goal by allocating available resources and is limited by several limitations and requirements that must be met. Linear programming can also be said as a step plan of activities to obtain optimal results, achieving the specified goals in the best way among all possible alternatives (Hillier and Lieberman, 2015). The following is a mathematical model formulation for the coal supply optimization model based on a linear programming model approach: (Table 1)

1. Determine Decision Variables. The decision variable in this coal blending planning optimization model is the quantity of coal supply from each type of product owned by PT XYZ to achieve the quality specifications desired by the buyer. The decision variable is denoted by X_{ij}.
2. Determine Objective Function. The objective function of this coal blending planning optimization model is the minimization of production costs for the coal blending process.

$$\text{Minimize } Z = \sum_{i=1}^{9} \sum_{j=1}^{n} (X_{ij} \cdot B_i) \qquad \dots \textbf{(2)}$$

$X_{ij} \geq 0;$

3. Determine Constraints. Determination of the constraint function is needed because each type of coal i has a different quantity and quality of supply, while buyer j requires coal with a certain quantity and quality of coal. The following are some of the constraint functions used, namely:

   a. Coal Supply. The quantity of coal supplied to the buyer must be less than or equal to the amount capable of providing each type of coal i. Then the function of the limitation for the supply of coal for each type of coal is as follows.

   $$\sum_{j=1}^{n} X_{ij} \leq S_i , i = 1, 2, 3, \dots, 9 \qquad \dots \textbf{(3)}$$

   b. Buyer Demand. The total quantity of coal type i to be supplied to buyer j must be equal to the total demand of buyer j.

   $$\sum_{j=1}^{9} X_{ij} = D_j , j = 1, 2, 3, \dots, n \qquad \dots \textbf{(4)}$$

   c. Calorie Value Buyer. The CV value of each type of coal i that will be carried out in the coal blending process must be greater than or equal to the CV value desired by each buyer. Then the constraint function for the CV value is as follows.

   $$RCV_j \leq \frac{\sum_{i=1}^{9} CV_i X_{ij}}{\sum_{i=1}^{9} CV_{ij}} \leq KCV_j , j = 1, 2, 3, \dots \qquad \dots \textbf{(5)}$$

   d. Total Sulphur Buyer. The sulfur content of the resulting coal blending must be less than or equal to the sulfur content desired by each buyer. Then the constraint function for sulfur content is as follows.

   $$KTS_j \leq \frac{\sum_{i=1}^{9} TS_i x_{ij}}{\sum_{i=1}^{9} x_{ij}} \leq RTS_j , j = 1, 2, 3, \dots \qquad \dots \textbf{(6)}$$

Table 1. Notation for Mathematical Formulation

No	Notation	Symbol	Unit
1	Quantity of coal type (i) to buyer (j)	X_{ij}	MT
2	Price of coal type (i)	P_i	$/CV
3	Supply capacity of coal type (i)	S_i	MT
4	CV value of coal type (i)	CV_i	Cal/g
5	Total sulphur of coal type (i)	TS_i	%
6	Demand of coal from buyer j	D_j	MT
7	CV value of coal needed by the buyer j	KCV_j	Cal/g
8	The minimum CV value of coal accepted by the buyer j	RCV_j	Cal/g
9	Total sulphur of coal needed by the buyer j	KTS_j	%
10	The maximum total sulphur of coal accepted by the buyer j	RTS_j	%

4. Data Collection

Collecting the data is the step to collect require data that related to the research to solve the problem. The data consist of primary data and secondary data as follows: (Table 2)

1. Primary Data. Primary data is data that taken through interviews. The interview aims to collect data that cannot be known in observations, so it needs to be asked directly to respondents. Respondents in this study are head of quality control and head of marketing and sales.
2. Secondary Data. Secondary data is obtained from the company. Secondary data on this research are inputs that will use in this research. Secondary data taken are quantity demand from buyer, type of coal that available, and quantity of coal that available in three periods.

Table 2. Secondary Data for Inputs

Type of Coal	Caloric Value	Total Sulphur	Quantity (MT)	Price ($/CV)
1	4.589	0,40	49.970	$3,62
2	4.586	1,51	129.696	$3,62
3	5.514	0,48	458.140	$3,36
4	6.288	0,55	130.000	$3,18
5	6.301	1,23	440.225	$3,18
6	3.557	1,20	30.000	$3,16
7	3.250	0,20	85.000	$2,01
8	4.000	0,17	35.000	$3,16
9	3.200	0,30	85.000	$2,01

ID Shipment	Contract Qty	Typical		Rejected	
		Caloric Value	Total Sulphur	Caloric Value	Total Sulphur
Buyer 1	48.000	4.450	0,80	4.350	1,00
Buyer 2	7.500	5.000	0,50	4.800	0,70
Buyer 3	48.000	4.600	0,50	4.400	0,90
Buyer 4	8.250	5.000	0,50	4.800	0,70
Buyer 5	52.000	4.450	0,80	4.350	1,00
Buyer 6	55.000	5.000	0,50	4.800	0,70

5. Results and Discussion

Completion of the model solution in this study was carried out using a solver which is an add-in for Microsoft Excel. The following is the result of the composition of coal allocation from each type of product owned by Coal Company to meet the buyer's request based on output from Solver Tool in Microsoft Office.

Table 3. Blending Results with Linear Programming

ID Shipment	Contract Buyer	Typical GAR	Typical TS	Rejected GAR	Rejected TS	1	2	3	4	5	6	7	8	9	Blending Results Total	Blending Results GAR	Blending Results TS	Cost
Buyer 1	48.000	4.450	0,80	4.350	1	0	4702	1531	0	13732	7461	7491	5398	7684	48000	4.450	0,80	$136.972,08
Buyer 2	7.500	5.000	0,50	4.800	0,7	445	1338	955	1270	983	0	116	428	1965	7500	4.800	0,70	$22.363,07
Buyer 3	48.000	4.600	0,50	4.400	0,9	5208	5333	5339	5344	5344	5344	5371	5344	5371	48000	4.586	0,67	$145.456,54
Buyer 4	8.250	5.000	0,50	4.800	0,7	493	1477	1049	1394	1077	0	125	486	2148	8250	4.800	0,70	$24.621,44
Buyer 5	52.000	4.450	0,80	4.350	1	0	5154	1666	0	14847	8049	8108	5850	8325	52000	4.450	0,80	$148.423,01
Buyer 6	55.000	5.000	0,50	4.800	0,7	3990	6489	6984	9305	8430	675	351	2713	16063	55000	5.000	0,66	$161.495,37
Total						10136	24494	17525	17313	44413	21530	21563	20220	41557	218750			$639.331,51

Table 3 shows the blending result if company using Linear Programming in optimized total production cost can meet the buyer's request with the desired quality specifications and low total production costs, which is $639,331.51. For example, buyer 1 wants coal as much as 48,000 MT with GAR specifications in the range of 4,350 cal/g to 4,450 cal/g and total sulfur in the field of 0.8% to 1% and the results of the blending show that the coal will have a calorific value of 4,450 cal/g and sulfur content of 0.8% are same with the contract that has been made. So, it can be said that with the new method, company still fulfill buyer demand based on contract with total production cost that has been optimized.

6. Conclusion

In answering the research question to optimize production cost in meeting the demand for Domestic Market Obligations (DMO) coal, a root cause analysis has been carried out related to the business issue. Thus, this study has produced a production cost minimization model for coal allocation in the coal blending process to meet buyer demands by considering the desired quality specifications, namely the calorific value and sulfur content contained in the coal. From this research, it is obtained an optimization mathematical model that can be used by coal company in planning blending coal to minimize production costs to reduce company losses in meeting DMO requests. The proposed model has been verified and validated to minimize production costs while still meeting the buyer's desired quality specifications. So, it can be concluded is better to use the proposed model because the model that has been designed has been verified and validated to minimize the total production cost while still considering the needs of the buyer in accordance with the allocation and specifications of the desired coal quality. Companies must continue to prioritize customer satisfaction by providing quality coal according to buyer's request and on time.

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Biography

Regita Hawari is student at Master of Business Administration, School of Business Management, Institute Technology Bandung (ITB), Indonesia. She was graduated from Industrial Engineering, Universitas Andalas, Indonesia in 2020 and continue her master at Institute Technology Bandung. She has experience in analized business process in company. Experienced in conducted assessment to view company needs and creating company strategic planning in five years based on company's vision and mission.

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