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Analysis of supply chain institutional efficiency performance in potato chips SMEs clusters after Covid-19 pandemic

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KEYWORDS

Data envelopment analysis

Efficiency

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ABSTRACT

The pandemic conditions in 2020-2021 resulted in problems for the potato chip micro, small, and medium-enterprise (SMEs) cluster, including an imbalance in sales numbers with the resulting production due to a drastic decline in demand, marketing, and business performance. The first trimester of 2022 shows an increased demand for potato chips. Therefore, efficient performance is needed to support production recovery and business performance by increasing supply chain institutional efficiency. This research aimed to analyze the efficiency performance value and the sub-variables input with the most influence on supplier efficiency performance. This research used the Data Envelopment Analysis (DEA) model CCR-I Dual with input sub-variables (i.e., cash-to-cash-cycle-time, lead time, and flexibility) and output sub-variables (i.e., percentage of conformance quality standards, order fulfilment, and delivery performance). The analysis was carried out on the flow of suppliers to potato chip MSMEs. The results show that 8 decision-making units (DMUs) were inefficient (55.56% and 33.33%), and 1 DMU was in efficient condition (100% green), namely is DMU 6. The results also show that the input sub-variable with the most influence on supplier efficiency performance was the flexibility of sending raw materials followed by cash-to-cash-cycle-time.

Introduction

Batu City, known as agrotourism city, is one of the famous areas for its agricultural products and abundant natural beauty. The city's growth and development of the tourism sector has led to the emergence of micro, small, and medium-enterprises (SMEs) that produce various horticulture-based products as souvenirs (Directory of Small and Medium Industry Companies in Batu City, 2020). One of the processed food featured and evolved in the snack industry sector in Batu City is potato chips. In 2020, more than 900 SMEs were registered in potato chips production.

The growing number of potato chip SMEs in Batu City increases the market competition; thus, innovation and best strategic plans are required to add value to the products. One of the basic strategies easily applied is improving the current supply chain performance. Supply chain performance is a system designed to measure and determine the company's achievement performance level (Mufaqih et al., 2017). This measurement is critical for the company to control and monitor the system in operation currently in operation. Furthermore, regular measurements enable the companies to acquire their latest supply chain conditions, determine the improvement direction, and create a profitable competitive advantage (Saleheen et al., 2018).

Based on a survey in 2021 in Batu City, about 30 small and medium enterprises (SMEs) of potato chips were still active with different scale of business and products (Kusumaningtyas et al., 2021). A high market competition has prompted several obstacles requiring the best development strategy as measures. Clustering is an alternative strategy to increase productivity and determine an effective business development strategy (Fleischmann et al., 2017).

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Based on the existing conditions in 2020-2021, a survey was conducted on 30 potato chip producers, showing that 9 SMEs could be further classified according the clustering criteria. The criteria comprised of average turnover, production capacity, number of workers, duration of operation SMEs, and ownership of product halal certification, which divided those SMEs into two business clusters of small and micro scale (Wahdania et al., 2021). Small-scale cluster SMEs consisted of A, B, E, and I, while micro-scale cluster SMEs were C, D, F, G, and H.

The clustering formation for agroindustry still could not optimize the potential of SMEs where the supply chain institutional performance is lacking (Meliala et al., 2014). The survey results from 2 clusters of potato chip SMEs showed that they had obstacles in their production process, particularly an imbalance between the sales numbers and the productivity. From the third trimester of 2020 until the end of 2021, the average production of potato chips in the clusters was 500 kg/month, with average sales of 200-300 kg/month. The covid-19 pandemic factor was reported as the root cause of limited market access and sales. Such condition triggered a significant reduction in consumption and consumer purchasing power, hence reducing the SMEs performance. Therefore, several SMEs experienced huge losses and were out of business operation.

The first trimester of 2022 showed that those two potato chips clusters had increased production process due to the increased yet fluctuating for potato chips demand. During this recovery period, SMEs owners need to gradually improve their efficiency, allowing them to expand and maintain production continuity. This can be done by evaluating the performance of current supply chain institutions. In any industry, winning the market competition means developing and implementing a sustainable supply chain institutions (Mukhsin, 2021). The performance measurements should be continuously done to identify and investigate the cause of inefficiency which then can be immediately recognized and mitigated. These are expected to improveme the supply chain institutional performance. The efficiency of supply chain's institutional performance can be measured using the Data Envelopment Analysis (DEA) method. This method can measure the efficiency of decision-making units (DMUs) by using input and output variables. As a relative efficiency measurement tool, the DEA method can provide clear boundaries; thus, efficient and inefficient DMUs can be easily distinguished.

This study analyzed the activities of supply chain actors from the main supplier to potato chips SMEs. Two clusters of potato chip SMEs in Batu City were used as objects for this research. Determining the number of (DMUs was based on clusters that have been formed and the existing conditions of the potato chips production process in early 2022. The measurement outputs showed the DMU efficiency value and provided recommendations for improving inefficient DMUs. This study aimed to analyze the efficiency performance value and the sub-variables input with the most influence on supplier efficiency performance in the potato chip SMEs clusters.

Research Methods

This research was conducted on the potato chip SMEs clusters located in Batu City, East Java. This study used two types of data: primary data (i.e., input and output variable values) and secondary data (i.e., relevant data from literature studies). The input variables were obtained from observations and interviews with expert respondents (i.e., SMEs owners, and employees in the production and raw material handling). While, the output variable data were obtained from calculations using mathematical formulas. In this study, input and output variable data used were the average value of the supply chain activity during March 2022. The strategy proposed for performance improvement was designed only based on the value obtained from the analysis results.

This study used Data Envelopment Analysis (DEA) approach with the CCR model and Constant Return to Scale (CRS) assumptions. With CRS assumption, the inputs changes were considered to affect outputs proportionally. This means that the ratio between the addition or reduction of inputs and outputs must be linear, and all DMUs were considered to operate at optimal capacity (Amdahl and Soares, 2021). In this case, the measurement focused on the supply chain flow from suppliers to SMEs. The analysis was carried out based on input orientation, where the calculation was done using Banxia Frontier Analyst 4.0 software. The input-oriented DEA-CCR model aimed to measure and evaluate the relative efficiency of all DMUs by using the inputs without reducing the value of the outputs.

Decision making unit (DMU)

DMU is a collection of decision-making units from input data processing Results. DMU in DEA is a resource or object that becomes a unit for measurement (i.e., an individual unit, a group of individuals, a business, a bank, a school, etc.) depending on the scope of the system being studied (Mandal and Dastidar, 2014). In this study, the measured DMUs were 9 SMEs in the potato chip cluster in Batu City to their suppliers (Karina et al., 2021). DMU classification is shown in Table 1.

Input-output variables

Input and output variables used in this study were based on the performance measurement attributes of the Supply Chain Operation Reference (SCOR) method. SCOR is a systematic method based on performance measurement, process modeling, and best practice implementation (Camargo et al., 2013). The SCOR model measures performance that can provide direction on increasing supply chain efficiency (Prakash et al., 2013). In this study, the SCOR attributes used as input and output variables include responsiveness, agility, and reliability. The determination and elaboration of the input and output variables can be seen in Table 2.

Table 1. DMU classification

DMU type	Industry Cluster	DMU
SME A	Small	DMU 1
SME B	Small	DMU 2
SME C	Micro	DMU 3
SME D	Micro	DMU 4
SME E	Small	DMU 5
SME F	Micro	DMU 6
SME G	Micro	DMU 7
SME H	Micro	DMU 8
SME I	Small	DMU 9

Table 2. Research input-output variables

Variable name	Criteria Sub-variable	Symbol	Measuring unit	Variable type	Description
Responsi-veness	Cash to Cash Cycle Time	CCCT	Day	Input	SMEs money turnover time (i.e., payment or repayment of products or raw materials from SMEs to suppliers) (Praharsi et al., 2021)
	Lead Time	LT	Day	Input	The time needed by a supplier to fulfill product order requests from SMEs (in one order) (Alad and Deshpande, 2014)
Agility	Flexibilty	F	Day	Input	The average time needed by a supplier to respond to the supply chain when there is an unexpected change in an order from SMEs (i.e., adding or reducing the number of orders) (Yusuf and Shehu, 2017)
Reliability	Quality Standard Compliance	QSC	%	Output	The percentage value of conformity with the standard of raw materials received (Bubun et al., 2018)
	Order Fulfilment	OF	%	Output	The percentage value of raw materials order fulfillment that must be fulfilled without waiting time (Habsari et al., 2020)
	Delivery Performance	DP	%	Output	The percentage value of timeliness in the delivery of raw materials orders (according to the agreed date) (Anand and Grover, 2015)

The values of the output sub-variable were used in measuring supply chain institutional efficiency for the clusters of potato chip agroindustry, which was calculated using the following formula:

1. Percentage of Quality Standard Compliance (QSC)

$$\frac{\text{Commodity Accepted} - \text{Commodity Rejected}}{\text{Total product receipts}} \times 100\% \text{.......(1)}$$

2. Percentage of Order Fulfilment (OF)

$$\frac{\text{Number of requests fulfilled}}{\text{Total orders}} \times 100\% \text{........................ (2)}$$

3. Percentage of Delivery Performance (DP)

$$100\%\text{-}\left(\frac{\text{Acceptance Date} - \text{Agreement Date}}{\text{Lead Time}}\right) \times 100\% \text{................(3)}$$

Calculation of efficiency value

The calculation of the efficiency performance value is carried out to determine the relative efficiency value of each DMU with the aim of minimizing the use of input sub-variables in the supply chain and to find out the efficient DMU as a reference for improving other inefficient DMUs. In this study, analysis was carried out using the CCR-I Dual from Data Envelopment Analysis (DEA) approach. Systematically, the linear equation of the objective function can be written as follows (Anggela and Prajitno, 2012):

$$\text{Minimum } Z_k = \theta_k - \varepsilon \left(\sum_{r=1}^{m} S_r + \sum_{i=1}^{m} S_i\right) \text{........ (4)}$$

Subject to (Constraint Function):

(i) $\theta_k X_{ij} - S_i - (\sum_{i}^{n} X_{ij}\lambda_j) = 0$ .... (5)

(ii) $(\sum_{r=1}^{n} Y_{rj}\lambda_j) - Y_{rj} - S_r = 0$........................... (6)

$X_{ij}, Y_{rj} \geq 0$

$S_i\ ,\ S_r \geq 0$

$\lambda_j \geq 0$

Where:

Z_k = DMU relative efficiency value (CRS)

θ_k = optimized DMU relative efficiency value

ε = very small positive value ($1\text{x}10^{-6}$)

S_r = slack value of output

S_i = slack value of input

Y_{rj} = value of the r-th output used in the j month

X_{ij} = the i-th input value used in the j month

λ_j = j-th activity for input and output of each DMU (weight of j-th month variable)

i = input sub-variable index; i=1 (cash-to-cash-cycle time); i=2 (lead time); i=3 (flexibility)

j = planning period supply chain period (j=1,2,.....n)

The above of model works by comparing (i.e., benchmarking) the efficiency value of each DMU with the optimal DMU efficiency to achieve the objective function.

Interpretation of DEA calculation results

The DMU conditions measured by DEA can be identified and recognized from the output description in the Banxia Frontier Analyst 4.0 Software. In general, several colors and conditions can describe the DEA results; for instance, Red with a score ranging from 0-89.9% (i.e., inefficient), Amber with a score ranging from 90-99.99% and 100% (i.e., marginally efficient), and Green with a score of 100% (i.e., efficient) (Hussain and Jones, 2022).

Sensitivity analysis

Sensitivity analysis was used to evaluate what variables can be changed in value without causing changes to the optimal solution (i.e., efficiency value) previously achieved. The main purpose of sensitivity analysis is to improve how a project or activity is carried out. Thus, it can reduce the risk of loss by providing preventive and corrective actions. The sensitivity analysis stage is conducted by observing any changes in the efficiency score of a DMU (Lathifah and Atmanti, 2013). The implementation was done by omitting one of the input or output variables used interchangeably or eliminating the efficient DMUs obtained from DEA results (Azimian et al., 2013). Variables that can affect the changes in the efficiency values need more attention to their application and treatment.

Recommendations for improvement of inefficient DMUs

The stages of improvement can be performed by taking into account the previous factors, as follows (Fauziah and Vaulina, 2020):

1. Adjust the actual value with the target value of each DMU contained in the Banxia Frontier Analyst Software output for the potential improvement section.
2. The previous sensitivity analysis results can be used as a reference to determine the input sub-variables values (i.e., cash-to-cash-cycle time, lead time, and flexibility) with a significant influence on each DMU efficiency value. Therefore, using these sub-variables should be put into more consideration.

Results and Discussion

Supply chain structure of potato chips agroindustry cluster

The supply chain is built to increase product competitiveness by considering consumers' needs and satisfaction. The supply chain involves an integrated relationship of a systematic flow from producing raw materials and production to the final consumer (Huddiniah and Mahendrawathi, 2019). There are three system flows in the supply chain: (1) the financial flow that comes from downstream to upstream, (2) the product flow (i.e., raw materials) that comes from the upstream to downstream, and (3)is the information flow that comes from both directions (i.e., upstream to downstream and downstream to upstream). The illustration of the supply chain in clusters of potato chips SMEs (i.e., from suppliers to SMEs) is shown in Figure 1.

The supply chain activities carried out by potato chip SMEs clusters in Batu City involved suppliers and manufacturers (i.e., potato chips SMEs). These two links in the supply chain institutional system have different roles and tasks, including:

Supplier

The supplier is the first chain where product distribution begins and provides primary raw materials in supply chain activities (Bilgin et al., 2021). In this study, potato farmers and collectors are the main suppliers of raw potatoes to the potato chip SMEs. Each SMEs cooperates with one or several suppliers to meet their raw material needs. The suppliers were generally local suppliers from Batu City, such as Sumber Brantas and Jurang Kuali areas. However, under certain conditions, some SMEs also cooperate with regional suppliers from outside Batu City, such as Ngadas Region (Tengger and Bromo, Poncokusumo-Malang District), Karangploso (Malang), Wonosalam (Jombang), Wonosobo (Central Java), and the Dieng Plateau (Central Java). The procurement of potatoes from regional suppliers was to fulfill outstanding stocks. Several SMEs consider the standard quality and price when using regional suppliers. In the supply chain system, the selection of raw materials suppliers must be considered because it can affect the effectiveness of the supply chain activities (Lau et al., 2019).

Activities in the supply chain include transferring information flow from suppliers to SMEs and vice versa. The flow of information includes the latest price of potatoes, potato's production capacity, and the quality of potatoes. Based on the information flow, the flow of products emerges, including the delivery of potatoes from suppliers to SMEs following the agreed time and the potatoes' quantity and quality. In the supply chain system, suppliers act as partners with the resources (assets) needed by the industry (Patrucco et al., 2022). Therefore, the relationship between the industries and their suppliers must be maintained. Furthermore, the quality of raw materials supplied for production depends on the quality of the suppliers cooperating with the industries.

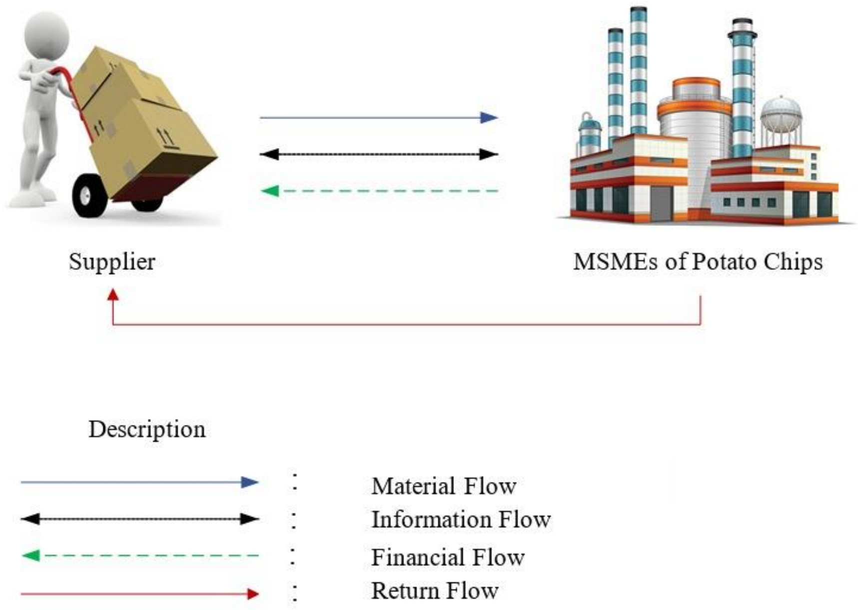

Figure 1. Illustration of supply chain conditions focused on the flow from supplier to SMEs

Manufacturer (Potato chips SMEs)

A manufacturer is a place to convert raw materials into final products in the form of finished or semi-finished products (Swierczek, 2019). In this study, the potato chip SMEs clusters act as a manufacturer or processing industry that processes raw potatoes into cooked and semi-finished potato chips and sends them to retailers to be marketed.

In the supply chain system, the behavior pattern of producers (manufacturers) is influenced by the relationships between suppliers and retailers. Supply chain activities between suppliers and manufacturers include the flow of information, funds, and materials (Mohammadi and Mukhtar, 2018). The information flow from SMEs to suppliers includes the number of orders for raw potatoes with a certain quantity and quality and agreement on the date of receipt of raw materials. The products flow from companies (SMEs) to suppliers includes returned potatoes under quality standard or the order requirement criteria. The financial flow occurs after fulfilling the orders, namely the payment of the potatoes purchased by the company (SME) to the supplier. The payments of raw materials in several SMEs were made in cash or credit.

Supply chain efficiency performance analysis using DEA

The actual data of input and output variables used in this study are shown in Table 3. The analysis results of supply chain institutional efficiency performance value of each DMU in the potato chips SMEs cluster in Batu City are shown in Table 4.

The results show that one DMU has a 100% with the green condition of efficiency performance value, namely DMU 6. The green condition indicates that the measured DMU is optimal or has reached a perfect efficiency level. Thus, the supply chain activities are considered safe and follow the objectives. The achievement of efficient performance in DMU 6 is due to short cash-to-cash-cycle time, lead time, and flexibility input sub-variables. DMU 6 bought potatoes from suppliers in Karangploso Market, close to the production site. Thus, the orders, payments, and delivery of potatoes can be done quickly. The shorter payment cycle (i.e., cash-to-cash-cycle time) of potatoes can enhance the supply chain efficiency performance (Praharsi et al., 2022).

Inefficient supply chain performance in other DMUs with amber conditions were DMU 1, DMU 3, DMU 4, DMU 7, and DMU 8, while red condition was DMU 2, DMU 5, and DMU 9. DMUs classified in amber condition were considered less efficient despite their efficiency value being close to optimal (i.e., 99.9% - 100.0%). The amber condition indicates that DMUs have less risks, thus improvements needed could be done quickly and precisely. The red condition means that DMUs have high risks, thus prompt and appropriate management actions are needed for improvement. The amber and red conditions are influenced by the use of high flexibility and cash-to-cash-cycle time, followed by lead time. Based on the existing condition of the SMEs cluster, most of the payments or cash-to-cash-cycle time for potatoes are made by consignment. Most SMEs bought potatoes from middlemen with credit or debt (notes) payment after order completed. This often happens because of their limited funds (Wahyudi, 2019).

Table 3. Input-output variable actual data

DMU	Input Variables			Output Variables		
	Responsiveness		Agility	Reliability		
	Cash to Cash Cycle Time (Day)	Lead Time (Day)	Flexibility (Day)	Quality Standard Conformance (%)	Order Fulfillment (%)	Delivery Performance (%)
DMU 1	30	2	1	99.98	100	100
DMU 2	14	3	2	100	100	100
DMU 3	45	1	1	100	100	100
DMU 4	14	2	1	99.93	66.67	50
DMU 5	30	3	2	99.75	100	83.34
DMU 6	1	1	1	100	100	100
DMU 7	30	2	1	99.88	66.67	50
DMU 8	1	2	2	100	100	100
DMU 9	10	2	2	100	100	83.33

Table 4. Performance value of supplier flow efficiency to SMEs

DMU	Variables	Sub-variables	Actual	Target	Unit	TE (%)	Condition	Information
1		CCCT	30	1	Day			
	Input	LT	2	1	Day			
		F	1	1	%	100.0	Amber	Marginally Efficient
		QSC	99.98	100	%			
	Output	OF	100	100	%			
		DP	100	100				
2		CCCT	14	1	Day			
	Input	LT	3	1	Day			
		F	2	1	%	50.0	Red	Inefficient
		QSC	100	100	%			
	Output	OF	100	100	%			
		DP	100	100				
3		CCCT	45	1	Day			
	Input	LT	1	1	Day			
		F	1	1	%	100,0	Amber	Marginally Efficient
		QSC	100	100	%			
	Output	OF	100	100	%			
		DP	100	100				
4		CCCT	14	1	Day			
	Input	LT	2	1	Day			
		F	1	1	%	99.9	Amber	Marginally Efficient
		QSC	99.93	100	%			
	Output	OF	66.67	100	%			
		DP	50	100				
5		CCCT	30	1	Day			
	Input	LT	3	1	Day			
		F	2	1	%	50,0	Red	Inefficient
		QSC	99.75	100	%			
	Output	OF	100	100	%			
		DP	83.34	100				
6		CCCT	1	1	Day			
	Input	LT	1	1	Day			
		F	1	1	%	100.0	Green	Efficient
		QSC	100	100	%			
	Output	OF	100	100	%			
		DP	100	100				
7		CCCT	30	1	Day			
	Input	LT	2	1	Day			
		F	1	1	%	99.9	Amber	Marginally Efficient
		QSC	99.88	100	%			
	Output	OF	66.77	100	%			
		DP	50	100				
8		CCCT	1	1	Day			
	Input	LT	2	1	Day			
		F	2	1	%	100.0	Amber	Marginally Efficient
		QSC	100	100	%			
	Output	OF	100	100	%			
		DP	100	100				
9		CCCT	10	1	Day			
	Input	LT	2	1	Day			
		F	2	1	%	50.0	Red	Inefficient
		QSC	100	100	%			
	Output	OF	100	100	%			
		DP	83.33	100				

Note: DMU can be less efficient because it is in amber condition even though it has an efficiency value close to optimal, namely 99.9% and 100.0%. The amber condition indicates that the DMU still has risks so improvements are needed shortly which must be done quickly and precisely.

From the company's viewpoint, the lead time for order fulfillment is the time interval needed to wait for raw materials, from the order placement to order received (Alad and Deshpande, 2014). Potato suppliers need leasd time to sort, pack, prepare, and deliver products to meet the SMEs demands. The suppliers' ability to respond the demand changes in the supply chain is called flexibility, which is the key to running a business with a competitive advantage (Yusuf and Shehu, 2017). Therefore, a company with a higher flexibility may achieve higher performance and profitability.

Sensitivity analysis

The sensitivity analysis results in Table 5 show that flexibility in delivering raw materials greatly influences supplier efficiency performance in the potato chips SMEs clusters. Flexibility is one of the indicators in supply chain risk management, which accommodates the uncertainty of internal and external changes with the potential to disrupt business operations (Jafari et al., 2022). Each supply chain may produce different flexibility. A company with much higher demand uncertainty needs a supply chain with more flexibility to survive and compete with competitors (Tama et al., 2019).

Sub-variable input of cash-to-cash-cycle time also influences the flow efficiency from the suppliers to SMEs clusters. This is indicated by a decrease in the efficiency value of DMU 8 from 100.0% (i.e., amber condition) to 50.0% (i.e., red condition). From the supplier's viewpoint, cash-to-cash-cycle time is when a company must pay for raw materials ordered. This input variable consideration may affect the financial flow between suppliers and SMEs and the production sustainability. This relates to the procurement of raw materials by SMEs (or DMUs). A much shorter time required to complete the payment indicates that the supply chain performance is better and more efficient. Figure 2 shows spider diagrams that compare between the original value and sensitivity analysis.

Potential improvement

The measurement of supply chain performance from supplier to SMEs shows that 1 DMU was under efficient conditions and 8 other DMUs were in inefficient conditions. The existing DMU under efficient condition (i.e., DMU 6) was not included in the potential improvement category. In detail, the potential improvement based on input orientation for each DMU with inefficient condition (i.e., DMU 8) can be seen in Table 6.

Table 6 shows two values with a negative sign (-) and zero value (0). A negative sign (-) means that input sub-variables must be reduced to produce a constant output in achieving optimal or efficient conditions. While a zero value (0) means there is no need to add or subtract input sub-variables because these conditions are sufficient for producing optimal output with efficient performance

Table 5. Sub-variable sensitivity analysis of supplier flow input to SMEs

			Omitted Input Sub-variable								
DMU	**Initial Value Efficiency (%)**	**Initial Condition**	**Cash-to-Cash-Cycle Time (%)**	**Condition**	**Decrease (%)**	**Lead Time (%)**	**Condition**	**Decrease (%)**	**Flexibility (%)**	**Condition**	**Decrease (%)**
1	100.0	Amber	100.0	Amber	0	100.0	Amber	0	50.0	Red	50
2	50.0	Red	50.0	Red	0	50.0	Red	0	33.3	Red	16.7
3	100.0	Amber	100.0	Green	0	100.0	Amber	0	100.0	Amber	0
4	99.9	Amber	99.9	Amber	0	99.9	Amber	0	50.0	Red	49.9
5	50.0	Red	50.0	Red	0	50.0	Red	0	33.3	Red	16.7
6	100.0	Green	100.0	Green	0	100.0	Green	0	100.0	Green	0
7	99.9	Amber	99.9	Amber	0	99.9	Amber	0	49.9	Red	50
8	100.0	Amber	50.0	Red	50	100.0	Amber	0	100.0	Amber	0
9	50.0	Red	50.0	Red	0	50.0	Red	0	50.0	Red	0

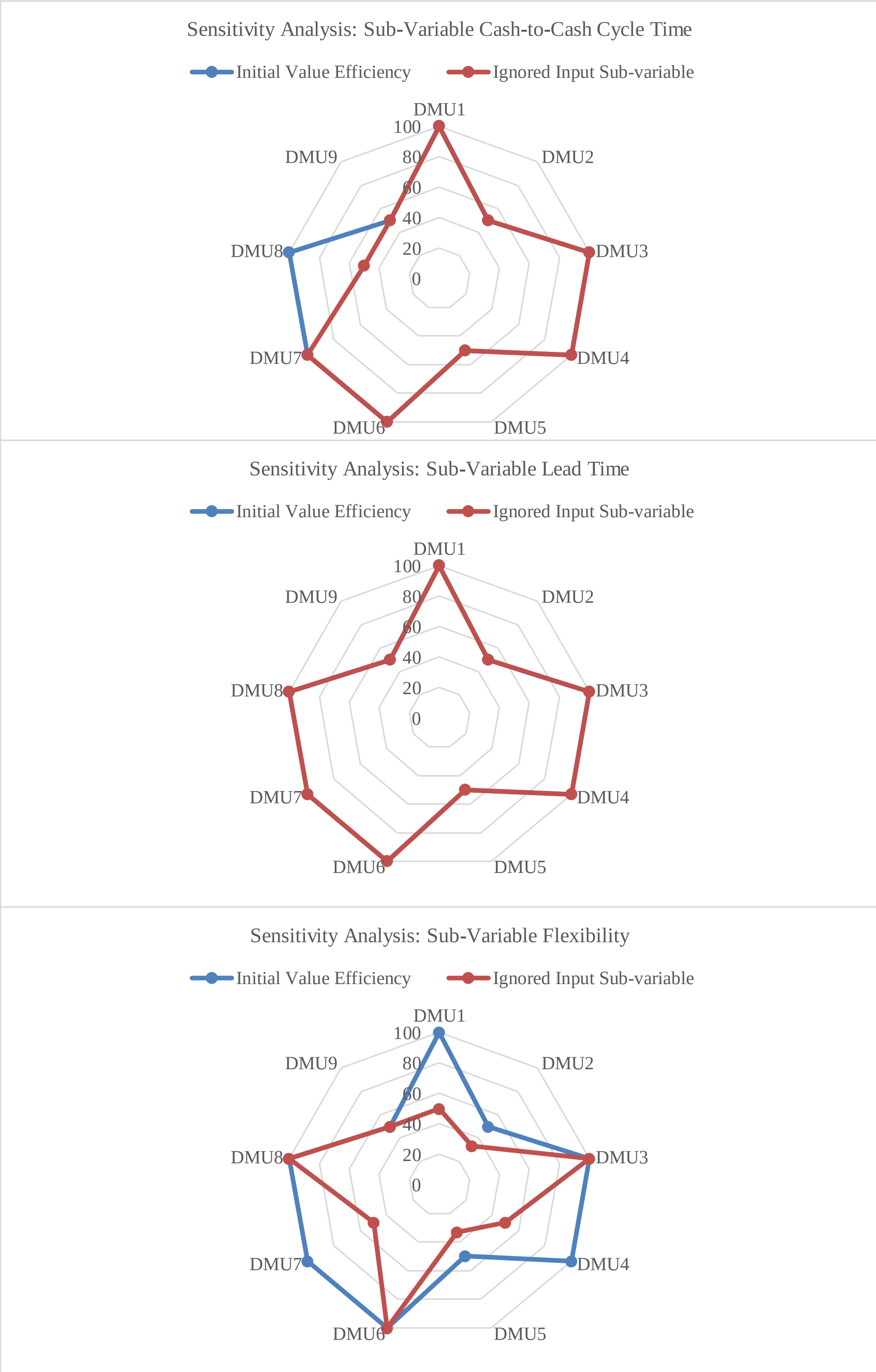

Figure 2. The Comparison between original value and sensitivity analysis

Table 6 also indicates that the average DMU in the potato chips SMEs' supply chain can operate efficiently if the input variables of cash-to-cash-cycle time, lead time, and flexibility are 1 day from the order time received or confirmed. The value of the target input variable in each DMU must be maintained and evaluated periodically to achieve a long-term efficient state.

The value of potential improvement achieved by DMUs if the whole can run efficiently is called total potential improvement. The output of the total potential improvement value for the main supplier flow to SMEs is represented in a pie chart, as shown in Figure 3. All DMUs can operate efficiently with 100.00% (i.e., green conditions) based on the input orientation. Therefore, it is necessary to improve each input variable, including reducing the cash-to-cash-cycle time value to 41.82%, accompanied by a decrease in lead time and flexibility by 24.17% and 12.62%, respectively.

Table 6. Potential improvement of supplier flow to SMEs

DMU	Factor	Performance Metrics	Actual (Day)	Target (Day)	Slack Movement (Day)	Potential Improvement (%)
1	Input Variable	CCCT	30	1.00	-29.00	-96.67
		LT	2	1.00	-1.00	-50.00
		OF	1	1.00	0.00	0.00
2		CCCT	14	1.00	-13.00	-92.86
		LT	3	1.00	-2.00	-66.67
		OF	2	1.00	-1.00	-50.00
3		CCCT	45	1.00	-44,.00	-97.78
		LT	1	1.00	0.00	0.00
		OF	1	1.00	0.00	0.00
4		CCCT	14	1.00	-13.00	-92.86
		LT	2	1.00	-1.00	-50.04
		OF	1	1.00	0.00	-0.07
5		CCCT	30	1.00	-29.00	-96.67
		LT	3	1.00	-2.00	-66.67
		OF	2	1.00	-1.00	-50.00
7		CCCT	30	1.00	-29.00	-96.67
		LT	2	1.00	-1.00	-50.06
		OF	1	1.00	0.00	-0.12
8		CCCT	1	1.00	0.00	0.00
		LT	2	1.00	-1.00	-50.00
		OF	2	1.00	-1.00	-50.00
9		CCCT	10	1.00	-9.00	-90.00
		LT	2	1.00	-1.00	-50.00
		OF	2	1.00	-1.00	-50.00

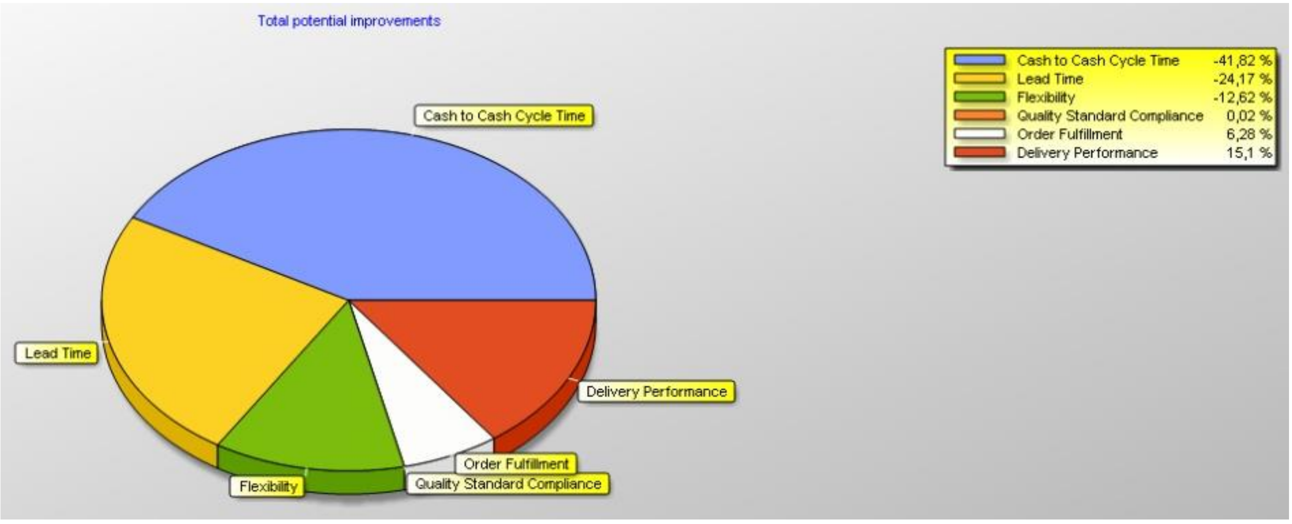

Figure 3. Total potential improvement

Managerial implication

The supply chain institutional performance results show that each DMU measured has a different efficiency level, whether it is efficient or inefficient. The measurement was based on each DMU's actual value and target value. Then, the best efficiency value was sought to be used as a comparison or benchmarking in improving the performance of inefficient DMUs. Based on the analysis results, improvements can be made by reducing the actual value of each input sub-variable and accompanied by improvements to the supply chain management system. In the supply chain of suppliers to SMEs, it can be done by the following measures:

1. Shortening the payment time of raw materials (i.e., cash-to-cash-cycle time) to suppliers (i.e., before the maximum payment deadline),
2. Organizing the number of raw material orders by applying consumer demand forecasting methods to accelerate the turnover time of raw materials,
3. Developing an integrated information system to reduce the lead time for raw material procurement.

Therefore, suppliers and SMEs must meet and accommodate all demands by integrating their resources to increase flexibility. The efficiency performance value of 100.00% is achieved by shortening the payment time for raw materials to 1 day after receiving the orders. Supply chain performance could be better if a shorter time is needed to settle raw material payments. This may affect the production process as it relates to SMEs' procurement of raw materials.

Conclusions

The supply chain institutional performance measurement of two potato chip SMEs clusters shows that the efficiency performance of 8 DMUs (SMEs) was not optimal (i.e., inefficiency) with the value of 88.89% (i.e., amber condition of 55.56% and red condition of 33.33%). The findings confirmed that only 1 DMU (i.e., DMU 6) had the optimal efficient performance of 100% (i.e., green condition). The results also indicate that the sub-variable with significant impacts on the supplier efficiency performance was the flexibility of sending raw materials, followed by cash-to-cash-cycle time. Using the most influential sub-variables must be considered to improve efficiency performance in the current supply chain system. Further research on adding more DMU to increase the number of comparisons is suggested to provide more accurate information ton their performance or efficiency.

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Declarations

Conflict of interests The authors declare no competing interests.

References

Alad, A. H., and Deshpande, V. A. (2014) 'A review of various tools and techniques for lead time reduction', *International Journal of Engineering Development and Research*, 2(1), pp. 1159-1164

Amdahl, J., and Soares, C. G. (2021) *Developments in the Analysis and Design of Marine Structure*. CRC Press: New York.

Anand, N., and Grover, N. (2015) 'Measuring retail supply chain performance', *Benchmarking: An International Journal*, 22(1), 135-166

Anggela, P., and Prajitno, I. S. (2012) Model Pemilihan Supplier dengan Menggunakan Data Envelopment Analysis (DEA) dan Teknik Data Mining (Supplier Selection Model Using Data Envelopment Analysis (DEA) and Data Mining Techniques). Undergraduate Thesis. Universitas Indonesia, Depok [In Indonesian]

Azimian, M., Badri, M., and Javadi, H. (2013) 'Sensitivity analysis of projects efficiency in a multi-project environtment based on data envelopment analysis', *International Journal of Engineering Sciences*, 2(7), pp. 259-265

Bilgin, M. H., Danis, H., and Demir, E. (2021) 'Eurasian business and economics perspectives', *Proceedings of the 30th Eurasia Business and Economics Society Conference*, pp. 1-339

Bubun., Sukardi., and Suparno, O. (2018) 'Kinerja rantai pasok kedelai di kabupaten grobogan (Soybean supply chain performance in Grobogan district)', *Jurnal Aplikasi Bisnis dan Manajemen*, 4(1), pp. 32-43 [In Indonesian]

Camargo, M., Zanandrea, G., Pacheo, M. T. M., Malafaia, G., and Motta, M. E. V. (2013) 'Supply chain management operation reference (SCOR): Study bibliometric', *International Journal of Operations and Logistics Management*, 2(4), pp. 1-13

Directory of Small and Medium Industry Companies in Batu City (2020) *Data Industri Kecil Menengah Kota Batu 2006-2016* (*Batu City Small and Medium Industry Data 2006-2016*) [Online]. Available at: https://batukota.bps.go.id/statictable/2020/06/05/796/data-industri-kecil-menengah-kota-batu-2006-2016.html (Accessed on 07 March 2022). [In Indonesian]

Fauziah and Vaulina, S. (2020) 'Kinerja rantai pasok fillet ikan patin beku di Desa Koto Masjid Kecamatan XIII Koto Kampar Kabupaten Kampar (Studi kasus pada CV Graha Pratama Fish) (Supply chain performance of frozen catfish fillets in Koto Masjid Village, XIII Koto Kampar District, Kampar Regency (Case study at CV Graha Pratama Fish)', *Jurnal Agribisnis Indonesia*, 8(2), pp. 115-130 [In Indonesian]

Fleischmann, K., Welters, R., And Daniel, R. (2017) 'Creative industries and regional economic development: Can a creative industries hub spark new ways to grow a regional economy', *Australasian Journal of Regional Studies*, 23(2), pp. 217-242

Habsari, W., Mu'tamar, M. F. F., Jakfar, A. A. (2020) 'Analisis kinerja rantai pasokan ikan bandeng dengan metode data envelopment analysis (Studi Kasus UD. TBS) (Analysis of the performance of the milkfish supply chain using the data envelopment analysis method (UD. TBS Case Study))', *Journal of Productivity, Optimazion, and Manufacturing System*, 4(2), pp. 17-28

Huddiniah, E. R., and Mahendrawathi, E. R. (2019) 'Product variety, supply chain complexity and the needs for information technology: A Framework based on literature review', *International Journal of Operations and Supply Chain Management*, 12(4), pp. 245-255

Hussain A., and Jones, M. (2022) *An Introduction to Frontier Analyst 4* [Online]. Available at: https://banxia.com-pdf-FA-Wooorkbook-PDF-An-Introduction-to-Frontier-Analyst-4-Banxia-Software (Accessed on 09 April 2022)

Jafari, H., Ghaderi, H., Malik, M., Bernardes, E. (2022) 'The effect of supply chain flexibility on customer responsiveness: the moderating role of innovation orientation', *International Journal of Production Planning and Control The Management of Operations*, 1(1), pp. 1-19

Karina, S., Mustaniroh, S. A., Purwaningsih, I., and Santoso, I. (2021) 'Determination of the best formula to increase potato chips quality with the integration of consumer acceptance and laboratory testing', *IOP Conference on Green Agro-industry and Bioeconomy*, 924, pp. 1-10

Kusumaningtyas, O. W., Mustaniroh, S. A., Astuti, R., and Sucipto. (2021) 'Risk identification in potato chips production using supply chain operation model (SCOR)', *Journal of Advances in Engineering Research*, 212, pp. 27-33

Lathifah, H. K., and Atmanti, H. D. (2013) 'Analisis produktivitas sekolah menengah atas negeri (SMAN) di Kabupaten Semarang (Productivity analysis of state senior high schools (SMAN) in Semarang Regency)', *Diponegoro Journal Of Economics*, 2(2), pp. 1-8 [In Indonesian]

Lau, Y., Adolf, K. Y. N., and Alarid, J. A. (2019) *Principles of Global Supply Chain Management*. London: Anthem Press.

Mandal S., and Dastidar, S. G. (2014) 'A DEA investigation of efficiency of the indian general insurance during recession', *Journal of Advances in Management Reseach*, 11(1), pp. 115-136

Meliala, A. S., Nazaruddin, M., Rahmi, M. (2014) 'Strategi peningkatan daya saing usaha kecil dan menengah (UKM) berbasis kaizen (Strategy for increasing the competitiveness of small and medium enterprises (SMEs) based on kaizen)', *Jurnal Optimasi Sistem Industri*, 13(2), pp. 641-664 [In Indonesian]

Mohammadi, M., and Mukhtar, M. (2018) 'Comparison of supply chain process models based on servive oriented architecture', *International Journal of Technology*, 9(1), pp. 35-45

Mufaqih, I. A., Indarti, N., Ciptono, W. S., and Kartikasari, A. (2017) Pengaruh integrasi, berbagi informasi, dan penundaan pada kinerja rantai pasokan: Studi pada usaha kecil menengah batik di Indonesia (The influence of integration, information sharing, and delays on supply chain performance: A study on batik small and medium enterprises in Indonesia)', *Jurnal Siasat Bisnis*, 21(1), pp. 19-36 [In Indonesian]

Mukhsin, M. (2021) *Kerjasama dan Berbagi Informasi dalam Kinerja Rantai (Studi Kasus pada Para Pedagang Telor Ayam Ras di Kabupaten Pandenglang Provinsi Banten) Cooperation and Information Sharing in Chain Performance (Case Study of Purebred Chicken Egg Traders in Pandenglang Regency, Banten Province).* Bandung: Media Sains Indonesia. [In Indonesian]

Patrucco, A., Harland, C. M., Luzzini, D., Frattini, F. (2022) 'Managing triadic supplier relationships in collaborative innovation projects: A relational view perspective', *Supply Chain Management: An International Journal*, 27(7), pp. 108-127

Praharsi, Y., Jami'in, M. A., Suhardjito, G., Reong, S., and Wee, H. M. (2022) 'Supply chain performance for a traditional shipbuilding industry in Indonesia', *Benchmarking: An International Journal*, 29(2), pp. 622-663

Prakash, S., Sandeep, Soni, G., and Rathore, A. P. S. (2013) 'Supply chain operations reference (SCOR) model: An overview and a structured literature review of its application', *Proceeding International Conference on Smart Technologies for Mechanical Engineering*, pp. 55-62

Saleheen, F., Habib, M. M., and Hanafi, Z. (2018) ‘Supply chain performance measurement model’, *International Journal of Supply Chain management*, 7(3), pp. 70-78

Swierczek, A. (2019) ‘The role of manufacturer in supply chain transformation from intransitive into transitive triads: implicatons for the network rent’, *Supply Chain Management: An International Journal*, 24(4), pp. 445-468

Tama, I. P., Yuniarti, R., Eunike, A., Azlia, W., and Hamdala, I. (2019) *Model Supply Chain Agroindustri di Indonesia Studi Kasus Produk Singkong (Agro-industry Supply Chain Model in Indonesia Case Study of Cassava Products)*. Malang: UB Press. [In Indonesian]

Wahdania, N. Z., Mustaniroh, S. A., Santoso, I., and Purwaningsih, I. (2021) ‘Clustering of potato chips SMEs in Batu City, Indonesia’, *IOP Conference Series: Earth and Environmental Science*, 924, pp. 1–6

Wahyudi, S. T. (2019) *Mengembangkan Daya Saing Industri Kecil dan Menengah Berbasis Ekonomi Klaster (Developing the Competitiveness of Small and Medium Industries Based on Cluster Economy)*. Malang: Media Nusa Creative. [In Indonesian]

Yusuf, R., and Shehu, A. U. (2017) ‘The review of supply chain management system and firm performance’, *International Journal of Management Research and Reviews*, 7(2), pp. 113-122