

EFFICIENCY MEASUREMENT WITH INDUSTRY-BASED DATA ENVELOPMENT ANALYSIS (DEA): A LITERATURE REVIEW

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This research describes efficiency measurement with Industry-based Data Envelopment Analysis (DEA). The samples obtained amounted to 25 articles that discussed Data Envelopment Analysis (DEA). Researchers classify based on researchers, titles, input and output variables, and the results of each article. The research design used in this research is Literature Review. Based on the results of a review of several articles regarding efficiency measurement with Data Envelopment Analysis, it is as follows, the ability to produce maximum output with existing inputs is the expected performance. When measuring Data Envelopment Analysis (DEA) we are faced with the condition of how to get the optimal output level with the existing input level, or determine the minimum input level by shouting a certain output level.

1. INTRODUCTION

Research in the fields of economics and business basically aims to maximize the results of limited resources, so research on efficiency, especially at the company level (Suliyanto & Jati, 2014). This efficiency is important so that the utilization of these limited resources can be maximized according to the needs of the company and in addition, efficiency is expected to be a tool that gives confidence to investors that they will get a *return* on the funds invested.

The basic efficiency of the variable output to the input, so a method is needed to be able to evaluate the efficiency of the company objectively based on input expenditures made to obtain an output result. According to Cooper et al. (2007), one approach that is considered effective in measuring performance in many service industries that have complex input-output relationships is Data Envelopment Analysis (DEA).

Data Envelopment Analysis is a mathematical programming technique used to evaluate the efficiency of a decision-making unit (work unit) responsible for using multiple inputs to produce a targeted output. The *Data Envelopment Analysis* method is included in a non-parametric approach that uses linear programming techniques that assume that there are no random errors. In response to this concept, Data Envelopment Analysis is recognized as a tool that can represent performance evaluation using linear programming-based techniques to measure the efficiency of organizational units, so in this study collected data from previous research on Data Envelopment Analysis used to *measure* efficiency.

2. RESEARCH METHODS

The research design used in this study is Literature Review. Literature review is a writing plan by searching literature from journals that have been published and studied. This literature search uses previous data or sources obtained from existing databases such as *Google Scholar* and *research gate*. By using the keywords "efficiency level", and " *data envelopment analysis* ". The criteria used in this study are: 1) The article has been published in national or international *journals or proceedings* ; 2) The article uses English or Indonesian; 3) Articles are qualitative and quantitative research. After obtaining the journal/article, the selection is carried out and the journal obtained is in accordance with the criteria. The data obtained will be used in a discussion that will answer the problems in this study.

3. RESULTS AND DISCUSSION

This study has described 25 articles discussing industry-based DEA classified by author measurements, title, input and output variables, and results of each article. The study of researchers that



efficiency measurement using data envelopment analysis is the ability to produce maximum output with existing inputs for expected performance. When measuring Data Envelopment Analysis you are faced with the condition of how to obtain the optimal output level with the existing input level, or determine the minimum input level with the achievement of a certain level of output.

Based on data that measurements using data envelopment analysis can be seen from the object of research and the input output variables of each author are different, but there are similarities in the examination using data envelopment analysis to measure the efficiency of the company.

Table 1. Results of the review literature

No	Writer	Title	object Study	Variable		Results
				Inputs	output	
1	Sinta Thia Anggraeni, Nur Hidayah & Azhar Alam (2023)	<i>The Efficiency of Conventional Rural Banks and Sharia Rural Banks : Case in Central Java</i>	BPRK and BPRS	Total assets, party funds third, cost power Work	total credit and total revenue	13 BPRK and 3 BPRS have achieved perfect efficiency. In 2018 the average efficiency value was 0.959, in 2019 it was 0.989, in 2020 it was 0.990 and in 2021 it was 0.998. The average efficiency value during the 2018-2021 period is 0.984. In addition, BPRK and BPRS that are not efficient can also manage input and output by looking at other BPRs that have achieved perfect efficiency and become a benchmark in this study, namely BKK Bapas 69, BKK Purwodadi, BPR Surya Yudhakencana, BPRS Artha Surya Barokah, officials BPRS Buana Mitra and BPRS Harta orang karimah (Anggraeni et al., 2023).
2	Mulyadi (2019)	<i>Data Envelopments Analysis for Profitability and Marketing in the 10 Largest Banks in Indonesia</i>	Top 10 banks in Indonesia	assets and labor expenses	<i>earnings operating income, market values, and returns earning per share.</i>	In 2017 sd. 2018 only BCA (private bank), BRI, Danamon (private bank), NISP (private bank), and Panin (private bank) have consistently good efficiency levels, while BTN, BNI, Mandiri, Maybank (private bank), and Niaga (private bank) no (Mulyadi, 2019).
3	Ersang & Atahau (2019)	<i>Comparison of the Efficiency of Government Commercial</i>	Government banks and commercial banks	labor expense, total assets, and equity	Profit	Commercial banks government and private banks in Indonesia have not yet reached an efficient level.

No	Writer	Title	object Study	Variable		Results
				Inputs	output	
		al Banks and Private Commercial Banks Using the Data Envelopme nt Approach Analysis				
4	Wasiaturrah ma, Sukmana, R., Ajija, SR, Salama, SCU, & Hudaifah, A. (2020)	BPR financial performanc e in Indonesia: A two-stage DEA approach	BPRs in Indonesia	Interest /margin/p rofit sharing from third parties, allowance for earning assets, administr ative and general expenses, non-operating costs, other costs, capital, savings, time deposits, bank loans	r receipt of interest/m argin/prof it sharing from loans, other income, disbursed loans/ financing	BPR and BPRS are still not efficient in carrying out their mediation role. However, both institutions proved to be efficient in terms of production. To improve intermediation and production efficiency, the two institutions must increase their capital (Wasiaturrahma et al., 2020).
5	Zahra & Darwanto (2019)	<i>The Determinants of banking Efficiency (Data Envelopme nt Analysis based on Intermedia tion approach)</i>	Bank	party funds and labor expenses	assets (net), interest income, operating income, and loans.	The majority of state-owned banks have a high level of efficiency (Zahra & Darwanto, 2019).

No	Writer	Title	object Study	Variable		Results
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6	Dea Rahmadiani, Sri Ramadhani and Muhammad Syahbudhi (2022)	Islamic Insurance Study Program, Faculty of Islamic Economics and Business North Sumatra State Islamic University	A sharia life insurance in Indonesia	Total assets, expenses, payments claim	Income investmen t, acquisitio n of funds tabaru '	PT Sinarmas MSIG Life company efficiency value in 2017 – 2021 better than other sharia life insurance companies. Level The efficiency of Syariah Life Insurance has an average of BNI Life Insurance 0981, PT Sinarmas MSIG Life 1000, PT Asuransi Jiwa Syariah Jasa Mitra Abadi Tbk 0.885, PT Avrast Assurance 0.877, PT Asuransi Jiwa Manulife Indonesia Sharia Business Unit 0.910.
7	Rinti Dwijayanthi e and JMV Mulyadi (2022)	Manufacturing Company Efficiency with Data Envelopme nt analysis	Manufact uring company	total assets, total equity, cost of productio n, selling expenses, general and administr ative expenses, expenses other operation s	Sale net and profit comprehe nsive year walk	On average from 2016 to 2021 more than half of the companies are not efficient with details namely: 30.7% of companies consistently have value The highest efficiency is up to 100%. 65.3% of companies have a relatively good efficiency value (> 90%-99%). While the remaining 4% is not yet efficient (Dwijayantie et al., 2022).
8	Nurhayati and Muhammad Reza Naufal (2019)	Analysis Efficiency Sharia Unit Life Insurance with use DEA method	Insurance soul of the Sharia Unit	Total assets, general and administr ative expenses, and commissi on expenses	gross premium and tabarru '	Sharia Unit Life Insurance shows the level efficiency could not reach 100% during the three study periods. The low level of efficiency of a number of insurance companies in the study This is affected by general and administrative expenses, total assets and expenses commission (Nurhayati & Naufal, 2019).
9	Endra Septiana Margareta	Analysis Efficiency Insurance	Insurance company	Assets, Expenses,	Tabarru ' income and fund	Based on the DEA approach, insurance company general sharia has operated with

No	Writer	Title	object Study	Variable		Results
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	(2020)	General Sharia Di Indonesia In Year 2015 Up to 2018	general sharia	Payment of claims.	acquisition.	efficient if it has an efficiency value of 100%, value company efficiency less than 100% means less or inefficient. This study shows the results if the company's efficiency level general insurance.
10	Biresh K. Sahoo, Jati K. Sengupta, and Anandadeep Mandal (2007)	<i>Productive Performance Evaluation of the Banking Sector in India Using Data Envelopment Analysis</i>	Banking in India	Investment, a set performing loans, non-interest income	Loans, manpower work, assets still	The trend of increasing annual averages in technical efficiency for all ownership groups indicates an affirmative attitude about the effect of the reform process on the performance of the Indian banking sector. Second, the accrual of higher cost efficiency private banks over nationalized banks show that nationalized banks, although old, do not reflect their learning experiences behavior minimizes their costs due to the inefficiency factor X arising from government ownership. This finding too highlighting the possibility of a stronger disciplinary role played by capital markets suggests a strong relationship between markets for corporate control and the efficiency of private firms is assumed by the property rights hypothesis. And, finally, about behavior elasticities of scale, technology and market-based outcomes differ significantly supporting empirical differences between returns to scale and economies of scale, are often used interchangeably in the literature (Sahoo et al., 2007).
11	Siti Nurhasanah and Deni Lubis (2017)	Efficiency of BAZNAS Bogor and	BAZNA S in Bogor and	Cost operation al and	Funds raised and funds disbursed	Efforts that can be made to increase the value of efficiency

No	Writer	Title	object Study	Variable		Results
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		Sukabumi : Data Envelopme nt Analysis Approach	Sukabumi	personnel costs		BAZNAS that is not yet efficient is based on the causes of institutional inefficiency. In the intermediation approach, the cause of inefficiency is operational costs and funds disbursed. Therefore, institutions that have not been efficient namely BAZNAS Bogor City and Bogor Regency need to reduce costs operations and increase disbursed funds (Nurhasanah & Lubis, 2017).
12	Benarda, Ujang Sumarwan, and Muhamad Nadratuza man Hosen (2016)	Efficiency Level Industry Sharia Life Insurance Using Approach Two Tag Data Envelopme nt Analysis	Sharia Life Insurance	assets, expenses, payment of claims owned	tabarru income and funds	The efficiency of sharia life insurance shows that the management of sharia life insurance in Indonesia is still fluctuating so it still needs to be improved to make it more efficient (Benarda et al., 2016).
13	Indah Wulandari and Djoni Djatnika (2023)	Implement ation of the BCC Data Envelopme nt Analysis (DEA) Model in Measurem ent SOE Bank Efficiency in 2017-2021	state-owned banks	Savings, fees labor and fixed assets	Credit and income operation al	PT Bank Negara Indonesia, PT Bank Rakyat Indonesia, PT Bank Negara Savings and PT Bank Mandiri. During the 5 year research period BRI and BTN were quite efficient because there are 4 relatively efficient scores of 100% and 1 relatively inefficient score. While BNI has only 1 relatively efficient score and 4 others close to the score relatively efficient. Bank Mandiri has 3 relatively efficient scores and 2 scores relatively inefficient (Wulandari et al., 2023).
14	Lian Fuad (2023)	Analysis Efficiency with Methods of	Amil Zakat Institutio n	cost operation al, Cost personnel,	receipt of ZIS funds and distributio	in all periods from 2017-2020 showing efficiency performance of 100% or 1. But in 2019,

No	Writer	Title	object Study	Variable		Results
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		Data Envelopment Analysis (DEA) in Institutions Amil Zakat Muhammadiyah		costs of socialization and total assets	n of ZIS funds	Lazismu efficiency performance gets a value of 0.977.
15	Seyed Hossein Razavi Hajiagha, Hannan Amoozad Mahdiraji, Shide Sadat Hashemi, Jose Arturo Garza-Reyes and Rohit Joshi (2023)	<i>Public Hospitals Performance Measurement through a Three- Staged Data Envelopment Analysis Approach: Evidence from an Emerging economy</i>	House sick in the United States	Amount of beds, Number of doctors, Total nurses, Total staff costs Administr ation, Total services addition, Total support services, Total medical, Total power technical, Medicine s, Food rations, Total assets	Amount operation, Total operation emergenc y, Total patient take care road, length of stay, Case consulting , Total revenue, Receipt, Delivery, Amount patient take care stay, returning patient, Amount patient take care deceased hospital during take care stay, Technician laboratory	only 4 out of 11 hospitals have been working independently efficient while other hospitals experience at least one type of inefficiency purely technical, mixed, or scaled. The proposed approach can be used in the case when the number of DMUs is small compared to the number of inputs and outputs (Hajiagha et al., 2023).
16	Martin Flegl, Hazael Ceron Monroy,	<i>Estimating the hospitality efficiency</i>	Hospitality in Mexico	Amount star hotel room one, Total star hotel	Occupancy rate, arrivals tourists, income	: There is a significant difference between state with respect to its overall efficiency, as well as regarding volatility during

No	Writer	Title	object Study	Variable		Results
				Inputs	output	
	Igor Krejchi, Josef Jablonsky (2022)	<i>in Mexico using Data Envelopment Analysis</i>		room two, Total star hotel room three, Total star hotel room four, Total five star hotel room,	per available room	analyzed period. In addition, significant differences in national and tourism internationally observed. In this case, international tourism is mainly concentrated only in several coastal countries, so the overall efficiency of hospitality is very low. On the other hand, national tourism is not characterized by such a concentration in coastal countries, because it is more land oriented. These different characteristics result in more hospitality efficiency overall height (Flegl et al., 2023).
17	Nadhifah Salsabila Firdaus, Radia Purbayati, and Iwan Setiawan (2022)	Analysis Efficiency Managemen of Zakat with Super Efficiency Data Envelopment Analysis (DEA) method at LAZ Mizan Amanah	LAZ Mizan Amanah	costs, expenses socialization, and costs operation al	Amount Zakat receipt and amount distributio n of zakat	it was found that inefficiencies on the input side were mainly caused by high personnel costs and operational costs. So these costs need to be reduced. While on the output side, inefficiency is caused by the collection and distribution of zakat which needs to be optimized so that it can achieve the expected target.
18	Ahmad Madih Najibullah, Muh Zaini Haris Munandar, Shifia Chafi Azka Haq (2023)	Analysis Comparison Bank Performance Efficiency with Data Envelopment Analysis Method (Study Comparative on Bank Permata and Bank	Gem Bank and Bank General Indonesia n Sharia	Savings	Credit/fin ancing	Indonesian Sharia Commercial Banks have a better efficiency level than Gem Bank. This can be seen from the average efficiency value of Islamic Commercial Banks Indonesia which is higher is good compared to the Bank Gemstone.

No	Writer	Title	object Study	Variable		Results
				Inputs	output	
		General Indonesian Sharia Period Quarter III 2021- Quarter IV 2022)				
19	Adristi Prily Auliani and Willy Perwithosuci (2023)	Technical Efficiency of Islamic Banks in Indonesia During Pandemic Covid-19: Data Envelopme nt Analysis Approach	Islamic Banks in Indonesia	party funds third, cost power work and costs operation al other.	financing and income operation al other.	Efficiency in each bank, both Islamic Commercial Banks and Business Units Sharia, there is four period Where all banks experience efficiency. Besides it, only one bank experienced efficiency on each period for Islamic Commercial Banks. On the contrary, in the Sharia Business Unit there is three banks that experienced efficiency.
20	Fauziah Salma, Djoni Djatnika and Fifi Afiayanti Triuspitori ni (2022)	Approach to Data Envelopme nt Analysis Measuring Bank BJB Period's Financial Performan ce 2015-2020 year	bank bjb	Party Funds Third (DPK), Human Resources (HR), and assets still	Credit used	year 2015 Bank BJB achieved a fairly efficient condition with a score of 99.80%. Furthermore, in 2016 Bank BJB achieved a fairly efficient condition of 99.58%. Next, in 2017 Bank BJB achieved a fairly efficient condition with a score of 99.78%. In 2018, Bank BJB achieved a fairly efficient condition of 99.46%. Furthermore, in 2019, Bank BJB achieved a fairly efficient condition with a score of 99.70%. Next, in 2020, Bank BJB will achieve a fairly efficient condition of 99.73%. kindly for the entire period of 2015-2020, Bank BJB the average has reached a fairly efficient condition with a score of 99.67% (Salma et al., 2022).
21	Ulfi Hidayah, Atieq Amjadallah	Analysis Efficiency of Islamic People's	Islamic People's Financin g Bank	Party Funds Third (DPK),	Financing and Income	BPRS in the Special Region of Yogyakarta have a higher level of efficiency compared to BPRS in the Central Java

No	Writer	Title	object Study	Variable		Results
				Inputs	output	
	Alfie, Rosida Dwi Ayuningtyas (2020)	Financing Banks (BPRS) in the Central Java and DIY Regions with Period Data Envelopme nt Analysis (DEA) method 2016–2018	(BPRS) for Central Java and DIY	operating expenses, assets still	operation al	region. Of the 33 BPRS that became sample research, only there are 6 regular BPRS reach level 100% efficiency during 2016-2018, consisting of of 2 BPRS in Java region and 4 BPRS in the DIY region, namely PT. BPRS Sukowati Sragen and PT. BPRS Treasure human Karimah Bahari for the Central Java region, PT. BPRS Madina Mandiri Sejahtera, PT. BPRS Mitra Amal Mulia, PT. BPRS Danagung Sharia and PT. BPRS Mitra Harmoni Yogyakarta for the DIY region (Ulfi Hidayah, Atieq Amjadallah Alfie, 2018).
22	Mikhael Garda Prasetya and Gideon Setyo Budiwitjaks ono (2023)	Digital Bank Efficiency in Indonesia Using Data Envelopme nt Analysis (DEA)	Digital Banks in Indonesia	Third-party funds (DPK), Operating Expenses and total assets	Financing and income operation al	efficiency score obtained by 32 digital bank samples during the 2018 – 2021 period stated the average efficiency results shows a high efficiency value. A digital bank capable of achieving perfect efficiency namely PT Bank BCA Digital, PT Bank KEB Hana and Bank Raya Indonesia
23	Darkiman Rumina (2022)	Analysis Efficiency of PT Pupuk Indonesia (Persero) With Model Data Envelopme nt Analysis (DEA)	PT Pupuk Indonesia (Persero)	Total assets and total costs	Sales and profit	value of PT Pupuk Indonesia from 2016 to 2020 reached 100 percent or was declared efficient. Even though the value of assets, financing expenses, sales receipts and company profits change every year, the condition of the company after becoming a <i>holding company company</i> is numerically more efficient (Ruminta, 2022).
24	Hirofumi Fukuyama, Mike Tsionas and	<i>Dynamic network data envelopme nt analysis</i>	Banks in China	fixed assets, savings, and	investmen t securities and loans	The highest efficiencies were dominated by state-owned banks, and although banks foreign exchange is less efficient than joint stock

No	Writer	Title	object Study	Variable		Results
				Inputs	output	
	Yong Tan (2022)	<i>with a sequential structure and behavior - causal analysis: Application to the Chinese industrial banking</i>		employee expenses in the current year		banks. Finally, we found that BPRs have inefficiency highest.
25	Francis O. Ikapel, Gregory S. Namusonge and Maurice M. Sakwa	<i>Determinants of Banking Sector Efficiency in Kenya: Application of Non-parametric Data Envelopments Analysis (DEA) Models</i>	Banking in Kenya	Bank size, capital adequacy, liquidity risk, leverage and market capitalization	Income interest, total loans and income other.	Bank size, capital adequacy, liquidity risk, leverage and market capitalization have a significant effect on bank efficiency (Ikapel et al., 2023).

4. CONCLUSION

The results of the review of 25 articles show that there are measurements of Data Envelopment Analysis faced with the condition of how to obtain the optimal level of output with the existing input level, or determine the minimum input level with the achievement of a certain level of output.

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