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STUDY OF TECHNICAL EFFICIENCY OF THE COCOA INDUSTRY USING DATA ENVELOPMENT ANALYSIS

Estudio de eficiencia técnica de la industria del cacao utilizando análisis envolvente de datos

Estudo de eficiência técnica da indústria de cacau utilizando análise envolvente de dados

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ABSTRACT
The processed cocoa agroindustry is entering a new phase of hypercompetitive business where all companies focus on becoming low-cost producers. The problem becomes complex, with the tendency to decrease business units yearly. This study aims to determine which decision-making units (DMUs) have technical efficiency in producing processed cocoa products sustainably. Researchers used purposive sampling to determine research locations, questionnaires and interviews to collect data, and Data Envelopment Analysis (DEA) to analyze data. The study results show that all DMUs produce different percentages of technical efficiency, so they are categorized into three types: high, medium, and low. The score distribution shows thirty efficient DMUs and seven inefficient DMUs. In order to achieve operational efficiency and stability of DMU, it is necessary to improve the allocation of cocoa raw material input, labor costs, and industrial capital input. The conclusion is that industrial efficiency has a vital role in the existence of DMU if it can pay attention to the quality and quantity of production at an optimal efficiency scale and can meet domestic and export demand so that it is competitive in global markets.

KEYWORDS
Cocoa agroindustry, industrial efficiency, data envelopment analysis.

RESUMEN
La agroindustria del cacao procesado está entrando en una nueva fase de negocios hipercompetitivos donde todas las empresas se enfocan en convertirse en productores de bajo costo. El problema es complejo, con tendencia a disminuir las unidades de negocio anualmente. Este estudio tiene como objetivo determinar qué unidades de toma de decisiones (DMU por sus siglas en inglés) tienen eficiencia técnica para producir productos de cacao procesados de manera sostenible. Para ello, utilizamos muestreo intencional para determinar las ubicaciones de la investigación, cuestionarios y entrevistas para recopilar datos y Análisis Envolvente de Datos (DEA) para analizar los datos. Los resultados del estudio muestran que todas las DEA producen diferentes porcentajes de eficiencia técnica, por lo que se clasifican en tres tipos: alta, media y baja. La distribución de puntaje muestra treinta DMU eficientes y siete DMU ineficientes. Para lograr la eficiencia operativa y la estabilidad de la DMU, es necesario mejorar la asignación de insumos de materia prima de cacao, los costos de mano de obra e insumos de capital industrial. La conclusión es que la eficiencia industrial cumple un papel vital en la existencia de DMU si puede prestar atención a la calidad y cantidad de producción en una escala de eficiencia óptima, y así poder satisfacer la demanda interna y de exportación para que sea competitivo en los mercados globales.

PALABRAS CLAVE
Agroindustria del cacao, eficiencia industrial, análisis envolvente de datos.

RESUMO
O agronegócio do cacau processado está entrando em uma nova fase de negócios hipercompetitivos, onde todas as empresas se concentram em tornar-se produtoras de baixo custo. O problema é complexo, com tendência à redução anual de unidades de negócio. Este estudo visa determinar quais unidades de toma de decisões (DMUs por sua sigla em inglês) possuem eficiência técnica para produzir produtos de cacau processados de forma sustentável. Para isso, usamos amostragem proposital para determinar locais de pesquisa, questionários e entrevistas para coletar dados e Análise Envoltória de Dados (DEA) para analisar os dados. Os resultados do estudo mostram que todos os DEAs produzem diferentes percentuais de eficiência técnica, por isso são classificados em três tipos: alto, médio e baixo. A distribuição de pontuação mostra trinta DMUs eficientes e sete DMUs ineficientes. Para alcançar a eficiência operacional e a estabilidade da DMU, é preciso melhorar a alocação de insumos de matéria-prima do cacau, os custos trabalhistas e insumos de capital industrial. A conclusão é que a eficiência industrial desempenha um papel vital na existência da DMU se puder prestar atenção à qualidade e quantidade da produção numa escala de eficiência ótima, e assim puder satisfazer a procura interna e de exportação para a tornar competitiva nos mercados globais.

PALAVRAS-CHAVE
Agroindústria do cacau, eficiência industrial, análise envolvente de dados.

Introduction

The World Cocoa Foundation states that the global demand for cocoa has been three percent yearly for the last three years. It is estimated that global cocoa demand will continue to increase every year. Given that Indonesia is one of the major producers and exporters of cocoa, this might put it in an advantageous position (Indonesia-Investment, 2022). The role of cocoa in the national economy, as a provider of various fields of employment and a source of foreign exchange, is the most significant contribution to sources of income. Cocoa has a role in encouraging the development of agroindustry and the development of a region. Sukardi (2011) explains that the agroindustry's function and role have a significant meaning, significantly when associated with perishable agricultural products. Agro-industrial activities, as well as industrial activities, generally encourage the growth and development of various economic activities, including the provision of employment, financial transactions, and product marketing activities.

Based on AIKI data, cocoa bean exports in January-November 2018 reached US$71.67 million, or an increase of 39.81% compared to exports in the same period the previous year of US$51.26 million. Increasing cocoa bean production is not only important for the domestic cocoa processing industry, but also for exports. In fact, The International Cocoa Organization estimates that global cocoa demand will increase to 4 million tons/year in the future. In the context of globalization and economic challenges, efforts to increase cocoa production are needed to meet the country's income, development and foreign exchange needs.

East Java, as one of the processed cocoa producers in Indonesia, has a high opportunity to continue to develop the processed cocoa agroindustry. The availability of cocoa beans can be the principal capital in increasing the production of processed cocoa at an intermediate level, namely in cocoa butter, cocoa powder, and cocoa paste. The East Java processed cocoa industry obtains raw materials for cocoa beans, though most cocoa cultivation comes from smallholder plantations. Geographically, East Java has land suitability for cocoa cultivation and agro-climatic conditions regarding altitude, rainfall, and soil profile. Cocoa planting is spread from Pacitan, Madiun, Blitar, and Jember to the Banyuwangi districts. This sector involves many small and medium industries.

Central government policies such as Minister of Finance Regulation No. 67/PMK are reformulated.011/2010 concerning the Determination of Cocoa Export Duty has not had a significant impact on the development of the processed cocoa industry, with many companies trying to get back up, but most have gone bankrupt. In 2017 it was discovered that 68 business units were recorded by the East Java Provincial Office of Industry and Trade; two years later, it decreased to 53 business units. 2020 was a success for this sector to rise with the emergence of micro-businesses in the processed cocoa industry, so there were 84 business units recorded. Not even a year has passed since this agroindustry was confronted with a pandemic outbreak that has shaken the national and even world economies so that its existence faces the problem of the raw material procurement cycle, which is hampered by the problem of product delivery for the consumption of exporters. So that in mid-2022, it is known to have dropped dramatically by 37 business units.

The fundamental problem of the processed cocoa industry is the demand for survival and competitiveness through a series of efficient production actions. Arbelo et al (2020) define efficiency as the company's efforts to produce optimal output at the lowest possible cost. Efficiency is one of the crucial indicators in testing the industry's ability to survive and be competitive. In this context, allocate resources carefully and efficiently to produce optimal production levels from the limited resources available. Harya et al. (2020) and Indah et al. (2018) reminded us that the constraints that need to be considered by the cocoa processing industry are whether raw materials are sufficient, what is the available machine capacity, and whether available direct labor hours are fulfilled. Amankwah-Amoah et al. (2018) clarified that even though the cocoa industry is the leading sector in Ghana, its sustainability will be threatened along with a decrease in the quality of the supply of cocoa beans. Sriwana (2013) agrees with the results of Sriwana's research, namely that it is known that the capacity utilization of the processed cocoa industry, especially in cacao butter products, could be more optimal, not due to the processes in the industry. It is proven by the high value of factory efficiency, which reaches 96%, so other problems may need to be the more optimal use of factory capacity so that it can be used as material for further research.

Permatasari and Setyawan (2019) obtained results that the efficiency value below one hundred percent indicated that the performance of the three MSMEs was still low due to the large enough burden on the workforce so that work could have been more optimal. Not achieving an optimal workforce will increase operating capital and overall capital used, resulting in decreased company profits. The results of Goyal et al. (2018) show that the Indian textile industry is inefficient and has enormous scope for improvement in terms of efficiency. It also confirms the existence of differences in the production function between industrial sub-sectors. In producing cotton, blended yarns, made fibers, fabrics, and others, the meta-frontier is the most efficient approach to garment production. Adittionally, Patel et al. (2022) concluded that by using the total factor productivity function and ROA, higher production efficiency is positively associated with an increase in received ROA, and Hosseini and Stefaniec (2019) found low efficiency among Iranian refineries and showed a significant negative relationship between overall efficiency scores and those produced at the refineries.

Florez et al. (2012) concluded that using the DEA model can maximize the export results obtained from the input level. Besides, Saputra (2014) examined the level of technical efficiency and export performance of the Indonesian manufacturing sector and found significant efficiency increases in 6 of 23 industries (including the tobacco, chemical, iron, and steel, machinery (non-electrical), machine (electrical), and transportation equipment). Sadaf and Ishaq (2018) concluded that the average technical efficiency score for non-exporting firms is slightly higher than for exporting firms in Pakistan. Likewise, research by Mok et al. showed the effect of export orientation on technical efficiency based on 287 clothing manufacturing companies in South China through regression analysis. A clothing company with a high level of sales in the domestic market or with a high level of export orientation can occur because it has a high level of technical efficiency.

The research carried out was built from the perspective that efficiency in the production concept is assessed operationally and technically. Therefore, to provide an answer to the argumentative hypothesis of whether the processed cocoa agroindustry in East Java is accurate or not efficient, it will be measured using a technical efficiency approach. In solving a problem can use Data Envelopment Analysis (DEA). DEA can measure several inputs and outputs and evaluate them quantitatively and qualitatively, thus enabling a company to make good decisions on the efficiency level of the analyzed unit. This step then becomes the latest idea from empirical studies that have appeared before. This research aims to measure the technical efficiency of the industry in producing processed cocoa in East Java, Indonesia.

Research methods

The selection of locations was determined with a sample area aimed at DMU (Decision Making Unit) based on industrial data spread across cocoa crop center areas and areas close to port docks in Gresik, Blitar, Pasuruan, Banyuwangi, Tulungagung, Trenggalek, Pacitan, Kediri, Madiun Regencies, Sidoarjo, Mojokerto and the City of Surabaya, namely 37 processed cocoa agroindustries in East Java, Indonesia.

This study used a purposive sampling technique. The sampling technique has a subjective objective (Augusty, 2006). The selected sample is an industry of 37 DMUs based on survey results and interviews with production managers and marketing managers of processed cocoa agroindustry, taking into account: i) The processed cocoa industry has carried out export activities of processed cocoa products, and ii) managers from the processed cocoa industry who know the distribution channels of processed cocoa products from their companies, for the domestic market as well as the needs of exporters.

This paper uses the Data Envelopment Analysis (DEA) version 2.1 approach to measure technical and efficiency changes. The Center for Efficiency and Productivity Analysis developed the DEA program at the Queensland University of Technology, Australia (Coelli et al., 2005). In the DEA analysis, measurement of technical efficiency data can be measured using two methods in DEA, namely the DEA CRS (Constant Returns to Scale) model, which assumes that the ratio of production inputs to output is fixed and has produced production at an optimal scale, and the DEA VRS model (Variable Returns to Scale) with the assumption that the ratio of production inputs to output is not fixed, which means that each addition of production inputs with a certain amount does not affect result with the same amount, the resulting work can be more excellent or smaller than the use of input. The constant return to scale (CRS) model assumes that the resulting output ratio and the addition of input use are the same as "constant." If x input is used differently, it will increase by x output, which in this measurement model also assumes that each DMU operates at an optimal scale. The variable return to scale (VRS) model assumes that for every increase in input an amount of x, it is still being determined if the output will operate or produce the same production. This increase can be in the form of increasing returns to scale (IRS) or decreasing returns to scale (Drs). The equation model used is as follows.

$$Min_{\theta,\lambda}\ (\theta_j),$$

Subject to

$$-q_{j1} + \left(q_1\lambda_1 + q_2\lambda_2 + q_3\lambda_3 + q_4\lambda_4 + q_5\lambda_5 + \cdots + q_{37}\lambda_{37}\right) \geq 0$$
$$-q_{j2} + \left(q_1\lambda_1 + q_2\lambda_2 + q_3\lambda_3 + q_4\lambda_4 + q_5\lambda_5 + \cdots + q_{37}\lambda_{37}\right) \geq 0$$
$$-q_{j3} + \left(q_1\lambda_1 + q_2\lambda_2 + q_3\lambda_3 + q_4\lambda_4 + q_5\lambda_5 + \cdots + q_{37}\lambda_{37}\right) \geq 0$$
$$\theta X_{1j} - \left(X_{11}\lambda_1 + q_{12}\lambda_2 + q_{13}\lambda_3 + q_{14}\lambda_4 + q_{15}\lambda_5 + \cdots + q_{137}\lambda_{37}\right) \geq 0$$
$$\theta X_{ij} - \left(X_{i1}\lambda_1 + q_{i2}\lambda_2 + q_{i3}\lambda_3 + q_{i4}\lambda_4 + q_{i5}\lambda_5 + \cdots + q_{i37}\lambda_{37}\right) \geq 0$$
$$\ldots$$
$$i_1\lambda_j = 1$$
$$\lambda_j \geq 0$$

Explanation:

θ_j : technical efficiency of the j- sample cocoa processed industry
j : sample cocoa processed industry, with a value of j = 1, ..., 37
q_{j1} : processed cocoa production results (kg/)
q_{j2} : processed cocoa export product output (kg/)
q_{j3} : processed cocoa local distribution product output (kg/)
X_{ij} : the amount of i-input used by the j-sample cocoa processed industry
i : input used, with a value of i = 1,..., 5
i_1 : row material (kg)
i_2 : labor costs (rupiah)
i_3 : capital (rupiah)
i_4 : production capacity (kg)
i_5 : number of workers (HOK)
λ_j : weight of jth peer industry
$i_1'\lambda_j$: convexity constraint to j th sample cocoa processed industry.

Results and discussion

The efficiency measurement results illustrate the value or level of efficiency of each DMU or processed cocoa agroindustry in East Java, namely a total of 37 DMU samples studied. It is known that there are 8 DMU units of processed cocoa on the IRS scale and as many as 8 DMU units on the DRS scale, while 21 DMUs of processed cocoa agroindustry are not on the IRS or DrS scale. The average DMU efficiency on the CRS (Constant Returns to Scale) scale is 0.893, and the average on the VRS (Variable Returns to Scale) scale is 0.956. Besides that, the average value on calculating the efficiency scale is as much as 0.913. From the results obtained, it can still optimize the allocation of inputs by reducing or adding the number of inputs to achieve optimal efficiency.

The level of technical efficiency in the 37 DMUs was mainly categorized as achieving the highest total efficiency score of 1 (ET = 1,000) in 30 DMUs out of a total of 37 DMUs with a percentage of 81.08%. The high percentage level is shown in the high-efficiency category (0.99-0.81), as many as 3 DMUs or 8.11%, and 3 DMUs (8.11%) in the medium category (0.80-0.51). Also found that 1 DMU with a percentage of 2.70% is included in the low-efficiency category with a value less than or below 0.50 (<0.50). DMU gets the highest rating of 0.996, the average efficiency value of 0.806, and the lowest efficiency category of 0.185.

Table 1. Percentage of 37 DMU units on the CRS and VRS efficiency scales
Tabla 1. Porcentaje de 37 unidades DMU en las escalas de eficiencia CRS y VRS

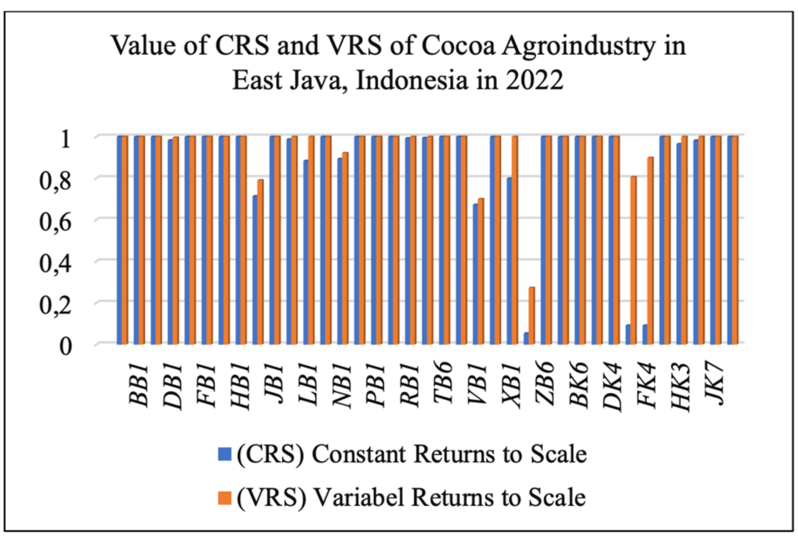
Efficiency Scale	DMU	Number of DMUs	Percentage
CRS (0,893)	AB1, BB1, CB1, EB1, FB1, GB1, HB1, MB1, OB1, PB1, QB1, TB6, UB1, WB1, ZB6, BK6, CK4, DK4, GK3, JK7, KK2	21	56,75 %
VRS (0,956)	AB1, BB1, CB1, EB1, FB1, GB1, HB1, JB1, KB1, LB1, MB1, OB1, PB1, QB1, RB1, SB1, TB6, UB1, WB1, XB1, ZB6, AMI, BK6, CK4, DK4, GK3, HK3, IK8, JK7, KK2	30	81,08 %

Source: output Results of DEAP Version 2.1 processed by author. Fuente: resultados de DEAP Versión 2.1 procesadas por el autor.

The results of the Data Envelopment Analysis (DEA) analysis using the VRS model assume that the DMU has produced at an optimal scale level and has allocated the right amount of additional production inputs. The results of multistage DEA calculations through the DEAP 2.1 software application obtained optimal technical efficiency scale results for 21 (56.75%) 37 DMUs and 16 other DMUs in an inefficient condition. Meanwhile, in the DEA calculation of the VRS model, which assumes that not all DMUs produce at an optimal scale, 30 DMUs (81.08%) are obtained, and seven other DMUs do not technically reach the efficiency level.

Figure 1 shows the difference in the number of technically efficient processed cocoa agroindustry on the CRS and VRS scales with an average value of 0.995 and 0.996, respectively. It can be seen that the number of DMUs in East Java efficiently in the VRS model is more than the DMUs in the CRS model with a difference of 9 DMUs. This condition is caused because the amount of supply of cocoa raw materials used is different and the use of different input allocations for each DMU, and there are still many DMUs that obtain the same production results from increasing the amount of input.

Figure 1. Comparison of Technical Efficiency Values with CRS and VRS approaches on DMU processed cocoa
Figura 1. Comparación de los valores de eficiencia técnica con los enfoques CRS y VRS en cacao



Source: own elaboration. Fuente: elaboración propia.

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Radial Movement (RM) and Slack Movement (SM) values can explain that there are DMUs that need to adjust the amount of input used. Most DMUs have yet to use inputs efficiently in producing processed cocoa. Some DMUs need to reduce the amount of input used in production to equal the amount of output. The results of a brief analysis can be seen in Tables 2 and 3.

Table 2. Radial movement and slack movement of output and input, part 1
Tabla 2. Movimiento radial y movimiento flojo de salida y entrada, parte 1

DMU	Processed cocoa production		Export products		Cocoa raw materials		Labor costs		Capital		Production capacity		Number of labors	
	RM	SM	RM	SM	RM	SM	RM	SM	RM	SM	RM	SM	RM	SM
AB1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BB1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CB1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DB1	0	0	0	0	-72.9	0	-1.7	-147	-2.2	-423	-0.46	-6.56	-2.49	0
EB1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FB1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GB1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HB1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IB1	0	0	0	0	-978	0	-206	-26	-177	-144	-62.7	0	-293	0
JB1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KB1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LB1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MB1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NB1	0	0	0	229	-246	-458	-62	-285	-35.4	0	-15.6	-11.9	-41.5	0
OB1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PB1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
QB1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RB1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SB1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TB6	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: Radial Movement (RM) and Slack Movement (SM). Source: own elaboration. Nota: movimiento radial (RM) y movimiento flojo (SM). Fuente: elaboración propia.

Table 3. Radial movement and slack movement of output and input, part 2

Tabla 3. Movimiento radial y movimiento flojo de salida y entrada, parte 2

DMU	Processed cocoa production		Export products		Cocoa raw materials		Labor costs		Capital		Production capacity		Number of labors	
	RM	SM	RM	SM	RM	SM	RM	SM	RM	SM	RM	SM	RM	SM
UB1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VB1	0	0	0	480	-429	0	-210	-215	-225	-266	-30	0	-67.2	0
WB1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
XB1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YB1	0	0	0	923	-453	-164	-290	0	-204	-10.1	-145	-52.5	-135	0
ZB6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AM1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BK6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CK4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DK4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EK4	0	0	0	174	-181	-560	-29	-9.25	-14.9	0	-1.45	-5.4	-36.5	-127
FK4	0	0	0	102	-84.9	-57	-12	0	-0.75	-6.19	-18	-6.19	-18	-137
GK3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HK3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IK8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JK7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KK2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
y	0	0	0	51.6	-66	-33.5	-22	-18.4	-17.9	-23	-7.38	-2.2	-16	-7.14

Note: Radial Movement (RM) and Slack Movement (SM). Source: own elaboration. Nota: movimiento radial (RM) y movimiento flojo (SM). Fuente: elaboración propia.

Peer-to-peer is a DEA feature that provides an overview of how the production efficiency of one DMU can be compared to other DMUs. The use of peer-to-peer will be able to provide how the existing DMU reference/benchmark can be a reference for other DMUs that are not yet efficient through the existence of lambda weights for improving input distribution, as one sample of DMU improving input on (DMU-IB1) shown in Table 4.

Table 4. Improved input (DMU-IB1) using VRS Assumptions

Tabla 4. Entrada mejorada (DMU-IB1) usando VRS Supuestos

Variable	Original Value (OV)	Radial Movement (RM)	Slack Movement (SM)	Projected Value (PV)
Cocoa Product (kg)	155250.000	0.000	0.000	155250.000
Export of Cocoa Products (kg)	87750.000	0.000	1260.902	89010.902
Raw Material (kg)	46800.000	-9781.433	0.000	37018.567
Labor Cost (Rp)	990.000	-206.915	-26.857	756.228
Capital (Rp)	850.000	-177.654	-144.471	527.875
Production Capacity (kg)	300.000	-62.701	0.000	237.299
Total Labours (HOK)	1402.000	-293.025	0.000	1108.985

Listing of Peers / List of Reference Agroindustry and Weight			
Lambda Weight	**DMU Peer**	**Lambda Weight**	**DMU Peer**
0.557	JB1	0.052	HB1
0.273	PB1	0.040	CB1
0.079	JK7		

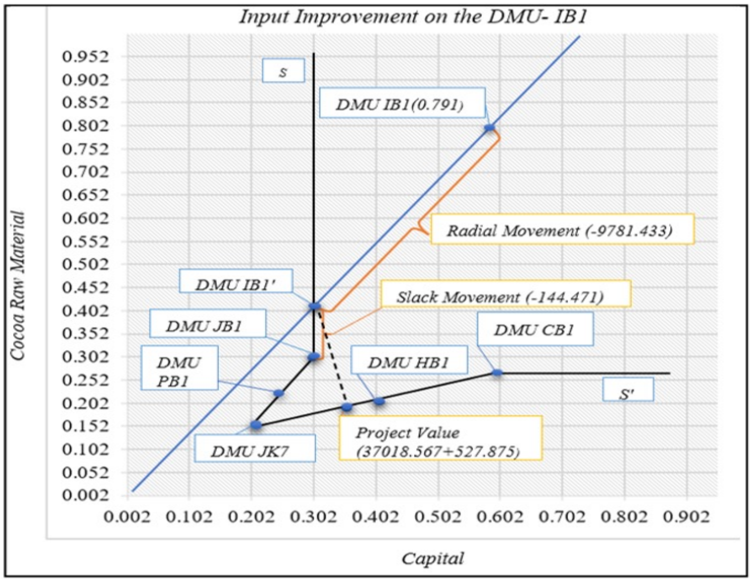
Source: output results of DEAP Version 2.1 processed by author. Fuente: resultados de DEAP Versión 2.1 procesadas por el autor.

DEA-VRS produces an efficiency value (DMU-IB1) in the VRS frontier 0.791, proving inefficient under the VRS assumption. The value (PV) of the input allocation from (DMU-IB1) experienced (SM) and (RM). The RM and SM values distribution can be seen in all inputs from (DMU-IB1). Cocoa, raw material input, requires a decrease in the input of 9.78 tons. This effort was carried out to achieve an efficient frontier from DEA-VRS and total efficiency under the CRS assumption, resulting in an output of 155.25 tons of processed cocoa products. The availability of raw materials in cocoa bean center areas is a comparative advantage for Indonesia, especially the province of East Java, in creating various cocoa products. As comparative data, the export value of processed cocoa in East Java from 2007 was 305,999 tons, and has an extreme difference in the following ten years, precisely in 2017, which was 1,120,765 tons, and ensures that it will continue to increase until 2022, namely 1,222,264 tons.

The volume of East Java processed cocoa imports has increased, this is due to the majority of DMUs not operating due to the impact of inconsistencies on the upstream side of cocoa, resulting in a lack of supply of raw materials, and this is against the background of the impact of the global crisis due to the Covid-19 pandemic that hit the world starting in 2020 - 2022. However, on the other hand, the export volume of processed cocoa in the province of East Java, Indonesia, has decreased in export volume 134,156.03 Kg/US$ to 112,456.38 Kg/US$ in 2021. However, this decline in export volume did not occur drastically, and cocoa exports of East Java processed products can increase again in 2022 to 136,698.99 Kg/US$. This case proves that an industry that produces efficiently will enable companies to survive in critical conditions due to the impact of the global crisis. This condition shows that the East Java DMU can change in a more positive and export-oriented direction.

Another variable that exists in the DEA-VRS analysis and has input slack is labor costs with an initial value of 990,000 having a Ra of -206,915 rupiahs and an SM of -26,857 rupiahs so that the actual value of using input labor costs is 756,228 rupiahs, a capital input with a value origin 850,000 rupiah has an RM of -177,654 rupiah and SM of -144,471 rupiah so that the supposed value of using capital input is 527,875 rupiah, production capacity with an original value of 300,000 kilograms has an RM of -62,701 kilogram so that the supposed value of using production capacity input is 237,299 kg. The number of workers with an initial value of 1402,000 HOK has an RM of -293,025 HOK but does not have SM, so the actual value of using labor input is 1108,975 HOK. Work and having an impact on the mismatch of labor optimization can increase the operational capital used, namely the input of labor costs which decreases company profits. Judging from its lambda weight, DMU-IB1 will be able to have total efficiency in its production when using input combinations such as those used in DMU-JB1 (DMU peer with the lowest or very close lambda weight).

Figure 2. DMU peer simulation to maximize DMU-IB1 efficiency
Figura 2. Simulación de pares de DMU para maximizar la eficiencia de DMU-IB1



Source: own elaboration. Fuente: elaboración propia.

Simulation analysis results using five peer DMUs to maximize the efficiency of DMU-IB1. The results of the DEA analysis using inputs of raw materials and capital produce RM values of 9781,433 kg and 144,471 rupiahs, respectively, and by drawing a line from the origin to the DMU-IB1 point, the intersection of the SS' isoquant curve at the DMU-IB1' point is obtained. It means that inputs must be reduced according to the amount of RM so that DMU-IB1 can fit into the SS' isoquant curve. The SM value can be found in the DEA CRS analysis for DMU-IB1, where there is a value of 144,471 so that it can produce optimally close to the peer DMU and it can be seen in Figure 3 that there is a DMU-IB1 point and a 'PV DMU-IB1' point as the SM. The results of the analysis have a tendency to compare DMU-IB1 with DMU-CB1, DMU-HB1, DMU-JK7, and DMU-PB1 because the point 'PV DMU-IB1 is at the point between DMU-CB1 (lambda weight 0.040), DMU -HB1 (lambda weight 0.052), DMU-JK7 (lambda weight 0.079), DMU-PB1 (lambda weight 0.273), while DMU-JB1 will form the SS' isoquant curve and do not intersect with DMU-DB1's PV point because it has the lowest lambda weight, for example, 0.557. Graphically and the results of the DEA analysis, DMU-IB1 will be able to have maximum production when using DMU-JB1 as a reference peer because it is the closest DMU to DMU-IB1.

The assumptions in the DEA analysis are different from the data on the frontier. From the use of inputs, DMU-IB1 assumes that VRS has peers with production scales that do not differ much in terms of output and use of inputs while using the assumption that CRS will have the most efficient peers with larger or unbalanced production scales compared to the assumptions of VRS, the results are following statements (Coelli et al., 2005). The application of DEA-VRS in this study was explored further because the assumption of proportionality may not necessarily apply to the food and beverage industry, considering that industries can use similar inputs but produce very different outputs.

The results indicate that higher productivity is linked to greater sales against the workers' expenses. This leads to surplus cash availability in the firms and high liquidity levels for overall operations. This leads to less dependence on the higher cost of external financing, diversified investments, lower cost of capital and higher bargaining power against the suppliers. Also, such probable situation acts as bigger goodwill for stakeholders and even boosts the faith of investors and suppliers in firms. Moreover, productive firms have enough internal finances for managing short-term or long-term expenses (Chaney, 2016). Hence, these firms have shorter CCC and higher WCM efficiency. Habib and Huang (2018) and Bellouma (2011) found a positive association between working capital and productivity.

Conclusions

This research is based on the concept of technical efficiency put forward by Farrell in 1957 with a focus on measuring efficiency (Coelli et al., 2005), wherein the model looks at the input ratio-fixed output or managerial efficiency when comparing a different group. This research is based on the theory of producers, where this theory seeks to maximize profits and minimize costs. This technique helps measure efficiency in the food and beverage processing industry as well as in the manufacturing industry. This technique is essential to be used as a decision-making unit for the public sector or non-profit institutions, where price data is primarily unavailable and has several objectives to be achieved (Asmara and Hanani, 2017). The role of industrial efficiency in export activities encourages the specialization of the products produced, takes advantage of the economies of scale that come with a broader market, and assimilates new technological and organizational norms derived from participation in world markets (Asmara et al., 2017). Then from activities for this export, the company will pay attention to and prioritize industrial efficiency before it boils down to its export performance. The current study involves calculating the technical efficiency of each processed cocoa agroindustry, but the efficiency values of all companies need to be displayed due to space limitations.

The Variable Return to Scale (VRS) approach has the efficiency scores of 37 respondents ranging from 0.81 to 1. In general, the average efficiency level was 0.956 or 95.6%. It means that the average processed cocoa agroindustry mainly reaches total efficiency. Processed cocoa agroindustry can still increase efficiency by 4.4% by adjusting the use of each input. Processed cocoa agroindustry that is fully efficient with as many as 30 DMUs and 7 DMUs still needs to reach total efficiency. Possible causes of inefficient processed cocoa agroindustry are wasteful inputs that must comply with food and beverage processing procedures.

The fully efficient processed cocoa agroindustry with the highest number of peers is the 3rd DMU, namely, three. Seven other DMUs can refer to this processed cocoa agroindustry to operate efficiently. DMU-VB1 uses the raw material of 155,000 kg/day or 155 tons/day, which is very large, but DMU-/VB1 can be a reference for improvements to the use of inputs by DMU-GB1 with an alternative to improve the distribution of inputs offered, namely reducing the RM of cocoa raw material by (-46,508). DMU-3/CB1 can be used as a reference or reference by DMU-YB1 for using cocoa raw materials, which are too wasteful at 62,400 kg/day. Another input that must be considered is the capital aspect of each DMU, as is the case with the distribution of capital in DMU-NB1 of 453,000 million/rupiah. In order to achieve the ideal number of inputs, it is necessary to decrease the RM (-35,418). For example, the improved input distribution suggested by DMU-JB1 with lambda weight (0.006).

The analysis results of the technical efficiency of the processed cocoa agroindustry, classified as an efficient food and beverage processing industry, must establish a development strategy to improve the performance and efficiency of each DMU. First, a proportional increase in the efficiency of various industries will require proper allocation of production inputs and government support, various forms of cooperation with advanced companies to obtain effective processing technology, and policy induction towards the processed cocoa agroindustry and other industries for labor management, supply chain management, innovation, and R&D, thereby increasing the efficiency of the processed cocoa agroindustry. Second, this result can be used as an efficiency index in countries with abundant resources and similar country conditions and industrial conditions or countries that are late in entering the food and beverage business world. Pursuing appropriate input management is a strategy that can be used to generate strategies development of the processed cocoa agroindustry. Third, the methodological contribution of the model presented in this study is that the most critical inputs to be improved are raw materials, labor, and capital costs. These three inputs need to pay attention to the limits of their use to achieve total efficiency values compared to other inputs, namely production capacity and number of workers.

The results of this study are supported by empirical studies from Attipoe et al. (2020) showing that capital support can be used as a measure of efficiency and, according to Goyal et al. (2018) and Moral-Pajares et al. (2015), workforce and age industry is a relevant factor for calculating efficiency. In this study, the labor variable is included in labor costs. However, the results contradict the results of previous research, namely, research conducted by Seth et al. (2020) concluded that stable industrial efficiency could be obtained by considering production capacity to produce internal resources, size, age, productivity, gross domestic product, and interest rates. In the research results, production capacity does not affect the stability of industrial efficiency. However, it can be obtained by considering raw materials, labor costs, and industrial capital in producing processed cocoa output. This study can be a helpful baseline for an in-depth review of industry efficiency and management resources for phase changes. Companies are concerned with working capital to pay attention to internal and external factors while determining investment in working capital for sustainable value creation for the company. In addition, they should strive to achieve optimal working capital levels that will add value to the company.

The research findings provide a novelty concept when minimal studies use Data Envelopment Analysis to study the food and beverage processing industry, which can be measured accurately. Inefficient DMUs can make the right decisions based on the efficiency level of each input with slack and radial movement values. It requires more improvements in allocating raw material inputs needed in the processed cocoa production process. Improvements to inputs use too high labor costs if that is not matched by maximum processed cocoa production and improvements to wasted industrial capital inputs, where the DMU must consider the distribution of industrial capital to obtain stable DMU operations and competitive advantage. This study concludes that industrial efficiency has an essential role in the existence of DMU when it can pay attention to the quality and quantity of its production and meet domestic and export demand in realizing processed cocoa agroindustry that is competitive in the global market.

The current study has several limitations and many prospective opportunities for future research. By considering input and output, sensitivity analysis can be carried out by modifying the values. The results may not be generalizable to developed countries because the samples selected were from developing countries. Therefore, the combined approach of DEA and machine learning algorithm-based models may be integrated with other stand-alone efficiency models to produce a superior and powerful approach.

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