The Role of Digitalization in Moderating the Impact of Location, Labor, and Capital on the Productivity of Micro Culinary Businesses in Surabaya

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ABSTRACT

Micro-culinary enterprises have a strategic role in the urban economy but still face challenges of low productivity due to limited utilization of production factors and operational efficiency. This research aims to analyze the influence of location, labor, and capital values on the productivity of culinary micro-businesses in the city of Surabaya and to examine the role of digitalization in reducing business technical inefficiency. The analysis employed Stochastic Frontier Analysis (SFA) with a Cobb–Douglas production function, using primary survey data from culinary micro-enterprises in Surabaya. The estimation results show that location, labor, and capital each have a positive and significant effect on productivity. Location value is the most dominant factor, followed by capital and labor. The technical efficiency analysis indicates that the average efficiency level of culinary micro businesses is 0.8629, which suggests that business actors have operated quite efficiently but still have the potential to increase productivity by 13.71%. Digitalization has been shown to play a significant role in reducing technical inefficiencies, even though it does not have a direct influence on productivity increases. Digitalization strengthens the utilization of production inputs by increasing the operational efficiency of marketing and business management. Increasing the productivity of culinary micro businesses depends not only on increasing production inputs but also on strengthening business efficiency through the use of digital technology. The micro business development strategy needs to be directed toward improving input quality as well as accelerating digital transformation to foster sustainable business competitiveness.

KEYWORDS	*Productivity; Culinary Microenterprises; Digitalization; Technical Efficiency; Stochastic Frontier Analysis*

INTRODUCTION

Micro and small enterprises (MSEs) are one of the main pillars of the Indonesian economy due to their significant contribution to gross domestic product (GDP) and labor absorption. In urban areas, especially in the culinary micro business sector, business development is growing rapidly in line with increasing economic activity and changes in people's consumption patterns. The city of Surabaya, as one of the centers of economic growth in eastern Indonesia, has a high concentration of culinary MSEs and plays an important role in supporting the regional economy. However, the increase in the number of businesses has not been fully followed by an optimal rise in productivity. This condition indicates problems in the utilization of production factors, resulting in a gap between business potential and the actual performance of culinary MSEs (Purwa, 2022; Tobing & Soekarno, 2022; Wahyuni & Riptiono, 2022).

From a microeconomic perspective, business productivity is greatly influenced by the ability of business actors to manage production inputs efficiently, especially the value of location, labor, and capital. Strategic business locations increase accessibility and visibility; labor determines production capacity and quality; while capital supports smooth operations and business development. The development of digital technology also opens up opportunities for

MSEs to enhance efficiency and competitiveness. The use of social media, online ordering platforms, and digital payment systems has the potential to expand markets, accelerate services, and reduce operational costs. The level of digital adoption among culinary MSEs remains diverse and has not been fully integrated into business processes. Consequently, digitalization does not always have a direct impact on productivity improvement but rather strengthens input utilization through enhanced business efficiency.

Most previous research on MSE productivity still uses a conventional regression approach that focuses on the direct influence of input factors on output without considering technical efficiency aspects (Calvino et al., 2023; Eller et al., 2020; Radicic & Djalilov, 2023). Digitalization is generally positioned as an independent variable, not as a factor affecting business inefficiency (Bosker et al., 2024; Labolo et al., 2025; Parulian et al., 2025). This approach cannot comprehensively describe how close business actors operate to optimal production levels. From a microeconomic standpoint, business productivity is influenced not only by the quantity of production inputs but also by the efficiency with which those inputs are combined. Farrell (1957) emphasized that production efficiency reflects the extent to which a business unit operates close to the maximum production frontier given its inputs. This concept later evolved into the Stochastic Frontier Analysis (SFA) approach, which enables the separation of technical inefficiency factors from random disturbances in the production process. The SFA approach is relevant in analyzing MSE performance due to heterogeneous business characteristics and limitations in managing production inputs (Falentina et al., 2021; Zahoor et al., 2023; Tobing & Soekarno, 2022). This study employs the Stochastic Frontier Analysis (SFA) approach to analyze the influence of location, labor, and capital values on the productivity of culinary micro businesses in Surabaya and to examine the role of digitalization in reducing business technical inefficiency. The SFA approach allows for the measurement of each business unit's technical efficiency level as well as the identification of potential productivity improvement.

Despite the growing body of literature, several research gaps remain unaddressed. Most existing studies on MSE productivity in Indonesia have focused on the manufacturing or agricultural sectors, with limited empirical investigation of the urban culinary micro business sector, particularly in Surabaya. Previous research has largely positioned digitalization as an independent variable directly affecting productivity, rather than as a moderating factor that reduces technical inefficiency. Few studies have employed Stochastic Frontier Analysis to simultaneously estimate the influence of production inputs on productivity and measure the technical efficiency levels of culinary micro businesses. Moreover, there is a lack of research systematically analyzing the contribution of location value within an integrated production efficiency framework, and no study to date has specifically examined the moderating role of digitalization in reducing technical inefficiency among culinary MSEs in Surabaya using the SFA approach.

The urgency of this research is underscored by several factors. The culinary micro business sector in Surabaya faces increasingly intense competition, necessitating evidence-based strategies to improve productivity and efficiency. The Surabaya city government has been actively promoting digital transformation among MSEs, making it imperative to evaluate the effectiveness of digitalization in enhancing business performance. The potential productivity improvement of up to 13.71%, as indicated by the technical efficiency gap,

represents a significant opportunity for local economic growth and job creation. Furthermore, the findings from this study can serve as a benchmark for other Indonesian cities facing similar challenges in developing their culinary micro business sectors.

This study aims to analyze the influence of location, labor, and capital on the productivity of culinary micro businesses in Surabaya and to examine the role of digitalization in reducing technical inefficiency. Specifically, it seeks to estimate the elasticity of each production input using Stochastic Frontier Analysis, measure the technical efficiency level and productivity gap of culinary MSEs, analyze the moderating role of digitalization in reducing technical inefficiency, and formulate evidence-based policy recommendations to improve productivity and competitiveness through input optimization and digital transformation. The benefits of this research are multifaceted: from a theoretical perspective, it contributes to production economics and efficiency analysis by extending the application of Stochastic Frontier Analysis to urban culinary micro businesses; provides empirical evidence on the moderating role of digitalization in reducing technical inefficiency—a dimension largely overlooked in previous MSE productivity research; and enriches the literature on the Cobb–Douglas production function by incorporating location value as a strategic input factor for service-based micro enterprises.

METHOD

Research Design

This study uses a quantitative approach with an explanatory design to explain the causal relationship between production factors and productivity of Culinary Micro Businesses in the city of Surabaya. The analysis was carried out using the Stochastic Frontier Analysis (SFA) method with the Cobb-Douglas production function specification, which allows the separation between random errors and technical inefficiencies in the production process.

Research Time and Location

This research was carried out from September 1, 2025 to December 20, 2025 with a research location in the city of Surabaya, East Java. The period was chosen because it was able to represent the actual conditions of productivity and technical efficiency of Culinary Micro Enterprises at the time the research was conducted. The city of Surabaya was chosen as the research location because it is one of the centers of economic activity in East Java with a high concentration of culinary MSEs, a large level of community mobility, and relatively fierce business competition. These characteristics make Surabaya a relevant location to examine the relationship between production inputs, technical efficiency and business productivity using the Stochastic Frontier Analysis (SFA) approach.

Population and Sample

The population in this study is all Culinary Micro Businesses operating in the city of Surabaya. The research sample was determined using a purposive sampling technique with the following criteria: (1) including micro businesses (2) engaged in the culinary sector (3) still actively operating. Based on these criteria, 400 culinary MSEs were obtained which were used as analysis units. Purposive sampling ensures that the selected respondents are truly relevant

to answer the research objectives and support the accurate interpretation of the SFA results and their calculations:

$$n = \frac{N}{1 + N \cdot e^2}$$

$$n = \frac{55.509}{1 + 55.509 \cdot 0{,}05^2}$$

$$n = \frac{55.509}{1 + 55.509 \cdot 0{,}0025}$$

$$n = \frac{55.509}{1 + 138{,}7725}$$

$$n = \frac{55.509}{139{,}7725}$$

$$n = 397{,}138$$

Description:
n = Number of samples required
N = Number of tourist population
e = Margin of error (generally 0.05 or 5%)

Data Types and Sources

This study uses statistically analyzed quantitative data to measure the relationship between production inputs and business productivity within the framework of Stochastic Frontier Analysis (SFA). Based on the source, the data used consists of primary data and secondary data. Primary data was obtained through a structured questionnaire survey of Culinary Micro Enterprises in the city of Surabaya which included production input variables (location value, labor, and capital), output variables in the form of business productivity, and the level of implementation of business digitalization as variables supporting technical inefficiency. Secondary data was obtained from the Central Statistics Agency (BPS) of the Cooperatives and Micro and Small Enterprises Office of East Java Province as well as scientific publications and journals related to MSEs, productivity and technical efficiency which were used to support and strengthen the research analysis (Badan Pusat Statistik, 2023).

Data Analysis Methods

The data analysis method in this study uses the Stochastic Frontier Analysis (SFA) approach to estimate the relationship between production inputs and productivity as well as measure the level of technical efficiency of Culinary Micro Enterprises in the city of Surabaya. The model used is a Cobb-Douglas production function which is estimated by the Maximum Likelihood Estimation (MLE) method in which input and output variables are transformed in the form of natural logarithms. The analysis was carried out through three stages, namely the estimation of the frontier function to obtain the input coefficient and gamma value (γ), the calculation of the level of technical efficiency (TE) of each business unit, and the analysis of the influence of business digitalization on technical inefficiency. Parameter significance testing is carried out based on p-value at a significance level of 5 % with the entire analysis process using TATAA software.

RESULT AND DISCUSSION

A. Research Results

1. General Description of Research Data

a. Number of samples

This study uses primary data obtained from 400 units of Culinary Micro Businesses selected through purposive sampling techniques, which is based on the suitability of respondent characteristics with the research variables. Each business unit is treated as one observation that represents the condition of input output as well as the level of business efficiency and productivity. The number of samples is considered adequate to be analyzed using the Stochastic Frontier Analysis (SFA) method and is able to describe the variation in the performance of culinary MSEs empirically.

Table 1. Variable Description and Storage Type

Variable name	Storage type	Display format	Value label	Variable label
X1NilaiLokasi	long	%10.0g		X1 Nilai Lokasi
X2TenagaKerja	byte	%10.0g		X2 Tenaga Kerja
X3Modal	long	%10.0g		X3 Modal
YProduktivitas	long	%10.0g		Y Produktivitas
ZDigitalisasi	byte	%10.0g		Z Digitalisasi
lnY	float	%9.0g		
lnX1	float	%9.0g		
lnX2	float	%9.0g		
lnX3	float	%9.0g		
TE	float	%9.0g		technical efficiency via E[exp(-su)|e]

Source: Primary data processed using STATA (2025)

The results of the Cobb-Douglas production function estimation were obtained using the Stochastic Frontier Analysis (SFA) method. All input variables, namely the value of location, labor, and capital, have a positive value coefficient. These results show that the increase in the use of production inputs tends to increase the productivity of Culinary Micro Enterprises in the city of Surabaya.

Table 2. Summary Statistics of Research Variables

summarize

Variable	Obs	Mean	Std. dev.	Min	Max
X1NilaiLokasi	400	2.98e+07	1.19e+07	1.00e+07	5.00e+07
X2TenagaKerja	400	3.06	1.367873	1	5
X3Modal	400	1.13e+07	3670412	6000000	2.50e+07
YProduktivitas	400	1.68e+07	2770430	1.00e+07	2.50e+07
ZDigitalisasi	399	1.97995	0.8234008	1	3
lnY	400	16.6256	0.1652269	16.1181	17.03439
lnX1	400	17.1129	0.4670855	16.1181	17.72753
lnX2	400	0.9896637	0.5469159	0	1.609438
lnX3	400	16.18578	0.3254111	15.60727	17.03439
TE	399	0.862891	0.0890329	0.6057375	0.9859345

Source: Primary data processed using STATA (2025)

The amount of elasticity of each input to business productivity. The location value has the largest elasticity coefficient which indicates that the location factor is the most dominant input in increasing the productivity of culinary MSEs. Capital and labor also have a positive effect, but with relatively smaller elasticity.

b. Characteristics of research objects (culinary MSEs)

The object of this research is Culinary Micro Enterprises (MSEs) operating in the city of Surabaya. The culinary MSEs studied are micro-scale businesses engaged in the production and sale of food and beverages. The business is run independently with the characteristics of limited labor use, relatively small capital and diverse business locations both in residential areas and strategic urban areas. Most of the culinary MSEs in this study still rely on a simple management system, but have begun to implement business digitalization in the form of the use of social media online ordering platforms and digital payments. These characteristics make culinary MSEs a relevant object to be analyzed related to the relationship between production input factors, technical efficiency, and business productivity.

Table 3. Ordinary Least Squares (OLS) Regression Results

reg lnY lnX1 lnX2 lnX3

Source	SS	df	MS		Number of obs	= 400
					F (3, 396)	= 136.40
Model	5.53554936	3	1.84518312		Prob > F	= 0.0000
Residual	5.35712703	396	0.013528099		R – Squared	= 0.5082
					Adj R – Squared	=0.5045
Total	10.8926764	399	0.027299941		Root MSE	= .11631

lnY	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnX1	.2000432	.012474	16.04	0.000	.1755197	.2245666
lnX2	.1056175	.0106589	9.91	0.000	0.0846624	.1265726
lnX3	.1526355	.0179244	8.52	0.000	0.1173966	.1878744
_cons	10.62723	.3667237	28.98	0.000	9.906266	11.3482

Source: Primary data processed using STATA (2025)

The statistical value z is obtained from the comparison between the coefficient and standard error of each input variable in the SFA model. All variables have a significant z-value at a confidence level of 95% so that statistically the value of location, labor and capital is proven to have an effect on the productivity of culinary MSEs in the city of Surabaya.

c. Summary of input and output variables

The use of the Stochastic Frontier Analysis (SFA) method in MSE research is considered more comprehensive than conventional regression because it is able to measure the level of technical efficiency of each business unit. Coelli et al. (2005) explain that SFA not only estimates the effect of inputs on output but also identifies potential productivity increases that can still be achieved without additional inputs. In the context of micro and small businesses, this approach is very relevant because most MSEs have not operated at an optimal production level due to managerial, technological, and resource access limitations (Susilowati & Maulana, 2019).

-   Location Value: The location value variable is one of the production input variables that reflects the strategic level of the Culinary Micro Business place. The value of the

location is measured based on the estimated rental value or economic value of the business location in units of rupiah. This variable describes the ease of consumer access, business visibility, and market potential where an increasingly strategic location has the potential to increase sales volume and business productivity.

- Labor: The labor variable in this study is one of the production input variables used by Culinary Micro Enterprises. Labor is measured based on the number of workers directly involved in business activities including business owners and expressed in units of people. This variable reflects the operational capacity of the business in carrying out production and service processes, where the more labor used, the greater the potential of the business in increasing productivity output.

- Capital: The capital variable is one of the production input variables that reflects the ability of the business to support operational activities and production processes. Capital is measured based on the total operating capital used, both fixed capital and working capital in rupiah units. This variable shows business capacity in the procurement of raw materials for equipment and business development, where the greater the capital owned, the greater the potential to increase the productivity of culinary micro businesses.

- Productivity: The productivity variable is the output variable in this study which reflects the level of performance of Culinary Micro Enterprises in producing output. Productivity is measured based on the value of business sales turnover per month in rupiah units. This variable describes the ability of businesses to optimize the use of production inputs where the higher the productivity value indicates the better business performance.

2. SFA Model Estimation Results

- Models of production functions used (Cobb-Douglas)

The production function model used in this study is the Cobb-Douglas production function which is estimated using the Stochastic Frontier Analysis (SFA) approach. This model was chosen because it is able to describe the relationship between production inputs and outputs in an elastic manner and allows the measurement of the level of technical efficiency of the business. Mathematically, the Cobb-Douglas production function in this study is expressed in the form of natural logarithms as follows:

$$InYi = \beta_0 + \beta_1 InX1i + \beta_2 InX2i + + \beta_3 InX3i (v_i - v_i)$$

Where Yi is productivity or business turnover i β0 is a constant, while , and $\beta_1 \beta_2 \beta_3$ is the elasticity coefficient that shows the magnitude of the influence of the value of labor and capital locations on productivity. The component represents a random error that includes external factors beyond the control of business actors such as changes in the price of raw materials or market conditions while it represents a component of technical inefficiency that shows how far the business fails to achieve maximum productivity with its inputs. The basic equation of SFA without moderation allows researchers to identify input contributions to productivity while measuring the level of technical efficiency of each culinary MSE before including the digitization variable as moderation in the advanced model. $v_i u_i$

Frontier lnY lnX1 lnX2 lnX3, dist (hnormal) uhet (Zdigitalisasi)	
Iteration 0	Log Likelihood = 309.27373
Iteration 1	Log Likelihood = 310.70029
Iteration 2	Log Likelihood = 317.4083
Iteration 3	Log Likelihood = 318.2551
Iteration 4	Log Likelihood = 321.10575
Iteration 5	Log Likelihood = 321.53461
Iteration 6	Log Likelihood = 321.53582
Iteration 7	Log Likelihood = 321.53582

A gamma value (γ) that is close to one. This value indicates that the variation in the productivity of culinary MSEs is more predominantly caused by technical inefficiencies than by random error factors. , the difference in business performance is more determined by the internal ability of business actors to manage production inputs.

- The value of the coefficient of each input variable

The results of the Stochastic Frontier Analysis (SFA) model estimate show that all input variables used in the Cobb-Douglas production function have a positive value coefficient. The increase in the use of production inputs tends to increase the productivity of Culinary Micro Enterprises. The location value coefficient shows that an increasingly strategic business location contributes to increased productivity due to ease of consumer access and greater market potential. The labor coefficient shows that the increase in the number of workers affects the increase in business output through increasing production and service capacity. The capital coefficient reflects that increasing business capital plays a role in supporting smooth operations and increasing production scale. The magnitude of the coefficient of each variable reflects the level of elasticity of input to output where the variable with a larger coefficient has a more dominant influence on the productivity of culinary micro businesses.

- Statistical significance (z-value)

Based on the results of the Stochastic Frontier Analysis (SFA) model estimation, the statistical value z and probability (p-value) show that the input variables used in this study have an adequate level of significance. The variables of location, labor, and capital value were proven to have a significant effect on the productivity of culinary micro businesses at a significance level of 5%. The probability value of each variable is below the set significance limit, so the null hypothesis that states the absence of input influence on productivity can be rejected. These results indicate that changes in each input variable are statistically able to explain the variation in the productivity of culinary micro businesses analyzed through the frontier approach.

Table 4. Stochastic Frontier Analysis (SFA) Estimation Results

Stoc. frontier normal/half-normal model				Number of obs =		399
Log likelihood = 321.53582				Wald chi2 (3) =		894.18
				Prob > chi2 =		0.0000
	lnY	Coefficient	Std. Err.	Z	P>|z|	[95% conf. interval]
lnY	lnX1	0.225286	.0095854	23.50	0.000	0.206499	0.244073
	lnX2	0.1178619	.0079322	14.86	0.000	0.1023151	0.1334086
	LnX3	.1739562	.0138214	12.59	0.000	0.1468667	0.2010457
	cons	9.991704	0.2723778	36.68	0.000	9.457853	10.52555

lnsig2v						
_cons	-6.819374	.4690379	-14.54	0.000	-7.738671	-5.900077
lnsig2u						
ZDigitalisasi	-0.2923147	.0904398	-3.23	0.001	-0.4695734	-0.1150561
_cons	-2.770229	.1990483	-13.92	0.000	-3.160357	-2.380102
sigma_v	.0330515	.0077512			.0208722	.0523377

Source: Primary data processed using STATA (2025)

Distribution of the technical efficiency level of culinary MSEs in the city of Surabaya. Most of the business actors are at a medium efficiency level which shows that the business has operated quite efficiently but has not reached the production frontier. This condition indicates that there are still opportunities to increase productivity through improving technical efficiency.

3. Technical Efficiency Level

• Minimum, maximum and average technical efficiency values

The results of the Stochastic Frontier Analysis (SFA) analysis show that the level of technical efficiency of Culinary Micro Enterprises has quite various variations. The minimum technical efficiency value shows that there are still businesses that have not been able to optimize the use of production inputs to the maximum. The maximum technical efficiency value reflects the presence of a business that has been operating close to the production frontier conditions. The average technical efficiency value shows that in general the Culinary Micro Business is not fully efficient, so there is still an opportunity to increase productivity through improving input management and production processes. There is the potential to improve business performance by minimizing the level of existing technical inefficiency.

Table 5. Technical Efficiency (TE) Summary Statistics

summarize TE					
Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
TE	399	.862891	.0890329	.6057375	.9859345

Source: Primary data processed using STATA (2025)

The value of the minimum, maximum, and average technical efficiency of culinary MSEs. The average value of technical efficiency that has not reached one indicates that in general MSEs still have the potential to increase productivity without having to increase production inputs. The difference in efficiency value also reflects the heterogeneity of performance between business actors

• Distribution of the efficiency level of business actors

The distribution of technical efficiency levels shows that Culinary Micro Business actors are spread across several levels of efficiency. Most of the business actors are at a medium level of efficiency, which indicates that the business has been able to utilize production inputs quite well, but has not reached optimal conditions. A small number of business actors are at a low level of efficiency, which reflects that there are still obstacles in the management of inputs and production processes. Business actors with a high level of efficiency are relatively few but show business ability to approach the production frontier. This distribution indicates that there is an opportunity to improve technical efficiency for most business actors.

4. A brief presentation of the most efficient and least efficient business units

As a complement to the technical efficiency analysis, this study also briefly presents the business units with the highest and lowest levels of technical efficiency based on the results of the Stochastic Frontier Analysis (SFA) estimate. This presentation aims to provide an overview of the variation in efficiency performance between culinary MSE business units in the city of Surabaya. Business units with the highest technical efficiency value reflect business actors who are able to manage production inputs optimally so that they can operate close to the production frontier. The business unit with the lowest technical efficiency value shows limitations in the utilization of production inputs, so that the level of productivity achieved is still far from the maximum potential that should be achieved. This brief presentation of the most efficient and least efficient business units is not intended to conduct an individual assessment but as an empirical illustration of the difference in the level of technical efficiency among culinary MSEs. These results can serve as a starting basis for the formulation of policy recommendations and strategies for increasing productivity.

The Most Efficient Effort

Table 6. Top 10 Most Efficient Culinary MSEs in Surabaya

list TE X1NilaiLokasi X2TenagaKerja X3Modal YProduktivitas ZDigitalisasi in 1/10

	TE	X1Nila~i	X2Tena~a	X3Modal	YProdu~s	ZDigit~i
1	0.6057375	48000000	3	14000000	14000000	1
2	0.6075157	28000000	4	6000000	11000000	3
3	0.6244123	40000000	5	7000000	13000000	2
4	0.6379519	32000000	2	15000000	13000000	1
5	0.6415849	44000000	1	6000000	11000000	2
6	0.6424727	44000000	5	8000000	14000000	2
7	0.6536604	32000000	2	13000000	13000000	1
8	0.6537512	42000000	4	13000000	15000000	1
9	0.6562655	22000000	3	6000000	11000000	1
10	0.6633565	20000000	5	12000000	13000000	2

Source: Primary data processed using STATA (2025)

Business unit with the highest level of technical efficiency based on the results of SFA estimates. This business unit reflects business actors who are able to optimally combine production inputs so that they can operate close to the production frontier. The existence of the most efficient business unit shows that the optimal level of productivity can be achieved in the conditions of culinary MSEs in Surabaya.

Inefficient Efforts

Table 7. Bottom 10 Least Efficient Culinary MSEs in Surabaya

	TE	X1Nila~i	X2Tena~a	X3Modal	YProdu~s	ZDigit~i
1	.9859345	40000000	3	12000000	23000000	1
2	.9853431	36000000	3	18000000	24000000	2
3	.9851651	26000000	1	8000000	17000000	1
4	.9833669	46000000	3	11000000	23000000	3
5	.9831046	38000000	3	11000000	22000000	3
6	.9826710	38000000	5	13000000	24000000	3
7	.9814185	20000000	3	6000000	17000000	1

8	.9811308	14000000	4	11000000	18000000	3
9	.9808391	20000000	5	11000000	20000000	3
10	.9808277	24000000	2	12000000	19000000	1

Source: Primary data processed using STATA (2025)

Business unit with the lowest level of technical efficiency. This condition shows that there are limitations in the management of production inputs and business processes so that the output produced is still far from the maximum potential. Business units with low efficiency illustrate the need for managerial improvement and the use of technology to improve business performance.

1. Discussion of the Influence of Inputs on Productivity Output

It should be emphasized that digitalization in this study is not included as a production input in the Cobb-Douglas production function, but as a variable that affects the level of technical inefficiency. Therefore, digitalization does not directly increase productivity output, but plays a role in strengthening the efficiency of the utilization of production inputs so that MSE actors can operate closer to the production frontier.

a) The role of location value on productivity

The results of the Stochastic Frontier Analysis (SFA) estimate show that the value of the location has the greatest elasticity compared to other inputs, making it the most dominant factor in increasing the productivity of culinary MSEs in the city of Surabaya. This indicates that changes in the value of the location provide a greater output response than labor and capital. The characteristics of culinary businesses are highly dependent on accessibility and proximity to consumers. Strategic business locations such as in areas with high visitation rates and easy to reach are able to increase sales opportunities and transaction volume, thus having a direct impact on increasing productivity. According to Hutagalung (2023), choosing the right location can increase sales turnover by up to 25% for MSEs due to easy access to consumers. A good location also supports the more efficient use of labor and capital, making the location factor a key aspect in the performance of culinary MSEs in Surabaya.

b) The role of labor on productivity

The results of the Stochastic Frontier Analysis (SFA) estimate show that the workforce has a positive and significant effect on the productivity of culinary MSEs in the city of Surabaya. These findings indicate that increasing the number and effectiveness of the workforce can increase production capacity and business turnover. In production theory, labor is not only seen in terms of quantity, but also in terms of the quality of skills and the effectiveness of their use in the production process. If not managed properly through quality and skill improvement, then this potential can actually trigger open unemployment and other social problems (Putri & Rachmawati, 2022). The results of the Stochastic Frontier Analysis (SFA) estimate show that the workforce has a positive and significant effect on the productivity of culinary MSEs in Surabaya. The addition of labor and the increase in work effectiveness can increase production capacity and encourage an increase in business turnover. The contribution of labor to productivity is not fully optimal because most culinary MSEs still rely on workers with limited skills and minimal training. This condition is in line with the concept of technical efficiency in SFA where inefficiency arises due to the use of inputs that have not been

maximized. Increasing the productivity of culinary MSEs needs to be directed not only at increasing the number of workers but also at improving the quality of human resources through job management skills training and digitalization support to improve operational efficiency.

c) The role of capital in productivity

Capital is a strategic production factor that plays an important role in increasing the output of Culinary Micro Businesses. Capital includes working capital and fixed capital used for the procurement of raw materials, production equipment and supporting business operations. The results of the Stochastic Frontier Analysis (SFA) estimate show that capital has a positive and significant effect on the increase in the output of culinary MSEs in Surabaya which indicates that the greater the capital used, the greater the output produced. Within the framework of SFA, capital constraints are often a source of technical inefficiencies because businesses have not been able to combine inputs optimally and approach the production frontier. MSEs with larger capital have a higher chance of achieving optimal output levels and increasing competitiveness. Limited access to formal financing is still a major obstacle, so strengthening access to capital and the use of digitalization is needed to improve capital use efficiency and encourage sustainable output increases. Many business actors still depend on personal capital due to limited access to credit (Nugroho & Lestari, 2022).

2. **Implications of Estimation Results on the Characteristics of Culinary MSEs in the City of Surabaya**

The results of the Stochastic Frontier Analysis (SFA) estimation provide important insights into the characteristics of culinary MSEs in the city of Surabaya. The dominant influence of location value shows that the productivity of culinary MSEs is strongly affected by spatial conditions and the business environment—particularly proximity to consumers and the high mobility of urban communities. Labor and capital also have positive effects but with smaller elasticity values, indicating that most MSEs still operate on a limited scale and use relatively simple technology. This condition suggests that productivity improvements rely more on external factors than on internal production efficiency and business modernization. The level of technical efficiency that has not yet reached the production frontier reflects the heterogeneity of business management capabilities, especially in terms of managerial practices and technology utilization. Culinary MSEs in Surabaya continue to face challenges in sustainably increasing productivity through improved technical efficiency and optimized use of production inputs. Micro and small enterprises have a strategic role in the national economy, particularly in labor absorption and GDP contribution. However, MSEs also face various structural challenges that affect business productivity and efficiency. According to Tambunan (2019), limited capital, low human resource quality, and weak business management are the main factors hindering MSEs from scaling up and improving performance. Data from the Central Statistics Agency (2023) likewise show that most MSEs continue to operate using simple technology and non-standardized management systems, conditions that contribute to technical inefficiencies.

3. **Technical Efficiency Analysis of Culinary Micro Enterprises**

The average value of Technical Efficiency (TE) of 0.863 indicates that, in general, culinary MSEs in the city of Surabaya have not yet fully operated at the maximum production frontier. With the same combination of inputs, business actors still have the opportunity to increase productivity without significantly expanding production inputs. This finding suggests

the presence of technical inefficiencies in the production process that can still be improved. The fact that the maximum production frontier has not been achieved reflects limitations in business management, including managerial practices, labor organization, and the use of capital and technology. In micro-scale culinary MSEs, technical inefficiencies often arise from unstandardized production processes, the use of simple equipment, and limited access to training and business advisory support.

The suboptimal technical efficiency value also illustrates performance disparities among culinary MSE actors. Some businesses are close to achieving the production frontier, while others remain considerably behind. This condition shows that improving the productivity of culinary MSEs in Surabaya depends not only on increasing production inputs but also on enhancing how these inputs are managed and utilized efficiently. The role of government policy and institutional support is therefore crucial in raising MSE productivity and efficiency. The Ministry of Cooperatives and Small and Medium Enterprises of the Republic of Indonesia (2023) emphasizes that strengthening MSEs should focus on increasing business capacity through better access to financing, managerial training, and accelerated adoption of digital technology. Such support is expected to help MSEs optimize the use of production inputs and reduce efficiency gaps among business actors, particularly in urban areas with high levels of competition such as the city of Surabaya.

4. Interpretation of Gamma Parameters (γ) in Stochastic Frontier Analysis Model

The very high gamma (γ) value, which is 0.983, indicates that almost all variations in the productivity output of culinary MSEs in the city of Surabaya are predominantly caused by technical inefficiencies rather than random error factors. Differences in productivity performance among MSE actors are thus not mainly influenced by external or accidental factors but by their internal ability to manage and utilize production inputs efficiently. The high gamma value reflects that the main challenges faced by culinary MSEs in Surabaya lie in the area of business management, particularly in production process efficiency, labor regulation, and the use of capital and technology. Increasing business productivity, therefore, requires more than simply adding production inputs—it must be directed toward improving technical efficiency. The gamma value, which is close to one, also reinforces the appropriateness of using the Stochastic Frontier Analysis (SFA) method in this study. The SFA model has proven effective in capturing the main sources of productivity variation arising from technical inefficiencies, thereby providing a strong foundation for formulating strategies to improve the performance of culinary MSEs in the city of Surabaya through an efficiency-oriented approach.

5. Overview of the Technical Efficiency Level of Culinary MSEs in the City of Surabaya

Based on the results of the Stochastic Frontier Analysis (SFA), the technical efficiency of culinary MSEs in the city of Surabaya is classified as quite efficient but not optimal. The average value of technical efficiency that has not reached the production frontier shows that there is still an opportunity to increase productivity without additional production inputs. The difference in efficiency levels between business units reflects variations in business management capabilities, especially in the use of labor, capital, and technology. The high gamma value indicates that the variation in productivity is more predominantly due to technical inefficiencies than to random factors. Increasing the productivity of culinary MSEs is more effectively directed at improving business management, improving the quality of the workforce, and utilizing technology and digitalization.

6. Non-Input Factors Affecting The Technical Efficiency of Culinary MSEs

In addition to the use of production inputs, the level of technical inefficiency among culinary MSEs in the city of Surabaya is also influenced by various non-input factors related to the characteristics of business actors and their operational environment. These factors include managerial skills, education level, business experience, and the use of technology and digitalization. Limitations in business planning, financial management, and decision-making can result in suboptimal input utilization and lead to technical inefficiencies. MSEs that have not effectively adopted digital technology tend to experience inefficiencies in operations, making it difficult to achieve maximum productivity. Access to training, business assistance, and market information also plays a crucial role in determining the level of technical efficiency.

Improving the technical efficiency of culinary MSEs depends not only on the management of production inputs but also on strengthening managerial capabilities, enhancing human resource quality, expanding technology adoption, and fostering institutional support. Business digitalization is increasingly regarded as a strategic instrument for improving the operational efficiency of MSEs. OECD (2020) emphasizes that digital transformation in small and micro enterprises enhances efficiency by accelerating business processes, expanding market access, and improving information and financial management. In the context of MSEs, digitalization does not always directly increase output but serves to reduce the level of technical inefficiency within businesses. Nugraha (2022) shows that digitalization functions as a moderating variable that strengthens the utilization of production inputs, enabling business actors to operate closer to the production frontier more efficiently.

CONCLUSION

Based on the results of the analysis using the Stochastic Frontier Analysis (SFA) method, this study concludes that the values of location, labor, and capital have positive and significant effects on the productivity of culinary micro businesses in the city of Surabaya. Among these three factors, location value is the most dominant determinant of productivity, followed by capital and labor. Spatial characteristics and business accessibility play crucial roles in shaping the productivity performance of culinary MSEs in urban areas. The results of the technical efficiency estimation show that the average efficiency level of culinary MSEs in Surabaya is 0.863. This value indicates that, in general, business actors have operated quite efficiently but still have the potential to improve productivity by approximately 13.7% without increasing production inputs.

The high gamma value, which is close to one, suggests that variations in business productivity are predominantly caused by technical inefficiencies rather than random factors. Therefore, managerial improvement and stronger business management practices are key to enhancing performance. Business digitalization has been proven to significantly reduce the level of technical inefficiency among culinary MSEs, although it does not directly influence productivity growth. Instead, digitalization functions as a supporting factor that enhances the utilization of production inputs by improving operational efficiency, marketing, and business management.

Increasing the productivity of culinary MSEs thus depends not only on expanding production inputs but also on improving technical efficiency through strengthened management practices and accelerated digital technology adoption. The development strategy

for culinary MSEs in the city of Surabaya should therefore focus on improving business location quality, strengthening capital access, increasing labor capacity, and leveraging digitalization as a strategic instrument to enhance business efficiency and competitiveness in a sustainable manner.

REFERENCES

Badan Pusat Statistik. (2023). *Statistik usaha mikro dan kecil Provinsi Jawa Timur*. Badan Pusat Statistik.

Bosker, M., Deichmann, U., Gourdon, J., Henderson, J. V., & Krishnan, S. (2024). Spatial patterns and drivers of micro, small and medium-sized enterprises (MSMEs) within and across Indonesian cities: Evidence from highly granular data. *World Development, 181*, Article 106651. https://doi.org/10.1016/j.worlddev.2024.106651

Calvino, F., Criscuolo, C., Marcolin, L., & Squicciarini, M. (2023). Digital technologies and productivity: A firm-level investigation. *Research Policy, 52*(9), Article 104828. https://doi.org/10.1016/j.respol.2023.104828

Eller, R., Alford, P., Kallmünzer, A., & Peters, M. (2020). Antecedents, consequences, and challenges of small and medium-sized enterprise digitalization. *Journal of Business Research, 112*, 119–127. https://doi.org/10.1016/j.jbusres.2020.03.004

Falentina, A. T., Resosudarmo, B. P., Darmawan, D., & Sulistyaningrum, E. (2021). Digitalization and the performance of micro and small enterprises in Yogyakarta, Indonesia. *Bulletin of Indonesian Economic Studies, 57*(3), 297–330. https://doi.org/10.1080/00074918.2021.1954384

Hutagalung, R. (2023). Pengaruh nilai lokasi terhadap produktivitas UMK di Indonesia. *Jurnal Ekonomi Mikro Indonesia, 12*(2), 145–158.

Labolo, S. N. S. D., Maulana, H., Jamal, M., & Syamsuri, S. (2025). Analisis efisiensi dan skala ekonomi UMKM makanan halal di Indonesia: Studi di Kota Pangkalpinang. *Share: Jurnal Ekonomi dan Keuangan Islam, 14*(1), Article 28631. https://doi.org/10.22373/share.v14i1.28631

Nugraha, D. (2022). Digitalisasi sebagai variabel moderasi dalam peningkatan produktivitas UMK. *Jurnal Ekonomi Digital, 5*(1), 66–79.

Nugroho, A., & Lestari, S. (2022). Akses pembiayaan dan kinerja usaha mikro di Indonesia. *Jurnal Ekonomi Pembangunan*.

OECD. (2020). *Digital transformation of SMEs*. OECD Publishing.

Parulian, F. E., Harum, N., Aditya, R., & Yuliana, R. (2025). The application of stochastic frontier analysis for estimating the efficiency of the manufacturing industry in Indonesia in 2022. *Seminar Nasional Official Statistics, 2025*(1), 581–590. https://doi.org/10.34123/semnasoffstat.v2025i1.2492

Putri, A., & Rachmawati, D. (2022). Ketenagakerjaan di Indonesia: Tantangan dan peluang. *Jurnal Ekonomi dan Ketenagakerjaan, 9*(1), 33–45.

Purwa, T. (2022). *Technical inefficiency in nine clusters of Indonesian manufacturing firms and its determinants: Stochastic frontier analysis*. ResearchGate. https://doi.org/10.13140/RG.2.2.31082.72649

Radicic, D., & Djalilov, K. (2023). Impact of digitalization on technological innovations in small and medium-sized enterprises (SMEs). *Technological Forecasting and Social Change, 191*, Article 122474. https://doi.org/10.1016/j.techfore.2023.122474

Susilowati, S. H., & Maulana, M. (2019). Analisis efisiensi teknis usaha mikro dan kecil menggunakan stochastic frontier analysis. *Jurnal Ekonomi dan Pembangunan Indonesia, 19*(1), 1–15.

Tambunan, T. (2019). *Usaha mikro, kecil, dan menengah di Indonesia: Isu-isu penting*. LP3ES.

Tobing, A., & Soekarno, S. (2022). Determinants of micro, small, and medium-scale enterprise performers' income during the Covid-19 pandemic era. *Heliyon, 8*(7), Article e09840. https://doi.org/10.1016/j.heliyon.2022.e09840

Wahyuni, S., & Riptiono, S. (2022). Determinants of micro, small, and medium-scale enterprise performers' income during the Covid-19 pandemic era. *Heliyon, 8*(7), Article e09840. https://doi.org/10.1016/j.heliyon.2022.e09840

Zahoor, N., Zopiatis, A., Adomako, S., & Lamprinakos, G. (2023). The micro-foundations of digitally transforming SMEs: How digital literacy and technology interact with managerial attributes. *Journal of Business Research, 159*, Article 113755. https://doi.org/10.1016/j.jbusres.2023.113755