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MODIFIED LEAN, AGILE, RESILIENCE, GREEN WITH INNOVATION FOR COMPETITIVENESS INDEX: EVIDENCE IN FERTILIZER INDUSTRY IN INDONESIA

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Abstract

Competitiveness is a multidimensional concept involving various aspects, so we need measurements according to the industry's characteristics and the type of organization. The research aims to design a competitiveness index in industry and state-owned enterprise fertilizer producers. The research used quantitative methods using Confirmatory Factor Analysis and a composite index. We employed primary data using a purposive sampling survey on 344 respondents at the middle-up management level in state-owned enterprise fertilizer producers. The study results showed that modified Lean, Agile, Resilience, and Green with Innovation were valid and reliable for measuring the competitiveness index of industrial and fertilizer-producing companies. The competitiveness index was in excellent condition but still had limitations in the innovation dimension. State-owned enterprise fertilizer producers could use the competitiveness index in benchmarking and setting key performance indicators for companies or management.

Subjects: Business, Management, Innovation

Keywords: Competitiveness Index, Fertilizer, modified LARG, State-Owned Company

Classification codes: M10; M12; O30

1. INTRODUCTION

The fertilizer industry is a non-oil and gas processing industry's business sector. The non-oil and gas processing industry contributes around 20% to Indonesia's GDP (BPS, 2021). The fertilizer industry's sustainability determines the agricultural sector's performance and is essential to the national economy.

Currently, 5 (five) SOE fertilizer producers determine the majority of the competitiveness of the national fertilizer industry, which can meet domestic demand for almost 55.9% (Pupuk Indonesia 2020).

The existence of SOEs plays a vital role in the global economy (Lin et al., 2020). An estimated 22% of the world's 100 largest companies are now effectively under state control, the highest percentage in recent years (OECD, 2016). However, SOEs are less efficient than privately owned enterprises (Belloc, 2014). Factors that make SOE companies inefficient are the tendency to ignore market signals, soft budget constraints, weak management, agency problems, hierarchical costs, information asymmetry, political intervention, and lack of innovation (Stan et al., 2014; Bruton et al., 2015; Liang et al., 2015; Lin et al., 2020). Innovation is the primary driver of competitive advantage and a unique factor in the market (Zhou et al.,

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2017). Innovation is the key to industrial and enterprise development (Decheng & Shujie, 2010). In SOE fertilizer producers, the innovations developed are relatively limited to products and work processes (Pupuk Indonesia, 2019). Innovation is the key to company competitiveness.

Competitiveness is a multidimensional concept involving various aspects: comparative advantage, competitive advantage, strategy, and results, which, among other things, show that prosperity is not inherited but is created and depends on the ability to adapt to environmental changes (Sanchez-Gutierrez et al., 2016). Competitiveness is the most straightforward concept to identify at the corporate and organizational levels. Competitive companies can enjoy a high level of profitability continuously (Wheelen et al., 2017). Conversely, a lack of competitiveness can lead companies to erode returns and bankruptcy. It is not surprising that all disciplines within the management field have devoted themselves to understanding what companies and organizations can do to increase competitiveness.

Competitiveness is the keyword to face global competition. Some researchers conduct competitiveness research at the company level, such as Lii and Kuo (2016) on electronics companies; Bloodgood (2019) on automobile companies; Camisón and Forés (2015) on travel companies, Jiang et al. (2016) high tech and manufacturing companies, Kiveu et al. (2019) manufacturing MSME companies, Mohamad & Zin (2019) in construction companies, Li & Wang (2019) in non-financial companies, Khaksar et al. (2016) on a cement company, Zhao et al. (2019) in banking companies, Abd Aziz & Samad (2016) in food manufacturing companies. Researchers have carried out studies on industrial competitiveness in the apparel industry (Nawrocki & Carter, 2010; Luh et al., 2016; Abeysekara et al., 2019), the manufacturing industry (Sanchez-Gutierrez et al., 2016), and the textile industry (Vu & Pham 2016).

Measurement of competitiveness in the modern world applies the concepts of lean, agile, resilience, and green (LARG) for business excellence (Amjad et al., 2020). Researchers apply LARG concept to agro-industry (Aisyah, 2019), manufacturing (Amjad et al., 2020), automobile supply chains (Azevedo et al,. 2016a), supply chains (Azfar et al., 2017; Raut et al., 2021), fast-moving consumer goods (Udokporo et al., 2020) and business models (do Rosário Cabrita et al., 2016). Previous studies focused more on LARG, but this study seeks to modify LARG, enriched with innovation, as an indicator of competitiveness in the fertilizer industry in Indonesia. This research also develops the Lean, Agile, Resilience, and Innovative indexes modified from LARG.

2. METHOD

This study used a quantitative approach with a confirmatory factor analysis (CFA) approach. There were 4 (four) processes carried out in CFA. First, evaluation of measurement indicators through validity and reliability tests where validity using factor loading and reliability was measured by Crobanch's Alpha and average variance extracted (AVE). An indicator was valid when it had a factor loading above 0.5 and reliable when it had Cronbach's Alpha and AVE values above 0.5. Second, the evaluation of goodness of fit used several criteria, including GFI (Goodness of Fit Index), TLI (Tucker-Lewis Index), CFI (Comparative Fit Index), RMSEA

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(Root Mean Square Error Approximation), and SRMR (Square Root Mean Residual). Third, calculating the composite index for each variable dimension was based on measurement indicators and weights obtained from factor loading. Fourth, calculating the competitiveness index used the score of the composite dimension index and the measurement dimension weights.

We measured competitiveness in four dimensions, namely lean, agility, resilience, and innovation, where each dimension consisted of several indicators, namely lean consisting of 6 indicators, agility with four indicators, resilience with four indicators, and innovation consisting of 7 measurement indicators shown in Figure 1 below.

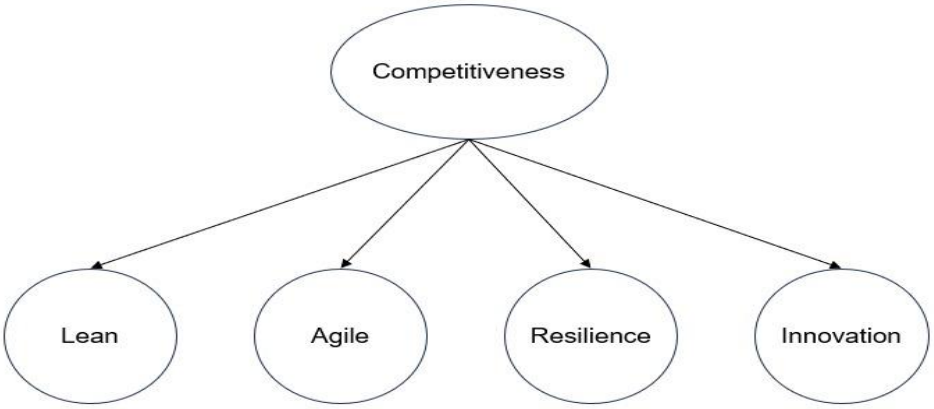

Figure 1: Competitiveness index measurement with CFA

The measurement of the competitiveness index uses a survey on middle management to top-level management in state-owned fertilizer-producing companies in Indonesia, namely PT Pupuk Kalimantan Timur (PKT), PT Petrokimia Gersik (PKG), PT Pupuk Sriwidjaja Palembang (PSP), PT Pupuk Kujang (PKC), and PT Pupuk Iskandar Muda (PIM). We conducted the survey using an online system. The survey was non-probability sampling with purposive sampling of 344 respondents. We collect data using an online questionnaire instrument, with respondents filling out the questionnaire through self-administration. Table 1 shows the dimensions and indicators. The survey instrument has passed an ethical review from the Ethics Commission for Research Involving Human Subjects, IPB University, Bogor, Indonesia, according to letter number 770/IT3.KEPSM-IPB/SK/2022 dated 10 October 2022.

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Table 1: Dimensions and indicators

Dimension	Indicator
Lean (Qrunfleh & Tarafdar, 2013)	1. The company has product quality according to customer requirements 2. The company conducts regular product inspections 3. The company makes efforts to reduce waste 4. The company has a supply chain system that can deliver products in the correct quantity 5. The company has a supply chain system capable of delivering products on time 6. The company has a supply chain system that can deliver products to the correct location
Agile (Qrunfleh & Tarafdar, 2013)	1. The company can respond effectively to changes in product requirements 2. The company can respond quickly to customized requirements. 3. The company can maintain the capacity to respond to volatile markets 4. The company can keep up with technological developments
Resilience (Parker & Ameen, 2018)	1. The company can cope with changes in the fertilizer business 2. The company can quickly adjust if there is a disruption in business operations 3. The company can respond quickly to the harmful effects of business changes 4. The company can be aware of changes in the business environment at any time
Inovation (Chen, 2019; Del Giudice et al., 2021; Khin & Ho, 2019)	1. The company is looking for new ways to make breakthroughs in business 2. The company innovates to produce new products 3. The company innovates to improve operating methods 4. The company applies the integration method with suppliers 5. The company collaborates to produce new products 6. The company uses technologies like big data and smart sensors to generate innovation. 7. The company has digital solution applications that are different from competitors.

Calculation of the industrial competitiveness index with the following dimension composite index formulation modified from Azevedo et al. (2016):

$$IKD_{ik} = \frac{\sum \gamma_{ij} I_{ijk}}{\sum \gamma_{ij}} \times \frac{100}{5}$$

IKD_{ik} : the ith dimensional composite index

γ_{ij} : the weight/factor loading of the ith dimension and the jth indicator

I_{ijk} : the score of the jth indicator in the Ith dimension and the kth respondent

While we calculate the company's competitiveness index through a modified formulation as follows (Azevedo et al., 2016)

$$IDS_k = \frac{\sum \omega_i IKD_{ik}}{\sum \omega_i}$$

IDS_k : competitiveness index

ω_i : weight/factor loading the ith dimension

IKD_{ik} : the composite index of the Ith dimension and the kth respondent

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3. RESULT AND DISCUSSION

Table 2 shows the profile of the respondents in this study; as much as 85.9 percent were male. It is reasonable because most jobs in fertilizer manufacturers are more in demand and match the characteristics of men. Furthermore, the most recent education is a Bachelor's degree (S1), as much as 57 percent, followed by a Master's degree, as much as 33.3 percent. The most educational background is engineering, as much as 47.3 percent, considering that fertilizer producers are manufacturing companies, followed by finance with 17.4 percent. Most respondents have worked in SOE fertilizer producers for over ten years, as much as 62.8 percent, indicating that they are senior management with experience in the fertilizer industry.

Table 2: Description of respondents

Description	Amount (percentage)
Gender	
Man	289 (85.9%)
Woman	55 (14.0%)
Level of education	
D3	31 (9.6%)
S1	183 (57.0%)
S2	107 (33.3%)
Educational background	
Engineer	152 (47.3%)
Finance	56 (17.4%)
Marketing	19 (5.9%)
HR	10 (3.1%)
Information Technology	12 (3.7%)
Agriculture	18 (5.6%)
Other	54 (16.8%)
Length of work	
< 5 years	51 (15.8%)
5 – 8 years	29 (9.0%)
> 8 – 10 years	39 (12.1%)
> 10 – 15 years	111 (34.5%)
>15 years	91 (28.3%)

Furthermore, the results of the evaluation show that all the Lean, Agility, Resilience, and Innovation indicators used in the study are valid because they have a factor loading above 0.5 and also meet reliability where each variable dimension has a Cronbach's Alpha value above 0.6 and AVE above 0.5. On the variable Lean, Cronbach's Alpha value of 0.921 indicates strong reliability. The highest contribution that describes the lean variable is the indicator that the company has a supply chain system capable of delivering the correct quantity of products (factor loading of 0.924); meanwhile, the lowest contribution is that the company has product quality according to customer needs (factor loading of 0.664).

On the variable Agility, Cronbach's Alpha value of 0.865 indicates strong reliability. The highest contribution describing the agility variable indicates that the company can keep up with technological developments (factor loading of 0.806). In contrast, the lowest contribution is

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the company's ability to respond quickly to customized requirements with a factor loading of 0.748. On variable Resilience, Cronbach's Alpha value of 0.919 indicates strong reliability. The highest contribution describing the resilience variable is an indicator that the company can respond quickly to the harmful effects of business changes with a factor loading of 0.888, while the lowest contribution is that the company can easily adjust when there is a disruption to business operations with a factor loading of 0.841.

Finally, Cronbach's Alpha value of 0.924 indicates strong reliability on the variable innovation. The highest contribution describing the innovation variable indicates that the company is looking for new ways to make various breakthroughs in business with a factor loading of 0.842, and the lowest contribution is the company having a digital solution application that is different from competitors with a factor loading of 0.772.

We evaluated the goodness of fit. The goodness of fit value of the confirmatory factor analysis for the competitiveness model consists of the dimensions of lean, agility, resilience, and innovation with only one chi-square indicator that is not fit. However, the rest fulfills the goodness of fit principle. Even 10 of the 12 other criteria meet the close fit category shown in Table 4. In comparison, two criteria meet the marginal fit. The competitiveness index model is statistically fit and can be used to calculate the competitiveness index.

Table 3: Results of evaluation of the goodness of fit model

Criteria	Value	Description
Chi square	472.345	Not fit
GFI	0.887	Marginal fit
Std RMR	0.054	Close fit
RMSEA	0.072	Close fit
AGFI	0.846	Marginal fit
NFI	0.929	Close fit
NNFI	0.942	Close fit
CFI	0.953	Close fit
IFI	0.953	Close fit
RFI	0.912	Close fit
PNFI	0.752	Close fit
PGFI	0.653	Close fit

The next step is calculating each dimension's factor loading (weight). Table 4 is the factor loading (weight) for each dimension of competitiveness, where the resilience dimension has the most significant weight with a magnitude of 0.936, and the lowest weight is the lean dimension with a magnitude of 0.820.

Table 4: Factor loading (weight) dimensions of competitiveness

Dimension	Factor loading
Lean	0.820
Agility	0.961
Resilience	0.936
Innovation	0.931

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Based on the results of this study, the competitiveness described or represented by these four indicators, the two most important indicators are agility (factor loading of 0.96) and resilience (factor loading of 0.94). These two indicators are critical in measuring the competitiveness of fertilizer producers. While the other two indicators, namely lean and innovation, although still important, are in a position after agility and resilience.

Table 5 presents the composite index competitiveness at the industry level. The industry competitiveness index is at a value of 85.59 from a range of 0 – 100, meaning that the competitiveness index is in a reasonably high category. It also appears that the highest composite index is the lean dimension, with a value of 88.04, followed by agility, with a value of 85.26. The next is resilience, with a value of 84.89, and innovation dimension, with a composite index of 84.47.

Table 5: The composite index of competitiveness at the industry level

Dimension	Mean	Std Dev.	Min.	Max
Lean	88.04	10.24	10.24	100.00
Agility	85.26	10.51	10.51	100.00
Resilience	84.89	11.30	11.30	100.00
Inovation	84.47	11.28	11.28	100.00
Competitiveness	**85.59**	**9.89**	**9.89**	**100.00**

The lean competitiveness index reached the highest with a value of 88.04 points. The indicators that make up the lean competitiveness index based on their importance are as follows: (1) the company has a supply chain system capable of delivering products in the correct quantity (2) the company has a supply chain system capable of delivering products on time, (3) the company has product quality according to customer requirements, (4) the company has a supply chain system that can deliver products to the correct location, (5) the company is making efforts to reduce waste, and (6) the company conducts regular product inspections.

Lean manufacturing is an effort to minimize waste in the manufacturing process (Amjad et al., 2020). The SOE fertilizer-producers has implemented environmental friendliness and reduced waste by developing an ISO 14001 and PROPER environmental management system to reduce pollution due to waste generated by factory operations by building a Waste Water Management Installation (WWMI), installing emission control devices, and managing harmful waste. In addition, the fertilizer producers have met the requirements for fertilizer products based on national and international product standards, such as ISO:9001, ISO:17025, SNI 02-2801, SNI 06-0045, SNI 02-2803, and other regulations.

Fundamental lean implementation applies Value Stream Mapping, Continuous Flow, Value Addition for End users, Pull system, and Continuous Improvement (Amjad et al., 2020). In the SOE industry, fertilizer producers already have a performance improvement system by implementing Malcolm Baldrige and a quality system based on PDCA (Plan-do-Check-Action). In addition, the industry already has a reliable supply chain network system with a distribution network spread throughout Indonesia and a general trading sector with 11 branches in 11 central regions in Indonesia (Pupuk Indonesia 2022).

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Furthermore, the agility competitiveness index ranks second at 85.26 points. The indicators that make up the agility competitiveness index based on their importance are as follows: (1) the company can respond effectively to changes in product requirements, (2) the company can follow technological developments, (3) the company can maintain the capacity to respond to volatile markets, and (4) the company can respond quickly to customized requirements.

Agility is needed to respond to unexpected and sudden market changes (Raut et al., 2021). One of the efforts is using a matrix organizational mechanism to maintain the capacity, respond to market volatility, integrate new technology know-how and improve excellent products, assess customers, mitigate risks, and evaluate organizational capabilities in meeting customer needs. In addition, the producers have used the application of technology in purifier technology, factory revamping, digital manufacturing excellence IT systems, online Occupational Safety and Health (OSH), digital fertilizer, and customer listening through the customer interface.

The following competitiveness index concerns resilience, with a value of 84.89 points. The indicators that make up the resilience competitiveness index based on their importance are as follows: (1) the company can cope with changes in the fertilizer business, (2) the company can be aware of changes in the business environment at any time, (3) the company can quickly adjust if there is a disruption to business operations and (4) the company can respond quickly to the adverse effects of business changes.

Resilience is self-regulation and resistance to disturbance from a system (Amjad et al., 2020). One of the current system disturbances is the potential for an oversupply of world urea fertilizer at low prices (Fertecon, 2020). In addition, the government plans to divert the fertilizer subsidy mechanism from product subsidy to direct transfer subsidy to farmers (Bappenas, 2022). Efforts made by the fertilizer industry are implementing a customer-centric model as a strategic pillar in the industry's transformation plan (Pupuk Indonesia, 2022).

The innovation competitiveness index occupies the lowest rank, at 84.47 points. The indicators that make up the innovation competitiveness index based on their importance are as follows: (1) the company is looking for new ways to make various breakthroughs in business, (2) the company innovates to produce new products, (3) the company innovates to improve operating methods, (4) the company collaborates to produce new products, (5) the company applies the integration method with suppliers, (6) the company uses technology such as big data and smart sensors to generate innovation and (7) the company has digital solution applications that are different from competitors.

Innovation is a keyword in facing global competition (Decheng & Shujie, 2010), especially in the fertilizer industry. The value of product, process, and business process innovation in the fertilizer industry still needs to be higher. There are still dominant old fertilizer plants, the product focus is on single fertilizers, and revenue is mainly from the sale of subsidized fertilizers (Pupuk Indonesia, 2022). One of the efforts that has started to be carried out by digital technology in the supply chain, which is currently piloting integration, is shown in Figure 2. One fertilizer company that has implemented innovation in a business model that not only produces fertilizer products as a commodity but has provided additional conveniences, such as

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that done by Yara, has strong distribution reaching more than 60 countries and has launched precision agriculture applications (Atfarm).

Figure 2: Fertilizer supply chain digital innovation

Table 6 shows the competitiveness index at the company level. PT Pupuk Kalimantan Timur (PKT) in Province East Kalimantan obtained the highest competitiveness index with a score of 89.11, and the lowest is PT Pupuk Iskandar Muda (PIM) in Province Aceh with 81.60. PKT has the highest competitiveness index because it has efficient plants, large production capacities, a significant market share and marketing area, and the availability of raw materials to achieve economies of scale. In contrast, PIM has low productivity because the plants are old and need more gas as raw materials.

The results of the research show that there is a positive relationship between efficiency and performance. SOE fertilizer producers in the efficient category tend to have good performance. PKG and PKT with indexes are more efficient than other SOE fertilizer producers. PKT has the most considerable net profit and the largest NPM, followed by PKG. Meanwhile, PIM has the lowest rank and is in the inefficient category. Thus, there is a positive correlation between the categories of efficiency and performance (net profit and NPM) of SOE fertilizer producers during the study period.

The results also show a positive relationship between performance and the competitiveness index. SOE fertilizer producers with good performance also have a better competitiveness index than others. PKT has the best competitiveness index (89.11), followed by PKG (88.59), PSP (84.78), PKC (82.01), and PIM (81.60).

Table 6: Competitiveness index of SOE fertilizer producers

Company	Competitiveness	Lean	Agility	Resilience	Inovation
PKT	89.11	90.37	88.51	89.52	88.21
PKG	88.59	89.88	88.20	87.49	88.96
PSP	84.78	88.71	84.12	82.87	83.93
PKC	82.01	84.95	82.26	80.95	80.23
PIM	81.60	85.51	81.17	81.91	78.27

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4. CONCLUSION

Measuring competitiveness needs to use multidimensional factors and capture intangible indicators to become more comprehensive than simple measurement. The results are valid and reliable in using modified LARG to measure the competitiveness index in the fertilizer industry and companies. The competitiveness index value of the fertilizer industry in the category is excellent but still lacks in innovation dimension. A fertilizer company's highest competitiveness index value is PT Pupuk Kalimantan Timur, and the lowest is PT Pupuk Iskandar Muda. Adoption of the competitiveness index measurement can be used to measure the soundness of a company and used as a benchmark and Key Performance Indicator (KPI) for companies and management of SOE in Indonesia.

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