

Efficiency of The Tourism Supporting The Halal Tourism Ecosystem in Indonesia, 2019-2024: A DEA and SFA Approach

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ABSTRACT

The intention of this paper is to analyze the efficiency of the tourism industry supporting the halal tourism ecosystem in Indonesia during the 2019–2024 period using Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). The background of this research is based on the recovery of Indonesia's tourism sector and the growing importance of halal tourism as part of the Islamic economic ecosystem. However, tourism recovery should not only be measured by increasing tourist numbers or spending, but also by the ability of supporting industries to transform labor and domestic tourist expenditure into Gross Value Added of Tourism Industries (GVATI). This study uses a quantitative descriptive-comparative approach with secondary data from Indonesia's Tourism Satellite Account. The input variables consist of tourism industry labor and domestic tourist expenditure by product, while the output variable is GVATI. The unit of analysis consists of tourism industries observed during 2019–2024, analyzed using output-oriented DEA-BCC and SFA models. The DEA results show that the average CRS technical efficiency is 0.538, VRS technical efficiency is 0.788, and scale efficiency is 0.696, indicating that efficiency among tourism industries is still heterogeneous. Air transportation, vehicle rentals, and other tourism services are fully efficient both technically and in scale, while travel agencies, cultural services, tourism merchandise, land transportation, water transportation, and sports and recreation remain inefficient. The SFA results show that labor and domestic tourist expenditure have positive effects on GVATI, with domestic tourist expenditure having a stronger elasticity. The study concludes that halal tourism development in Indonesia should focus not only on increasing demand, but also on improving productivity, digitalization, service integration, and the efficiency of supporting tourism industries.

A. INTRODUCTION

One of the cross-industry sector that is strategically important to the economy is tourism, because its activities are not limited to travel services but also drive the accommodation, food and beverage, transportation, travel agency, cultural services, recreation, and tourism goods sectors. Globally, the tourism sector has entered a recovery phase following the pressures of the COVID-19 pandemic. UNWTO notes that by 2024, there will be approximately 1.4 billion international tourist arrivals, marking the recovery of global tourism to pre-pandemic levels. This indicates that tourism is once again becoming a driver of the global economy; however, this recovery phase also demands a more in-depth evaluation not merely in terms of growth in tourist numbers, but also regarding the industry's efficiency in transforming resources into economic value (UN Tourism, 2025).

In Indonesia, the TSA's tourism indicators have improved, reflecting the industry's revival. Indonesia's GVATI increased from Rp1,099,416 billion in 2022 to Rp1,301,340 billion in 2023 and Rp1,449,530 billion in 2024. During the same period, TDGDP increased from



Rp729.144 billion to Rp975.207 billion and Rp1.067.283 billion. GVATI's contribution to the national economy also rose from 5.87 percent in 2022 to 6.51 percent in 2023 and 6.84 percent in 2024, while TDGDP's contribution to GDP increased from 3.72 percent to 4.67 percent and 4.82 percent. This data indicates that Indonesia's tourism recovery is not limited to the number of visitors but also extends to the generation of economic value added (BADAN PUSAT STATISTIK, 2026)

Indonesia's tourism performance is also heavily influenced by the domestic market. In the TSA, domestic tourist spending is broken down by tourism product, such as accommodation, food and beverages, transportation, vehicle rentals, travel agencies, cultural services, recreation, tourism goods, and other tourism services. This data is relevant to Islamic economics research because the majority of the halal tourism ecosystem relies on domestic consumption, particularly the consumption of halal food and beverages, Muslim-friendly accommodations, transportation, religious tourism, family recreation, and halal SME products (Sodawan & Hsu, 2022). Therefore, domestic tourist spending can be positioned as a key input in measuring the efficiency of the tourism industry supporting the halal tourism ecosystem.

From a labor perspective, The labor-intensive tourist sector in Indonesia is vital to creating a number of job. The TSA 2019–2023 and TSA 2022–2024 provide data on the number of tourism workers by industry, enabling an analysis of efficiency at the industry level on an annual basis. The use of labor as an input is important because an increase in the labor force does not always equate to an increase in efficiency. An industry with a large workforce may have low productivity if the value added generated is not proportional to the inputs used (Korneeva, 2020). In the other hand, an industry with a relatively small workforce can be more efficient if it can generate a large GVATI.

From an Islamic economics perspective, halal tourism cannot be understood merely as a destination label or product certification, but rather as an economic ecosystem that involves the industry's value chain. Accommodation services, food and beverage, transportation, travel agencies, recreation, culture, and the trade of tourism goods are key components that determine the quality of the Muslim traveler's experience. The literature on halal tourism indicates that destination attributes, perceived value, trust, and supporting factors influence tourists' interest in visiting halal destinations. However, most of these studies still focus on tourist behavior and destination competitiveness, rather than on the efficiency of the industries that underpin the halal tourism ecosystem (Lestari et al., 2023).

The expansion of the global Islamic economy accentuates the imperative nature of this investigation. The State of the Global Islamic Economy report explains that the global Islamic economy persists in its trajectory of growth, with the Muslim-friendly travel sector emerging as a pivotal element within the halal economic framework. The report highlights that the global Islamic economy has escalated from an approximated US\$1.62 trillion in consumer expenditure in 2012 to US\$2.29 trillion in 2022. This development demonstrates that halal tourism holds significant potential, but this potential must be accompanied by improved industry efficiency so that growth is not merely expansive but also productive and value-added (Salaam Gateway, 2025).

From an academic perspective, over the past decade, halal tourism research has increased significantly, but it still has methodological limitations. A Scopus-based bibliometric study of halal tourism indicates that research in this field primarily addresses themes such as destinations, tourist behavior, marketing, satisfaction, and competitiveness, while studies that treat halal tourism as an industrial system whose efficiency can be measured remain relatively scarce. Consequently, there is room for research to shift the focus from merely analyzing tourist preferences toward analyzing the efficiency of the tourism industry, which serves as the foundation of the halal economy (Ratnasari et al., 2024).

From a methodological perspective, Data Envelopment Analysis (DEA) has been widely applied in tourism and hospitality studies because it can measure the relative efficiency of decision-making units without requiring a specific form of production function. Nurmatov et al. demonstrate that DEA is extensively used in tourism research to evaluate the efficiency of hotels, destinations, and the tourism industry, while also identifying methodological gaps in the

measurement of tourism efficiency. However, DEA has limitations because it is deterministic and does not distinguish inefficiency from statistical noise. Therefore, combining DEA with Stochastic Frontier Analysis (SFA) becomes relevant because SFA allows for the estimation of technical efficiency while considering random errors (Nurmatov et al., 2021).

The main research gap in this study lies in the limited number of studies that measure the efficiency of the tourism industry supporting halal tourism in Indonesia using TSA data and combining DEA and SFA. International tourism efficiency studies have indeed used a frontier approach to evaluate the tourist industry's technical effectiveness across nations, as demonstrated by Alinsato in their analysis of the technical efficiency of the global tourism industry (Alinsato et al., 2022). However, such research generally uses countries, hotels, or destinations as units of analysis, rather than the tourism industry according to TSA classification. The novelty of this study lies in using the tourism industry's labor force and domestic tourist expenditure by product as inputs, along with GVATI as the output, to assess the efficiency of the tourism industry, which serves as a proxy for Indonesia's halal tourism ecosystem during the 2019-2024 period.

Thus, the study titled "Efficiency of the Tourism Industry Supporting the Halal Tourism Ecosystem in Indonesia, 2019–2024: A DEA and SFA Approach" is significant because it integrates issues of Islamic economics, the tourism industry, and production efficiency into a single analytical framework. This study not only assesses whether the tourism industry is growing but also whether it is efficient in converting labor and domestic tourist spending into GVATI. Another novelty lies in the comparative use of two frontier approaches: DEA to measure relative efficiency across industries and SFA to estimate technical efficiency while considering statistical disturbances.

B. THEORETICAL STUDY

The Production Theory

The Production theory serves as the primary foundation of this study because the efficiency of the tourism industry is fundamentally linked to an industry's ability to transform inputs into outputs. In production theory, economic units utilize factors of production—such as labor, capital, technology, and market demand—to produce goods or services of economic value. In the context of this study, the tourism industry is positioned as a production unit that uses the tourism industry's labor and domestic tourist spending on products as inputs to generate GVATI (Gross Value Added of the Tourism Industry) as output. Thus, production theory explains that the more optimal the combination of inputs used, the greater the industry's potential to generate high economic value added (Coelli, 2005).

The Theory of Efficiency

The theory of technical efficiency explains the ability of a production unit to generate maximum output from a given amount of inputs or to use minimum inputs to produce a given output. In this study, technical efficiency is used to assess the extent to which the tourism industry supporting the halal tourism ecosystem is capable of generating GVATI from the tourism industry's labor inputs and domestic tourist expenditures. An industry is considered efficient if it lies on the best-possible production frontier, whereas an industry located below the frontier indicates inefficiency. Thus, technical efficiency is more appropriate than standard growth analysis because it assesses the quality of input utilization, not merely changes in output over time (Parmeter, 2025).

In tourism efficiency research, two widely used frontier approaches are Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). DEA is a non-parametric approach that constructs a frontier based on the best performance of the observed units, making it suitable for use when the form of the production function is not precisely known. Meanwhile, SFA is a parametric approach that estimates the production frontier by separating the inefficiency component from random error. This distinction is important because the tourism industry is highly vulnerable to external fluctuations such as pandemics, changes in



tourist mobility, inflation, changes in transportation prices, and shifts in domestic tourist preferences (Nurmatov et al., 2021)(Alinsato et al., 2022).

The Tourism Industry Workforce

The tourism industry workforce consists of individuals who are dedicated and qualified in the field of tourism, working in various related sectors such as hospitality, travel agencies, the culinary industry, and tourist destinations, to produce goods or services aimed at meeting the needs of tourists (Tulumang et al., 2019). Workers are selected because the tourism industry is a service sector that is highly dependent on the quality and quantity of human resources. Activities in accommodation, food and beverage, transportation, travel agencies, recreation, culture, and the trade of tourism goods require labor in the service provision process. However, a large workforce does not always indicate high efficiency. If the workforce increases but the value added generated does not rise proportionally, the industry may experience technical inefficiency. Therefore, labor serves as a critical input in the DEA and SFA models (Klitgaard et al., 2022)

Domestic Tourist Expenditures by Product

Domestic Tourist Expenditures by Product refers to the total consumption or costs incurred by domestic travelers during their trips. These are categorized into specific goods and services enjoyed during the trip (Widayanti et al., 2025). This variable is used because domestic expenditures reflect actual demand for tourism products. In the context of halal tourism, the domestic market is crucial because Indonesia has a large Muslim tourist base, and domestic tourism consumption is closely tied to accommodation, food and beverages, transportation, family travel, recreation, and tourism goods. Domestic tourist spending is positioned as a demand input because tourist spending creates an economic stimulus for the industry to generate value-added output. However, the efficiency of increased domestic tourist spending still needs to be tested because high spending does not necessarily result in optimal GVATI if there are leaks, high costs, or low productivity (Zulvianti et al., 2022)(Mujiatun et al., 2023).

GVATI (Gross Value Added of Tourism Industries)

GVATI or Gross Value Added of Tourism Industries, is an economic indicator that measures the total value added generated by all domestic industries as a direct response to tourism consumption. This figure reflects the magnitude of the tourism sector's contribution to the economy from the supply side. In practical terms, GVATI calculates the amount of value added created by various tourism-related sectors as a result of tourist activities (Mun'im, 2022). GVATI was chosen because it is conceptually stronger than indicators of the number of tourist visits or total tourist spending, as GVATI demonstrates the value added that is actually generated by the tourism industry. In efficiency research, a good output must reflect the economic results of the production process, and GVATI meets this criterion because it reflects the tourism industry's contribution to the formation of gross value added. Thus, this research model assesses the efficiency of the tourism industry based on its ability to convert labor inputs and domestic tourist expenditures into GVATI output (Alinsato et al., 2022).

C. RESEARCH METHODS

This study focuses on measuring the efficiency of the tourism industry supporting the halal tourism ecosystem in Indonesia during the 2019–2024 period, using secondary data drawn from the Indonesian Tourism Satellite Account published by the Central Statistics Agency. The research subject is the tourism industry, which conceptually serves as the foundation of the halal tourism ecosystem. This sector encompasses lodging services, culinary and beverage services, rail transportation services, terrestrial transportation services, maritime transportation services, aerial transportation services, vehicle leasing services, travel consultancy and additional reservation services, cultural offerings, athletic and recreational services, commerce in tourism-related goods, as well as other tourism-related services.

This is a quantitative study employing a descriptive-comparative approach and frontier efficiency analysis. The study is classified as quantitative because it utilizes numerical data, where the input variables are the number of workers and domestic tourist expenditures by product, while the output variable is GVATI. The unit of analysis in the DEA and SFA models is the Decision Making Unit (DMU), which is a combination of industry and year; if 12 industries are used over 6 years, there are 72 DMUs. The data are systematically analyzed using the DEA and SFA methods to generate efficiency scores. A quantitative approach is considered most appropriate because the research problem relates to measuring input-output efficiency across industries and over time (Nurmatov et al., 2021).

Data analysis techniques employ two approaches: Data Envelopment Analysis and Stochastic Frontier Analysis. The DEA model used is DEA-BCC (Borderless Common Scale) or Variable Returns to Scale, output-oriented. The SFA model will use the Frontier 4.1 application, output-oriented with technical efficiency measurement. DEA and SFA efficiency scores fall within the 0–1 interval; a score of 1 indicates the industry is relatively efficient, while a score below 1 indicates the industry is not yet efficient (Adawiyah et al., 2024).

D. RESULTS AND DISCUSSION

RESULT

DEA Estimation

The DEA results show that the average technical efficiency based on the CRS assumption is 0.538, the average technical efficiency based on the VRS is 0.788, and the average scale efficiency is 0.696. The difference between the CRS and VRS scores indicates that some of the industry's inefficiencies stem not only from technical issues but also from issues related to the scale of operations. In other words, some industries are able to perform relatively well when differences in scale are taken into account, but are not yet operating at an optimal scale. These results are important because the tourism industry is heterogeneous, in terms of labor intensity, the size of domestic demand, and the ability to generate GVATI.

DEA-VRS Efficiency Table

No.	Tourism Industry	CRS TE	VRS TE	Scale Efficiency	RTS
1	Accommodations	0,408	1,000	0,408	DRS
2	Food and Beverage	0,258	1,000	0,258	DRS
3	Rail Transportation	0,425	1,000	0,425	IRS
4	Land Transportation	0,463	0,765	0,606	DRS
5	Water Transportation	0,601	0,654	0,919	IRS
6	Air Transportation	1,000	1,000	1,000	CRS
7	Vehicle Rentals	1,000	1,000	1,000	CRS
8	Travel Agencies and Reservations	0,248	0,285	0,870	IRS
9	Cultural Services	0,219	0,266	0,821	DRS
10	Sports and Recreation	0,678	0,836	0,811	DRS
11	Tourism Merchandise	0,156	0,650	0,239	DRS
12	Other Tourism Services	1,000	1,000	1,000	CRS

Source : Processed Secondary Data, 2026

Based on the VRS scores, there are six technically efficient industries: accommodation, food and beverage, rail transport, air transport, vehicle rental, and other tourism services. Three of these air transport, vehicle rental, and other tourism services also have a scale efficiency of 1.000, meaning they can be categorized as efficient both technically and in terms of scale. These industries can be viewed as best practices in the use of inputs to generate GVATI. In the context of the halal tourism ecosystem, these findings indicate that several supporting industries such as accommodation, air transport, and tourism support services hold strategic positions in the creation of tourism value added.

On the other hand, six industries have not yet achieved full technical efficiency: land transportation, water transportation, travel agencies and reservations, cultural services, sports



and recreation, and tourism goods trade. The industries with the lowest VRS scores are cultural services at 0.266 and travel agencies at 0.285. This means these two industries are relatively farthest from the efficiency frontier. This condition indicates that the inputs used have not been able to generate GVATI optimally compared to the benchmark industries in the sample. These results align with the DEA principle that industries far from the frontier require technical improvements, whether through increased productivity, service digitization, improved governance, or strengthened connectivity with other tourism industries.

The DEA results also indicate the presence of scale issues. The accommodation, food and beverage, land transportation, cultural, sports, and recreational services, and tourism goods trade industries are experiencing decreasing returns to scale (DRS). This condition indicates that increased inputs in these industries do not always result in a proportional increase in output. In a policy context, DRS indicates the need for productivity consolidation, not merely input expansion. Meanwhile, rail transport, water transport, and travel agencies are in a state of increasing returns to scale (IRS), meaning these industries still have the opportunity to increase output through more productive scale expansion.

Table of Input Slack

No.	Tourism Industry	Input 1	Input 2
1	Accommodations	0,000	0,000
2	Food and Beverage	0,000	0,000
3	Rail Transportation	0,000	0,000
4	Land Transportation	1740083,976	0,000
5	Water Transportation	0,000	0,000
6	Air Transportation	0,000	0,000
7	Vehicle Rentals	0,000	0,000
8	Travel Agencies and Reservations	0,000	0,000
9	Cultural Services	0,000	0,000
10	Sports and Recreation	0,000	0,000
11	Tourism Merchandise	6041753,500	0,000
12	Other Tourism Services	0,000	0,000
	Mean	6484486.456	0.000

Source : Processed Secondary Data, 2026

The slack analysis shows that output slack is zero for the entire industry, but there is labor input slack in land transportation and tourism goods trade. In land transportation, labor input has a slack of 1,740,083.976 people, while in tourism goods trade, labor slack reaches 6,041,753.500 people. These findings indicate that inefficiencies in both industries primarily stem from an excess of labor input relative to the resulting GVATI output. In other words, the main issue is not only low output but also suboptimal labor productivity.

DEA Output Target Table For Industries That Are Not Yet Efficient

Industry	Current GVATI	GVATI Target	Required Increase	Interpretation
Land transportation	42,830	56,009	13,179	Output needs to increase by approximately 30.77%
Water transportation	15,980	24,453	8,473	Output needs to increase by approximately 53.02%
Travel agencies and reservations	5,410	18,956	13,546	Output needs to increase by approximately 250.39%
Cultural services	13,840	51,970	38,130	Output needs to increase by approximately 275.51%
Sports and recreation	44,310	53,019	8,709	Output needs to increase by approximately 19.65%
Tourism merchandise	79,720	122,653	42,933	Output needs to increase by approximately 53.85%

Source : Processed Secondary Data, 2026

These output targets highlight the significant room for improvement in industries that are not yet efficient. The cultural services and travel agency sectors have the greatest relative need for output growth. From a halal tourism perspective, this is important because cultural services, travel agencies, and recreation are integral parts of the Muslim traveler's experience. Low efficiency in these industries can hinder the development of a robust halal tourism ecosystem, as the halal travel experience is determined not only by halal food and accommodations but also by the quality of attractions, travel packages, destination information, and service integration.

SFA Estimation

The SFA estimation results show that the model has 12 cross-sections, 6 time periods, and a total of 72 panel observations. The dependent variable used is the log of GVATI, while the independent variables are the log of the tourism industry workforce and the log of domestic tourist expenditure by product. The MLE estimation results show that the labor coefficient is positive at 0.328539 with a t-ratio of 5.008640, while the domestic tourist expenditure coefficient is positive at 0.416173 with a t-ratio of 6.433933. Both coefficients are statistically significant, indicating that increases in labor and domestic tourist expenditure are positively associated with increases in GVATI.

SFA Estimation Table

Parameter	Coefficient	Standard Error	t-ratio	Interpretation
β_0	-2,089619	0,663189	-3,150865	Intercept of the production function
β_1 : Input 1	0,328539	0,065594	5,008640	The elasticity of GDP per capita with respect to labor is positive
β_2 : Input 2	0,416173	0,064684	6,433933	The elasticity of GDP per capita with respect to domestic expenditure is positive
Sigma-squared	0,169003	0,029840	5,663724	Residual variance of the model
Gamma	0,0000097	0,011114	0,000874	The inefficiency component is very small

Source : Processed Secondary Data, 2026

The labor coefficient of 0.328539 indicates that a 1 percent increase in the labor force is associated with an increase in GVATI of approximately 0.329 percent, assuming all other variables remain constant. Meanwhile, the domestic tourist expenditure coefficient of 0.416173 indicates that a 1 percent increase in domestic tourist expenditure is associated with an increase in GVATI of approximately 0.416 percent. The fact that the domestic expenditure coefficient is larger than that of labor suggests that domestic demand plays a stronger role in driving the creation of tourism industry value added than labor growth alone.

These results are consistent with the nature of Indonesia's tourism industry, which is highly dependent on the domestic market. In the context of halal tourism, domestic tourist spending can be understood as a driver of demand for products related to the needs of Muslim tourists, such as accommodation, food and beverages, transportation, travel agencies, recreation, and tourism goods. Therefore, an increase in domestic tourist spending is a key factor in the generation of tourism industry value added. However, since this study employs an efficiency approach, the increase in domestic spending must still be viewed in relation to the industry's ability to convert that spending into GVATI.

A gamma value of 0.0000097 with a very small t-ratio indicates that the technical inefficiency component in the SFA model is virtually undetectable. In other words, the variation in residuals within the model is explained more by random disturbances than by technical inefficiency. This is also reflected in the average SFA technical efficiency score of 0.998978. This value is very close to 1, so according to the SFA, almost all industries appear to be highly efficient. However, these results must be interpreted with caution because the FRONTIER



output warns that the MLE likelihood value is no better than OLS and suggests using a different starting value. This warning indicates that the SFA model is not yet fully stable in capturing the inefficiency component.

Summary Table of SFA Technical Efficiency Scores

No.	Tourism Industry	Average TE SFA	Minimum	Maximum	Interpretation
1	Accommodations	0,998978	0,998977	0,998979	Very efficient
2	Food and Beverage	0,998977	0,998975	0,998979	Very efficient
3	Rail Transportation	0,998978	0,998976	0,998979	Very efficient
4	Land Transportation	0,998978	0,998976	0,998979	Very efficient
5	Water Transportation	0,998978	0,998975	0,998979	Very efficient
6	Air Transportation	0,998978	0,998975	0,998979	Very efficient
7	Vehicle Rentals	0,998978	0,998977	0,998980	Very efficient
8	Travel Agencies and Reservations	0,998978	0,998977	0,998979	Very efficient
9	Cultural Services	0,998980	0,998977	0,998985	Very efficient
10	Sports and Recreation	0,998979	0,998977	0,998980	Very efficient
11	Tourism Merchandise	0,998979	0,998978	0,998980	Very efficient
12	Other Tourism Services	0,998979	0,998978	0,998982	Very efficient

Source : Processed Secondary Data, 2026

In general, the SFA results indicate that all industries have very high technical efficiency scores that are very close to one another. The variation in scores across industries is very small, ranging from approximately 0.998975 to 0.998985. This means that the SFA model does not produce a sharp distinction in efficiency among industries. This finding differs from the DEA results, which show considerable variation in efficiency. Thus, the SFA places greater emphasis on the fact that aggregate labor and domestic expenditure can adequately explain GVATI, but do not capture much of the technical inefficiency across industries.

DISCUSSION

The DEA results indicate that efficiency within the tourism industries supporting Indonesia's halal tourism ecosystem is not yet uniform. Some industries, such as air transport, vehicle rentals, and other tourism services, have achieved both technical efficiency and economies of scale. This suggests that these three industries are relatively capable of optimally converting labor inputs and domestic tourist spending into GVATI. Conversely, industries such as travel agencies, cultural services, and the trade of tourism goods still face technical inefficiencies and/or scale inefficiencies. In production theory, this condition indicates that not all industry units are on the production frontier, the maximum output achievable from a given combination of inputs. Thus, the magnitude of inputs does not always guarantee high value added if not accompanied by adequate productivity, service technology, human resource quality, and governance (Coelli, 2005).

This finding reinforces the argument that the development of halal tourism cannot rely solely on destination promotion, increasing the number of tourist visits, or expanding domestic tourist spending. Halal tourism must be viewed as an industrial ecosystem comprising accommodation, food and beverages, transportation, travel agencies, recreation, culture, tourism goods, and supporting services. Within the framework of the Tourism Satellite Account (TSA), GVATI is understood as the gross value added generated by the tourism industry; thus, this indicator is more appropriate for measuring economic contribution than merely the number of tourists or gross spending. Therefore, the supporting industries of halal tourism need to be evaluated based on their ability to create value-added efficiently, not merely on the volume of demand entering the tourism sector (BADAN PUSAT STATISTIK, 2025) (BADAN PUSAT STATISTIK, 2026).

The travel agency and cultural services industries are of particular concern because both have relatively low efficiency scores. Within the halal tourism ecosystem, travel agencies play a role in designing tour packages, providing destination information, integrating transportation

and accommodation services, and connecting Muslim tourists with facilities that meet their religious and cultural needs. Meanwhile, cultural services play a role in creating tourism experiences based on local identity, Islamic history, art, traditions, and cultural attractions. The low efficiency of these two industries indicates that the value added generated is not yet commensurate with the inputs used. This finding aligns with halal tourism studies that emphasize the importance of supporting factors, destination quality, perceived value by tourists, and trust in enhancing the competitiveness of halal destinations (Lestari et al., 2023).

The low efficiency of travel agencies can also be attributed to changes in the tourism industry structure, which is becoming increasingly digitized. Post-pandemic, tourist behavior has shifted toward self-directed information seeking, online bookings, travel flexibility, and a preference for fast and integrated services. If travel agencies fail to undergo digital transformation, strengthen the curation of halal tour packages, build networks with halal SMEs, and provide services tailored to the needs of Muslim tourists, the industry's value added will lag behind. Tourism literature and DEA analysis indicate that inefficiencies in the tourism sector often stem not only from insufficient inputs but also from managerial weaknesses, low service innovation, and suboptimal use of technology in converting inputs into outputs (Nurmatov et al., 2021) (Stoiljković et al., 2025).

Cultural services with low efficiency scores also need to be interpreted with caution. In halal tourism, culture is not merely an additional attraction but an integral part of the travel experience that can strengthen a destination's identity. Local Islamic history, mosque architecture, halal culinary traditions, performing arts, crafts, and cultural narratives can be sources of added value if managed professionally. However, if cultural services are not integrated with travel packages, digital promotion, the creative economy, and the halal SME supply chain, their economic output will be relatively small. Thus, the DEA results indicate that the cultural sector requires a strategy for increasing added value, not merely symbolic preservation. Strengthening the halal tourism ecosystem requires integration among cultural attractions, institutions, business actors, technology, and destination governance (Rachmiate et al., 2024) (Ratnasari et al., 2024).

Tourism goods trade also exhibits significant efficiency issues, with a VRS score of 0.650 and scale efficiency of only 0.239. Additionally, there is significant labor input slack, meaning the industry absorbs a high volume of labor but has not yet generated GVATI proportionally. From the perspective of technical efficiency theory, this condition indicates that the primary issue is not merely a shortage of output but also low input productivity. In the context of Islamic economics, the tourism goods trade is highly significant as it relates to halal souvenirs, Muslim fashion, local crafts, halal food products, and the creative economy. Therefore, the required policies should not only focus on expanding labor absorption but also on enhancing worker productivity, product quality, halal certification, digital marketing, packaging standardization, and connectivity with tourist destinations.

Findings regarding the trade of tourism goods are also consistent with research on SMEs within the halal tourism ecosystem. Mujiatun et al. (2023) demonstrate that marketing communication, Islamic financial literacy, and financial inclusion play a crucial role in improving the performance of halal tourism SMEs (Mujiatun et al., 2023). This is relevant to the DEA results because low efficiency in the tourism goods trade may occur if business operators lack access to financing, digital marketing capabilities, halal certification, and adequate business management. Thus, improving the efficiency of the tourism goods trade industry requires strengthening SME capacity, integrating with digital platforms, enhancing human resource quality, and strengthening the halal value chain from production to distribution.

The SFA results offer a different perspective from the DEA. The positive coefficients for labor and domestic tourist spending indicate that both inputs remain crucial in determining GVATI. Domestic tourist spending even exhibits greater elasticity compared to labor, making domestic demand a key factor in generating added value within the tourism industry. Theoretically, these findings align with service sector production theory, where output is determined not only by labor but also by the level of demand for the services offered. In the context of halal tourism, this indicates that the Muslim domestic tourist market is a vital



foundation for value creation, particularly through consumption of halal accommodations, food and beverages, transportation, family recreation, and tourism products aligned with Muslim preferences.

However, a near-perfect SFA score cannot be directly interpreted to mean that the entire industry is truly efficient without issues. A very small gamma value indicates that the SFA model captures more of the output variation as random noise or general variation in the production function, rather than as technical inefficiency. In the SFA methodology, the error is divided into two components: the random component and the inefficiency component. If the inefficiency component is very small, the model tends to produce a technical efficiency score close to one. This can occur because the Cobb-Douglas model specification is too simple, the number of observations is limited, inter-industry variation is too heterogeneous, or the input variables do not fully capture other production factors such as capital, business capacity, investment, technology, the number of business units, and human resource quality (Alinsato et al., 2022).

The differences between DEA and SFA results can also be explained by the fundamental characteristics of the two methods. DEA is non-parametric and deterministic, so any deviation from the frontier is considered relative inefficiency. Therefore, DEA is more sensitive in distinguishing performance across industries and more precise in identifying lagging sectors. Conversely, SFA is parametric and stochastic, so deviations from the frontier are separated into technical inefficiencies and random disturbances. This difference causes DEA to show a wide range of efficiency variations, while SFA can produce more homogeneous efficiency scores if residual variations are interpreted more as noise. In tourism efficiency studies, differences in results between DEA and SFA are to be expected because the two methods are built on different econometric assumptions (Nurmatov et al., 2021) (Parmeter, 2025).

Theoretically, the results of this study support production theory and technical efficiency theory. An efficient industry is one capable of producing maximum output from available inputs, whereas an inefficient industry lies below the production frontier. DEA results indicate that some industries still have room to increase GVATI without proportionally increasing inputs. Meanwhile, the SFA results indicate that labor and domestic tourist spending are productive inputs in the formation of GVATI. Thus, halal tourism development strategies should focus on enhancing input productivity rather than merely expanding inputs. Increasing the labor force, promoting destinations, or boosting domestic tourist spending will only yield optimal results if accompanied by improvements in industrial efficiency.

In terms of policy, the results of this study provide four main implications. First, industries with increasing returns to scale (IRS), such as rail transport, water transport, and travel agencies, still have opportunities for productive scale expansion. Second, industries with decreasing returns to scale (DRS), such as accommodation, food and beverage, road transport, cultural services, sports and recreation, and tourism goods trade, need to be more cautious in expanding inputs because additional inputs do not necessarily generate proportional GVATI. Third, industries with significant labor slack should focus on improving productivity, human resource training, service digitalization, halal certification, and halal value chain integration.

In the context of halal tourism development, the results of this study demonstrate that efficiency is a critical prerequisite for the economic sustainability of halal tourism. Efficient industries can serve as the primary drivers of value addition, whereas inefficient industries may become weak points in the ecosystem. This aligns with the latest trends in halal tourism research, which is shifting from destination-related issues and tourist behavior toward ecosystem dynamics, governance, institutional networks, technology, and sustainability. Thus, this study provides an empirical contribution by demonstrating that the development of halal tourism requires not only Muslim-friendly destinations but also efficient, productive supporting industries capable of generating sustainable value-added.

Thus, the findings of this study imply that the efficiency of the supporting industries within the halal tourism ecosystem in Indonesia is heterogeneous. Some industries are already efficient, while others still face technical and scale-related challenges. A comparison of DEA

and SFA reveals that non-parametric approaches are more sensitive in mapping efficiency differences across industries, whereas parametric approaches are stronger in explaining aggregate input-output production relationships. Therefore, the combined use of DEA and SFA should not be viewed as yielding conflicting results but rather as complementary approaches to understanding efficiency from two perspectives: DEA provides benchmark mapping and improvement targets, while SFA offers insights into input elasticity relative to output and the role of noise in the production function. The combination of both provides a stronger foundation for formulating development strategies for the value-added halal tourism industry.

E. CONCLUSION AND SUGGESTIONS

Conclusion

This study's result and discussion lead it to the conclusion that the efficiency of the tourism industries supporting Indonesia's halal tourism ecosystem during the 2019–2024 period is still heterogeneous. The DEA results show that the average CRS technical efficiency is 0.538, VRS technical efficiency is 0.788, and scale efficiency is 0.696. This indicates that the tourism industries are not only facing technical inefficiency but also scale-related inefficiency in converting labor and domestic tourist expenditure into GVATI.

The DEA-VRS results show that several industries have achieved technical efficiency, namely accommodation, food and beverage, rail transportation, air transportation, vehicle rentals, and other tourism services. However, only air transportation, vehicle rentals, and other tourism services are fully efficient both technically and in terms of scale. These sectors can be considered benchmark industries because they are relatively able to generate optimal value added from the available inputs.

On the other hand, several industries remain inefficient, especially travel agencies and reservations, cultural services, tourism merchandise, land transportation, water transportation, and sports and recreation. The lowest efficiency scores are found in cultural services and travel agencies, indicating that these sectors are still far from the efficiency frontier. This finding is important because travel agencies and cultural services play strategic roles in strengthening the halal tourism ecosystem through package integration, destination information, cultural attractions, and Muslim-friendly tourism experiences.

The slack analysis shows that land transportation and tourism merchandise experience excess labor input. This means that inefficiency in these sectors is closely related to low labor productivity rather than merely insufficient output. Therefore, increasing labor absorption alone is not enough; it must be followed by improvements in skills, technology, digital marketing, halal certification, service quality, and integration with the halal tourism value chain.

The SFA results provide a complementary explanation by showing that labor and domestic tourist expenditure have positive effects on GVATI. Domestic tourist expenditure has a stronger elasticity than labor, indicating that domestic demand plays an important role in creating tourism value added. However, the SFA efficiency scores are almost perfect, so they should be interpreted carefully. Overall, DEA is more sensitive in mapping efficiency differences across industries, while SFA is useful for explaining the input-output relationship. Thus, halal tourism development in Indonesia should focus not only on increasing demand, but also on improving the efficiency and productivity of its supporting industries.

Suggestions

1. The government and tourism policymakers should prioritize efficiency-based development in the halal tourism ecosystem. Policies should not only aim to increase the number of tourists or expand tourism promotion, but also strengthen the ability of each supporting industry to generate GVATI from available inputs. Industries that have achieved full efficiency, such as air transportation, vehicle rentals, and other tourism services, can be used as benchmarks for improving the performance of less efficient sectors. Meanwhile, industries with decreasing returns to scale should focus on productivity consolidation rather than excessive input expansion.



2. For travel agencies and reservation services, the main recommendation is to strengthen digital transformation and halal tourism package innovation. Travel agencies need to develop integrated digital platforms, improve online booking systems, curate Muslim-friendly travel packages, and collaborate with halal-certified accommodation, restaurants, transportation providers, and local SMEs. Since this sector has one of the lowest DEA efficiency scores, improving managerial capacity, digital literacy, product differentiation, and service integration is essential to increase its contribution to GVATI.
3. For cultural services, improvement should focus on transforming cultural assets into high-value tourism experiences. Cultural services should not only be preserved symbolically, but also integrated into halal tourism routes, religious tourism narratives, local Islamic history, creative economy products, cultural festivals, and digital promotion. Collaboration among local governments, cultural communities, halal tourism businesses, and creative industry actors is needed so that cultural attractions can generate stronger economic value added.
4. For tourism merchandise, the large labor slack indicates the need to improve labor productivity and business competitiveness. The government and industry stakeholders should strengthen training in product design, packaging, branding, halal certification, digital marketing, financial literacy, and e-commerce access. Tourism merchandise such as halal souvenirs, Muslim fashion, local crafts, and halal food products should be connected more closely with tourist destinations and digital marketplaces so that the sector can generate higher GVATI without merely increasing labor input.
5. For transportation sectors that are not yet fully efficient, particularly land and water transportation, policy should focus on service integration, route efficiency, connectivity with halal destinations, and quality improvement. Transportation is a key component of the Muslim tourist experience because it affects accessibility, comfort, safety, and destination connectivity. Therefore, strengthening transportation governance, digital ticketing, intermodal integration, and service standards can help increase efficiency and improve the overall halal tourism ecosystem.
6. Future researchers are advised to expand the model by adding other input variables, such as capital investment, number of business units, technology adoption, halal certification ownership, infrastructure quality, and human resource quality. The SFA results in this study show very high efficiency scores and a very small inefficiency component, which may be influenced by limited variables and observations. Therefore, future studies can use a longer observation period, provincial-level data, or firm-level data to obtain more detailed efficiency estimates.
7. Finally, future research can also compare halal tourism efficiency across regions in Indonesia or between Indonesia and other Muslim-majority countries. Such comparative studies would provide deeper insight into the competitiveness of Indonesia's halal tourism ecosystem. In addition, combining DEA and SFA with qualitative analysis, such as interviews with tourism business actors, halal certification bodies, travel agencies, and local governments, would enrich the interpretation of efficiency results and provide more practical policy recommendations.

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