

# **Implementation of Cost Leadership Strategy in Indonesian Fertilizer Company**

**Arief Nurdini, Elsa Wahyu Harliana, Lathifah Karina Putri**

Department of Industrial Engineering, Faculty of Engineering  
Universitas Indonesia, Kampus UI Depok, 16424, Indonesia  
[arief.nurdini11@ui.ac.id](mailto:arief.nurdini11@ui.ac.id), [elsa.wahyu@ui.ac.id](mailto:elsa.wahyu@ui.ac.id), [lathifah.karina@ui.ac.id](mailto:lathifah.karina@ui.ac.id)

## **Abstract**

The increasing global population drives up food demand which means crop production needs to increase. To achieve that, fertilizer is used. Many industries, including the fertilizer industry, are feeling the impact of COVID 19. This paper presents the implementation of cost leadership strategy in Indonesia fertilizer company, the effect of COVID 19 on the fertilizer industry, and how the strategy is used to achieve competitiveness. This paper also discusses the impact of the implementation of cost leadership strategy to the company's financial performance. Based on the result, the five components of the cost leadership strategy can be fulfilled by the company. However, for the component that consumers have the power to bargain the price is not in accordance with the fertilizer industry. This is generally due to the fact that fertilizer prices in Indonesia depend on and affect world fertilizer prices. The impact of the implementation of the cost leadership strategy is carrying out effectiveness such as operational costs, managing inventory, and the use of raw materials.

## **Keywords**

Competitiveness, Cost Leadership, COVID 19, Fertilizer, Strategy

## **1. Introduction**

From the 1960s to 2020 the global population increased from 3.032 to 7.762 billion persons (World Bank 2022). This correlates with increased food demand and has resulted in the need for increased crop production. The increased crop production was achieved by expansion in cropland area and yield increase. The global cropland area has increased by 4% from 2000 to 2019 while fertilizer use has increased by 34% during the period (FAO 2021). Fertilizer use immensely contributes to sustaining higher crop productivity and ensuring food security around the globe. Fertilizer prices are known to be volatile in the past years due to many reasons such as raw materials price, rising market competitions, and recent disruptions from COVID 19 (Ilinova et al. 2021; Widmar 2020).

An ongoing new virus outbreak causing pneumonia-like clusters in Wuhan city, China, has gleamed the world. The outbreak, confirmed on New Year's Eve 2020, has known no boundaries since then. The number has surpassed that of Severe Acute Respiratory Syndrome (SARS) and the Middle East respiratory syndrome (MERS) and is uninterruptedly escalating (Gupta Et al 2019). Many industries, including fertilizer, are feeling the impact of COVID 19, especially the declining production and sales. Large-scale restrictions to slow the pace of COVID-19 implemented by the government disrupt the company's logistics supply which affects the production and sales of products.

Pupuk Kaltim is a company that produces urea, NPK Fertilizer, and ammonia. Urea has the largest application as a source of nitrogen (N) fertilizer. The total world urea requirement in the year 1970 was 32 million tons which showed a tremendous increasing trend up to 2015 i.e. 111.6 million tons, which is expected to be 130–150 million tons/year in 2050 (Rudmin et al. 2019). The application of NPK fertilizers has been the most common strategy to improve plants' N, P, and K uptake efficiency and increase plant yields in many countries (Tahery et al. 2022). The global ammonia production reached 176 million metric tons in 2016, of which about 79% was used in the production of fertilizers (Fasihi et al 2021). Being associated with the food supply of a growing population, the ammonia demand experienced an average growth of 1.9% from 2006 to 2016 and is expected to continue this trend during the coming decades (Yara 2018). Of the three types of products produced by PT Pupuk Kaltim. Urea Fertilizer and ammonia are export products. Conditions in the year 2020 amid the COVID-19 pandemic had affected economic performances at both the global and national levels. So that every country competes to become the most competitive economy to survive in the era of globalization by increasing competitiveness. The concept of competitiveness can be used as a

policy strategy in building the strength of the national economy through the integration of macroeconomic policies that are very instrumental in strengthening national competitiveness (Wibowo and Nurcahyo 2020).

Throughout 2020, PT Pupuk Kaltim had to face several obstacles and challenges, namely a decline in the prices of several agricultural products. This adversely affected the purchasing power of farmers who are the main consumers of fertilizer, thus affecting the performance of the company, so PT Pupuk Kaltim must organize the entire management system adopted. One of the factors that can affect operational and business performance is the implementation of the ISO 9001 quality management system (Nurcahyo et al 2021). Aside from that, in terms of production feedstock, PT Pupuk Kaltim had to pay for higher rates of natural gas than other fertilizer-producing companies in the world are paying, subsequently affecting the company's product competitiveness. During the pandemic, PT Pupuk Kaltim maintain production reliability and maintenance scheduling through a program of predictive maintenance excellence. Predictive Maintenance needs the records of failure and repair data can be a useful database for the management of fertilizer production line to improve system reliability (Nuryanto et al 2020). Against this background, this paper will focus on exploring the existing competitive strategies along with their theoretical basis.

### 1.1 Objectives

This study aims to understand the implementation of cost leadership strategies to achieve competitiveness in the market. To achieve this goal, then:

1. Understand the implementation of cost leadership strategy
2. Identify the impact of cost leadership strategy on the company's financial performance

## 2. Literature Review

### 2.1 Fertilizer

Fertilizers are organic or inorganic substances containing chemical elements that improve the growth of plants and the fertility of the soil. The percentage content of nutrients in organic fertilizers (manure) is relatively low (oecd.org 2003). fertilizer is a material that provides nutrients to plants. N, P, and K are considered primary nutrients; secondary nutrients include S, Mg, Ca, and Na; and micronutrients include B, Co, Cu, Fe, Mn, Mo, and Zn, all of which are essential for plant growth but in small quantities compared to those of primary and secondary nutrients. A straight fertilizer contains only one of the primary nutrients – N, P, or K – while a compound fertilizer contains two or more. Compound fertilizers are usually labeled with 3 numbers, e.g., NPK 10-10-15, meaning 10% N, 10% PO<sub>4</sub> (as P<sub>2</sub>O<sub>5</sub>), and 15% K (as K<sub>2</sub>O). A secondary nutrient fertilizer and a micronutrient fertilizer are characterized by a determined content of secondary or micronutrients, respectively. A mineral fertilizer contains nutrients in inorganic form, or as urea or cyanamide, and an organo-mineral fertilizer contains nutrients in both organic and inorganic form (Otero et al 2005).

One of the factors that influenced fertilizer's price is its raw materials prices. Table 1 shows main raw materials to produce ammonia, urea, and NPK fertilizer.

Table 1. Main raw materials to produce ammonia, urea, and NPK

Product	Ammonia	Urea	NPK
Raw Material	Natural gas	Natural gas	Urea
	Air	Ammonia	DAP (Diammonium Phosphate) / RP (Rock Phosphate)
	Sea water		KCl (Potassium Chloride)

### 2.2 Generic Strategy

A few decades ago, Porter (1980) proposed three key business-level strategies encompassing cost leadership, differentiation, and integrated strategies that firms can employ to safeguard, preserve or confront rivals in the marketplace. Extant research in strategy has shown the appropriate alignment and adoption of these competitive strategies have a strong influence on firms' outcomes (Adomako et al 2022).

### **2.2.1 Cost Leadership Strategy**

Cost-leadership strategy or low-cost strategy refers to a strategy whereby a firm seeks “to outperform competitors by doing everything the company can to produce goods or services” at a cost lower than that of rival businesses (Hill and Jones 2012). A typical cost leadership strategy will involve amassing market share in the pursuit of efficiencies of scale, keeping tight control of overheads, and maximizing the cost benefits of industry experience and new technology. The company will avoid unprofitable or marginal customer accounts and minimize running costs or investment in processes seen as ancillary, such as research and development, salesforce, advertising, and customer service (Porter 1997).

The goal of the cost leader is to have a comprehensive cost advantage over the competitors. In order to assess the cost advantage, PORTER refers to the profitability or the key figure of the so-called Return on Investment (ROI) (Porter 2004). When employing a cost leadership strategy, a firm must be careful not to use such aggressive price cuts that their profits are low or nonexistent. A Type cost leadership strategy can be especially effective under the following conditions (David 2013):

- When price competition among rival sellers is especially vigorous.
- When the products of rival sellers are essentially identical and supplies are readily available from any of several eager sellers.
- When there are few ways to achieve product differentiation that have value to buyers.
- When most buyers use the product in the same ways.
- When buyers incur low costs in switching their purchases from one seller to another.
- When buyers are large and have significant power to bargain down prices.
- When industry newcomers use introductory low prices to attract buyers and build a customer base.

## **3. Methods**

First, to prove that the company's strategy is cost leadership, the authors choose several fertilizer companies in Indonesia. Data was collected from several fertilizer companies in Indonesia. The data collected from each company are product, product specification, and retail price. The next step is to collect data from the annual report and sustainability report of PT. Pupuk Kalimantan Timur (PKT). The impact of cost leadership strategy is identified through the company's financial performance.

## **4. Data Collection**

The Authors use secondary data collected from the annual report and sustainability report of PT. Pupuk Kalimantan Timur (PKT). The report is officially released on the Pupuk Kaltim website. The information taken from the annual report was the operating expenses, sales, cost of goods sold, and profit loss statement from 2016 to 2020. Another piece of information taken from the sustainability report was gas procurement. The data is used to show the effect of implementing cost leadership on the company's financial performance.

### **4.1 Competition in Fertilizer Industry**

There are several companies that produce fertilizer in Indonesia. The types of fertilizers produced by the company include urea and NPK. Urea and NPK fertilizers have different ingredients and percentages of ingredients in each company. This affects the price of fertilizer. The price of non-subsidized fertilizers in Indonesia has increased every year. Prices for the two types of fertilizers are different in each company. Table 2 shows the price of urea fertilizer in several companies in Indonesia. Urea fertilizer has the same ingredients in each company, which contains 46% nitrogen (N) and white color. There are two forms of fertilizer produced including granules and prilles.

Table 2. Price of urea fertilizers in Indonesia

Company	Product	Price (Rp per 50 Kg)
---------	---------	-------------------------

PT Pupuk Kaltim	Pupuk Urea Granul Daun Buah Kaltim	525,000
	Pupuk Urea Prill Daun Buah Kaltim	540,000
PT Pupuk Iskandar Muda	Pupuk Urea PIM	800,000
PT Pupuk Kujang Cikampek	Pupuk Urea Kujang Nitrea	675,000
PT Pupuk Sriwidjaja Palembang	Pupuk Urea PUSRI	550,000
PT Petrokimia Gresik	Pupuk Urea Petro	567,000

Meanwhile, Table 3 shows the price of NPK fertilizers and product details in several companies in Indonesia.

Table 3. Price of NPK fertilizers and product detail in several companies in Indonesia

Company	Product	Product Description Detail	Price (Rp per 50 Kg)
PT Pupuk Kaltim	NPK Pelangi	Contains Nitrogen 12%, Phosphate 12%, Kalium 17%. Magnesium 2%	545,000
Saprotan Utama	NPK Pak Tani 12-12-17-2	Contains nitrogen 12%, phosphate 12%,kalium 16%, magnesium 2%	650,000
	NPK Pak Tani 15-15-15 + TE	Contains nitrogen 15%, phosphate 15%,kalium 15%, trace elements such as copper, zinc, manganese, boron	560,000
	NPK Pak Tani 16-16-16	Blue/red granule shaped containing nitrogen 16%, phosphate 16%,kalium 16%	850,000
PT Meroke Tetap Jaya	NPK Mutiara 16-16-16	Blue granule shaped containing nitrogen 16%, phosphate 16%,kalium 16%	575,000
	NPK Mutiara Sprinter 20-10-10	Blue prill containing nitrogen 20%, phosphate 10%, kalium 10%	570,000
	NPK Mutiara Professional 9-25-25	White yellowish granule shaped containing nitrogen 9%, phosphate 25%, kalium 25%	800,000
PT Pupuk Kujang Cikampek	NPK Granule 15-15-15	Contains nitrogen 15%, phosphate 15%,kalium 15%, granule shape	675,000
PT Pupuk Sriwidjaja Palembang	NPK PUSRI	Contains nitrogen 15%, phosphate	600,000

		15%,kalium 15%, Brown Color	
--	--	--------------------------------	--

#### 4.2 Raw Material Price

COVID 19 disrupted DAP's supply chain. Major DAP's producers cannot operate in full capacity due to labor shortages. These disruptions led to its price increases. Figure 1 shows an increase of DAP price in 2020.

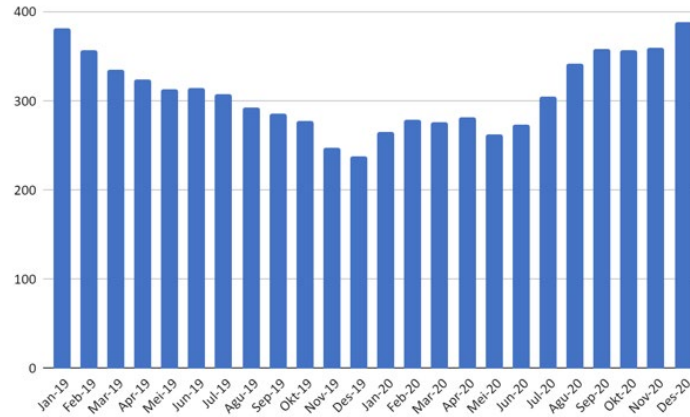


Figure 1. DAP (Diammonium Phosphate) Prices

#### 4.3 Production

Price of raw material of NPK, DAP, keeps rising so Pupuk Kaltim implemented several initiatives to increase their competitiveness, such as increasing its raw material consumption efficiency, lowering its operating expenses, and maximizing its plant's capacity. Table 4 shows natural gas consumption and Table 5 shows operating expenses keep decreasing each year.

Table 4. Raw Materials Consumption

Information	2016	2017	2018	2019	2020
Average Ratio of Natural Gas Consumption per ton of Ammonia Product (MMBTU/ton)	N/A	34,79	35,04	34,75	33,85
Average Ratio of Natural Gas Consumption per ton of Urea Product (MMBTU/ton)	N/A	26,72	26,71	25,97	25,29

Table 5. Operating Expenses

Information	2016	2017	2018	2019	2020
Operating Expenses (in Billion Rupiah)	1.771	1.603	2.135	1.664	1.498

## 5. Results and Discussion

### 5.1 Cost Leadership's Requirements

According to David (2013), several conditions have to be met so the cost leadership strategy can be effectively implemented.

**5.1.1 When price competition among rival sellers is especially vigorous**

Based on Table 2 and Table 3, competition among rival sellers is very vigorous. The prices of Urea and NPK fertilizer PT Pupuk Kaltim are the lowest prices compared with other rivals, which are 525.000 - 540.000 Rupiah for Urea and 545.000 rupiahs for NPK. Although the competition is very tight among rivals, in 2020 PT Pupuk Kaltim recorded an increase in sales of urea by 17% (from 3,2 million tons in 2019 to 3,8 million tons in 2020) and NPK by 52% (from 151 thousand tons in 2019 to 229 thousand tons in 2020) compared to the year 2019 (annual report 2020).

**5.1.2 When the products of rival sellers are essentially identical and supplies are readily available from any of several eager sellers**

Urea fertilizer products have the same percentage and component content as each rival seller, which contains 46% nitrogen (N) and white color. The difference is the form of fertilizer, some are in the form of granules and prill. However, for NPK fertilizer products, each competitor has the same material components with different percentages. For each product, the details are shown in table 3. PT Pupuk Kaltim produces NPK with Nitrogen 12%, Phosphate 12%, Potassium 17%, and Magnesium 12%.

**5.1.3 When there are few ways to achieve product differentiation that have value to buyers.**

The product differentiation among rivals is different percentages of material components for NPK Fertilizer. The difference in the percentage of material in NPK is related to the function of the fertilizer, for example, NPK Mutiara 16 16 16 containing nitrogen 16%, phosphate 16%, kalium 16% is a fertilizer that specifically for decoration plant, NPL Pelangi Containing Nitrogen 12%, Phosphate 12%, Kalium 17%. Magnesium 2% is a NPK fertilizer that is specifically for horticulture although it can be used for all plants.

**5.1.4 When most buyers use the product in the same ways**

Fertilizer is a material that contains one or more nutrients for plants to support plant growth and development. So that consumers who use this product are used for agriculture. One of them is urea fertilizer produced by PT Pupuk Kaltim. Prill urea is most widely used for the food crop segment and industry, while granulated urea is more suitable for the plantation segment, and can also be used for food crops. The benefit of NPK fertilizer, in general, is that it helps plants grow to develop optimally.

**5.1.5 When buyers incur low costs in switching their purchases from one seller to another**

In general, in urea products which have the same material percentage for all companies, namely 46% Nitrogen, buyers will buy products at the lowest prices in the market. However, for NPK products, buyers will buy products according to their needs. For general plants, the buyer can buy NPK Pelangi, but for special plants such as ornamental plants, etc. The buyer will buy special NPK products as well.

**5.1.6 When buyers are large and have significant power to bargain down prices**

Fertilizer prices in Indonesia depend on world fertilizer prices. So the buyer can not have significant power to bargain down prices. especially now that China has stopped the export of phosphate has a big influence on the situation of international raw material prices. Besides phosphate, other raw materials such as KCL also increased by about three times. Likewise, there is an increase in gas prices in Europe which causes international fertilizer prices

**5.1.7 When industry newcomers use introductory low prices to attract buyers and build a customer base**

In the fertilizer industry, it is difficult for newcomers to enter the competition unless they introduce new fertilizers for certain varieties with better quality and lower prices.

**5.2 Profit Loss Statement**

Based on data from annual report of PT Pupuk Kaltim from 2016 to 2020, an analysis of the company’s financial data such as profit loss statement is carried out. Table 6 shows the profit loss statement data from 2016 to 2020. The profit loss statement includes company income, cost of goods sold, gross profit, and gross profit margin.

Table 6. Profit Loss Statement

<b>Information</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>
Income (In Billion Rupiah)	16.230	15.098	18.966	17.034	18.486

Cost of Good Sold (In Billion Rupiah)	11.975	10.719	13.426	12.752	14.417
Gross Profit (In Billion Rupiah)	4.255,71	4.379,43	5.539,85	4.282,10	4.069,53
Gross Profit Margin (Percentage)	26	29	29	25	22

Figure 2 shows the graphical visualization of profit loss statements from 2016 to 2020. The graph shows that there are fluctuations in revenue and cost of goods sold from 2016 to 2020. This is due to fluctuation in sales of urea and NPK fertilizers from year to year. For example, the realization of non-subsidized Urea sales in 2019 was 796.4 thousand tons, decreased by 32% from the previous year's sales of 1.2 million tons. In addition, sales of non-subsidized NPK fertilizer in 2019 amounted to 23,934.4 tons, decreased by 10% from the previous year, which was 26,520.9 tons. The percentage of gross profit margin and gross profit is shown in Table 5. This shows an increase in gross profit from 2016 to 2018 and in 2019 and 2020 gross profit has decreased. This has an effect on the percentage of gross profit margin in 2019 and 2020 to decrease.

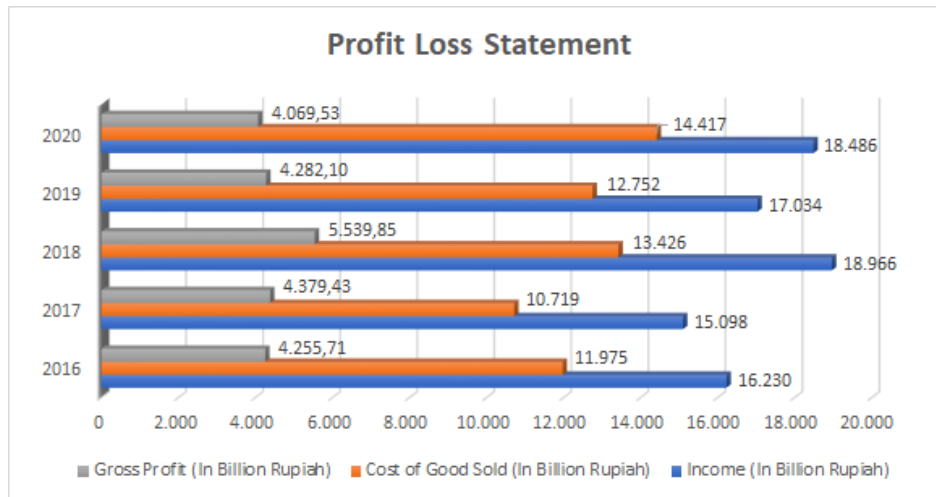


Figure 2. Profit Loss Statement

### 5.3 Profitability

Measuring profitability, it can be shown by profitability ratios such as net profit margin, return on equity (ROE) and return on investment (ROI). In the Table 7 it can be shown that the Return on equity (ROE) has increased and in 2020 is the highest value, which is 7%. Therefore, it can be said that the company uses its assets efficiently. Then Return on investment (ROI) also has an influence on company profits. The company's ROI percentage value has also increased. Even though in the midst of the COVID-19 pandemic which negatively affected the profitability of most companies, Pupuk Kaltim was able to maintain its net profit margin at 10%. The company's gross profit margin is an important thing that must be considered. Gross profit margin from 2018 to 2020 has decreased. The percentage of gross profit margin is directly proportional to the net profit margin

Table 7. Pupuk Kaltim Ratio Probability and Turnover from 2016 to 2020

Information	2016	2017	2018	2019	2020
Inventory Turnover (Days)	71	85	70	85	57
Total Assets Turnover (%)	57	51	62	61	68
Gross Profit Margin (%)	26	29	29	25	22
Net Profit Margin (%)	10	11	10	10	10
Return of Investment (ROI) (%)	5	6	6	6	7
Return of Equity (ROE) (%)	9	9	10	8	8

Return of Assets (ROA) (%)	5	6	6	6	7
----------------------------	---	---	---	---	---

In 2020, the inventory turnover rate was faster than the previous year, from 85 days to 57 days. Meanwhile, total asset turnover grew, from 61% last year to 68%. Therefore, the company makes efficiency in managing inventory, where the faster the inventory turnover, the more effective the product is marketed.

#### 5.4 Proposed Improvements

During the pandemic, PT Pupuk Kaltim carried out appropriate production strategies and programs, in addition to carrying out a predictive maintenance excellence program which made PT Pupuk Kaltim's activities less affected by the pandemic. This effort must always be maintained and improved. In addition, PT Pupuk Kaltim can use an expansion strategy in which the strategy is used on products that have high profits and potential for greater market development. PT Pupuk Kaltim also has Ammonia products that allow for its derivatives such as soda ash which is a raw material in the manufacture of glass and detergent, so far the Indonesian government is still importing 900,000 tons of soda ash per year from abroad such as the United States, China, and Turkey.

### 6. Conclusion

This study aims to determine the implementation of a cost leadership strategy which is one of the generic porter strategies to gain a competitive advantage in the fertilizer industry. By using a case study approach to PT Pupuk Kaltim to represent the fertilizer industry. PT Pupuk Kalimantan Timur (PKT) is one of the largest producers of urea and NPK fertilizers in Asia. This study uses secondary data such as the annual report and sustainability report of PT Pupuk Kaltim from 2016 to 2020.

This study aims to determine if the cost leadership strategy is an effective strategy used in the company and to determine the impact of implementing cost leadership on the company's financial performance. In determining an effective cost leadership strategy for the company, several requirements or conditions must be met. PT. Pupuk Kaltim can meet five of the seven component requirements, including numbers 1 to 5 on cost leadership conditions. PT. Pupuk Kaltim offers a lower price compared to its competitors who provide similar products. This can have an impact on consumers who tend to be loyal to the company's products. In addition, fertilizer prices in Indonesia depend on world fertilizer prices.

This study also aims to analyze company's strategy to increase their competitiveness during COVID 19. COVID 19 disrupted Diammonium Phosphate (DAP)'s supply chain and then causing its prices to keep increasing. PT Pupuk Kaltim implemented several initiatives to increase their competitiveness, such as increasing its raw material consumption efficiency and lowering its operating expenses.

The limitation of this research is that the data used are only the annual report and sustainability report of PT. Pupuk Kaltim For further research, wider data and objects can be used.

### References

- Adomako, S., Amankwah-Amoah, J., and Frimpong, K., Human capital, reverse engineering, and new venture growth: The moderating role of competitive strategy, *Technovation*, no. 102520, 2022.
- Annual report 2016, Available: [https://www.pupukkaltim.com/uploads/attc\\_\\_5DF44EB3182210E627BFF89FDCC63318.pdf](https://www.pupukkaltim.com/uploads/attc__5DF44EB3182210E627BFF89FDCC63318.pdf), April 8, 2022.
- Annual Report 2017, Available: <https://www.pupukkaltim.com/uploads/AR-PKT-2017-17-Oktober-2018.pdf>, April 8, 2022.
- Annual Report 2018, Available: [https://www.pupukkaltim.com/uploads/8-14-2019%20AR\\_PKT\\_2018.pdf](https://www.pupukkaltim.com/uploads/8-14-2019%20AR_PKT_2018.pdf), Accessed on April 8, 2022.



- Annual Report 2019, Available: [https://www.pupukkaltim.com/uploads/9-17-2020%20AR%202019%20Pupuk%20Kaltim\\_14%20September.pdf](https://www.pupukkaltim.com/uploads/9-17-2020%20AR%202019%20Pupuk%20Kaltim_14%20September.pdf), April 10, 2022.
- Annual Report 2020, Available: [https://www.pupukkaltim.com/uploads/12-13-2021\\_AR\\_PKT\\_2020.pdf](https://www.pupukkaltim.com/uploads/12-13-2021_AR_PKT_2020.pdf), April 10, 2022.
- David, F. R., David, F. R., and David, M. E., *Strategic management: Concepts and cases: A competitive advantage approach*, Pearson, 2013.
- Fasihi, M., Weiss, R., Savolainen, J., and Breyer, C., Global potential of green ammonia based on hybrid PV-wind power plants, *Applied Energy*, vol. 294, no. 116170, 2021.
- Glossary of Statistical Terms, Available: <https://stats.oecd.org/glossary/detail.asp?ID=947>, April 10, 2022.
- Gupta P., Goyal K., Kanta P., Ghosh A., and Singh M. P., Novel 2019-coronavirus on new year's Eve, *Indian J Med Microbiol*, vol. 37, no. 4, pp. 459-477, 2019.
- Hill, C. W. L. and Jones, G. R., *Essentials of Strategic Management*, 3rd edition, Cengage Learning, Inc. USA, 2012.
- Ilinova, A., Dmitrieva, D., and Kraslawski, A., Influence of COVID-19 pandemic on fertilizer companies: The role of competitive advantages, *Resources Policy*, vol.71, pp. 102019, 2021.
- Nurchahyo, R., and Habiburrahman, M., Relationship between ISO 9001: 2015 and operational and business performance of manufacturing industries in a developing country (Indonesia), *Heliyon*, vol. 7, no.1, 2021.
- Nuryanto, R., Nurchahyo, R., and Farizal, Using Failure And Repair Data For Performance Evaluation of NPK Fertilizer Production Line, 2020 IEEE 7th International Conference on Industrial Engineering and Applications (ICIEA), pp. 404-408, Bangkok, Thailand, April 16-21, 2020.
- Otero, N., Vitoria, L., Soler, A., and Canals, A., Fertiliser characterization: major, trace and rare earth elements. *Applied Geochemistry*, vol. 20, no. 8, pp. 1473-1488, 2005.
- Population, total: Data, Available: <https://data.worldbank.org/indicator/SP.POP.TOTL>, April 10, 2022.
- Porter M. E., *Competitive Strategy: Techniques for analyzing industries and competitors*, New York: The Free Press; pp .35-81, 2004.
- Porter, M. E. *Competitive Strategy: Techniques for analyzing industries and competitors*, 1980.
- Porter, M.E, "COMPETITIVE STRATEGY", *Measuring Business Excellence*, vol. 1, no. 2, pp. 12-17,1997.
- Rudmin, M., Abdullayev, E., Ruban, A., Buyakov, A., and Soktoev, B, Mechanochemical preparation of slow-release fertilizer based on glauconite-urea complexes, *Minerals*, vol. 9, no.9, pp. 507, 2019.
- Sustainability Report 2017, Available: <https://www.pupukkaltim.com/uploads/SRPKT2017FinalforWeb17Oktober2018.pdf>, April 10, 2022.
- Sustainability Report 2018, Available: [https://www.pupukkaltim.com/uploads/ALLSRPKT2018\(14%20AGUSTUS2019\).pdf](https://www.pupukkaltim.com/uploads/ALLSRPKT2018(14%20AGUSTUS2019).pdf), April 10, 2022.
- Sustainability Report 2019, Available: [https://www.pupukkaltim.com/uploads/9-30-2020%20PKT\\_SR2019\\_30%20September%202020\\_Final.pdf](https://www.pupukkaltim.com/uploads/9-30-2020%20PKT_SR2019_30%20September%202020_Final.pdf), April 10, 2022.
- Sustainability report 2020, Available: [https://www.pupukkaltim.com/uploads/12-13-2021\\_SR\\_PKT\\_2020.pdf](https://www.pupukkaltim.com/uploads/12-13-2021_SR_PKT_2020.pdf), April 10, 2022.
- Tahery, S., Munroe, P., Marjo, C. E., Rawal, A., Horvat, J., Mohammed, M., and Joseph, S, A comparison between the characteristics of a biochar-NPK granule and a commercial NPK granule for application in the soil, *Science of The Total Environment*, no. 155021, 2022.
- Wibowo, N., and Nurchahyo, R., Competitiveness in global transformation: A systematic review, *Proceedings of the International Conference on Industrial Engineering and Operations Management*, vol. 12, no. 10, Dubai, March 10-12, 2020.
- Widmar, D., Fertilizer prices create reduced cost, Available: [https://www.agupdate.com/agriview/news/business/fertilizer-prices-create-reduced-cost/article\\_e83c4e0f-c245-524c-bc15-1a38c310d2ca.html](https://www.agupdate.com/agriview/news/business/fertilizer-prices-create-reduced-cost/article_e83c4e0f-c245-524c-bc15-1a38c310d2ca.html), April 27, 2022.
- World Bank, Available at: <https://blogs.worldbank.org/opendata/fertilizer-prices-rise-moderately-2021>, April 10, 2022.
- World Food and Agriculture – Statistical Yearbook 2021, Available: <https://www.fao.org/documents/card/en/c/cb4477en>, April 10, 2022.
- Yara Fertilizer Industry Handbook, Available: <https://www.yara.com/siteassets/investors/057-reports-and-presentations/other/2018/fertilizer-industry-handbook-2018.pdf/>, April 12, 2022.
- Yessy, Pangsa Pasar Pupuk Komersil NPK Dalam Negeri Dikuasai Produsen Swasta, Available: <https://www.jpnn.com/news/pangsa-pasar-pupuk-komersil-npk-dalam-negeri-dikuasai-produsen-swasta?page=3>, April 22, 2022.

## **Biographies**

**Arief Nurdini** is a Ph.D. student in Industrial Engineering Department, Universitas Indonesia.

**Elsa Wahyu Harliana** is currently pursuing a master's degree in the Industrial Engineering Department, Faculty of Engineering Universitas Indonesia. She holds a Bachelor of Engineering degree in Industrial Engineering from Telkom University, Indonesia.

**Lathifah Karina Putri** is a graduate of Institut Teknologi Bandung's Bachelor of Chemical Engineering program and currently pursuing a master's degree in Industrial Engineering at Universitas Indonesia.