p-ISSN: 1907-8056
e-ISSN: 2527-5410
AGROINTEK
Jurnal Teknologi Industri Pertanian
journal homepage: journal.trunojoyo.ac.id/agrointek

Analysis of the efficiency level of the mozzarella cheese distribution channel (case study of CV Narendra Food Malang)

Miftakhurrizal Kurniawan*, Tri Kurniawan Laksono, Mas'ud Effendi

Agroindustrial Technology, Universitas Brawijaya, Malang, Indonesia

Article history
Received:
17 January 2023
Revised:
30 May 2023
Accepted:
18 August 2023

Keyword
Distribution Efficiency Analysis; Mozzarella Cheese; Two-Stage Data Envelopment Analysis (DEA).

ABSTRACT

The distribution process has an essential role in the sustainability of an industry. The company's distribution process must be carried out effectively and efficiently, especially in terms of using human resources, capital, and others, to increase profits. Many companies need help with distribution efficiency, especially regarding CV Narendra Food. CV Narendra Food is a company that produces mozzarella cheese products with a short shelf life. The problem of short product shelf life requires companies to carry out effective and efficient distribution. The distribution process is currently experiencing issues related to efficiency. This study aims to measure the efficiency level of the distribution process carried out by CV Narendra Food and provide suggestions for improvement. This study uses the External Two-Stage Data Envelopment Analysis (DEA) model. The results showed that only two areas were efficient out of 8 distribution areas. Companies can make improvements by reducing distribution costs by using the services of delivery parties, increasing distribution in the regions that are considered inefficient, maximizing delivery to areas that are considered efficient, and setting a minimum number of orders so that deliveries can be made at optimal capacity.

* Corresponding author
Email : miftakhurrizal@ub.ac.id
DOI 10.21107/agrointek.v19i3.18473

INTRODUCTION

Indonesia is one of the countries with a wealth of natural resources. These advantages make industries that process natural resources in Indonesia multiply, such as the food industry. The food industry is growing because the need for nutritious food is increasing. One type of food that is widely known and liked by the public is milk. East Java is one of Indonesia's provinces with the highest milk production. Data from the BPS-Statistic Indonesia (2022) states that milk production in East Java Province in 2018 was 512,846.75 tons; in 2019, it reached 523,103.69 tons. This improvement shows the potential for using milk as a processed product with a very high selling value.

Many processed products use milk as raw material. Cheese is a processed dairy product. Cheese is a food product made from fermented milk which involves microorganisms for the fermentation process (Masotti et al. 2017). The cheese fermentation process involves several lactic acid microorganisms such as *Streptococcus thermophilous, Lactococcus lactis,* and *Leuconostoc mesenteroides* (Crevier et al. 2017). One type of cheese is mozzarella cheese. Mozzarella cheese is a cheese that has a soft texture and does not undergo a ripening process. This type of mozzarella cheese has elastic, stringy, and soft characteristics. Mozzarella cheese contains lactic acid bacteria, which are beneficial for health because they function as probiotics (Ah and Tagalpallewar 2017).

CV Narendra Food is a business unit focusing on milk processing in Malang City, East Java. Some of the processed products are yogurt and cheese. Cheese products are the superior product of CV Narendra Food because the demand for cheese products is increasing compared to other processed products. The company markets its products in several areas around Malang City and outside Malang City. Many other companies use cheese products produced by CV Narendra Food for various purposes, so their products are available in several food outlets and distributors in various cities.

As a business unit that competes with large companies, CV Narendra Food must maximize its resources, such as financial resources, human resources, and others. This effort is a strategy to survive in similar business competition. One of the current problems CV Narendra Food faces is the need to know the efficiency level of its distribution area. Measurement of efficiency is essential to determine the level of efficiency of a company's business management (Kurniawan et al. 2021). Measurement of efficiency, especially in distribution, is essential because the distribution process involves human resources, costs, and others (Pham et al., 2021). Hence, an efficient distribution process is the primary goal of a company to gain profits and compete with similar companies. Therefore, the company must know the efficiency of its distribution. According to Haryati et al. (2018), distribution efficiency analysis aims to determine the efficiency level of each distribution area and improve inefficient distribution areas.

METHODS

The research uses the External Two-Stage Data Envelopment Analysis (DEA) method. In the first stage, an analysis uses the DEA method to determine the efficiency score of each Decision Making Unit (DMU) involving input and output variables. Then the research was carried out in the second stage using Tobit regression to determine the relationship of the independent variables with the efficiency value of the analysis results from the first stage. The second stage involves external variables as independent variables (Henriques et al. 2020). The description of the external two-stage data envelopment analysis (DEA) method is presented in Figure 1.

Figure 1 External Two-Stage Data Envelopment Analysis Method

First stage

In the first stage, efficiency calculations for each DMU are carried out using the DEA method. The data obtained is assumed to be a Constant Return to Scale (CRS), meaning that the addition of input results in a constant output expansion. The efficiency value of many inputs and outputs can be defined as follows:

$$efficiency = \frac{output}{input} \quad (1)$$

If we assume that there are n DMUs, where each DMU has m inputs and s outputs, the relative efficiency of each DMU will be obtained as follows:

$$Max \frac{\sum_{r=1}^{s} V_r y_r}{\sum_{i=1}^{m} u_i x_i} \quad (2)$$

$$subject\ to\ \frac{\sum_{r=1}^{s} v_r y_{rj}}{\sum_{i=1}^{m} u_i x_{ij}} \leq 1 \forall j \quad (3)$$

$$v_r u_i \geq 0 \forall r, i \quad (4)$$

Where:
Y = output variable r = 1 until s (index for output)
X = input variable I = 1 until m (index for input)
u = input weight j = 1 until n (index for the number of DMUs)
v = output weight

This formula cannot be directly solved using a linear program; therefore, it is necessary to change it into the following form:

$$maximize \sum_{r=1}^{s} v_r y_r \quad (5)$$

$$subject\ to\ \sum_{i=1}^{m} u_i x_i = 1 \quad (6)$$

$$\sum_{r=1}^{s} v_r y_{rj} - \sum_{i=1}^{m} u_i x_{ij} \leq 0; j = 1,2,3,\dots,n \quad (7)$$

$$v_r \geq 0\ ; r = 1,2,3,\dots,s \quad (8)$$

$$u_i \geq 0\ ; i = 1,2,3,\dots,m \quad (9)$$

The researcher will run the above problems in times to calculate the relative efficiency values for each DMU.

Besides calculating efficiency values, this method also provides a reference for improving inefficient DMUs. The suggested improvement comes from adjusting the actual data against the target. Respect for improvement is known after the efficiency value of each DMU is obtained.

Second Stage

Tobit regression is a regression analysis in which the dependent variable has an input value in the form of mixed data or some discrete data (zero value) and some continuous data (no zero value) (Medarevic and Vukovic 2021). In this second stage, an analysis is carried out with Tobit regression to know the effect of the independent variables on the dependent variable, where, in this case, the dependent variable is the efficiency value obtained from the analysis in the first stage. The independent variables used are the number of distributors in each distribution area (DMU) and the number of shipments in 1 year (2021 period). At this stage, the Tobit model acts as a model to determine the determinants of the efficiency level by first knowing the level of efficiency with DEA. The model for the Tobit regression is (Otero et al. 2012):

$$y_i = \begin{cases} y_i *, y_i * > 0 \\ 0, y_i * \leq 0 \end{cases} \quad (10)$$

Where :

$$y_i * = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_k x_{ki} + u_i \quad (11)$$

$$y_i * = 1\beta_0 + x_{1i}\beta_1 + x_{2i}\beta_2 + \cdots + x_{ki}\beta_k + u_i \quad (12)$$

$$y_1 * = \begin{bmatrix} 1 & x_{11} & x_{21} & \cdots & x_{k1} \\ 1 & x_{12} & x_{22} & \cdots & x_{k2} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 1 & x_{1i} & x_{2i} & \cdots & x_{ki} \end{bmatrix} \begin{bmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_k \end{bmatrix} + \begin{bmatrix} u_1 \\ u_2 \\ \vdots \\ u_i \end{bmatrix} \quad (13)$$

$$y_1 * = \begin{bmatrix} 1 & 1 & \cdots & 1 \\ x_{11} & x_{12} & \cdots & x_{1i} \\ x_{21} & x_{22} & \cdots & x_{2i} \\ \vdots & \vdots & \vdots & \vdots \\ x_{k1} & x_{k2} & \cdots & x_{ki} \end{bmatrix} \begin{bmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_k \end{bmatrix} + \begin{bmatrix} u_1 \\ u_2 \\ \vdots \\ u_i \end{bmatrix} \quad (14)$$

$$y_i * = x_i' \beta + u_i \quad (15)$$

Where :
$y_i *$= the actual value of the dependent variable
x_i' = transpose of x_i
β = parameters of size k x 1
u_i = residual

RESULT AND DISCUSSION

Mozzarella Cheese Supply Chain

The supply chain for mozzarella cheese products consists of four actors: suppliers, manufacturers, distributors, and consumers. Supplier is a supplier of raw materials needed to produce mozzarella cheese. Suppliers consist of suppliers of primary raw materials, additional raw materials, and packaging. The primary raw material required is pasteurized milk, while supplemental raw materials include citric acid, rennet, and salt. CV Narendra Food is a business unit engaged in processing mozzarella cheese. The location of this business unit is in Malang City, East Java. The main product produced by CV Narendra Food is mozzarella cheese, which in its capacity can make 180 kg of mozzarella cheese with a volume of 1,300 liters of raw milk in each production. The product produced is named "Chizzu". CV Narendra Food has eight leading distributors ready to supply products to consumers.

Figure 2 shows the supply chain flow that occurs in mozzarella cheese products. The flow of the mozzarella cheese supply chain consists of 3 streams, namely material, information, and financial flows. Suppliers supply materials to factories in the form of raw materials. The factory will send materials in the form of finished products to distributors. Distributors will send materials in the form of finished products to

consumers. The financial flow is the opposite. That is, it flows from the consumer to the supplier. In comparison, the flow of information flows to each party that is directly related.

Product Distribution System

In marketing products to consumers, CV Narendra Food applies several methods. The first way is buying and selling directly by consumers at the factory location, where consumers around the factory or the city of Malang usually carry out the process. The second way is by ordering online through the admin, which later the company will send the product to consumers or ordering via expedition services. The third way is to cooperate with third parties or distributors. The company will send the product to the distributor later, and the consumer will purchase from the distributor. Then consumers will make purchases from the distributor. Until now, distributors only exist in a few cities, namely Malang, Surabaya, Kediri, Bogor, Jakarta, Bali, Samarinda, and Banjarmasin. However, it does not rule out consumers from outside the area where there are no distributors in the city to order products.

Data analysis

Data analysis used the two-stage data envelopment analysis method through 2 stages. In the first stage, the researchers conducted an efficiency analysis using input and output variables at each DMU. The results of the first research stage include each DMU's efficiency value and improvements to achieve efficiency values if the DMU is inefficient. Then the researcher will conduct a second analysis stage, namely Tobit regression analysis. At this stage, the aim is to determine the relationship between the independent and dependent variables. At this stage will know the effect of external variables on the value of efficiency.

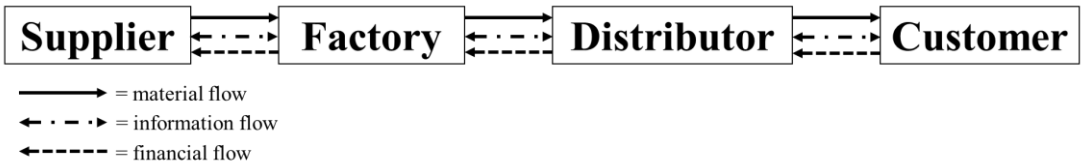

Figure 2 Supply chain flow of mozzarella cheese products

Table 1 Actual input and output data

DMU	Distribution Area	*Input*		*Output*
		Sales volume (kg)	Distribution cost (Rp)	Revenue (Rp)
DMU 1	Malang	6198	19.239.600	528.996.000
DMU 2	Surabaya	2955	4.626.000	258.036.000
DMU 3	Kediri	1253,75	2.010.625	108.632.000
DMU 4	Banjarmasin	861,75	1.154.100	73.176.000
DMU 5	Jakarta	342,25	683.375	29.452.000
DMU 6	Samarinda	300,5	390.600	26.246.000
DMU 7	Bali	101,5	157.025	8.746.000
DMU 8	Bogor	60	100.000	5.280.000

Table 2 Value of distribution efficiency of mozzarella cheese products

DMU	Distribution area	Efficiency value (%)	Condition
DMU 1	Malang	97,0	Inefficient
DMU 2	Surabaya	99,4	Inefficient
DMU 3	Kediri	98,6	Inefficient
DMU 4	Banjarmasin	97,1	Inefficient
DMU 5	Jakarta	97,8	Inefficient
DMU 6	Samarinda	100	Efficient
DMU 7	Bogor	100	Efficient
DMU 8	Bali	98,1	Inefficient

Table 3 Efficiency distribution in Malang area

DMU	Score	Variable	Actual	Target	%
Malang	97,0%	Sales Volume (Kg)	6.198	6.198	0
		Distirbution cost (Rp)	19.239.600	10.330.000	-46,31
		Revenue (Rp)	528.996.000	545.424.000	3,11

Table 4 Surabaya area distribution efficiency

DMU	Score	Variable	Actual	Target	%
Surabaya	99,4%	Sales Volume (Kg)	2.955	2.955	0
		Distirbution cost (Rp)	4.626.000	4.626.000	0
		Revenue (Rp)	258.036.000	259.551.762,93	0,59

Table 5 The distribution efficiency of the Kediri area

DMU	Score	Variable	Actual	Target	%
Kediri	98,6%	Sales Volume (Kg)	1.253,75	1.235,75	0
		Distirbution cost (Rp)	2.010.625	2.010.625	0
		Revenue (Rp)	108.632.000	110.201.068,94	1,44

Table 6 Efficiency of distribution in Banjarmasin area

DMU	Score	Variable	Actual	Target	%
Banjarmasin	97,1%	Sales Volume (Kg)	861,72	861,75	0
		Distirbution cost (Rp)	1.154.100	1.154.100	0
		Revenue (Rp)	73.176.000	75.373.277,29	3,00

Table 7 Distribution efficiency for the Jakarta area

DMU	Score	Variable	Actual	Target	%
Jakarta	97,8%	Sales Volume (Kg)	342,25	342,25	0
		Distirbution cost (Rp)	683.375	570.461,63	-16,53
		Revenue (Rp)	29.452.000	30.118.000	2,26

First Stage (DEA Analysis)

In the first stage, researchers analyzed the distribution efficiency of mozzarella cheese products using the Data Envelopment Analysis (DEA) method. The data used in calculating the efficiency value is data for 2021. This data is input and output from the company, which the researcher will later analyze to determine the efficiency value. The actual data used can be seen in Table 1.

The data shows the value of distribution efficiency in 8 distribution areas (DMU). In the first stage, the researcher conducted an analysis using the DEA method with the output-oriented CCR model. the output orientation function is to maximize output with constant input. The results of the first stage efficiency analysis with the DEA method can be seen in Table 2.

Table 2 shows the efficiency values of each distribution area (DMU). From these results, 2 DMUs are efficient because they get an efficiency score of 100%, and 6 DMUs are inefficient because they don't get an efficiency score of 100%. The inefficient DMUs were DMU 1, with an efficiency score of 97.0%; DMU 2, with an efficiency score of 99.4%; DMU 3, with an efficiency score of 98.6%; DMU 4, with an efficiency score of 97.1%; DMU 5 with an efficiency score of 97.8%, and DMU 8 with an efficiency score of 98.1%.

Tables 3 to 10 show detailed descriptions of each DMU. From these tables, the researcher knows certain variables that need improvement,

whether it's increasing or decreasing each variable. The actual value is the value derived from the company's existing data. In contrast, the target value is the optimal value from each variable to make the DMU efficient. A DMU that has the same actual value as the target value for all of its variables is said to be efficient (Mahmoudi et al. 2020).

Second Stage (Tobit Regression)

The second stage of this research is to do a Tobit regression analysis. This analysis aims to determine the effect of the independent variables on the dependent variable. According to (Aziz and Chowdhury, 2021), Tobit regression is appropriate for use in the second stage, which determines the relationship between the independent and dependent variables. This result is because the efficiency scores obtained from the first stage of the analysis using the DEA method have lower and upper limit values, which are between 0 and 1.

Based on the analysis results, a value of P>|t| or the P-Value on the two variables does not have a significant effect on efficiency. The analysis results show that the variable number of distributors has a value of P>|t| of 0.714, which is not below the value of α, which is 0.1, so this variable does not have a significant effect on the efficiency score. The variable number of shipments in 1 year obtains the value of P>|t| of 0.749, where the variable is also above the value of α = 0.1. Hence, the variable has no significant effect on the efficiency score.

Managerial Implications

The distribution performance of CV Narendra Food as a whole has yet to reach efficiency. This result is evident from the fact that most DMUs are almost efficient. Some suggestions for improvement steps for companies are:

Selective distribution and distributor categorization

The first improvement is combining selective distribution with categorizing main and supporting distributors. These steps focus on delivery at one distributor point where the distributor acts as the primary distributor (Mihajlovic et al. 2019). Distributors other than the main distributor act as supporting distributors where they obtain products from the leading distributor, and the company does not bear these costs. This step is to reduce distribution costs and focus orders from leading distributors so that the number of distributed products will increase. In addition, it is also necessary to set a minimum order by distributors in one order so that distribution costs are more optimal.

Table 8 Efficiency of distribution in Samarinda area

DMU	Score	Variable	Actual	Target	%
Samarinda	100%	Sales Volume (Kg)	300,5	300,5	0
		Distirbution cost (Rp)	390.600	390.600	0
		Revenue (Rp)	26.264.000	26.264.000	0

Table 9 Efficiency of distribution in Bogor area

DMU	Score	Variable	Actual	Target	%
Bogor	100%	Sales Volume (Kg)	60	60	0
		Distirbution cost (Rp)	100.000	100.000	0
		Revenue (Rp)	5.280.000	5.280.000	0

Table 10 Efficiency of distribution in Bali area

DMU	Score	Variable	Actual	Target	%
Bali	98,1%	Sales Volume (Kg)	101,5	101,5	0
		Distirbution cost (Rp)	157.025	157.025	0
		Revenue (Rp)	8.746.000	8.912.173,87	1,90

Table 11 Tobit regression analysis

efficiency score	Coef.	Std.error	t	P>|t|	95% Conf. interval	
Number of distributors	-0.0061074	0.0158945	-0.38	0.714	-0.0449998	0.032785
Number of deliveries in 1 year	-0.0000494	0.0001474	-0.33	0.749	-0.0004102	0.0003114
_cons	0.9973106	0.0189002	52.77	0.000	0.9510634	1.043558
Var(e.efficicncy score)	0.0001856					0.0008414

Policy regarding the minimum number of orders by distributors

Companies need to set a minimum order limit by distributors so that these orders reach the optimal point between the number of orders and the cost of shipping (Kostikov et al. 2021). This policy can reduce fluctuating demands by distributors. This policy occurs because the distributor orders in small quantities, but the company's distribution costs are the same as if the distributor ordered in large quantities. This policy often occurs, especially for shipments involving expeditionary services.

Schedule delivery and select means of delivery

The next step, especially for areas that do not involve expedition parties, is to schedule the distribution process, where the scheduling aims to send products with the planned amount according to the maximum capacity of each shipment. Another improvement is choosing suitable delivery means by using certain vehicles and paying workers wages based on the number of shipments to reduce distribution costs.

CONCLUSION

Based on the analysis and calculations of the ten distribution areas, there are only two areas with efficient distribution processes, namely Bogor and Samarinda. Meanwhile, eight other regions obtained almost efficient results because they obtained scores between 95 and 100%, including Malang (97.0%), Surabaya (99.4%), Kediri (98.6%), Banjarmasin (97.1%), Jakarta (97.8%), and Bali (98.1). In the next stage, the Tobit regression concludes that the independent variables do not affect efficiency. Therefore, improvement steps that companies can take are to reduce distribution costs by using the services of delivery parties, increasing distribution in areas considered inefficient, maximizing delivery to areas considered efficient, and setting a minimum number of orders that can be sent with optimal capacity.

REFERENCES

Ah, J., and Tagalpallewar, G.P., 2017. Functional properties of Mozzarella cheese for its end use application. *J Food Sci Technol* 54, 3766–3778. https://doi.org/10.1007/s13197-017-2886-z

Aziz, S., and Chowdhury, S.A., 2021. Performance evaluation of solar mini-grids in Bangladesh: A two-stage Data Envelopment Analysis. *Clean. Environ. Syst.* 2, 100003. https://doi.org/10.1016/j.cesys.2020.100003

BPS-Statistic Indonesia, 2022. Fresh Milk Production by Province (Tons), 2015-2017. Fresh Milk Prod. Prov. Tons 2015-2017. URL https://www.bps.go.id/en/statistics-table/2/NDkzIzI=/fresh-milk-production-by-province.html (accessed 2.12.22).

Crevier, B., Belanger, G., Vuillemard, J.-C., and St-Gelais, D., 2017. Short communication: Production of cottage cheese fortified with vitamin D. *J. Dairy Sci*. 100, 5212–5216. https://doi.org/10.3168/jds.2016-12308

Haryati, N., Surahman, M.A., Kurniawan, M., and Amalia, F., 2018. Entrepreneurial marketing strategy on tempe sanan chips small and medium entreprises in Malang. Adv. Food Sci. *Sustain. Agric. Agroindustrial Eng*. 1, 34–39. https://doi.org/10.21776/ub.afssaae.2018.001.02.5

Henriques, I.C., Sobreiro, V.A., Kimura, H., and Mariano, E.B., 2020. Two-stage DEA in banks: Terminological controversies and future directions. *Expert Syst. Appl*. 161, 113632.

https://doi.org/10.1016/j.eswa.2020.113632

Kostikov, E., Jilkova, P., and Stranska, P.K., 2021. Optimization of e-commerce distribution center location. *Mark. Manag. Innov*. 166–178. https://doi.org/10.21272/mmi.2021.2-14

Kurniawan, M., Wijana, S., and Wilinda, E.O., 2021. Application of Craig Harris and fuzzy analytical hierarchy process methods to improve chicken farming productivity at Jimny's farm. IOP Conf Ser. Earth Environ. Sci. 733, 012042. https://doi.org/10.1088/1755-1315/733/1/012042

Mahmoudi, R., Emrouznejad, A., Shetab-Boushehri, S.-N., and Hejazi, S.R., 2020. The origins, development and future directions of data envelopment analysis approach in transportation systems. *Socio-Econ. Plan. Sci*. 69, 100672. https://doi.org/10.1016/j.seps.2018.11.009

Masotti, F., Cattaneo, S., Stuknyte, M., and De Noni, I., 2017. Technological tools to include whey proteins in cheese: Current status and perspectives. *Trends Food Sci. Technol.* 64, 102–114. https://doi.org/10.1016/j.tifs.2017.04.007

Medarevic, A., and Vukovic, D., 2021. Efficiency and Productivity of Public Hospitals in Serbia Using DEA-Malmquist Model and Tobit Regression Model, 2015–2019. *Int J Env. Res Public Health* 18, 12475. https://doi.org/10.3390/ijerph182312475

Mihajlovic, J., Rajkovic, P., Petrovic, G., and Ciric, D., 2019. The selection of the logistics distribution fruit center location based on MCDM methodology in Southern and Eastern region in Serbia. *Int. J. Environ. Res. Public. Health* 2, 72–85. https://doi.org/10.31181/oresta190247m

Otero, L.D., Centeno, G., and Otero, C.E., 2012. A DEA–Tobit Analysis to Understand the Role of Experience and Task Factors in the Efficiency of Software Engineers. *IEEE Trans. Eng. Manag*. 59. https://doi.org/10.1109/TEM.2010.2101078

Pham, T.Q.M., Park, G.K., and Choi, K.-H., 2021. The efficiency analysis of world top container ports using two-stage uncertainty DEA model and FCM. *Marit. Bus. Rev*. 6, 2–21. https://doi.org/10.1108/MABR-11-2019-0052