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A DATA ENVELOPMENT ANALYSIS APPROACH TO BENCHMARKING THE EFFICIENCY IN SELECTED MALAYSIAN FOOD MANUFACTURING COMPANIES

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ABSTRACT

Food industry, which includes every stage of the production process, from farming and manufacturing to distribution, retail and services, is one of the biggest and most significant sectors in the global economy. The relative efficiency of Malaysian food manufacturing companies is still unclear since many of them lack benchmarking tools and struggle to allocate labor, energy and raw materials optimally. This study applies the Data Envelopment Analysis (DEA) method to examine the relative efficiency of Malaysian food manufacturing companies. Relative efficiency refers to the ratio of the weighted sum of the outputs to the weighted sum of the inputs. The main objectives of this research are to measure the relative efficiency of a selection of companies, identify the most efficient companies and provide strategies to improve resource use. DEA is a mathematical approach that compares several inputs and outputs to measure how efficient decision-making units (DMUs) are. Seven companies were chosen for this study and their financial information for 2023, which is represented by DMU1, DMU2, DMU3, DMU4, DMU5, DMU6 and DMU7 have been examined. Capital, fixed assets, operating expenses, current assets and liabilities are the input variables taken into consideration while revenue and net profit are the output variables. Five businesses, DMU2, DMU4, DMU5, DMU6 and DMU7, had a complete relative efficiency score of 100% and DMU1 got a near-perfect efficiency score of 99.98%. Meanwhile, DMU3 has shown lower efficiencies of 71.49%. DMU3 was subjected to an improvement strategy to enhance the performance of the most inefficient units. This company was able to achieve a 100% relative efficiency score after implementing the strategy. The findings of this research offer insightful information about efficiency in Malaysia's food manufacturing industry as well as an approach for underperforming businesses to improve their utilization of resources and decision-making procedures.

Keywords: *Benchmarking, Data Envelopment Analysis, Decision-making Units, Efficiency.*

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1. Introduction

Efficiency in Data Envelopment Analysis (DEA) refers to the relative ability of a decision-making unit (DMU) to transform multiple inputs into outputs when compared with an empirical efficiency frontier. The CCR model introduced by Charnes *et al*. (1978) provides a non-parametric framework for estimating this relative efficiency and benchmarking less efficient units against best-performing peers.

The food manufacturing sector is a key segment of Malaysia's broader food and beverage (F&B) industry. National industrial policy identifies food processing as an important manufacturing sector, with emphasis on value creation, sustainability and competitiveness (Ministry of Investment, Trade and Industry, 2023). Malaysia's position as a global halal hub also strengthens the relevance of food manufacturing to domestic and international markets (Ahmad *et al*., 2024).

From processing basic raw materials to manufacturing value-added finished goods, food manufacturing in Malaysia lies at the very heart of its F&B industry for both domestic and international markets. In this case, the Ministry of Investment, Trade and Industry (2023) defined the food manufacturing sector as filling in the gap between agricultural output and final products for export and local consumption. Malaysian food manufacturers have established themselves as market leaders in both the regional and international markets because of their dedication to long-term sustainability, innovative approaches and Halal certification (Ahmad *et al*., 2024). These businesses, starting from global conglomerates like Nestlé Malaysia to small and medium-sized enterprises (SMEs) that focus on niche products, are crucial in determining the future development of the sector.

According to the U.S. Bureau of Labor Statistics (2025), food manufacturing covers a wide range of production and processing activities, including meat, seafood, fruit and vegetable products, dairy products, grain and milling products, bakery products, other food products and animal feed. These categories illustrate the diversity of activities that may be evaluated using efficiency and productivity measures.

Amid economic uncertainty, rising operating costs, and stronger sustainability expectations, food manufacturers increasingly need to monitor and improve resource efficiency.. Data Envelopment Analysis (DEA) is a non-parametric efficiency evaluation method that provides a strong basis to evaluate the performance of decision-making units (DMUs) like branches or companies and to find out the best practices. DEA is widely used to determine the performance of organizations including banks, insurance companies, hospitals, hotels and many other entities. Its broad applicability and dependability have been highlighted by its versatility, which has been shown in a variety of sectors, including non-profit organizations and profit-driven businesses.

Abidin *et al*. (2024) examined 71 Indonesian commercial banks in 2018–2019 using DEA and stochastic frontier analysis (SFA). The average DEA efficiency declined slightly from 0.82 to 0.81, with larger banks generally outperforming smaller banks. Darko *et al*. (2025) examined the technical efficiency of 70 commercial banks from 19 African countries over 2009–2020 using DEA under variable returns to scale (VRS) and constant returns to scale (CRS). Their findings indicated higher efficiency under VRS, while many banks remained technically and scale inefficient.

Saliman *et al*. (2022) investigated ten Malaysian public university libraries from 2016 to 2019 using the Zero-Sum Gains Data Envelopment Analysis (ZSG-DEA) model for evaluating inputs such as staffing and material availability against outputs like material circulation, to formulate resource reallocation strategies. While conventional DEA revealed that only five to six libraries achieved full efficiency across the four-year period, the application of ZSG-DEA demonstrated that inefficient libraries could systematically improve their

performance metrics when operating under fixed-resource constraints, offering practical benchmarks for university library administration.

A study by Zubir *et al*. (2024) uses Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) technique to analyze 89 hospital-based DEA studies. The data which was taken from 2014 to 2022 looked at input-output selection strategies and new advancements in DEA. The results show similarities with previous trends and no evidence for the universal applicability of the DEA model. Different strategies might improve variable selection in different contexts or viewpoints. Apart from the study, Tsai *et al*. (2024) used a non-homogeneous DEA model to analyze the effectiveness of 53 hotels in the Guangdong-Hong Kong-Macau Greater Bay Area on 2015–2019 data. According to the results, hotels that provide a variety of services, such as rooms, food, meetings and spas, are more efficient than those that only offer rooms. Hotels in core cities and Guangzhou did better than those in important node cities, demonstrating the advantages of location and service diversification.

Panda *et al*. (2024) used DEA to assess the efficiency of women's self-help groups (SHGs) in Odisha, India. Socio-economic and human-development indicators were treated as outputs, while facilitating activities were treated as inputs. The study reported that 30 of 62 SHGs were relatively efficient, illustrating the wider applicability of DEA beyond conventional commercial settings.

Within the F&B industry, DEA has been used in numerous studies to evaluate the relative efficiency of food manufacturing companies, as well as service providers like restaurants and eateries. To find inefficiencies and recommend changes, a comparison can be made based on multiple companies' input and output factors. A study by Rusmita *et al*. (2023) looked at how technical efficiency (TE) affects business value in five important halal F&B marketplaces. With inefficiencies ranging from 38 to 48%, Indonesia had the greatest TE (62%), followed by Pakistan, South Africa, Malaysia and Singapore. In many nations, TE has a major impact on company value, highlighting its significance for stock performance. Efficiency measures should be given top priority by businesses, investors and governments to increase industry growth, value and sustainability.

Rajapakasha and Prasada (2025) used SFA with a translog function to evaluate the efficiency of 1,516 food manufacturing companies in 27 European Union (EU) nations based on data of year 2020 to 2021. The overall efficiency score is 0.81, while firm size, age, tax rates, trade restrictions and political instability are significant causes of inefficiency. Reducing political influence, increasing firm size and improving tax laws could improve efficiency and reduce the differences between nations. In other study, Wittayakorn-Puripunpinyoo (2025) analyzed the efficiency changes of dairy cooperatives in Saraburi province by applying DEA. The study considered technical efficiency change (TEC), technological change (TC), pure technical efficiency (PTE) and scale efficiency (SE). Findings indicated no change in TEC resulting in better managerial performance with PTE equal to 1.000, a marginal decrease in TC (0.995) and a slight decrease in total productivity (0.996).

Resource efficiency remains an important concern in food manufacturing because inefficient use of financial, operational and productive resources can weaken firm performance. Recent evidence from food-manufacturing and halal F&B studies shows that efficiency varies across firms and markets and can be associated with firm characteristics and value creation (Rajapakasha & Prasada, 2025; Rusmita *et al*., 2023). DEA therefore provides a useful basis for identifying relative inefficiency and supporting data-driven benchmarking decisions.

Therefore, this study seeks to assess the relative efficiency of selected businesses in Malaysia's food manufacturing companies, identify the most efficient company and provide businesses practical suggestions to improve the selected companies resource utilization. When companies have an idea of their efficiency level, they will be able to utilize the available resources effectively, consequently, reduce waste of resources. This study focuses on assessing the relative efficiency of food manufacturing companies in Malaysia. Due to the accessibility and availability of relevant data, only seven food manufacturing companies were chosen for

this study. The selected inputs are capital, fixed assets, operating expenses, current assets and liabilities, with selected outputs of revenue and net profit. To maintain consistency and comparability among the chosen companies, the scope is limited to only data in year 2023. However, the inputs and outputs selected might not reflect all factors that influence performance, including market dynamics, product quality and innovation. By focusing on this approach, the study attempts to offer an accurate and reliable evaluation of the selected companies' operational relative efficiency.

2. Methodology

This study uses the DEA model introduced by Charnes *et al*. (1978), known as the CCR model. It assumes constant returns to scale, meaning that a proportional increase in inputs is associated with a proportional increase in outputs. The model compares each DMU's relative performance with an efficiency frontier formed by the best-performing units, which serve as benchmarks for less efficient DMUs.

By considering $k=1,2,3,..,n$ DMUs, each using $i=1,2,3,..,m$ inputs to produce $r=1,2,3,..,s$ outputs, with v_i and u_r indicating the weights assigned to the inputs and outputs, respectively. The DEA model evaluates the efficiency of each DMU by solving the following optimization problem for DMU k such that,

$$\text{Maximise} \quad \sum_{r=1}^{s} u_r y_{rk} \tag{1}$$

Subject to:

$$\sum_{i=1}^{m} v_i x_{ik} = 1 \tag{2}$$

$$\sum_{r=1}^{s} u_r y_{rk} - \sum_{i=1}^{m} v_i x_{ik} \leq 0 \tag{3}$$

$$u_r \geq 0 \tag{4}$$

$$v_i \geq 0 \tag{5}$$

where

x_{ik}	:	input i for DMU k
y_{rk}	:	output r for DMU k
$\mathrm{u_r}$	:	weights allocated to output r
v_i	:	weights allocated to input i
s	:	number of outputs
m	:	number of inputs

Equation (1) is a linear model that seeks to maximize the weighted outputs for a particular DMU under evaluation, using optimally selected weights. Equation (2) applies constraints that normalize the input values to 1 to ensure fairness, while Equation (3) prevents any DMU from exceeding an efficiency score of 1 when evaluated with the same weights. Equation (4) and Equation (5) ensure that all weights assigned to outputs and inputs are non-negative, respectively. This ensures that the calculated efficiency score lies between 0 and 1, where a score of 1 indicates that the DMU is operating efficiently relative to others in the dataset.

The selection of the inputs and outputs is based on the literature review conducted on multiple authors. There is a total of five inputs in this study, that are capital, fixed assets, operating expenses, current assets and liabilities. Capital refers to wealth in the form of money or other assets that are owned by an individual or organization and made available for uses like investment or starting a business. Fixed assets are resources for long-term use while operating expenses consist of ongoing costs incurred while operating a system, business or product. Current assets are those that a business holds and plans on using or turning into cash within a

year. Finally, liability is the amount that a financial organization owes or more precisely, it is the worth that an organization is supposed to provide in the future to fulfil a current obligation brought on by previous occurrences. In contrast, for the outputs, there are two variables selected for this study that are revenue and net profit. Revenue is the total amount of money made from the sale of products and services associated with the main business activities, meanwhile the total revenue of a business after all costs are deducted is known as net profit. Table 1 shows the list of selected inputs and outputs for this study.

Table 1. List of selected inputs and outputs.

Inputs	Outputs
Capital Fixed Assets Operating Expenses Current Assets Liabilities	Revenue Net Profit

The financial data used in this study were obtained from the 2023 annual reports of the selected listed companies available through Bursa Malaysia's company-announcement platform (Bursa Malaysia, n.d.). DEA requires non-negative input and output values, whereas the net-profit output contained negative values for two DMUs. To address this issue, the translation-invariance property of DEA was applied. Sueyoshi and Goto (2018) discuss translation-related issues and remedies in DEA modelling. The most negative net profit, RM49,884,000 for DMU7, was identified and a buffer of RM1,000,000 was added to ensure strict positivity. Accordingly, RM50,884,000 was added to the net profit of all DMUs. Table 2 presents the seven selected food manufacturing companies with their DMU labels and transformed input and output values.

The relative efficiency scores of seven food manufacturing companies were calculated using QM for Windows. Using the DEA model, QM for Windows optimizes the weights of each input and output so that the most efficient DMUs obtain a score of 1 (100%) and the others receive relative ratings based on their performance. By using linear programming tools to solve these models, the software makes it possible to compare each DMU to an efficient frontier made up of the top-performing units. This procedure guarantees consistency and objectivity in the efficiency measurement.

Table 2. List of transformed input and output data of selected food manufacturing companies.

DMU	Inputs					Outputs	
	Capital (RM'000)	Fixed Assets (RM'000)	Operating Expenses (RM'000)	Current Assets (RM'000)	Liabilities (RM'000)	Revenue (RM'000)	Net Profit (RM'000)
1	267,500	2,263,216	1,570,543	1,306,006	2,894,326	7,050,879	710,754
2	80,000	80,173	66,889	158,442	76,430	357,270	95,969
3	184,889	223,651	57,212	237,104	67,590	287,215	81,012
4	29,933	43,728	19,648	53,118	70,162	80,682	43,780
5	279,607	152,096	54,551	67,883	396,867	168,994	57,916
6	50,528	1,799	21,712	69,518	10,471	124,879	55,337
7	718,255	1,901,490	102,561	989,263	1,425,677	3,091,223	1,000

3. Computational Result and Improvement Strategy

Output for the efficiency values was generated through several steps, starting with data acquisition from Bursa Malaysia. Followed by data transformation to ensure strictly positive values without altering relative efficiency scores. Then CCR model was constructed to maximize weighted outputs subject to normalized inputs. Using QM for Windows software, optimal weights and relative efficiency scores were calculated. All financial inputs and outputs were scaled to millions to ensure computational stability and prevent raw value distortions. Based on the result of the computational experiment, DEA has successfully measured the relative efficiency score of food manufacturing companies. Table 3 shows the result of the relative efficiency score for the seven DMUs.

Table 3. Results of the relative efficiency scores of seven DMUs.

	Relative Efficiency
DMU 1	99.98%
DMU 2	100%
DMU 3	71.49%
DMU 4	100%
DMU 5	100%
DMU 6	100%
DMU 7	100%

From the relative efficiency obtained, it is noted that DMU2, DMU4, DMU5, DMU6 and DMU7 are the companies that are the most efficient ones, with an efficiency score of 100%. It is followed by DMU1 with a near-perfect relative efficiency score of 99.98%. In contrast to other DMUs, DMU3 has recorded an efficiency score of 71.49%. This company is identified as having a significant inefficient score since it is below 85%. Taking this into consideration, an improvement strategy is being carried out to push the efficiency value to a better efficiency score. This business needs to improve, either by increasing or decreasing the input and output values, to maximize their efficiency score. To serve this purpose, a model by El-Mahgary and Lahdelma (1995) is implemented to calculate the new improved values of input and output. The model is given by,

$$x_{iE'} = x_{iA}\lambda_{iA} + x_{iB}\lambda_{iB} \tag{6}$$

where

$x_{iE'}$ is the input/output value i of DMU3 that needs to be revised
x_{iA} is the input/output value i of the reference set DMU A
λ_{iA} is the dual weight of input/output i of the reference set DMU A
x_{iB} is the input/output value i of the reference set DMU B
λ_{iB} is the dual weight of input/output i of the reference set DMU B

DMU A and DMU B must be selected from the DMU list with good efficiency scores. For this reason, DMU6 and DMU7 were selected as reference sets, as both exhibited perfect efficiency scores of 100%. Additionally, they were chosen based on the presence of dual weight values in the dual solution of the computational outputs, indicating their role in defining the efficiency frontier. For the improvement of DMU3, the dual weights associated with DMU6 and DMU7 were 1.78561 and 0.020778, respectively. The reference sets for improvement of DMU3 are shown in Table 4.

Table 4. The reference set for improvement of inefficient DMU3

DMU to improve	Efficiency Score	Reference Set	Dual Weight
DMU3	71.49%	{DMU6, DMU7}	{1.78561, 0.020778}

Table 5 compares the actual and improved inputs and outputs values for DMU3 highlighting how resource optimization can lead to better efficiency and profitability. All the calculated values are rounded off to the nearest RM'000. In general, the suggested values for inputs are lower than the current input values, whereas the suggested value for output shows a slight increase as compared to the current ones. By implementing these changes, DMU3 will be able to improve the efficiency score.

Table 5. Comparison of input and output values for DMU3 before and after the improvement strategy

	Input (RM'000)					Output (RM'000)	
	Capital	Fixed Assets	Operating Expenses	Current Assets	Liabilities	Revenue	Net Profit
Actual Values	184,889	223,651	57,212	237,104	67,590	287,215	81,012
Improved Values	105,148	42,722	40,900	144,687	48,319	287,216	47,948

Table 6 shows the comparison of the previous calculated relative efficiency score and the expected new relative efficiency score after utilizing the improvement values of DMU3. DMU3 initially had a comparatively low relative efficiency score of 71.49% which suggests that this company was not making the best use of their resources as compared to other companies. By modifying the input and output values based on El-Mahgary and Lahdelma model, it helps them to improve the efficiency frontier established by the DMUs with the best performance. As a result of the model implementation, DMU3 obtained a good efficiency scores of 100%, demonstrating maximum relative efficiency. This adjustment illustrates the usefulness of DEA as a basis for focused performance improvement as well as a diagnostic tool. The suggested changes provide decision-makers with precise, reliable guidance on how to boost operational effectiveness and competitiveness in the food manufacturing industry.

Table 6. The comparison of efficiency score before and after the improvement strategy

	Efficiency Score before improvement	Efficiency Score after improvement
DMU3	71.49%	100%

4. Conclusion and Recommendations

This study has successfully demonstrates the use of DEA method to measure the relative efficiency of seven different Malaysian food manufacturing companies. The finding has revealed that DMU2, DMU4, DMU5, DMU6 and DMU7 were operating at maximum efficiency with scores of 100%, while DMU1 closely followed with an efficiency score of 99.98%. Nevertheless, DMU3 was discovered to be comparatively inefficient, with the lowest efficiency values being shown by a score of 71.49%. The use of El-Mahgary and Lahdelma's improvement model made it possible for DMU3 to achieve maximum efficiency and enhance their performance, demonstrating the effectiveness of the model in recommending improvements to operations and resource optimisation. These findings highlight DEA's usefulness as a performance benchmarking tool that measures efficiency and offers a systematic approach for identifying and correcting inefficiencies. It helps companies utilise resources effectively and make accurate choices to increase efficiency as well as competitiveness.

The small sample size and complete dependence on financial data in the study have presented limitations, hence it serves as a decent background for further research. For future research, a larger number of companies from different sub sectors could provide a more practical view of relative efficiency and long-run improvement recommendations for Malaysia's food manufacturing industry. In addition, taking a larger domain of inputs and outputs could offer a more thorough and practical evaluation of relative efficiency. Additional inputs may include variables such as labour or number of employees, energy consumption or research and development expenditure, while outputs can be extended to include production volume, export value or customer satisfaction indices.

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Author Contribution

Zuraida Alwadood prepared the literature review, and she is the corresponding author for the paper. Natasya Syafiah Marlis Elias wrote the research methodology, worked on the modelling part and ran the computational experiment. Norlenda Mohd. Noor interpreted the results and did the formatting part. Bekzodjon Fayziev reviewed and edited the manuscript and provided critical feedback on the overall work.

Declaration of generative AI in the writing process

During the preparation of this work, the authors used *Chatgpt* to check the grammar of the manuscript. After using this tool, the authors reviewed and edited the content as needed and took full responsibility for the content of the publication.

Data Availability/Supplementary Materials

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Ethics Statement

The authors declare that this research did not involve human or animal subjects. All experimental procedures were performed following the institutional Safety, Health, and Environmental (HSE) protocols of Universiti Teknologi MARA (UiTM), Malaysia.

Conflict of Interest

The authors have no conflicts of interest to declare.

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