

Effects of Business and Supply Chain Uncertainty to Business Sustainability in Indonesian Coal Industry: An Exploratory Study

Firman Risqul Fidry¹, Iwan Vanany² and Jerry Dwi Trijoyo Purnomo¹

¹*Interdisciplinary School of Management and Technology, Institut Teknologi Sepuluh Nopember Surabaya, Indonesia*

²*Industrial and Systems Engineering Department, Institut Teknologi Sepuluh Nopember Surabaya, Indonesia*

Keywords: Coal Business Sustainability, Business Uncertainty, Supply Chain Uncertainty.

Abstract: There has been a significant paradigm shift with increasing awareness of environmental sustainability. It discusses the issue of carbon emissions produced by burning fossil fuels. Besides the uncertainty of energy needs related to fossil energy, there is also an unstable supply chain. These factors significantly influence the business sustainability of the coal mining industry in Indonesia one of the largest coal-producing countries in the world. Indicators of business sustainability for the coal industry include economic, social, and environmental aspects. This research examines the uncertainty of the coal business and supply chain regarding coal business sustainability (CBS), especially thermal coal and thermal coal supply in Indonesia. This research uses a qualitative exploratory method. There are interviews and data analysis on two companies engaged in the coal business. The research will reveal the factors that affects Indonesian CBS. The right solution will be obtained, especially supply chain capabilities in upstream process efficiency due to the uncertainty of the coal business going forward.

1 INTRODUCTION

There have been works of literature that deeply discuss the issue of sustainability in companies (van Kleef & Roome, 2007). However, there is still a limited analysis of the attitude of entrepreneurs, especially in Supply Chain (SC) activities in actual and stated activities for sustainable business models (Paulraj, Chen, & Blome, 2017).

Entrepreneur behavior usually reflects operational activities, especially in business processes and value chains. The supply chain is a structured grouping of activities with the core company as the center connected with others to support it (Sauer & Seuring, 2017).

Mining operations stages require reliable supply chain sustainability. In other words, the supply chain facilitates the coal cycle (Ding, Wang, & Zhang, 2021). Mine supply chain management (MSCM) is not only about the implementation process but is also related to analyzing planning, scheduling, and evaluating all activities of the entire SC process in the strategic, tactical, and operational fields.

The complexity of the coal supply chain is the main topic of several supply chain concepts like the Sustainable Supply Chain (SSC). However, many

parties in the coal supply chain also pose a high risk of uncertainty (Peng, Tian, Zhang, Zhang, & Wang, 2020); (Wibowo & Pujawan, 2018).

The negative economic impacts of climate change accompanied by the rapid depletion of natural capital remain a significant problem for industrial performance in many countries.

It is for their extreme vulnerability to climate change and resource-based economics (Klemeš, Varbanov, Walmsley, & Foley, 2019). The world's energy needs increase year by year. According to the World Energy Agency (International Energy Agency-IEA), by 2030 world energy demand will increase by 45% or an average increase of 1.6% per year.

Population growth affects energy needs, where fossil energy is still at the top of the table (80%), and the rest is met by non-fossil fuels (Tanaka, 2011). Such conditions indicate a high level of uncertainty in the coal business going forward.

This will affect the sustainability of the coal business. According to (John, 1998) sustainability consists of three principles: social, economic, and environmental. They aim to meet current and future human needs by maintaining environmental quality.

These principles constitute the triple bottom line (TBL).

(Stock & Seliger, 2016) suggested that Industry 4.0 has great potential in responding to the need for sustainable industrial value in the TBL. Next, the Sustainability Business Model (SBM) includes TBL and considers other stakeholders besides the environment and society (Bocken, Short, Rana, & Evans, 2014).

2 LITERATURE REVIEW

Some studies have discussed business sustainability and supply chain with an approach to environmental issues. There are not many authors that explore business sustainability against business and supply uncertainties, especially in the thermal coal industry in Indonesia.

(Bocken et al., 2014) and (Bichueti, Gomes, Kneipp, & Da Rosa, 2015) discussed controlling GHG emissions to minimize investment. (K. Muduli & Barve, 2013) and (Mathiyazhagan, Diabat, Al-Refaie, & Xu, 2015)) studied Green supply chain management (GSCM) to improve organizational environmental performance through cost savings.

However, they did not talk about business sustainability going forward. (Mathiyazhagan et al., 2015) proposed a new multi-objective model in closed-loop supply chain problems integrated with lot sizes while simultaneously considering lean, agility, and sustainability factors.

(Li, Xiang, & Qu, 2016) conducted meteorological, pandemic, and economic analyses of the macro-economy to mitigate potential losses in the mining and agriculture industries. (K. K. Muduli et al., 2020) analyzed the relationship between organizational behavior and green supply chain management (GSCM) performance. (Aguirre-Villegas & Benson, 2017) also conducted research on supply chain sustainability in terms of environmental aspects using the Life Cycle Analysis (LCA) analysis approach on the coal industry in Indonesia.

This research tries to determine the parameters of return on energy investment. It also aims to reveal the uncertainty factors in the coal business sustainability, especially in the supply chain context with indicators of business growth, profits, and net zero emission.

3 RESEARCH DESIGN

The conceptual framework is the uncertainty between demand and supply. Demand uncertainty usually occurs due to business uncertainty, while the uncertainty may be due to some external factors.

Meanwhile, supply uncertainty is generally related to the supply chain coming from internal factors. The business and supply chain uncertainties are the variables that determine the uncertainty of the thermal coal business in Indonesia.

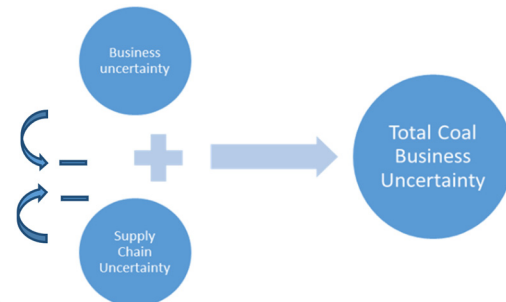


Figure 1: Conceptual framework.

Figure 1 shows that the uncertainty of the coal business influences its sustainability. The variables with sufficient influence include the instability of a country's political conditions, low global and national economic growth, restrictions on the use of fossil energy, a high number of pandemic victims in consumer countries, and frequent changes in government policies regarding permits and taxes on coal commodities.

The second influential factor in the uncertainty of the coal business is the supply chain. There are some interesting variables for research, including the decreasing reserves of thermal coal in Indonesia and the decreasing quality of thermal coal with a calorific value of coal above 4000 Kal/gr (GAR).

Some issues like low availability of access to coal and the availability of transportation, and a high amount of capital in investment financing strategies in the coal business trigger higher profitability sensitivity in the coal industry. The large investment value causes higher fixed costs in the cost structure of the coal business and inefficiency of the mining operational activities.

Those lead to higher production costs. These two factors encourage the unsustainability of the coal business in the future. Therefore, it is necessary to conduct a study to obtain a coal business model that can withstand these risks, especially the supply chain strategy based on disruptions or changes in the coal business.

3.1 Research Methods

This is an exploratory qualitative study (Shamsuddoha, 2015). It aims to determine business sustainability factors in the Indonesian thermal coal industry. This research methodology is based on efforts to carry out research stages to achieve research objectives. The methodology includes some case studies at some supply chain echelons (Babacinesami, Tohidi, & Seyedaliakbar, 2021).

They include suppliers, producers, and users of the coal commodity. There are also direct interviews with key actors in the coal mining industry supply chain. There are some case studies on the three companies that are directly experiencing uncertainty both from a business and supply chain perspective. The data are obtained from the companies' internal data and several sources outside the companies (Emberson, Storey, Godsell, & Harrison, 2006).

The primary data are interview results from several companies' internal sources (Aguirre-Villegas & Benson, 2017) with a minimum position of the general manager. The two data sources above complement and confirm each other. In the end, the purpose is to conclude the factors that influence coal business sustainability (CBS).

The results of interviews with several respondents need to be validated in this study. The validation method used is the source triangulation method. This method compares information obtained several different sources based on standardized source rules. Some sources used are the results of interviews with several respondents who have been determined, among others, current information from observations (Table 3) and information from respondents. Information from respondents compared with observational data (Table 3). The combination of observational data and interview results gives confident in research regarding the level of data validity. Observational data based on time series of business uncertainty and coal supply chain in the previous period. The interview data validated by the observation data above.

3.2 Data Collection

The data are from primary and secondary sources. The primary sources are the interview results from two companies. Meanwhile, the secondary ones are from internal and previous studies. The primary data is conducted through direct interviews with some informants from the supply chain and businesses in the coal industry.

The interviews are open-ended with exploratory questions so that the results are detailed and consistent. The table below presents the informants' profiles:

Table 1: Informants' profiles.

	Case 1	Case 2
Position	Director	General Manager
Working duration	>15 years	> 15 years
Education	Master/S2	Master/S2

There is a systematic interview protocol to guide the researcher to stay focused and make it easier to conduct interviews with the respondents. The interview protocol contains questions about the importance of business sustainability, business uncertainty effects, and supply chain uncertainty effects.

3.3 Case Profiles

The respondents come from the companies involved in the coal supply chain. They are the companies with private ownership status that have Mining Business Permits and Mining Service Business Permits. The three companies produce for a production target of over 100 million BCM per year with coal production of over 15 million.

Table 2: Case Profile.

No	Profiles	Case 1	Case 2
1	Business Portfolio	Mining Services	Mining Services & producer
2	Commodity	OB & Coal	OB & Coal
3	Production (Million BCM)	729,5	178,56
4	Total asset (USD Mio)		435.85
5	Firms Scale	Big	Big
6	Employees	>10.000	10.000-5000
7	Ownership	Private	Private
8	Position	General Manager	Director

The production capacity classifies the level of a large company. They have more than 5.000 employees. The respondents have working

experience more than 15 years with different positions, including directors and general managers. Table 2 displays the details of the case profiles.

business sustainability must be seen as a solution to the problems currently faced by the business world amid the disruptions at global and national levels.

3.4 Case Analysis

This section discusses some factors and variables that influence business sustainability. Business sustainability is interesting to study. The concept of

Table 3: Business and supply chain uncertainty factors.

Business Uncertainty	Description	Author(s)
1. Political instability	Political stability, economic stability, stakeholder pressure, competition, energy transition, and regulations.	Wan Ahmad, W.N.K
2. Low global and national economic growth	The economic slowdown will lead to a decrease in energy demand and prices	Correljé and van der Linde, 2006
3. Renewable Energy	Top management support, teamwork, workplace culture, resistance to change, green innovation, and green motivation.	Muduli K.K et al. (2020)
4. Effects of the Covid 19 Pandemic	Local response to the covid-19 pandemic resulted in a drastic drop in energy demand	IMF. World Economic Outlook, 2020
5. Government Policy	These policy uncertainties, along with the rising sentiment of resource nationalism, have resulted in foreign miners selling their operations	Mining in Indonesia Investment and Taxation Guide June 2019,
Supply Chain Uncertainty		
1. Coal reserves	Major sources of uncertainty that were considered are the reserves and the quality of the lignite.	Michael Galetakis (2012)
2. Quality	Eco-geo-environment quality generally has been declining since the development and utilization of coal resources	ZhiYang et al (2019)
3. Transportation model and infrastructure	Improve management of sub-processes in the coal supply chain and reduce costs along the supply chain.	James M. Ekmann et al.(2004)
4. Financing strategy	The expected lifespan of a newly built plant is estimated in carbon pricing scenarios.	Jianlei Mo et al (2021)
5. Operational strategy	to minimize the expected cost to the economy and environment driven by the production capacity (PC) under energy security	QingYang et al (2020)
Coal Business Sustainability		
1. Economical: Market share, profit. 2. Environmental: Carbon footprint	Components of business sustainability, including environmental, social, and governance components, linked to various stakeholders	Rezaee, (2016); Zhao et al., (2021)
3. Growth Index	Businesses can grow in four directions: (1) growth within their current market, (2) sales of new products in their current market, (3) sales of existing products to new markets, and (4) sales of new products to new markets.	Ansoff (1957)

There have been studies on several topics of business sustainability in the mining industry. However, they only discuss more from one side,

namely internal or external. Therefore, there are still research gaps to be studied deeply.

This research tries to make a thorough analysis that combines internal and external factors by considering the risk of some variables in it.

Table 3 presents the details of the variables that were the topic of previous research. Table 3 shows the factors and dimensions of uncertainty as risks from business and supply chain uncertainties. Several variables of business uncertainty include political instability, low global and national economic growth, restrictions on fossil fuels, the COVID-19 pandemic, and uncertainty over government policies.

The supply chain uncertainty starts from declining coal reserves, relatively declining coal quality, the difficulty of access and transportation, errors in coal mining financing schemes, and low work efficiency in mining operations.

The following describes the results of the interviews in case 1 and 2 to find out whether political instability affects coal business sustainability

Case 1: -'political stability in the coal industry is very crucial because we work in areas within political territories of the Head of Territory.

Case 2: - Political stability influences business sustainability, especially the process of changing leaders and changing policies.

Low Global and national economic growth affects coal business sustainability

Case 1: Economic growth is very crucial for our needs, so if we look at a country that has high economic growth, it means that energy needs are high, and the demands for coal are also high. If economic growth is low, the demand will also be low. That is what creates a disruptive relationship in our supply chain

Case 2: As we know, economic growth greatly influences a country's energy needs. Apart from that, fossil and non-fossil energy are currently experiencing significant growth

Renewable Energy affects coal business sustainability.

Case 1: Indeed, it is affected by renewable energy. The renewable energy that will later replace or become very competitive with coal is sunlight. We can see many industries have started to use solar panels. They can be effective and common. There must also be batteries for solar cell.

Case 2: The trend of using renewable energy is indeed increasing especially in 2030. However, until now we still rely on fossil energy, especially coal. The cost constraints of alternative energy are still more expensive than coal.

Case 1: The influence is quite significant. There will be a balance where everyone gets vaccinated, everyone is arrested, and people are all strong.

Case 2: - The covid pandemic which has been running for almost two years has had a huge impact on coal demands, especially at the beginning of the pandemic when almost coal importing countries carried out lockdowns and decreased demands for coal, but this only lasted until the end of 2020.

Government Policy

Case 1: The "less pro" policies towards fossil energy in the future, especially in coal, will also affect business sustainability in the coal industry - Very Important

Case 2: -Government policies towards the use of fossil energy are very far ahead and affect the coal business in the future, where the current government also needs coal revenue.

Table 4: Assessing business, supply chain uncertainty, and sustainable factors.

Business uncertainty factors	Case 1	Case 2	Average	Criteria
1. Unstable Political condition	5	5	5,0	Very Important
2. Low economical growth in national and global	5	5	5,0	Very Important
3. Fossil Fuel restriction	4	3	3,5	Moderate
4. Long Pandemics	3	4	3,5	Moderate
5. Government Policy ambiguity	4	4	4	Important
Supply chain uncertainty factors	Case 1	Case 2	Average	Criteria
1. Coal reserves reduced	5	5	5,0	Very Important
2. Decreased coal quality	4	4	4	Important
3. Low accessibility and transportation	4	4	4,0	Important
4. Low operational efficiency	5	5	5,0	Very Important
Sustainable factors	Case 1	Case 2	Average	Criteria
1. Economics: Market share	5	5	5	Very Important
2. Economics: Profit	4	5	4,5	Important
3. environment: Carbon footprint	4	4	4,0	Important

4 RESULTS AND DISCUSSIONS

The uncertainty score of the supply chain in case 1 and case 2 is higher (4.5) than the score of business uncertainty (4.2) means supply chain uncertainty has a greater risk than business uncertainty.

Cases 1 and 2 assume supply chain uncertainty is more important than business uncertainty. The important factors in supply chain uncertainty are coal reserves and operational efficiency.

The coal business sustainability strategy in overcoming supply chain uncertainties in case 1 and 2 is to find new coal reserves in large quantities with reduced mining operational costs that are more environmentally friendly.

5 CONCLUSIONS

Political instability and economic slowdown at national and global levels significantly influence the growth of energy needs. Energy demand will keep increasing in the future. The ability of the supply chain related to the decreasing amount of coal reserves and the low efficiency of operational activities to produce thermal coal is a very vital variable in the supply chain. There must be operational efficiency to fulfill one of the indicators for the sustainability of the thermal coal business in achieving net zero emission. To improve coal business sustainability (CBS), there should be an accurate mathematical model, especially for the optimization of uncertainty factors for improving coal supply chain capability.

REFERENCES

- Aguirre-Villegas, H. A., & Benson, C. H. (2017). Case history of environmental impacts of an Indonesian coal supply chain. *Journal of Cleaner Production*, 157, 47–56. doi:10.1016/j.jclepro.2017.03.232
- Babacinesami, A., Tohidi, H., & Seyedaliakbar, S. M. (2021). Designing a data-driven agile sustainable closed-loop supply chain network. *International Journal of Management Science and Engineering Management*, 16(1), 14–26. doi:10.1080/17509653.2020.1811794
- Bichueti, R. S., Gomes, C. M., Kneipp, J. M., & Da Rosa, L. A. B. (2015). Strategic management of the use of water in mining: A study in Brazilian Multicases. *Revista de Gestao Social e Ambiental*, 9(2), 102–119. doi:10.5773/rgsa.v9i2.986
- Bocken, N. M. P., Short, S. W., Rana, P., & Evans, S. (2014). A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production*, 65(February), 42–56. doi:10.1016/j.jclepro.2013.11.039
- Ding, S., Wang, M., & Zhang, H. (2021). Intergenerational externalities influence for exploitation process of rare metal minerals. *Processes*, 9(5). doi:10.3390/pr9050883
- Emberson, C., Storey, J., Godsell, J., & Harrison, A. (2006). Managing the supply chain using in-store supplier employed merchandisers. *International Journal of Retail and Distribution Management*, 34(6), 467–481. doi:10.1108/09590550610667056
- John, E. (1998). Accounting for the Triple Bottom Line. *Measuring Business Excellence*, 2(3), 18–22.
- Klemeš, J. J., Varbanov, P. S., Walmsley, T. G., & Foley, A. (2019). Process Integration and Circular Economy for Renewable and Sustainable Energy Systems. *Renewable and Sustainable Energy Reviews*, 116. doi:10.1016/j.rser.2019.109435
- Li, C., Xiang, X., & Qu, Y. (2016). Product quality dynamics in closed-loop supply chains and its sensitivity analysis. *Journal of Grey System*, 28(1), 180–190.
- Mathiyazhagan, K., Diabat, A., Al-Refaie, A., & Xu, L. (2015). Application of analytical hierarchy process to evaluate pressures to implement green supply chain management. *Journal of Cleaner ...*
- Muduli, K., & Barve, A. (2013). Establishment of a sustainable development framework in small scale mining supply chains in India. *International Journal of Intelligent Enterprise*. doi:10.1504/IJIE.2013.057340
- Muduli, K. K., Luthra, S., Kumar Mangla, S., Jabbour, C. J. C., Aich, S., & de Guimarães, J. C. F. (2020). Environmental management and the “soft side” of organisations: Discovering the most relevant behavioural factors in green supply chains. *Business Strategy and the Environment*. doi:10.1002/bse.2459
- Paulraj, A., Chen, I. J., & Blome, C. (2017). Motives and Performance Outcomes of Sustainable Supply Chain Management Practices: A Multi-theoretical Perspective. *Journal of Business Ethics*, 145(2), 239–258. doi:10.1007/s10551-015-2857-0
- Peng, J.-J., Tian, C., Zhang, W.-Y., Zhang, S., & Wang, J.-Q. (2020). An integrated multi-criteria decision-making framework for sustainable supplier selection under picture fuzzy environment. *Technological and Economic Development of Economy*, 26(3), 573–598. doi:10.3846/tede.2020.12110
- Sauer, P. C., & Seuring, S. (2017). Sustainable supply chain management for minerals. *Journal of Cleaner Production*, 151, 235–249. doi:10.1016/j.jclepro.2017.03.049
- Shamsuddoha, M. (2015). Integrated supply chain model for sustainable manufacturing: A system dynamics approach. *Advances in Business Marketing and Purchasing*. doi:10.1108/S1069-09642015000022B003
- Stock, T., & Seliger, G. (2016). Opportunities of Sustainable Manufacturing in Industry 4.0. *Procedia CIRP*, 40(Icc), 536–541. doi:10.1016/j.procir.2016.01.129

- Tanaka, K. (2011). Review of policies and measures for energy efficiency in industry sector. *Energy Policy*, 39(10), 6532–6550. doi:10.1016/j.enpol.2011.07.058
- van Kleef, J. A. G., & Roome, N. J. (2007). Developing capabilities and competence for sustainable business management as innovation: a research agenda. *Journal of Cleaner Production*, 15(1), 38–51. doi:10.1016/j.jclepro.2005.06.002
- Wibowo, A. B., & Pujawan, I. N. (2018). Procurement strategy and supply risk analysis of coal by considering price fluctuation and supplier delivery time. *Proceedings of the International Conference on Industrial Engineering and Operations Management*, 2018-March, 2903–2913.

