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Efficiency and Economies of Scale in the Indonesian Halal Food MSMEs: Evidence from Pangkalpinang City

ABSTRACT - This study assesses the technical efficiency and returns to scale of Micro, Small, and Medium Enterprises (MSMEs) within the halal food sector of Pangkalpinang City. Employing a Stochastic Frontier Analysis (SFA) with a Cobb-Douglas production function, the research analyzes cross-sectional data from 50 halal-certified fish processing MSMEs to determine the productivity of labor, capital, and raw materials. The findings reveal that the sector operates under decreasing returns to scale (total elasticity = 0.934), indicating systemic inefficiencies in scaling operations. Raw materials emerged as the primary positive driver of production. Conversely, capital investment was statistically insignificant, while increased labor inputs negatively impacted output, suggesting critical skills deficits and capital underutilization. The efficiency distribution confirms a significant performance gap, with the majority of firms (52%) operating at a moderate efficiency level (0.51–0.70) and only 24% achieving high efficiency (>0.75). The study concludes that there is an urgent need for targeted interventions aimed at enhancing operational efficiency—primarily through workforce upskilling and strategic capital investment—before these MSMEs can achieve sustainable growth.

ABSTRAK – Analisis Efisiensi dan Skala Ekonomi UMKM Makanan Halal di Indonesia: Studi di Kota Pangkalpinang. *Penelitian ini mengkaji efisiensi dan cakupan ekonomi Usaha Mikro, Kecil, dan Menengah (UMKM) makanan halal di Kota Pangkalpinang menggunakan fungsi produksi Cobb-Douglas dan model Stochastic Frontier Analysis (SFA). Analisis ini berfokus pada efisiensi teknis dan skala ekonomi dari UMKM halal ini, dengan perhatian khusus pada penggunaan tenaga kerja, modal, dan bahan baku. Data dikumpulkan dari 50 UMKM bersertifikat halal yang terlibat dalam pengolahan ikan halal. Temuan menunjukkan bahwa 52% dari UMKM memiliki tingkat efisiensi antara 0,51 hingga 0,70, sementara 24% menunjukkan efisiensi tinggi (0,75–0,96). Sebaliknya, 2% dari UMKM menunjukkan tingkat efisiensi rendah (0,09–0,50). Nilai elastisitas dari Analisis Frontier Stokastik menunjukkan bahwa tenaga kerja dan bahan baku memiliki dampak signifikan terhadap produksi, dengan tenaga kerja memiliki nilai elastisitas negatif sebesar -6,568 dan bahan baku memiliki nilai elastisitas positif sebesar 4,891. Namun, modal menunjukkan efek minimal pada produksi dengan elastisitas negatif sebesar -1,036. Selain itu, analisis skala ekonomi mengungkapkan bahwa UMKM ini mengalami penurunan hasil skala, dengan total elastisitas sebesar 0,934 untuk tenaga kerja, modal, dan bahan baku secara gabungan. Hasil ini menunjukkan bahwa meskipun banyak UMKM menunjukkan efisiensi tinggi, masih ada ruang yang signifikan untuk perbaikan, terutama dalam pemanfaatan modal dan pengembangan keterampilan tenaga kerja. Studi ini menekankan perlunya intervensi yang terarah untuk meningkatkan efisiensi operasional dan mengatasi ketidakefisienan dalam skala operasi.*

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INTRODUCTION

The assessment of financial performance is a fundamental determinant of an organization's health and competitive positioning, particularly within high-stakes sectors like the global halal food industry (Azizi et al., 2025; Zhou et al., 2022). Within this domain, operational efficiency emerges as a pivotal metric. Inefficiency, defined as the state where marginal production costs surpass marginal income, directly erodes profitability and competitive advantage (Borenstein & Bushnell, 2022; Sarif & Ismail, 2024; Saputra et al., 2020). Consequently, the rigorous evaluation of technical efficiency is essential for ensuring the long-term competitiveness and sustainability of halal food enterprises (Giyanti et al., 2021).

Micro, Small, and Medium Enterprises (MSMEs) are widely recognized as significant contributors to regional economic development, especially in emerging markets (Zhang & Chen, 2021). For MSMEs operating in the halal food sector, obtaining official halal certification is a critical factor for market penetration and consumer acceptance. However, despite their economic importance, these enterprises often grapple with significant barriers to growth, including resource inefficiencies, a lack of economies of scale, and the complexities of maintaining halal compliance (Bhadu et al., 2022; Masruroh, 2020). While prior research has examined aspects of halal certification and operational efficiency (e.g., Adenan et al., 2023; Hanim & Noorman, 2023; Muis et al., 2021), a discernible gap persists in the literature concerning the specific determinants of technical efficiency and economies of scale for halal food MSMEs within distinct regional contexts.

This study addresses this gap by focusing on Pangkalpinang City, a compelling case study due to its unique economic and sociocultural landscape. As the administrative and economic hub of Bangka Island, Indonesia, with a predominantly Muslim population, the availability of halal food is not merely a consumer preference but a fundamental requirement (Adenan et al., 2023). The city has witnessed substantial growth in its halal food MSME sector, driven by heightened consumer awareness. Yet, this growth is tempered by persistent operational challenges, including limited access to quality halal raw materials, high logistics costs, and intense competition from larger corporations (Hanim & Noorman, 2023; Maksum & Kamaludin, 2023). These localized pressures make Pangkalpinang an ideal setting to investigate the interplay between resource utilization and scalability.

Therefore, the primary objective of this research is to analyze the technical efficiency and economies of scale among halal food MSMEs in Pangkalpinang City. The study is guided by a conceptual framework that examines the relationship between productive inputs (labor, capital, and raw materials) and outputs, seeking to answer the following research questions: (1) To what extent do halal food MSMEs in Pangkalpinang efficiently utilize their labor, capital, and raw material inputs? and (2) What are the key factors influencing their ability to achieve economies of scale? This study will contribute localized empirical evidence to the broader literature and offer practical policy recommendations aimed at enhancing the competitiveness and sustainability of a vital economic sector in the region.

LITERATURE REVIEW

The global halal food industry is undergoing rapid expansion, driven by increasing demand from a growing Muslim population and rising consumer awareness of ethical and quality standards (Ahmad et al., 2023). Central to this industry's structure is halal certification, a formal process that verifies adherence to Islamic principles. This certification is more than a religious mandate; it is a critical strategic tool that shapes production processes, enhances market position, and builds consumer trust (Calder, 2020). Empirical evidence supports the direct link between certification and firm performance. Bidin et al. (2021) contend that halal certification strengthens competitiveness by expanding market share, while Tumiwa et al. (2023) found that it yields significant operational benefits, including improved productivity and efficiency.

Building on the link between certification and performance, the literature identifies technical efficiency and economies of scale as two primary determinants of competitiveness in the halal food sector. Technical efficiency—the ability to achieve maximum output from a given set of inputs—is crucial for minimizing waste and managing the costs associated with compliance (Al-Shami & Abdullah, 2023). Inefficiencies often stem from systemic challenges, particularly in developing nations, such as a lack of skilled labor and insufficient technological integration (Haleem et al., 2021). Parallel to efficiency, achieving economies of scale allows firms to reduce their average production costs as output increases, thereby improving profitability and price competitiveness (Tseng et al., 2022). This is especially pertinent for managing the financial burden of halal compliance, as larger firms can more easily absorb these costs (Azam & Abdullah, 2020). However, Micro, Small, and Medium Enterprises (MSMEs) frequently struggle to attain both technical efficiency and economies of scale due to resource and capital constraints, placing them at a competitive disadvantage.

Indonesia, home to the world's largest Muslim population, is a critical hub for halal food production and consumption. While government initiatives have been instrumental in promoting industry growth, MSMEs in outer regions like the Bangka Belitung Islands still face significant operational hurdles (Susilowati et al., 2024). Their limited access to capital, technology, and developed supply chains makes achieving scalability and efficiency particularly challenging. Therefore, a focused analysis of technical efficiency and economies of scale within this specific context is necessary to develop targeted strategies for sustainable growth. Methodologies such as Stochastic Frontier Analysis (SFA) are particularly well-suited for this task, as they can empirically identify the sources of inefficiency and inform policy interventions.

Based on the synthesis of this literature, this study proposes a conceptual framework (see Figure 1) to investigate the factors influencing the competitiveness of halal food MSMEs in Bangka Belitung. This framework posits that inputs—labor, capital, and raw materials—are foundational to achieving technical efficiency. In turn, enhanced efficiency is a prerequisite for attaining economies of scale. Together, these elements determine the overall competitiveness and long-term sustainability of enterprises in the regional halal food industry.

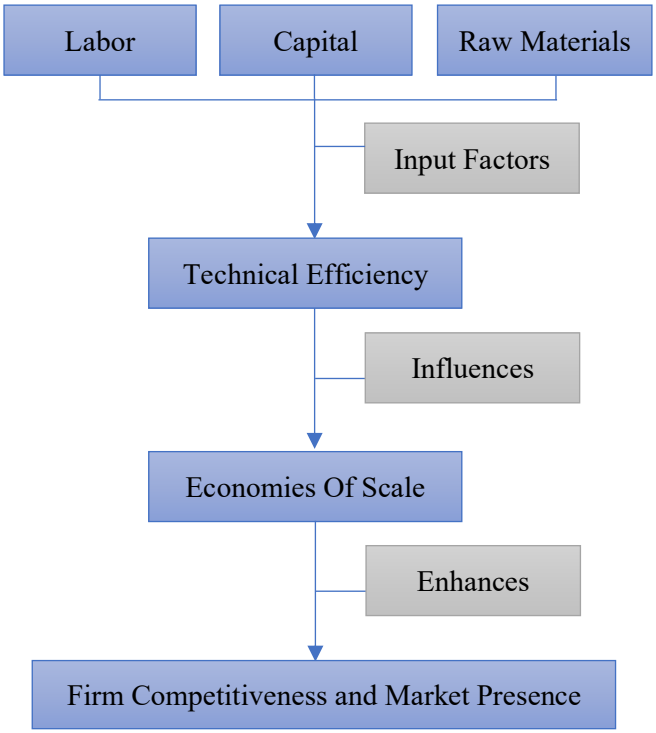

Figure 1. Conceptual Framework

METHODOLOGY

Research Design

This study employs a quantitative, cross-sectional research design to analyze the technical efficiency and economies of scale among halal food Micro, Small, and Medium Enterprises (MSMEs) in Pangkalpinang City, Indonesia. The analytical approach is grounded in a Stochastic Frontier Analysis (SFA) framework, utilizing the Cobb-Douglas production function to model the relationship between productive inputs and output.

Sampling and Data Collection

The target population for this study consisted of all halal-certified MSMEs in Pangkalpinang City registered with the Food, Drug, and Cosmetic Assessment Institute of the Indonesian Ulema Council (LPPOM MUI). A cluster random sampling method was employed, from which the seafood processing cluster was selected for its economic prominence and significant representation within the local halal industry. The final sample comprised 50 MSMEs from this cluster. Data were collected during a single production period through structured interviews with owner-managers and a review of company documentation. The primary variables measured included:

- Output (Q): Total production volume.
- Labor (L): Total labor costs.
- Capital (K): Total capital expenditures.
- Raw Materials (M): Total expenses for raw materials.

Analytical Framework

Stochastic Frontier Analysis (SFA) was chosen to estimate the production frontier and measure the technical efficiency of each MSME. SFA distinguishes between random statistical noise and technical inefficiency, providing a more robust efficiency measure than non-parametric methods. The analysis is based on the Cobb-Douglas production function, which is specified in its stochastic frontier form and linearized using a natural logarithm:

$$\ln(Qi) = \beta_0 + \beta_1 \ln(Li) + \beta_2 \ln(Ki) + \beta_3 \ln(Mi) + (v_i - u_i) \quad (1)$$

Where:

Qi = Production output of the i-th MSME.

Li, Ki, Mi = Inputs of labor, capital, and raw materials for the i-th MSME.

β_0 = Intercept or constant term.

β_1,β_2,β_3 = Output elasticities for labor, capital, and raw materials, respectively.

$(v_i - u_i)$ = The composite error term, where v_i is the two-sided random error term, representing stochastic effects beyond the firm's control (e.g., luck, weather). It is assumed to be independently and identically distributed as $N(0, \sigma_v^2)$. Meanwhile, u_i is the one-sided non-negative error term, representing technical inefficiency. It is assumed to follow a half-normal distribution, $N+(0, \sigma_u^2)$.

Two key parameters from the SFA model are used for interpretation:

1. Sigma-squared ($\sigma^2 = \sigma_v^2 + \sigma_u^2$): This parameter measures the total variance of the output from the production frontier.

2. Gamma ($\gamma = \frac{\sigma_u^2}{\sigma^2}$): This parameter indicates the proportion of the total variance that is attributable to technical inefficiency. A value of γ approaching 1 suggests that most of the deviation from the frontier is due to inefficiency, whereas a value approaching 0 suggests it is due to random noise.

Analysis of Economies of Scale

Economies of scale were determined by calculating the sum of the output elasticities derived from the Cobb-Douglas function $(RTS = \beta_1+\beta_2+\beta_3)$. The interpretation is as follows:

- If $RTS>1$: Increasing returns to scale (a proportional increase in all inputs results in a more-than-proportional increase in output).
- If $RTS=1$: Constant returns to scale.
- If $RTS<1$: Decreasing returns to scale.

Methodological Limitations

The findings of this study should be interpreted in light of its methodological scope. The sample size of 50 MSMEs, while sufficient for the SFA model, is relatively small and focused exclusively on the seafood processing cluster. This deliberate focus was chosen to ensure homogeneity but limits the generalizability of the results to other segments of the halal food industry in Pangkalpinang, such as livestock or plant-based food enterprises. Furthermore, the use of cross-sectional data provides a static snapshot of efficiency at one point in time and does not capture dynamic changes or allow for strong causal inference. Future research employing panel data could offer deeper insights into the temporal dynamics of efficiency.

RESULT AND DISCUSSION

Measurement Model Test Results

The analysis of production efficiency in the halal food industry requires identification of key production factors through Stochastic Frontier Analysis (SFA). This study examines three primary production factors—raw materials, labor, and capital—among halal food MSMEs in Pangkalpinang City. Both Maximum Likelihood Estimation (MLE) and Ordinary Least Squares (OLS) techniques were employed to estimate the Cobb-Douglas production function. The comparative analysis determines the most appropriate model for representing field conditions, where MLE values exceeding OLS estimates indicate model suitability.

Table 1. Ordinary Least Squares (OLS) Estimation Results

Parameter	Variable	Coefficient	Standard Error	T-Ratio
Beta 0	(Constant)	-0.70790043E+00	0.65806194E+00	-0.10757352E+01
Beta 1	Labor	-0.10386884E+01	0.15814020E+00	-0.65681488E+01
Beta 2	Capital	-0.49928676E+00	0.48181751E+00	-0.10362570E+01
Beta 3	Raw Materials	0.24926864E+01	0.50965574E+00	0.48909218E+01
Sigma-squared		0.13019716E+00		
Log likelihood function		-0.17894751E+02		
T tabel (α=1%)*		2.68701		

(Source: Authors based on output SFA, 2024)

Table 1 presents the results of estimating the production function for the halal food industry in Pangkalpinang City using the Ordinary Least Squares (OLS) method within the framework of Stochastic Frontier Analysis (SFA). The findings indicate that labor and raw materials significantly influence production output, whereas capital does not appear to contribute meaningfully to increased production levels.

The OLS estimation reveals that labor and raw materials significantly influence production levels at the 99% confidence level, with t-ratios exceeding the critical value of 2.687. Labor demonstrates negative elasticity (-6.568), as does capital (-1.036), while raw materials exhibit positive elasticity (4.891). The log likelihood function value of -17.895 serves as a baseline for comparison with MLE results.

Table 2 presents the results of estimating the production function for the halal food industry in Pangkalpinang City using the Maximum Likelihood Estimation (MLE) approach within the

Stochastic Frontier Analysis (SFA) framework. The findings suggest that the selected production parameters—labor, raw materials, and capital—play varying roles in influencing output growth in the sector.

Table 2. Maximum Likelihood Estimation (MLE) Results

Parameter	Variable	Coefficient	Standard Error	T-Ratio
Beta 0	(Constant)	-0.11396260E+00	0.41820686E+00	-0.27250295E+00
Beta 1	Labor	-0.11458688E+01	0.15353496E+00	-0.74632434E+01
Beta 2	Capital	-0.10236027E+01	0.62860805E+00	-0.16283640E+01
Beta 3	Raw Materials	0.31032512E+01	0.73334757E+00	0.42316241E+01
Sigma-squared		0.27417261E+00	0.11325088E+00	0.24209315E+01
Gamma		0.98295516E+00	0.70626318E-01	0.13917689E+02
Log likelihood function		-0.82893925E+01		
LR test		0.19210717E+02		
T tabel (α=1%)*		2.68701		

(Source: Authors based on output SFA, 2024)

Labor and raw materials are identified as significant contributors to production levels, while capital appears to have a minimal effect on increasing output. At a 99% confidence level, the t-ratio values for all three production factors exceed the critical value of 2.605, indicating statistical significance. The elasticity values further illustrate the nature of these relationships: raw materials exhibit a positive elasticity of 4.232, whereas labor and capital show negative elasticities of -7.463 and -1.628, respectively.

The MLE approach yields superior results with a log likelihood function value of -8.289, substantially higher than the OLS value of -17.895, confirming the appropriateness of the production function model. The estimated Stochastic Frontier production function is:

$$LnY = -0.114 - 1.146LnTK - 1.024LnM + 3.103LnBB + (v_i - u_i)$$

The labor coefficient of -1.146 indicates that a 1% increase in labor wages correlates with a 1.146% decrease in halal food output, suggesting the need for workforce skill enhancement. Despite a coefficient of -1.024, capital shows no significant effect on production (t-ratio = 1.628 < 2.687), indicating suboptimal capital utilization. Conversely, raw materials demonstrate a strong positive impact with a coefficient of 3.103, where a 1% increase in raw materials yields a 3.103% increase in output.

The sigma-squared value of 0.274 ($t = 2.421$, $p < .01$) indicates that technical inefficiencies account for 27.4% of model variation. The gamma coefficient of 0.983 ($t = 13.918$, $p < .01$) suggests that 98.3% of the error term derives from inefficiency rather than random noise. The Likelihood Ratio Test value of 19.211 confirms the validity of the stochastic frontier production function in explaining technical inefficiency.

Stochastic Frontier Efficiency Analysis

Technical efficiency levels were calculated for individual MSMEs using Frontier 4.1 software. The distribution of efficiency scores reveals substantial variation across business actors. Table 3 illustrates the distribution of technical efficiency levels among business actors in the halal food industry in Pangkalpinang City. The majority—26 business actors, representing 52% of the

sample—achieved an average efficiency score between 0.51 and 0.70. This range indicates moderate efficiency, suggesting that while operations are relatively effective, there remains substantial room for improvement.

Table 3. Technical Efficiency Levels Among Halal Food MSMEs

Efficiency Level	Number of Business Actors	Percentage (%)
0,75 - 0,96	12	24
0,71 - 0,85	11	22
0,51 - 0,70	26	52
0,09 - 0,50	1	2

(Source: Authors based on output SFA, 2024)

A further 12 business actors (24%) attained efficiency scores between 0.75 and 0.96. This range is categorized as extremely high, as it approaches the theoretical maximum efficiency value of 1. These businesses demonstrate near-optimal utilization of production inputs. Additionally, 11 business actors (22%) recorded efficiency levels between 0.71 and 0.85, which, although strong, still indicate potential for further optimization.

Only one business actor (2%) fell within the lowest efficiency range of 0.09 to 0.50. This actor, operating in the fish floss industry, achieved a minimum efficiency score of 0.09, meaning only 9% of potential output was realized from the given combination of production inputs. This implies a 91% opportunity for improvement in production efficiency. Conversely, the highest efficiency score of 0.96 was achieved by *Meba Kempelang* Crackers, indicating that this business has reached 96% technical efficiency in converting labor, capital, and raw materials into output. This leaves only a 4% margin for further improvement.

These findings suggest that while some MSMEs in Pangkalpinang's halal food sector operate at very high levels of efficiency, a significant portion still faces challenges in optimizing their production processes. This is consistent with the findings of Muliadi et al. (2020), who emphasized the need for improved efficiency in the MSME sector. However, unlike Muliadi et al., this study provides a more detailed breakdown of efficiency distribution among MSMEs. Similarly, Bhadu et al. (2022) did not quantify the proportion of MSMEs achieving high efficiency, as this study does. The discovery that 24% of business actors operate with extremely high efficiency highlights the potential for other MSMEs to adopt best practices and improve their performance. At the same time, the fact that 2% of actors exhibit low efficiency underscores the need for targeted interventions to address operational barriers.

This study offers valuable insights into the current state of halal food MSMEs in Pangkalpinang City. Comparing these results with previous research allows us to observe industry trends and challenges over time. These insights can serve as a foundation for developing more effective strategies and policies to support the growth and sustainability of halal food MSMEs in Pangkalpinang and beyond. According to Vogel (2020), a business is considered technically efficient if its efficiency index exceeds 0.7. Based on field data, 27 business actors had efficiency scores below this threshold, while 23 actors (46%) exceeded it. This indicates that a majority of halal food MSMEs in Pangkalpinang City have yet to achieve sufficient technical efficiency.

Furthermore, analysis of standard deviation values across product categories reveals that efficiency scores remain relatively homogeneous, as the standard deviations are consistently lower than the mean values. This suggests a uniformity in performance across the sector. In conclusion, the findings underscore the importance of enhancing efficiency within Pangkalpinang's halal food industry. The insights gained can inform strategic efforts to improve operational effectiveness, with the ultimate goal of positioning Pangkalpinang City as a leading example in Indonesia's halal food sector.

Economies of Scale Analysis

The estimation of the Cobb-Douglas production function for the halal food industry in Pangkalpinang City reveals that the sum of the output elasticities for labor (β_1), capital (β_2), and raw materials (β_3) is 0.934. Since this total is less than 1, it indicates that the industry is experiencing decreasing returns to scale. In economic terms, this means that a proportional increase in all input factors—such as labor, capital, and raw materials—results in a less than proportional increase in output (Azar & Vives, 2021).

In practical terms, if a business were to double its input usage, the resulting output would increase by less than double. This suggests that simply adding more resources does not lead to a significant rise in production, highlighting inefficiencies in the utilization of inputs among halal food MSMEs in Pangkalpinang City. The concept of decreasing returns to scale, as reflected in the Cobb-Douglas model, points to suboptimal resource allocation. When the sum of the production factor coefficients is below one, it implies that MSMEs may not be leveraging their inputs—labor, capital, and raw materials—to their full potential (Hossain & Shah, 2023; Aulia et al., 2020). This aligns with the broader economic theory that output growth will lag behind input growth under such conditions.

Several studies support this interpretation. Rostiana et al. (2022) identified limited access to essential resources—such as skilled labor, financial capital, and high-quality raw materials—as key contributors to declining returns in Indonesia's food sector. Lohmer & Lasch (2020) emphasized operational inefficiencies and challenges in production management. Additionally, Giyanti et al. (2021) examined the impact of regulatory and environmental factors, noting that restrictive policies or volatile input prices can hinder MSME performance. Taken together, these findings suggest that halal food MSMEs in Pangkalpinang City have considerable room for improvement in terms of operational efficiency and scalability. A deeper understanding of the underlying causes of decreasing returns to scale—combined with targeted support from government and relevant stakeholders—could enable these enterprises to enhance productivity and contribute more effectively to local economic development. Thus, Pangkalpinang's halal food sector has the potential to become a model of MSME growth and efficiency in Indonesia.

Discussion

This study provides a comprehensive analysis of the economic scope and operational efficiency of halal food micro, small, and medium-sized enterprises (MSMEs) in Pangkalpinang City. Through the application of Stochastic Frontier Analysis (SFA), the research offers critical insights into how labor, capital, and raw materials impact production outcomes in this growing

industry. The findings are contextualized within the broader literature, and practical recommendations for stakeholders are explored to address key challenges and opportunities.

The results reveal that labor and raw materials play significant roles in influencing production efficiency, while capital appears to be underutilized. Specifically, 24% of halal food MSMEs achieve high levels of efficiency (0.75–0.96), and 52% operate at moderate efficiency levels (0.51–0.70). This distribution highlights disparities in resource optimization, with some enterprises demonstrating strong performance while others struggle, particularly in capital allocation and workforce capabilities. These findings are consistent with Muliadi et al. (2020), who emphasized the importance of workforce training and effective capital deployment in enhancing MSME productivity. However, the current study provides a more detailed perspective by mapping the efficiency distributions and identifying specific areas for targeted interventions.

Analysis of Efficiency Distribution and Production Factors

Figure 2 presents a comprehensive analysis of efficiency distribution and scale economy among halal food MSMEs in Pangkalpinang City. The efficiency level distribution reveals that the majority of MSME operators (52%) function within the 0.51-0.70 efficiency range, suggesting substantial room for operational improvement.

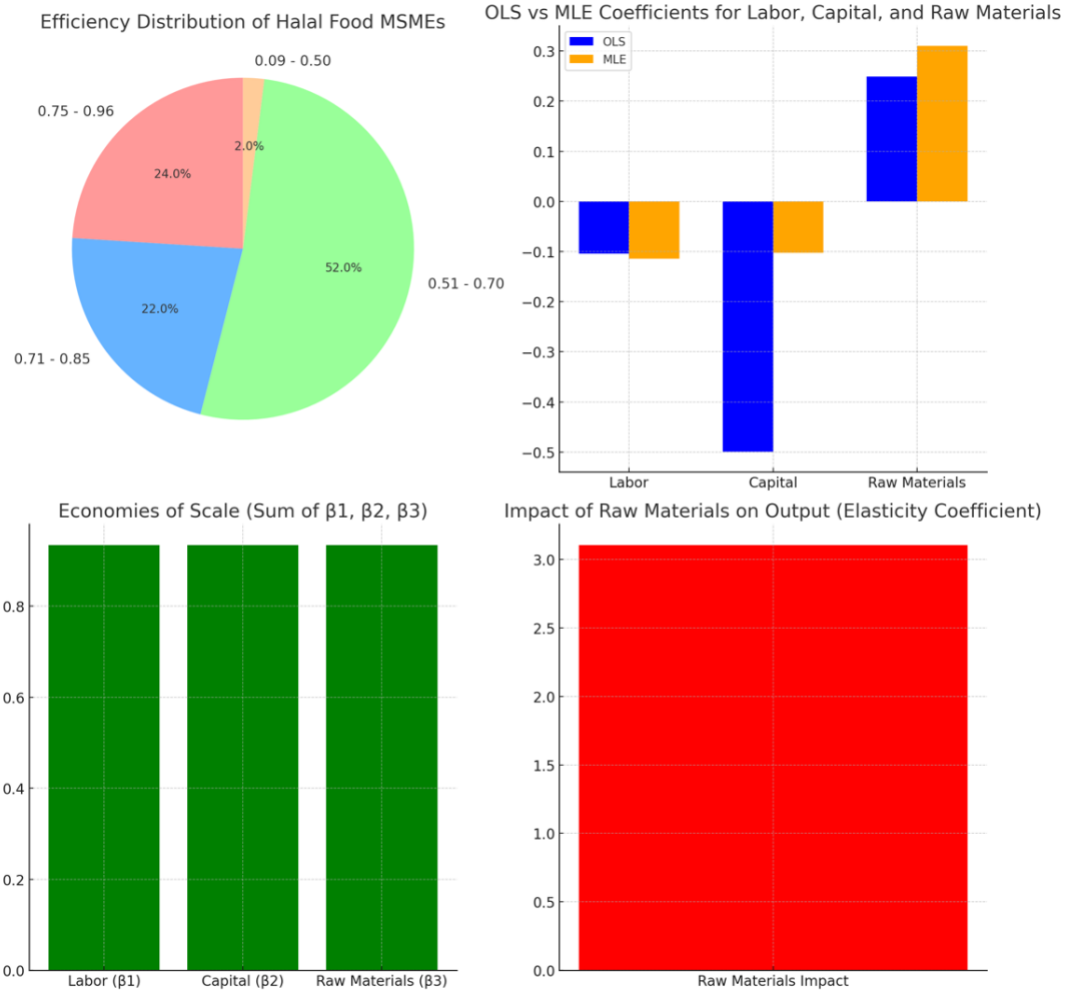

Figure 2. Distribution of Efficiency and Scale Economy Analysis in Halal Food SMEs in Pangkalpinang City

(Source: Processed by the author based on research data, 2025)

Meanwhile, 24% of enterprises achieve efficiency levels between 0.75-0.96, demonstrating near-optimal performance. Notably, only 2% of MSMEs exhibit critically low efficiency levels (0.09-0.50), indicating severe operational challenges requiring immediate intervention. These findings underscore the potential for efficiency enhancement, particularly in capital management and workforce skill development.

The comparative analysis of Ordinary Least Squares (OLS) and Maximum Likelihood Estimation (MLE) coefficients provides important insights into production factor dynamics. Both methodologies reveal negative coefficients for labor, suggesting that increased labor costs may actually reduce production levels. This counterintuitive finding likely reflects skill deficiencies within the existing workforce rather than an inherent problem with labor as a production factor. Similarly, capital demonstrates consistently low negative values across both estimation methods, indicating suboptimal utilization potentially caused by outdated technology or insufficient investment in modern equipment. In contrast, raw materials exhibit strongly positive coefficients, confirming their direct proportional relationship with production output and highlighting the critical importance of effective raw material management and quality halal ingredient procurement.

The economic scale analysis reveals a combined coefficient of 0.934 for all production factors, indicating declining returns to scale. This finding suggests that proportional increases in inputs do not yield equivalent increases in output, reflecting inefficiencies in resource utilization that must be addressed before enterprises consider expansion. The raw material impact analysis demonstrates a particularly high elasticity coefficient of 3.103, meaning that each 1% increase in raw material quantity generates a 3.103% increase in output. This substantial multiplier effect emphasizes the strategic importance of ensuring stable access to affordable, high-quality halal raw materials.

Labor Productivity, Capital Efficiency, and the Need for Modernization

The finding that increased labor input correlates negatively with production efficiency presents a noteworthy paradox, warranting deeper analysis. This result implies that the workforce may lack the requisite skills, training, or tools to contribute effectively to productivity gains. Similar challenges have been documented by Haleem et al. (2021), particularly in developing economies where operational performance is hindered by limited training and technological deficiencies. In the context of Pangkalpinang, addressing this issue requires the implementation of targeted capacity-building initiatives. Training programs should prioritize key competencies such as food safety standards, hygienic processing practices, and efficient packaging techniques. These efforts would help MSMEs maintain product consistency, elevate quality benchmarks, and strengthen their competitive position in the market. Importantly, the negative labor coefficient should not be interpreted as a rationale for reducing employment, but rather as a call to invest in human capital development.

In contrast to traditional economic expectations, capital investment appears to exert only a marginal positive influence on output among halal food MSMEs in Pangkalpinang. This limited impact may be attributed to outdated machinery, inefficient use of capital, or suboptimal facility design. Supporting this interpretation, Lohmer and Lasch (2020) demonstrate that technological

upgrades in manufacturing can substantially reduce inefficiencies and improve returns on capital. To address these constraints, it is essential to promote the adoption of modern technologies and expand access to affordable financing. Joint initiatives between government bodies and industry associations could facilitate grants or subsidized loans aimed at upgrading production infrastructure. Such measures would help bridge the technological divide and alleviate financial barriers, ensuring that capital investments lead to tangible improvements in productivity and operational performance.

The Role of Raw Materials and the Issue of Diminishing Returns to Scale

Raw materials play a central role in driving production efficiency within Pangkalpinang's halal food industry. This study emphasizes the necessity of reliable access to premium, halal-certified inputs. Despite this, Hanim and Noorman (2023) highlight that micro, small, and medium enterprises (MSMEs) often struggle with high procurement costs and competition from larger market players. One potential solution is the formation of cooperatives, which would enable MSMEs to consolidate resources and negotiate more favorable terms with suppliers. Moreover, government initiatives aimed at establishing localized halal-certified supply chains could enhance cost efficiency and reduce reliance on external providers. These efforts would contribute to a more robust and sustainable supply network for the region's halal food sector.

The calculated production input elasticity (0.934) reveals that MSMEs in this sector are experiencing diminishing returns to scale—where increases in input do not result in proportional output gains. This observation is consistent with findings by Mauler et al. (2021), who documented similar trends in industries constrained by limited resources. To address this issue, a two-pronged strategy is recommended: improving current production methods and carefully planning for scalable growth. Policymakers could support MSME clustering to facilitate shared infrastructure, joint marketing efforts, and operational collaboration. Such collective strategies may help businesses overcome the inefficiencies associated with scaling individually and foster greater competitiveness.

Economic Significance and Development Opportunities

The research reveals a pressing need to strengthen both the scale and operational efficiency of halal food MSMEs in Pangkalpinang City. Although these enterprises contribute actively to the local economy, they have yet to reach optimal levels of productivity and scalability, suggesting untapped potential for economic advancement. A deeper understanding of the factors driving diminishing returns to scale is essential for facilitating MSME growth (Wansi & Burrell, 2023). These factors may include suboptimal resource utilization, procedural inefficiencies, and restricted access to technology and market opportunities (Hendarto et al., 2023). Strategic support from government bodies and relevant stakeholders is crucial to help MSMEs overcome these structural challenges.

Policy interventions could encompass financial aid, training programs, and regulatory reforms aimed at fostering a more conducive business environment (Adobas et al., 2024). Partnerships with industry associations, academic institutions, and private sector actors can offer MSMEs access to expertise, resources, and networks that support sustainable growth (Tayibnapis et al., 2021). With such support, MSMEs are expected to enhance their performance and contribute

more significantly to regional economic development (Endris & Kassegn, 2022). Improvements in operational efficiency and business scale not only benefit individual firms but also generate positive spillover effects across the broader economy (Alam et al., 2024). As MSMEs expand, they stimulate demand, create employment, and drive innovation—ultimately fostering a more vibrant and resilient economic landscape in Pangkalpinang.

The development trajectory of halal food MSMEs in Pangkalpinang also reflects global trends in the halal industry, shaped by local characteristics such as the prominence of seafood processing and unique demographic factors. Susilowati et al. (2024) emphasize that MSME performance is closely linked to regional conditions, including market accessibility and the availability of halal certification services. Enhancing access to halal certification should be prioritized, with efforts to streamline administrative procedures and reduce associated costs. These improvements could encourage more MSMEs to pursue certification, thereby increasing their competitiveness and consumer trust. This would likely generate a reinforcing cycle, where greater certification leads to expanded market access and improved business outcomes.

Strategic Recommendations for Sustainable Development

To support the long-term sustainability and growth of the halal food industry in Pangkalpinang City, several strategic measures are recommended based on the research findings. First, workforce development should be prioritized through collaborative efforts between government agencies and industry stakeholders to deliver comprehensive training programs. These initiatives should focus on enhancing skills in food processing, safety standards, hygienic packaging, and efficient raw material management, thereby improving product quality and operational efficiency. Second, optimizing capital utilization requires improved access to modern halal food processing technologies. Financial institutions and government bodies should offer subsidized financing schemes to enable MSMEs to invest in advanced equipment, which can reduce production costs and boost competitiveness in global markets. Third, strengthening the raw material supply chain is essential. MSMEs should establish partnerships with local halal-certified suppliers or form cooperatives to secure consistent access to affordable, high-quality inputs, reducing reliance on dominant suppliers and ensuring supply chain stability.

Additionally, to address the issue of declining returns to scale, MSMEs should adopt clustering strategies and collaborative models that allow shared use of infrastructure such as production facilities, storage, and distribution networks. This approach facilitates more efficient scaling and market expansion. Regulatory simplification is also critical; local authorities should streamline halal certification procedures and reduce associated costs to encourage broader participation among MSMEs, thereby enhancing product credibility and market reach. Furthermore, product innovation and diversification should be encouraged, with MSMEs developing offerings aligned with evolving consumer preferences—such as ready-to-eat halal meals, health-conscious snacks, and locally sourced processed foods—to reduce dependency on single product lines and improve resilience. Infrastructure development, including halal logistics centers and digital marketing platforms, should be pursued through public-private partnerships to support efficient distribution and market access. Lastly, tailored financial support mechanisms, such as grants and flexible loan programs, should be introduced to empower MSMEs—especially startups and high-potential enterprises—to invest in expansion, research, and modernization. Collectively, these

strategic interventions can position Pangkalpinang as a leading hub for halal food production, fostering inclusive economic growth and serving as a model for other regions aiming to advance their halal sectors.

CONCLUSIONS

This study investigated the operational efficiency and economies of scale of halal food MSMEs in Pangkalpinang City, revealing a sector with significant yet unrealized potential. The key findings indicate that raw materials are the most critical driver of production, whereas capital is largely underutilized and has an insignificant impact on output. Counterintuitively, increased labor inputs were associated with decreased production, pointing to a pressing skills deficit rather than a labor shortage. The analysis of technical efficiency shows a performance gap: while a quarter of firms operate at high efficiency, the majority (52%) are moderately efficient, and the sector as a whole operates under decreasing returns to scale (DRS) with a combined elasticity of 0.934. This demonstrates that fundamental inefficiencies in resource allocation and production processes are hindering the ability of these MSMEs to scale up effectively.

The implications of these findings are twofold. For MSME managers, the discovery of DRS suggests that strategy should pivot from expansion to optimization; improving workforce skills, adopting modern technology to enhance capital productivity, and strengthening raw material supply chains must be prioritized before attempting to increase scale. For policymakers, this research highlights the need for targeted interventions beyond simple financial aid. Government support should focus on facilitating workforce training programs, providing subsidies for technology adoption, and promoting cooperative models for raw material procurement. Fostering an ecosystem that rewards efficiency, rather than just growth, is essential for building a resilient and competitive local halal industry. These actions can help transform the sector from one constrained by inefficiency to one capable of sustainable growth.

Finally, the conclusions of this study should be considered within the context of its limitations. The research was confined to a relatively small sample of 50 MSMEs within the seafood processing cluster, which may limit the generalizability of the findings to the broader halal food industry. Furthermore, the use of cross-sectional data provides a static snapshot and does not capture the dynamics of efficiency over time. Future research should therefore aim to broaden the scope by including more diverse MSME clusters, such as livestock and plant-based foods, and employ a longitudinal design. Such studies would offer a more comprehensive understanding of the sector's evolution and provide more robust evidence to guide the long-term strategic development of the halal food industry in Pangkalpinang and other similar regions

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