JURNAL PENDIDIKAN INDONESIA

Jurnal Pendidikan Indonesia
p-ISSN : 2745-7141 e-ISSN : 2746-1920 Vol. 6 No. 1, January 2025

THE FEASIBILITY OF DIVERSIFICATION STRATEGIES ON THE TRANSFORMATION OF COAL MINING COMPANIES INTO MINERAL MINING COMPANIES IN INDONESIA

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INFO ARTIKEL

Keywords: Feasibility; Diversification Strategies; Coal Mining Companies.

ABSTRACT

Following the global commitment on net zero emissions during the Paris Agreement in 2016, Indonesia is fulfilling its commitment by focusing their strategy on electric vehicles batteries investment and decreasing the coal-based power generation. One of the company groups in Indonesia that mainly operating on coal starts to look at green minerals that would increase in demand as a diversification strategy. This study aims to investigate which green mineral options that would be the most feasible strategy for the company through decision-making method. Based on the literature review on business strategy and decision-making method decision tree analysis, a questionnaire was distributed across the internal team of the target company that works on the diversification attempt. The respondents were asked on their confidence on the proposed green mineral options. Analysis on the responses shows that there is a strong, if not perfect, relationship between the confidence scores and all the calculated expected monetary values (EMV) of the proposed green minerals. The analysis also shows that the highest EMV compared to other green mineral option, is gold. On this basis, it is recommended for the company to choose gold as their diversification strategy on green minerals. Further research is needed to investigate other factors that has not been covered in this dissertation, or to investigate through other decision-making method.

INTRODUCTION

The 2016 Paris Agreement is a international treaty on climate change that has been enforced in November 2016. The goal of the treaty is to hold the rising global temperature into 2^0 Celsius above pre-industrial levels. Furthermore, the goal is also to pursue even further the limit of global temperature into 1.5^0 Celsius above pre-industrial levels (United Nations, 2015).

The 2016 Paris Agreement, which 185 parties have ratified, is aimed to combat the climate change such as the accumulation of greenhouse gas emissions. This climate change has global implications, such as higher global temperatures, rising sea levels, increasing variable rainfall affecting people and the environment (Church & Crawford, 2020).

Indonesia is attempting to fulfil its net zero emission commitment can be concluded by its electric vehicle and battery production focus (The Diplomat, 2024) (CSIS, 2022). Thus, it is expected that minerals such as lithium, copper, and nickel would soar (Mining Technology,

2022). It is also expected that bauxite, the ore to be processed as Aluminium, would also play crucial role in low carbon footprint effort (World Bank, 2023).

The global pressure to countries to meet the 2016 Paris Agreement and the increasing interest in electric vehicles has increased the global demand for mineral commodities, such as Nickel and Aluminium. On the other hand, Coal-based power plants in Indonesia are pressured to be decreased due to their tax on the environment (Simangunsong, 2023).

With the objective of Indonesia in fulfilling the 2016 Paris Agreement in mind, one of the company groups in Indonesia aims to take this opportunity to steadily shifting from coal mining activities by building a diversification strategy to green minerals as the first step.

The aim of this dissertation is to find out the feasibility of diversification strategies for a company with a long history of coal mining activity, which is choosing the most appropriate, best prospective green minerals mining to venture into.

The research aims to answer the following questions: 1. To investigate the advantages and disadvantages of green mineral mining options that TC Group is capable of entering. 2. To investigate the most feasible mineral for TC Group through the decision-making analysis as the diversification strategy. 3To investigate the relationship between the confidence of TC Group internal team to the expected monetary value on each mineral. 4 To know the advantages and disadvantages of the used decision-making method in this dissertation.

Many existing literatures discussed the feasibility of establishing a certain mineral mining operation in Indonesia. But not many literatures discussed establishing a mineral mining operation as a group company whose mining operation is heavily reliant on coal.

Furthermore, there is not much literature investigating using decision tree as a methodology through the experts' perception on business strategy, let alone in a mining industry. There are, however, literatures on similar field like the decision-making factors exploration, for example, on energy efficiency projects (Nita, et al., 2023). There are also research using the decision tree as decision-making tools on other field, for example in medical industry (Tsai, et al., 1997). Thus, there is a lack of research for using decision trees in this field.

RESEARCH METHODS

The term research may be traced back to the French word "recherché" which means to survey (Gómez, 2018). However, the term research in academic purposes have different definition across various accounts. Saunders et al. (2019) concluded in their book that research that research is something that people do, through a systematic way, to find out things with a purpose.

From this research may be defined as an activity through the use of scientific and systematic approaches with a purpose to gain a valuable information and understanding of specific area of topic, thereby increasing their knowledge (Anil, 2015) (Gómez, 2018) (Saunders, et al., 2019).

Research methodology is a strategy on how the research will be conducted. It is ideally follows believes, philosophical, and paradigms surrounding on the said research, which helps said research to chosen research techniques and understanding keep consistent and relevant (Melnikovas, 2018).

Research philosophy itself is a system of belief that may be used to develop knowledge. The construction of research methodologies may be aided by the understanding of research onion proposed by Saunders et al. (2019), which philosophy of research may be constructed by layers upon layers, similar to onion.

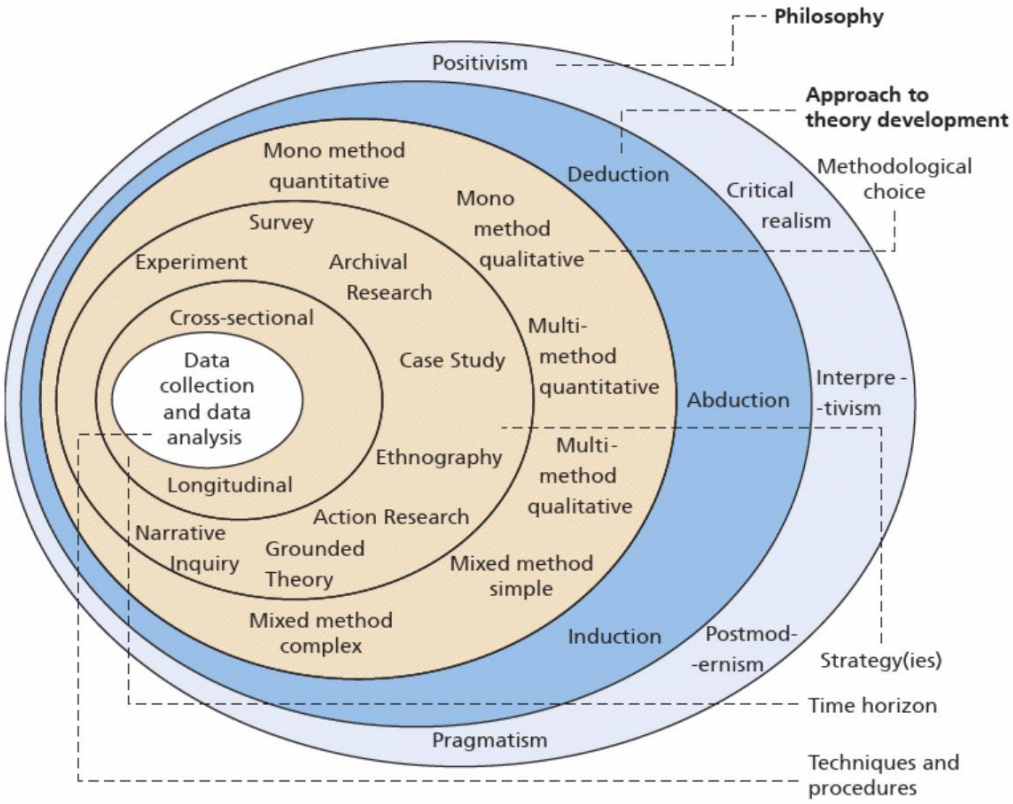

Figure 0.1. Research onion diagram (Saunders, et al., 2019)

The research onion is theoretical concept that constructed research philosophy as the outermost layer, followed by research approach, methodological choice, research strategy, time horizon, and techniques and procedures.

Following the construct of layers, this dissertation has chosen the pragmatism as research philosophy. Pragmatic approach is a philosophy where the research is conducted through method or methods that is best on solving the problem. Pragmatic researcher ignores the debate or discussion on the best method, because pragmatic research realizes each methods have their own unique strength and weaknesses (Alturki, 2021).

Pragmatic research emphasizes on the practical methods. This is supported by the fact that the nature of this research is to give insights and second opinion to firm that in the process of their new investment. Furthermore, one of the aims of this research is to find out how the process on this decision is based on a decision-making framework of decision trees.

On to the second layer of research onion, approach to the theory development, this dissertation has chosen on the abductive approach. Instead of going from theory to data like deduction approach, or the data to theory like inductive approach, the abductive approach will be the most suitable for this dissertation as it is going back and forth between deductive and inductive. This is supported by the fact that Indonesia is aiming for the EV batteries production that works as an early premises for this dissertation.

Furthermore, abductive approach is valued for this reason in management researcher (Saunders, et al., 2019). The abductive approach gives the dissertation a meaning as from the early premises to find the most feasible investment for the firm through the data, and giving recommendations for the firm is alike to those in inductive approach.

On the third layer of research onion, the mono method quantitative will be chosen as the decision tree is the exclusive chosen method for this dissertation as it is simple to use with the appropriate data, have a good accuracy with the probability and uncertainty of the outcome accounted for (Hartono & Putro, 2023). Which the probability is linked to the fourth layer of research onion.

The fourth layer of research onion, which is the strategy in which the chosen strategy is conducted through a survey. Survey research may employ large or small population that will be questioned about certain events. This nature of the strategy will give an idea on complex problems into statistical and non-statistical insights to get a generalization out of those insights (Jha, 2023). This dissertation enacts a strategy where the survey will be conducted on the experts, especially mining experts, of the company group.

The fifth layer of research onion, which is time horizon, the cross-sectional will be chosen. This is by the fact that the nature of the survey itself is cross-sectional (Jha, 2023). Unlike longitudinal research, cross-sectional study observes the characteristic of sample in the shorter period of time while the longitudinal research focuses on the longer period of time.

Furthermore, cross-sectional study does not suffer from time and mortality rate. Cross-sectional study offers merit of the possibility of solution with the time constraint, parallel with the very nature of this dissertation. Since the nature of this dissertation focuses on the best strategy with the current state of the firm in mind, choosing longitudinal research might prove to be an irrelevant strategy

RESULTS AND DISCUSSION

Result

Characteristics of the Respondents

A questionnaire has been handed out to the internal members across TC Group and AIM Company. Each internal member is regarded as an expert in their field, which in this case, is the mining industry. Each of these members have a varying result on their view of each mineral mining, thus resulting in a varying result of the data. First, we look at the characteristics of the respondents.

Respondent ID	Gender*	Age Group**	Employment Level***
A	1	2	2
B	1	3	2
C	1	2	2
D	1	1	1
E	1	3	2
F	1	4	4

Table A. Charasteristics of Respondents

Each respondent is categorized by their gender assigned at birth, age group, and employment level. This is so to see if there are any differences among the respondents, for

example experiences, that may have played a role in their subjective view to explore. While each respondent's gender, age group, and employment level are marked by the number codes as seen as below:

*Gender	Description
1	Male
2	Female
3	Others
**Age Group	Description
1	22-32 years old
2	32-42 years old
3	42-52 years old
4	more than 52 years old
***Employment Level	Description
1	Superintendent and below
2	Managers and equivalents
3	Excecutive officers
4	Board of Directors/shareholders
5	Others/External Stakeholders

Table B. Code numbers on charasteristics of respondents

The research managed to obtain six respondents from the firm. From the characteristics of the respondents, the respondents are all identifies as a male. Out of six respondents, one respondent is in the first age group, which is the 22-32 age group. Two respondents are in the second age group, which is the 32-42 age group. Two respondents are in the third age group, which is 32-42 age group. Lastly, one respondent in the fourth age group, which is more than 52 years old.

From the perspective of the employment level, out of six respondents, four of them are in the managerial position. One respondent is in the position below managerial level, which is the level of superintendent and below.

The research also aimed to obtain the respondent at the level of the executive officers, but the author was unable to obtain the respondent. The research also aimed to obtain the respondent of the external officers, for example, the consulting firm that the firm works with in their feasibility strategy phase. However, the author is also unable to obtain the respondent of the stakeholders.

While the dissertation is unable to obtain the respondent of the level of the executives and external stakeholders, the dissertation managed to obtain the respondent at the level of the board of directors or shareholders, which is the respondent F, that serves as the minor shareholder and previously worked at the firm as an advisory level before retiring recently. With that qualification and experiences, the author deemed the respondent F qualified to become the respondent of this dissertation.

Answers of the Respondents

This dissertation investigates the subjective view of the mining experts in the TC Group and AIM Company on mineral mining. Each respondent answered five questions on the statements on each mineral options that are given in the questionnaire. Each question has answering scale of one-to-five, with five being the highest favorable answer for the statements

given and one being the lowest favorable answer for the statements given. These answers given by the respondents are being averaged to each mineral options, like the figure below:

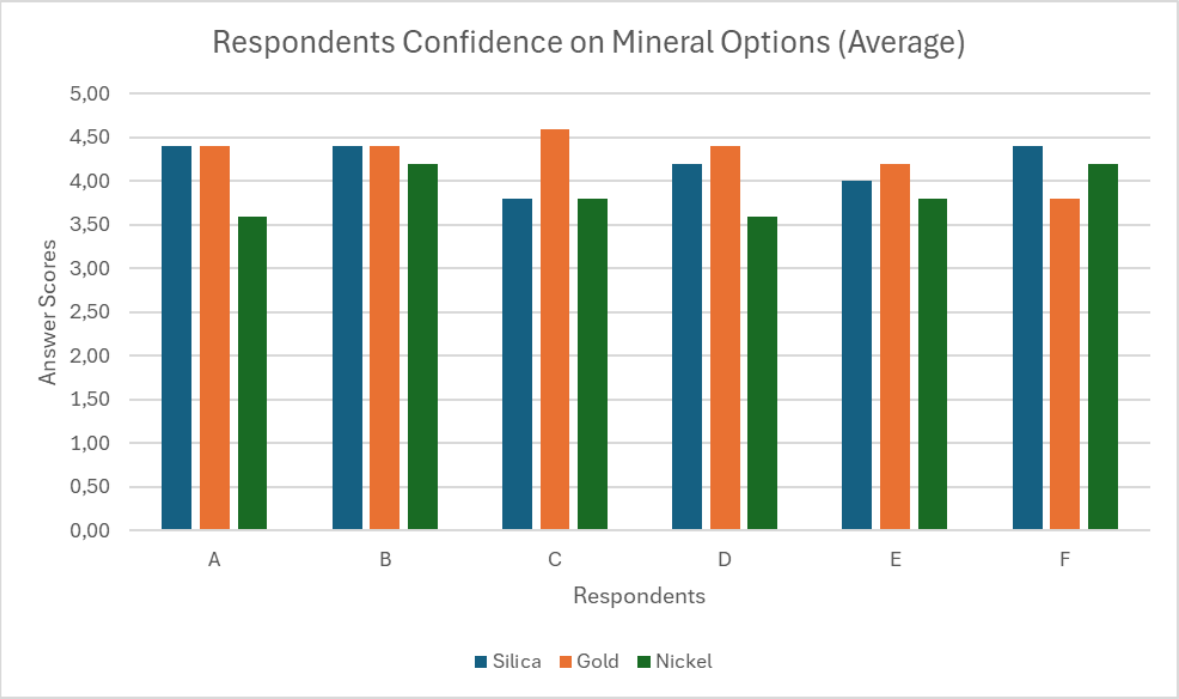

Figure 1 Confidence scores of the respondents

From the chart above, all the respondents have answered that the mineral options, which is silica, gold, and mineral to be favorable. This is due to the fact that all the average scores of the respondents' confidence on all mineral options scores more than three. Furthermore, all the answers submitted by the respondents showed that there are no answers less than three on the scale.

All the responses gathered by the respondents also showed that the mineral gold may prove to be the mineral with most confidence, as three respondents answered that the confidence on mineral gold is higher compared to two other minerals, showed in the answer results of the respondent C, respondent D, and respondent E.

Furthermore, two respondents answered that the confidence on mineral gold is high as the confidence on silica, as answered by the respondent A and respondent B, while the confidence on nickel answered by these two respondents are lower.

On the contrary, respondent F answered slightly differ than the rest of the five respondents. Respondent F answered that the confidence on mineral gold is the lowest compared to the other two mineral options.

From the focus on the nickel mineral options, the nickel mineral options may prove to be the the mineral options with the least confidence. Out of six respondents, four of the respondents answer results shows that the nickel is the lowest confidence compared to the other two minerals, as showed in the chart answer results of respondents A, respondent B, respondent D, and respondent E. respondent C also shows that the nickel is the lowest mineral options with silica mineral options, as low as 3.80 in the confidence score.

Decision Tree Analysis

As mentioned in the previous sub-chapter, the respondents' confidence on each mineral have different subjective view on the matter. The decision tree can be calculated and constructed by the confidence on each mineral option of each respondent.

Another variable to construct the decision tree is the payoff, which will be taken from the answers of the questionnaire on the NPV of each mineral options. All the responses of the respondents on the NPV of each mineral options are uniform, which are $35 million, $190 million, and $69 million, for silica, gold, and nickel, respectively.

Additional variable to construct to the decision tree of this research is to include the differences of good condition and bad condition of the projected mining activities, should they venture into specific mineral options. This is able to be obtained by the respondents answer of the projected production when the company is in good condition and bad condition, on each mineral, in a single year. Each respondent answers on the productions are uniform across the respondent. Each respondents answered the productions on the good and bad conditions are: 1.5 million Mt and 0,6 million Mt, respectively for mineral silica; 100,000 ounces and 50,000 ounces, respectively for mineral gold; and 20,000 Ton Ni and 14,000 Ton Ni, respectively for mineral nickel. These projected productions are assumed to be proportional to the NPV. With the information above, we can construct the decision tree of each respondent as follows:

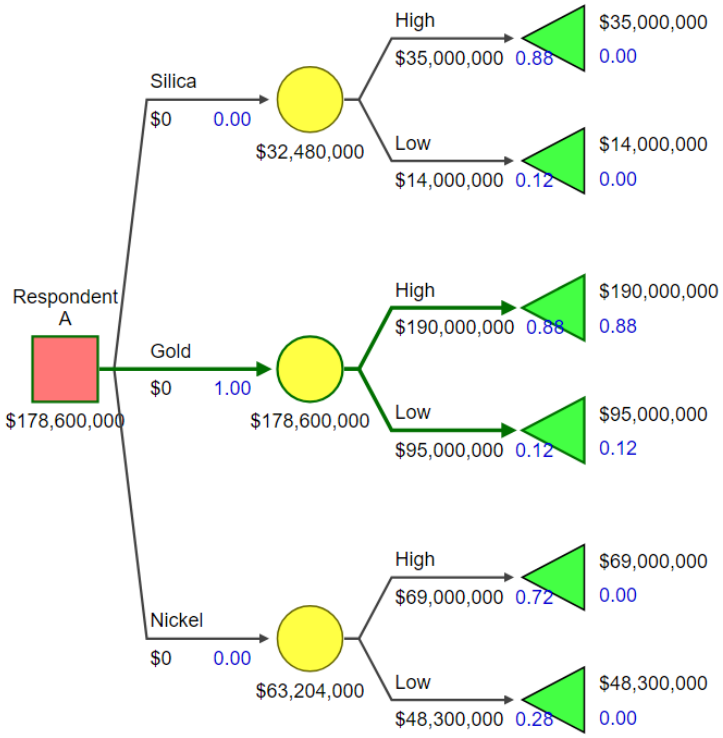

Figure 2 Constructed decision tree on Respondent A

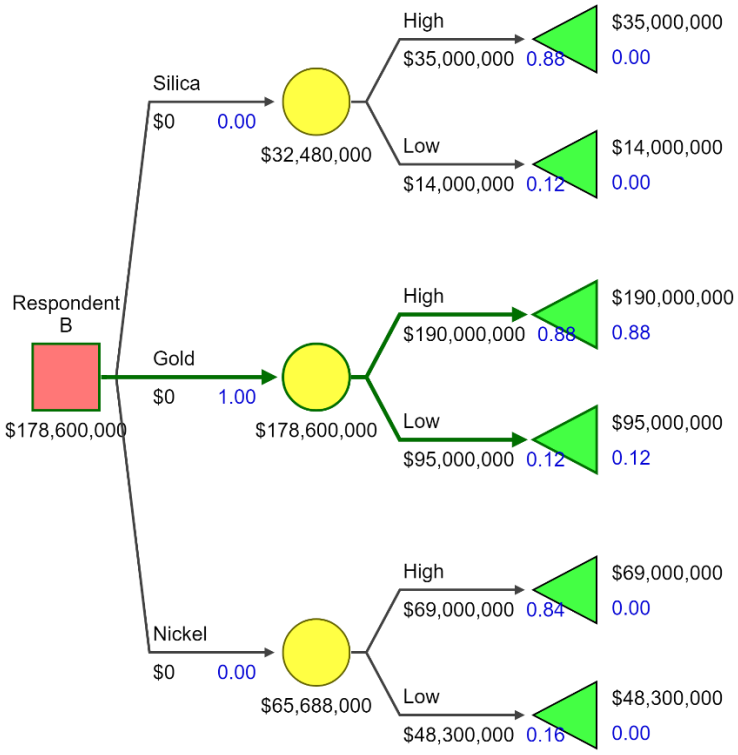

Figure 3 Constructed decision tree on Respondent B

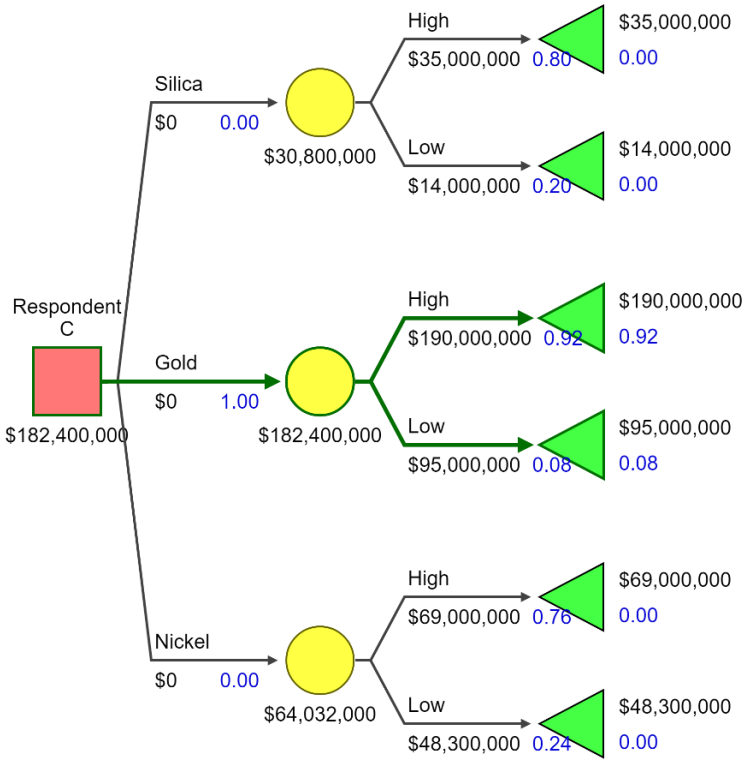

Figure 0 Constructed decision tree on Respondent C

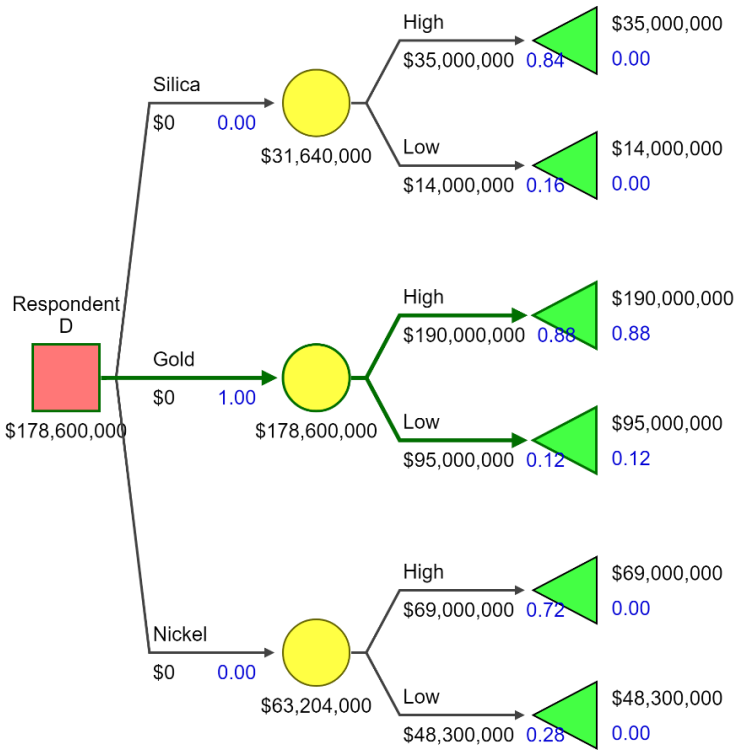

Figure 5 Constructed decision tree on Respondent D

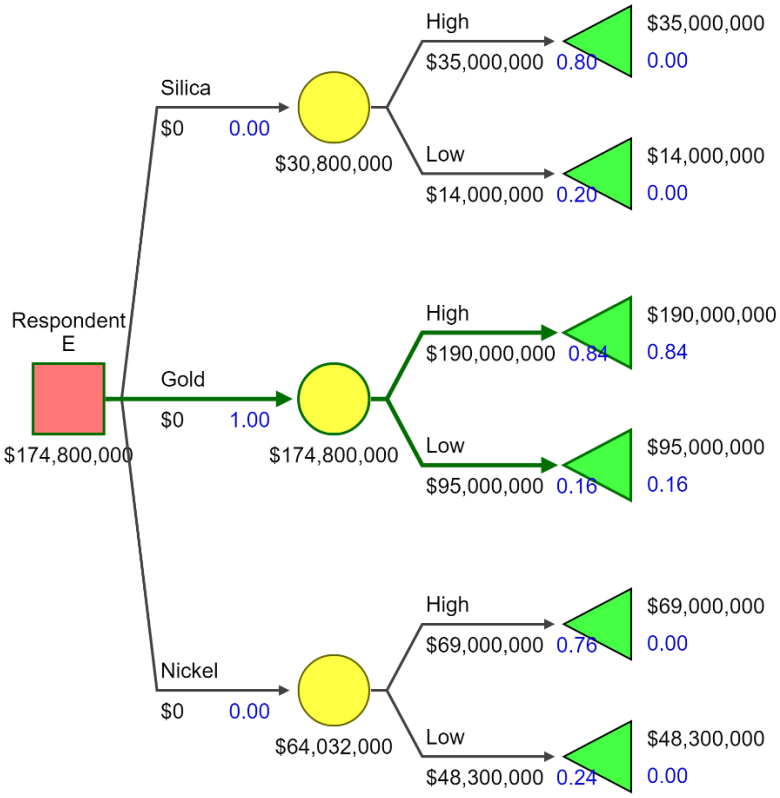

Figure 6 Constructed decision tree on Respondent E

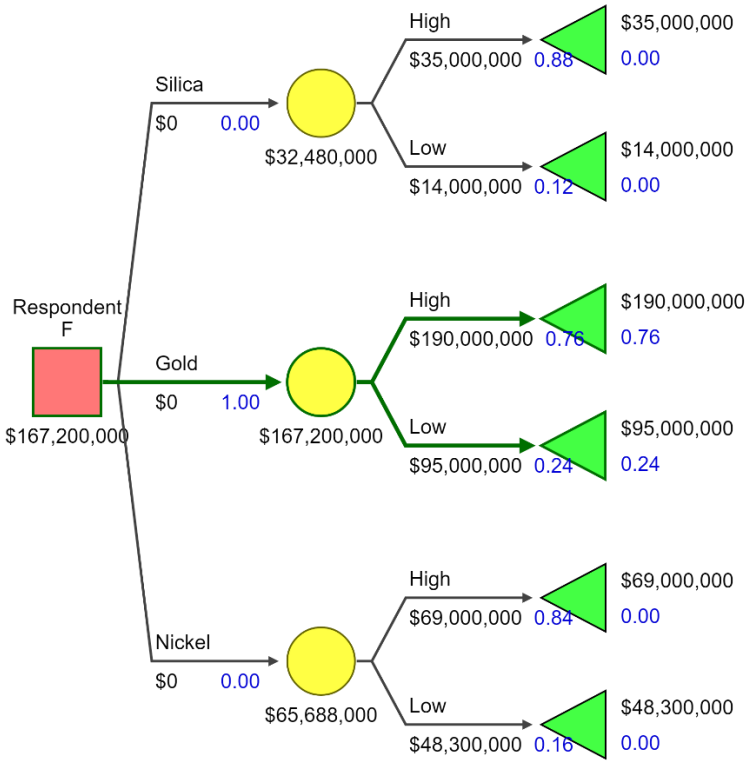

Figure 7 Constructed decision tree on Respondent F

All the decision trees in the figure above are constructed through the online software Silver Decisions. As mentioned in the previous chapter of literature review, expected monetary value (EMV) is calculated by the probability of each option and their respective payoffs.

In this research, the probability of each option is taken from the expert confidence on each mineral option, and the payoffs in the decision tree are taken from the expected NPV or net present value of each mineral option taken from the answers of the respondent in the questionnaire. Thus, in this research, the expert's confidence on each mineral options to their respective NPVs are used as the calculation basis.

Since there are both EMV on assumed good condition and bad condition on each mineral options (which denoted as high and low, respectively in the figure), both EMVs are summed to get the weighted EMVs of each mineral options. The good condition payoffs are assumed to be the NPV of each mineral option, while the bad condition payoffs are taken from the ratio of the good and bad projected production of each mineral. Then both EMVs are determined from which out of these EMVs has the highest amount as the most feasible strategy.

As can be seen by the constructed decision trees, the highest EMV of three mineral options out of each respondent showed to be the mineral gold option. The highest EMV of mineral option gold is shown by the respondent D, with the amount reaching $184 million. Respondent A, respondent B, and respondent D showed the second highest amount of mineral gold EMV with the amount of $178 million. Respondent E showed the second lowest amount of gold EMV with the amount of $174 million. Respondent F showed the lowest amount of mineral gold EMV compared to other respondents, with as much as $167 million.

On the contrary, the lowest amount of EMV out of three mineral options across the respondent showed to be the silica mineral option. The lowest EMV of silica mineral options are shown by the confidence results of the respondent C and respondent E, with the amount as low as $30 million. Followed by the confidence result of respondent D, with the amount of $31 million. The confidence result of respondent A, respondent B, and respondent F shows the highest EMV of silica mineral options, with the amount of $32 million.

While mineral gold options and mineral silica showed as the highest and the lowest EMV value among the respondent, the mineral nickel options show as the middle value between the other two minerals options. The lowest EMV of nickel was shown to be the result of the respondent A and respondent D, with the EMV amount of $63 million. While the highest EMV of nickel is shown by the result of the respondent B and respondent F.

Regression Analysis

Following the decision tree analysis done in the previous sub-chapter, this dissertation also carried out the regression analysis on the independent variable and the dependent variable used in this research. The regression analysis in this research is used to see the relationship between the dependent variable and the independent variable, which how close both variables are.

As mentioned in the previous chapter, the dependent variable in this research is the EMV of the respective mineral options. On the other hand, the independent variable in this research is the respondents' confidence in the respective mineral options.

The regression analysis table is constructed through the software of Microsoft Excel, with the regression result for the variables are shown below. Three regression analyses were done in this research, for each mineral option. There are three tables constructed, the first table shows the regression statistics, the second table shows the significance of the data, and the third table shows the coefficient of two variables.

The regression statistics table shows the fit of the data, which denoted by the letter R. This shows the fit or the strength of the linear relationship between two variables, also known as the Pearson correlation coefficient value, with the range value of negative 1 to positive 1. The value of negative 1 show that the variables have total negative correlation, the value of 0 shows no correlation, and the value of positive 1 shows the total positive correlation (Williams, et al., 2020). The regression statistics table also shows the R^2, also known as the coefficient of determination. This coefficient shows the variance of the dependent variable can be accounted for by the independent variable (Peter, 2021). The regression statistics table also shows the number of observations, this is referring to the amount of data used in the test, which in this case is six due to the data used in this research came from the six respondents.

The second table shows analysis of variance (ANOVA). It shows the significance of the data and denoted on the table as "significance F". This value shows the reliability of the hypotheses and helps in the decision whether a hypothesis has relationship between two variables or not. The hypothesis is accepted as having linear relationship between two variables when the value is less then 0.05, and no linear relationship is accepted when the value is more than 0.05.

The third table shows the coefficient table, which is to help draw the linear equation between the independent variables and the dependent variables. Where there are the intercept value, and the independent variables of experts confidence (Peter, 2021).

Regression Statistics	
Multiple R	1
R Square	1
Adjusted R Square	1
Standard Error	9,05616E-10
Observations	6

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	5,6448E+12	5,64E+12	6,88E+30	1,26657E-61
Residual	4	3,28056E-18	8,2E-19		
Total	5	5,6448E+12			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*
Intercept	14000000	6,73401E-09	2,08E+15	3,21E-61	14000000
Confidence	21000000	8,00459E-09	2,62E+15	1,27E-61	21000000

Table 3 Regression statistics on mineral option silica

Regression Statistics	
Multiple R	1
R Square	1
Adjusted R Square	1
Standard Error	8,46956E-09
Observations	6

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1,3718E+14	1,37E+14	1,91E+30	1,64064E-60
Residual	4	2,86934E-16	7,17E-17		
Total	5	1,3718E+14			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*
Intercept	95000000	5,91807E-08	1,61E+15	9,04E-61	95000000
Confidence	95000000	6,86972E-08	1,38E+15	1,64E-60	95000000

Table 4 Regression statistics on mineral option gold

Regression Statistics	
Multiple R	1
R Square	1
Adjusted R Square	1
Standard Error	1,17434E-10
Observations	6

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	6,39878E+12	6,4E+12	4,64E+32	2,78697E-65
Residual	4	5,5163E-20	1,38E-20		
Total	5	6,39878E+12			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*
Intercept	48300000	7,44705E-10	6,49E+16	3,39E-67	48300000
Confidence	20700000	9,60983E-10	2,15E+16	2,79E-65	20700000

Table 5 Regression statistics on mineral option nickel

This chapter serves as the continuation of the previous chapter, which is to discuss further the findings mentioned. This chapter also discusses whether the hypotheses mentioned in the second chapter are accepted or not based on the discussion in the fourth chapter.

As also mentioned in the second chapter, there are two types of hypotheses generated in the conceptual framework and hypotheses sub-chapter, which the first type of hypotheses is whether there is relationship between the independent variables and the dependent variables on the mineral silica, mineral gold, and mineral nickel.

The second type of hypotheses is whether one of mineral options will be deemed as the most feasible strategy through the analysis of the decision trees done in the previous chapter of analysis and findings.

Confidence on EMV Hypothesis Discussions

Hypothesis 1 (H_1) Discussion

Hypothesis H_1 is to investigate whether there is a positive linear relationship between the experts' confidence in silica and the expected monetary value on silica. As mentioned, the EMV of the mineral option silica serves as the dependent variable and the respondents confidence score serves as the independent variable.

As shown in the regression statistics table of the silica, the Pearson correlation coefficient, or denoted in the table as "Multiple R", shows that the value is 1. A value approaching 1 is considered as a strong, if not perfect relationship between the variables. Thus, the value of 1 in regression statistic of mineral option silica indicates strong strength, a 100% correlation between the variables.

Furthermore, if we look at the coefficient of determination, denoted as R^2, is calculated by square the value of R. Thus, the coefficient value is the range between 0 and 1. The value of 0 indicates that the independent variable is not correlated with the dependent variable. On the contrary, the value given in the regression statistic table of the mineral option silica is 1. It indicates that the value is perfect fit. Theoretically, the value of 1 also indicates the independent variable allows errorless prediction on the dependent variable.

On the second table, which is the ANOVA table, the significance of the data, which is the probability of the regression data model is wrong, may prove that the hypothesis is accepted or not whether the value of the Significance F is lower than 0.05 (the confidence is set at 95%). The value is significantly low, to the extent of 1.2 to the power of negative 61, making it have extremely low probability.

On the third table, the regression equation table, we can look at the two important things on the table. First, we can look at the coefficient of the confidence (the independent variable), which the value is positive, also indicates a positive relationship to the dependent variable. Second, we can also see that the P-value is significantly low, valued at 1 to the power of negative 61. This is extremely lower than the 0.05 from the 95% confidence. This shows that the significant value of the coefficient of independent value, or the probability of the coefficient is irrelevant.

From the analysis and discussion done above, it can be concluded that the independent variable of expert confidence on silica is having a linear relationship with the dependent variable of expected monetary value of silica. Thus, the hypothesis H_1 is accepted.

Hypothesis 2 (H_2) Discussion

Hypothesis H_2 is formulated similarly to hypothesis H_1, which is to investigate whether there is a positive linear relationship between the experts' confidence in silica and the expected monetary value on silica. However, hypothesis 2 investigates the same relationship on mineral gold. The EMV of the mineral option silica serves as the dependent variable and the respondents confidence score serves as the independent variable.

As shown in the regression statistics table of the mineral gold, the Pearson correlation coefficient, also shows that the value is 1. A value approaching 1 is considered as a strong relationship between the variables. Thus, the value of 1 in regression statistic of mineral option gold indicates strong strength relationship between the variables.

If we look at the coefficient of determination, the value of coefficient of determination of mineral gold option is1. It indicates that the value is perfect fit, like the silica option. Theoretically, the value of 1 also indicates the independent variable allows errorless prediction on the dependent variable.

Moving on to the ANOVA table, the significance of the data, which is the probability of the regression data model is wrong, may prove that the hypothesis is accepted or not whether the value of the Significance F is lower than 0.05. The value of the Significance F is 1.6 to the power of negative 61, making it the probability of data being incorrect is extremely low.

Focusing on the regression equation table, we can look at the two important things on the table. First, we can look at the coefficient of the confidence (the independent variable), which the value is positive, also indicates a positive relationship to the dependent variable. We can also see that the P-value is 1 to the power of negative 60, extremely lower than the 0.05 from the 95% confidence set.

From the analysis and discussion done above, it can be concluded that the independent variable of expert confidence on gold has a strong linear relationship with the dependent variable of expected monetary value of gold. Thus, the hypothesis H_2 is accepted.

Hypothesis 3 (H_3) Discussion

Hypothesis H_3, similar to hypothesis H_1 and H_2, is to investigate whether there is a positive linear relationship between the expert's confidence in nickel and the expected monetary value on nickel. The H_3 uses the EMV of the mineral option silica serves as the dependent variable and the respondents confidence score serves as the independent variable.

First, we look at the regression statistics table of the mineral option nickel, the Pearson correlation coefficient also shows that the value is 1, same value as the Pearson correlation

coefficient value of mineral silica and mineral gold. A value approaching 1 is considered as a strong relationship between the variables. Thus, the value of 1 in regression statistic of mineral option nickel indicates 100% correlation on the dependent variables.

Moving on to the ANOVA table, the significance of the data, which is the probability of the regression data model is wrong, may prove that the hypothesis is accepted or not whether the value of the Significance F is lower than 0.05. The value of the Significance F is 2.8 to the power of negative 65, making it the probability of data being incorrect is extremely low.

Focusing on the regression equation table, we can look at the two important things on the table. First, we can look at the coefficient of the confidence (the independent variable), which the value is positive, also indicates a positive relationship to the dependent variable. We can also see that the P-value is 2.7 to the power of negative 65, lower than the 0.05 from the 95% confidence set.

From the analysis and discussion done above, it can be concluded that the independent variable of expert confidence on nickel has a strong linear relationship with the dependent variable of expected monetary value of nickel. Thus, the hypothesis H_3 is accepted.

Feasible Minerals Hypothesis Discussions

As stated in the previous chapter, the calculated EMV of each mineral is accounted from the probability of each mineral, and the payoffs of both hypothetical good condition and bad condition. The probability of each mineral is taken from the respondents' confidence score, which is calculated from the answers of the respondents on their subjective view of the silica mineral. On the other hand, the payoffs of both hypothetical good condition and bad condition are taken from each respondent answer on the projected production per year, on good condition and bad condition.

There are assumptions being made in the calculation process. The first assumption was that the projected production is assumed to be constant throughout the lifetime of mining activity. The second assumption was that the answer of NPV of each mineral was proportional to the projected production. The third assumption that the expected NPV answers across the respondents was assumed to be the good condition payoff.

Hypothesis 4 (H4) Discussion

Hypothesis H_4 seeks to investigate whether mineral option silica, would be the most feasible strategy. This research also investigates alternative minerals comparatively with are mineral gold and mineral nickel.

First, we look at the constructed decision trees across six respondents. The confidence of mineral option silica for each respondent varied. Three out of six respondents have confidence score of 88%, while the other three respondents have insignificantly lower confidence score of 76%, 80%, and 84%.

The projected production and the expected NPV value of mineral option silica across the respondents are uniform, which all respondents suggest that the projected production of mineral option silica for hypothetical good condition and bad condition was 1.5 million Mt and 0.6 million Mt, respectively. Furthermore, all the respondents answered $35 million in rough approximation as the expected NPV.

The calculation of EMV of each respondent was taking the respondents' confidence score and the payoffs of both hypothetical conditions into account. The calculated EMV from each respondent was in the range of $30 million at the lowest and $32 million at the highest. The value of EMV of mineral option silica was the lowest in comparison with the other two mineral options. Thus, through the decision tree analysis, the hypothesis H_4 is rejected.

However, if we investigate other factors, such as qualitative factors, the respondents were asked on their opinion on benefit of venturing into mineral silica as diversification strategy

through the questionnaire. The respondents answered that mineral silica was one of the essential materials used in the production of photovoltaic cells, or commonly known as solar panels. This is consistent with study that shows high purity silica is essential towards the production of photovoltaic cells (Prasetyo, et al., 2023). Other answer of the benefits of the venturing into silica mentioned was that the silica mine is the least amount of capital required, citing approximate $60 million; another benefit was Indonesia is potentially high in silica deposit.

On the other hand, there are some challenges should the company venture into silica mine. Respondents answered that silica mining is a new industry in Indonesia, mining licenses are limited, the midstream and downstream value chain is still underdeveloped. Another challenge was that the risk of substitution, as one of the respondents answered that there are risk of silica being material of photovoltaic cells is being replaced with other materials.

Hypothesis 5 (H_5) Discussion

Hypothesis H_5 seeks to investigate whether mineral option gold, would be the most feasible strategy. This research also investigates alternative minerals comparatively with mineral silica and mineral nickel.

From the constructed decision trees on gold, the confidence of mineral option gold for each respondent varied. Three out of six respondents have a confidence score of 88%, while the other three respondents have insignificantly lower confidence scores of 76%, 84%, and 92%.

The projected production of mineral option gold across the respondents are uniform, which all respondents suggest that the projected production of mineral option gold for hypothetical good condition and bad condition was 100,000 ounces and 50,000 ounces, respectively. Furthermore, the respondents' answer on the expected NPV on mineral option gold also uniform across the respondents, which all the respondents answered $190 million in rough approximation.

The calculated EMV from each respondent varied, with valued at $167 million at the lowest and $182 million at the highest. The value of EMV of mineral option gold was the highest in comparison with the other two mineral options, across all respondents. Thus, through the decision tree analysis, the hypothesis H_5 is accepted as the most feasible mineral option.

Even though the gold mineral option has the highest value of EMV out of all mineral options, there are some benefits and challenges. For example, the respondents' answers on the benefit of venturing into mineral gold stated that gold is an attractive industry, due to the market stability and the high commodity prices.

However, the challenges of venturing into gold are not benign. Respondents' answers cited the challenges where the opportunity of gold mine is limited due to lack of exploration. This is supported by reports published that gold exploration phase took many years, as much as 12-16 years (Internal Energy Agency, 2021) (Manalo, 2023). Aside from the long exploration duration, capital required for venturing into gold is also extremely high, the highest among three mineral options, citing approximately $350 million, making the idea of venturing into gold mine as a high-risk investment.

Hypothesis 6 (H_6) Discussion

Hypothesis H_6 seeks to investigate whether mineral option nickel, would be the most feasible strategy. This research also investigates alternative minerals comparatively with other mineral options, which are mineral silica and mineral gold.

Focusing on the constructed decision trees across six respondents, the confidence of mineral option nickel for each respondent varied. Among six respondents, each pair of respondents have confidence scores on silica of 72%, 76%, and 84%.

The projected production and the expected NPV value of mineral option nickel across the respondents are uniform, which all respondents suggest that the projected production of mineral option silica for hypothetical good condition and bad condition was 20,000 Ton Ni and 14,000 Ton Ni, respectively. Furthermore, all the respondents answered that the expected NPV of nickel in rough approximation was $69 million.

The calculated EMV from each respondent varied, with each pair resulting in a value of $62 million at the lowest and $65 million at the highest. The value of EMV of mineral option gold was the highest in comparison with the other two mineral options, across all respondents.

In conclusion, through the decision tree analysis, the hypothesis H_6 is rejected as the most feasible mineral option, as the highest calculated EMV belongs to the mineral option gold.

Nickel mining as a diversification strategy poses benefits and threats. One of the benefits of venturing into nickel mining, as the respondents suggest, Indonesia is one of the countries with the highest nickel deposit, in parallel with the report that Indonesia is the highest nickel extractor according to published report (Internal Energy Agency, 2021). Furthermore, nickel is also one of the essential materials for EV industry, making it attractive mineral to venture.

In contrast, the threat of venturing into nickel poses, comes in the form of finding the suitable partner for nickel processing is limited. As one answer suggests, class 1 nickel is required for EV production. Class 1 nickel is purity grade with more than 99.8% purity (Campagnol, et al., 2017). Furthermore, acquisition on nickel mine is deemed expensive

CONCLUSION

This chapter aims to see the dissertation in full view, concluding its results and further discussion that has not been covered in the previous chapters. This chapter also aims to discuss the research, such as the limitations emerged on doing the research, and recommendations on possible future research in filling the gaps on said limitations.

BIBLIOGRAPHY

Alturki, R., 2021. Research Onion for Smart IoT-Enabled Mobile Applications. Scientific programming, 7 September, 2021(1), pp. 1-9.

Anderson, D., Sweeney, D., Williams, T. & Wisniewski, M., 2009. An Introduction to Management Science: Quantitative Approaches to Decision Making. 1st ed. London: Cengage Learning.

Anil, J., 2015. Use of Research Methodology in Research: An Overview. The Social Onlooker, Volume 2, p. 44.

Ayandibu, A. & Houghton, J., 2017. External Forces Affecting Small Businesses in South Africa: a Case Study. A Journal of the Academy of Business and Retail Management Research (JBRMR), 11(2).

Campagnol, N., Hoffman, K., Lala, A. & Ramsbottom, O., 2017. The Future of Nickel: A Class Act. Mckinset Quarterly, November.

Campbell, D., Stonehouse, G. & Houston, B., 2022. Business Strategy: an Introduction. 2 ed. New York: Routledge.

Church, C. & Crawford, A., 2020. Minerals and the Metals for the Energy Transition: Exploring the Conflict Implications for Mineral-Rich, Fragile States. The Geopolitics of the Global Energy Transition, 10 June, 73(1), pp. 279-304.

Clark, W. A. V. & Deurloo, M. C., 2005. Categorical Modeling/Automatic Interaction Detection. In: K. Kempf-Leonard, ed. Encyclopedia of Social Measurement. New York: Elsevier, pp. 251-258.

Clement, R. T., 1996. Making Hard Decisions: Introduction to Decision Analysis. 2nd ed. Belmont Calif: Duxbury Press.

CSIS, 2022. Indonesia's Battery Industrial Strategy. [Online] Available at: https://www.csis.org/analysis/indonesias-battery-industrial-strategy [Accessed 17 April 2024].

David, F. R. & David, F. R., 2017. Strategic Management: A Competitive Advantage Approach, Concepts and Cases, Sixteenth Edition. Florence: Pearson.

Esmaeili, R., Shakerian, M. & Yazdi, M., 2024. Decision-Making in Project and Operations Management. In: M. Yazdi, ed. Progressive Decision-Making Tools and Applications in Project and Operation Management. Sydney: Springer Nature, pp. 32-48.

Garbarino, S. & Holland, J., 2009. Quantitative and Qualitative Methods in Impact Evaluation and Measuring Results. [Online] Available at: https://www.gsdrc.org/docs/open/eirs4.pdf

Gómez, J. M., 2018. Modernizing the Academic Teaching and Research Environment Methodologies and Cases in Business Research. Cham: Springer.

Hammond, D. R. & Brady, T. F., 2022. Critical Minerals for Green Energy transition: a United States Perspective. International Journal of Mining, Reclamation and Environment, 36(9), pp. 624-641.

Hartono, Y. & Putro, U. S., 2023. ANALISIS KEPUTUSAN PEMILIHAN PROSPEK PENGEBORAN STEP OUT DI LAPANGAN BAMBU TERBANG, Bandung: Magister Bisnis dan Administrasi - Teknologi.

Herbst, M., 1998. Henry Mintzberg's The Rise and Fall of Strategic Planning. Tertiary Education and Management, 4(2), pp. 153-157.

Hussein Almuallim, S. K. Y. A., 2022. Development and Applications of Decision Trees. In: Expert Systems, The Technology of Knowledge Management and Decision Making for the 21st Century. Burlington: Academic Press, pp. 53-77.

Internal Energy Agency, 2021. The Role of Critical Minerals in Clean Energy Transitions, Paris: IEA.

Islam, M. M., Sohag, K., Mamman, S. O. & Herdhayinta, H., 2024. Response of Indonesian mineral supply to global renewable energy generation: Analysis based on gravity model approach. Geoscience Frontiers, 15(4), p. 101658.

Jha, A., 2023. Social Research Methodology: Qualitative and Quantitative Designs. 1st ed. London: Routledge India.

Jonsson, E. et al., 2023. Critical metals and minerals in the Nordic countries of Europe: diversity of mineralization and green energy potential. In: The Green Stone Age: Exploration and Exploitation of Minerals for Green Technologies. s.l.:Geological Society of London.

Kamiński, B., Jakubczyk, M. & Szufel, P., 2018. A Framework for Sensitivity Analysis of Decision Trees. Central European Journal of Operations Research, 26(1), pp. 135-159.

Kesler, S. E., Chryssoulis, S. L. & Simon, G., 2002. Gold in porphyry copper deposits: its abundance and fate. Ore Geology Reviews, 21(1), pp. 103-124.

Leonidou, L. C., Christodoulides, P., Kyrgidou, L. P. & Palihawadana, D., 2018. Internal Drivers and Performance Consequences of Small Firm Green Business Strategy: The Moderating Role of External Forces. Journal of Business Ethics, 8 May, 140(3), pp. 585-606.

Maceika, A., Bugajev, A., Šostak, O. R. & Vilutienė, T., 2021. Decision Tree and AHP Methods Application for Projects Assessment: a Case Study. Sustainability, 14 May, 13(10), p. 5502.

Manalo, P., 2023. Discovery to Production Averages 15.7 Years for 127 Mines. [Online] Available at: https://www.spglobal.com/marketintelligence/en/news-insights/research/discovery-to-production-averages-15-7-years-for-127-mines

Mazhar, S. A., Anjum, R., Anwar, A. I. & Khan, A. A., 2021. Methods of Data collection: a Fundamental Tool of Research. Journal of Integrated Community Health (ISSN 2319-9113), 14 June, 10(1), pp. 6-10.

Melnikovas, A., 2018. Towards an Explicit Research methodology: Adapting Research Onion Model for Futures Studies. Journal of Futures Studies, 23(2), pp. 29-44.

Mining Technology, 2022. Concerns for mineral supply chain amid booming EV sales. [Online]
Available at: https://www.mining-technology.com/features/concerns-for-mineral-supply-chain-amid-booming-ev-sales/?cf-view
[Accessed 17 April 2024].

Mintzberg, H., 1987. The Strategy Concept I: Five Ps for Strategy. California Management Review, 30(1), pp. 11-24.

Navada, A., Ansari, A. N., Patil, S. & Sonkamble, B. A., 2011. Overview of Use of Decision Tree Algorithms in Machine Learning. s.l., s.n., pp. 37-42.

Nita, A., Sunitiyoso, Y., Tiara, A. R. & Kim, A. A., 2023. Exploring decision making factors in public buildings' energy efficiency projects. Energy and Buildings, 298(1), p. 113563.

Peter, M., 2021. Linear regression: an introduction to statistical models. 1st ed. London: SAGE Publications Ltd.

Podgorelec, V., Kokol, P., Stiglic, B. & Rozman, I., 2002. Decision Trees: An Overview and Their Use in Medicine. Journal of Medical Systems, October, 26(5), pp. 445-463.

Prasetyo, A. B. et al., 2023. Fabrication of high purity silica precipitates from quartz sand toward photovoltaic application. Journal of Ceramic Processing Research, February, 24(1), pp. 103-110.

Ramadan, M., Amer, T., Salah, B. & Ruzayqat, M., 2022. The Impact of Integration of Industry 4.0 and Internal Organizational Forces on Sustaining Competitive Advantages and Achieving Strategic Objectives. Sustainability, 11 May, 14(10), p. 5841.

Rothaermel, F. T., 2017. Strategic Management. 3e ed. Georgia Institute of Technology: McGraw-Hill.

Saunders, M., Lewis, P. & Thornhill, A., 2019. Research Methods for Business Students. 8th ed. Harlow: Pearson Education.

Schiro, J. J., 2006. External Forces Impacting the Insurance Industry: Threats From Regulation. The Geneva Papers on Risk and Insurance - Issues and Practice, 31(1), pp. 25-30.

Shamim, A., Hussain, H. & Shaikh, M. U., 2010. A Framework for Generation of Rules from Decision Tree and Decision Table. 2010 International Conference on Information and Emerging Technologies, ICIET 2010, June.

Simangunsong, T., 2023. FairPlanet. [Online]
Available at: https://www.fairplanet.org/story/indonesia-coal-fossil-fuel-clean-energy-transition/
[Accessed 19 August 2024].

The Diplomat, 2024. Indonesia Announces New Tax Incentives to Encourage EV Sales. [Online]
Available at: https://thediplomat.com/2024/02/indonesia-announces-new-tax-incentives-to-encourage-ev-sales/#:~:text=Indonesia's%20aims%20are%20ambitious%3A%20President,first%20half%20of%20this%20year.
[Accessed 17 April 2024].

Trench, A., Baur, D., Ulrich, S. & Sykes, J. P., 2024. Gold Production and the Global Energy Transition—A Perspective. Sustainability, 16(14), p. 5951.

Tsai, Y. S. et al., 1997. An expert-guided Decision Tree Construction strategy: an Application in Knowledge Discovery with Medical Databases. s.l., s.n., pp. 208-212.

United Nations, 2015. The Paris Agreement. [Online] Available at: https://www.un.org/en/climatechange/paris-agreement [Accessed 16 August 2024].

Williams, B. et al., 2020. Data-Driven Model Development for Cardiomyocyte Production Experimental Failure Prediction. In: 30th European Symposium on Computer Aided Process Engineering. s.l.:Elsevier, pp. 1639-1644.

Wolf, V., Dobrucka, R., Przekop, R. & Haubold, S., 2021. An Exemplary Approach to Measure an Innovation Strategy with a questionnaire-based Business Survey in SMEs. Innovations, 9(2), pp. 43-47.

World Bank, 2023. Cost-competitive, low-carbon aluminum is key to the energy transition. [Online]
Available at: https://blogs.worldbank.org/en/energy/cost-competitive-low-carbon-aluminum-key-energy-transition#:~:text=Energy%20for%20All-,Cost%2Dcompetitive%2C%20low%2Dcarbon%20aluminum%20is,key%20to%20the%20energy%20transition&text=Metal%20industry%20worker.&text=It%
[Accessed 17 April 2024].

Yananto, H., Putro, U. S. & Sunitiyoso, Y., 2019. A Literature Review of Multi Conflicting Decision Making in State-Owned Oil & Gas Business Development. Bandung, Unit Penerbitan Universitas Teknologi MARA Cawangan Kelantan, pp. 244-253.

You, Z. et al., 2015. A Decision-Making Framework for Precision Marketing. Expert Systems with Applications, 42(7), pp. 3357-3367.

Zaku, A. & Uysal, F., 2022. Decision Tree Analysis in Project Risk Management: A Systematic Review. Amman, s.n.