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RESEARCH PAPER

Comparing the Efficiency of Rural Ecolodges Using by Data Envelopment Analysis Method (Case Study: Iranian Provinces)

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Abstract

Ecolodges, which allow visitors to stay in the community, are one of the services offered in rural tourism. This study aims to evaluate the efficiency of these units in the Iranian regions. The Ministry of Handicrafts, Cultural Heritage, and Tourism provided the necessary information, and the statistical population comprises ecolodge units in 31 provinces. The study is done using Data Envelopment Analysis (DEA), with the model's inputs being the number of ecolodge units and the number of beds, and the outputs being the number of visitors and income, respectively, for each province. According to the features of the research, envelope form (BCC), slack-based measurement (SBM), super efficiency (SE), and most productive scale size (MPSS) models have been utilized among the many efficiency estimate models. The findings indicate that six provinces—Tehran, Mazandaran, Golestan, Isfahan, Qom, and Kurdistan—are efficient in ecolodge units and they have grade 1 in the efficiency calculations, whereas the other provinces in the country are inefficient when the overlap of the results of all four models is taken into account, and their efficiency scores are as follows: the provinces of "East Azerbaijan (0.75), West Azerbaijan (0.68), Ardabil (0.79), Alborz (0.65), Ilam (0.77), Bushehr (0.68), Chaharmahal and Bakhtiari (0.62), South Khorasan (0.67), Razavi Khorasan (0.9), North Khorasan (0.73), Khuzestan (0.95), Zanjan (0.87), Semnan (0.58), Sistan and Baluchestan (0.67), Fars (0.83), Qazvin (0.89), Kerman (0.84), Kermanshah (0.7), Kohgiluyeh (0.68), Gilan (0.88), Lorestan (0.9), Markazi (0.56), Hormozgan (0.8), Hamedan (0.7), and Yazd (0.64)". Suggestions have also been made to attract tourists and boost the efficiency of ecolodge facilities.

Keywords: DEA method, ecolodge, most productive scale size model, slack-based measurement model, super efficiency model.
JEL Classification: D61, Q5, R2, Z30.

Introduction

Currently, tourism is one of the biggest global sectors and is crucial for boosting employment, fostering economic growth, closing the regional divide, and

encouraging cross-cultural interactions (Lozano-Oyola et al., 2019). For many nations in Asia and the Pacific, tourism is a significant economic engine and a significant source of foreign exchange revenues (Wang, 2010). One of the forms of tourism that are becoming more and more popular across the world is rural tourism, particularly as urban life gets more challenging and complex and as people become more and more cut off from the agricultural and rural roots that they may have known in the past (Luo et al., 2022). Rural tourism is a type of travel and leisure that highlights the countryside as a space and places emphasis on characteristics like the preservation of the environment and the utilization of natural areas (Su et al., 2022).

The local government takes the lead in managing tourist operations directly and working with local companies and communities to offer services and address issues, while the central government plays a key role in steering rural tourism in the right direction. The fast growth of rural tourism is stimulated by the cooperative efforts of central and local governments (Liu et al., 2020). The supply of services by ecolodges in villages and the job creation they generate may be considered among the service providers in the field of rural tourism and one of the companies associated with it. Accommodations that are found outside of cities, in the countryside or in natural settings are referred to as ecolodge accommodations. Accommodations for eco-tourists often have less than 30 rooms. They are made to use resources sustainably and with the least potential negative influence on the environment. In addition, they promote the use of regional suppliers and employees to enhance residents' quality of life[1].

Due to weather patterns and repeated droughts, Iran has experienced a decline in agricultural revenue in recent years. The absence of a steady source of income is currently the biggest issue for Iranian villagers after the transmission of amenities like water, electricity, gas, telephone, internet, and the development of the health and educational systems to the villages. Consequently, developing ecolodge facilities was one of the ways that the villages might generate income. Iran has experienced a boom in ecolodges since 2015. The province of Isfahan has the most ecolodge units, with a share of 16.55%, out of 2,755 that have been registered in various villages throughout Iran's provinces, according to the most recent official figures available (2019). followed by the provinces of Kerman (11.76%) and Mazandaran (8.57%). The main problem and question of this research is that these ecolodges were greatly promoted in a period of time (2015-

[1]. https://www.xotels.com/en/glossary/eco-lodge

2019) and their number increased, but now they have not been able to attract enough tourists in most days of the year, even in summers, and therefore it is necessary to check their efficiency from an economic point of view. In this study, the efficiency of these ecolodge units in different Iranian provinces will be compared, and the efficiency of each province will be examined concerning the inputs and outputs of these ecolodges. The Data Envelopment Analysis (DEA) model has been applied for this aim.

Literature Review

Following that, research looking into tourist efficiency is provided, with a focus on "landscape tours and the use of the DEA model," and a summary of them is offered at the conclusion.

With the use of the DEA model, Galluzzo et al. (2022) looked at the connection between agritourism and social capital in Italy. The results demonstrate that social capital for cooperative members has played a significant role in the growth of agritourism in Italy. Guo et al. (2022) employed the Super-SBM model; their findings indicated that the optimal regional environmental performance evaluation should consider a variety of elements, including inputs from various production aspects as well as environmental outputs (such as ecosystem services) and social outputs (such as resident and visitor happiness) (e.g., water). In a study by Wu et al. (2022), the results obtained with the dynamic DEA model differ considerably from those obtained with the static DEA model. The findings indicate that for the development of a synergy between tourism and culture, raising awareness of the value of cultural resources is essential. 350 articles were examined by Nurmatov et al. (2021) as part of their study on tourism and the use of DEA in linked publications. The findings reveal a significant geographic (Europe and Asia) and industry (hotel sector) concentration of the investigations. Using panel data, Chaabouni (2019) researched the efficiency of regional tourism in China. This research explores the efficiency of tourism and its factors. The findings demonstrate that during the sample period, tourist efficiency in China was low and that variables including trade openness, climate change, and the level of market rivalry all contribute to higher tourism efficiency. Mic and Eagles (2019) did a case study in Costa Rica while researching the branding of business cooperatives for ecolodges. The findings demonstrated that branding ecolodges as a cooperative activity boosted efficiency and was warmly received by the participants. Based on the DPSIR-DEA model, Ruan et al. (2019) assessed the driving forces behind the ecological security of tourism. The findings

demonstrated that several elements, such as the rate of industrial expansion and visitor density, that have been identified and are driving factors in this area are those that impact the ecological security of tourism. Data envelopment analysis (DEA)-Tobit model was used by Liu et al. (2017) to examine the efficiency of ecolodges in coastal towns in 53 Chinese cities for the years 2003–2013. The key conclusions indicate that most cities still have the potential for development and that the total efficiency of tourism in China's coastal cities is 0.860.

The synthesis of prior research demonstrates that the development of ecolodges and attracting tourists to stay in them will be facilitated by the coordinated efforts of local government authorities and that factors like trade openness, climate change, and the level of market rivalry have an impact on the efficiency of tourism. The existence of social capital for those involved in the development of agricultural tourism is highly significant and effective in attracting visitors, and it is crucial to analyze all economic, social, environmental, and ecological elements in measuring the effects of the presence of ecolodges.

Materials and Methods

The non-parametric technique applied in this study is data envelopment analysis (DEA). Traditional DEA models, such as the CCR and BCC models, are radial and often fail to fully account for slacks in inputs or outputs (Liu et al., 2017). Recently, certain more sophisticated DEA models (such as the SBM model and the Metafrontier model) that are appropriate for measuring efficiency in the tourist industry have been used (Zha, 2020; Peng, 2017). According to Emrouznejad and Yang (2018), the DEA model is by far the most popular operations research (OR) technique used to assess efficiency internationally as well as in the hotel and tourist industries (Assaf and Josiassen, 2016). Recent years have seen a rise in the use of the data envelopment analysis model in the tourist industry, and this problem was highlighted in the research by Nurmatov et al. in 2021.

As previously mentioned, efficiency in the sphere of ecolodges and tourism is a measure of sustainability that demonstrates how effectively economic activity takes into account ecosystem resources and services as well as environmental repercussions (Liu et al., 2017). The four models employed in this study are as follows:

BCC Model

The BCC model was applied in this study in an input-oriented manner depending on the features of the individual units. The envelopment model was selected from

among the BCC models. The objective function makes it obvious that this model, which solves the value of variables Ui and Vi to quantify the efficiency of the unit under investigation, is non-linear (Charnes et al., 1978).

$$
\begin{aligned}
&Max \quad \sum_{r=1}^{s} u_r y_{rp} + u_0 \\
&s.t \quad \sum_{i=1}^{m} v_r x_{ip} = 1 \\
&\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} + u_0 \leq 0 \qquad j \\
&\qquad\qquad = 1,2,\dots,n \\
&u_0 \geq 0 \qquad\quad u_r, v_i \geq 0
\end{aligned}
\tag{1}
$$

y_{rj}=r[th] output rate for unit j

X_{ij}= Input amount for the unit

W=The amount of weight that is determined judiciously.

V_i= the weight given to the i[th] entry

U_r= Weight given to r[th] output

Super Efficiency Model

A more precise list of efficient units may be produced with the use of super-efficiency models. A modified DEA model known as super-efficiency allows units to have efficiency ratings higher than one (100 percent). This is because the unit under evaluation is excluded from the reference set for efficiency calculations. To determine the efficiency of the decision-making unit O, a super-efficiency model uses the following algebraic relationship (Banker et al., 1978):

Min θ

$$\sum_{j=1, j\neq O}^{n} \lambda_j x_{ij} \leq \theta x_{ij} \quad i = 1,2,\dots,m$$

Subject to:

$$
\begin{aligned}
&\sum_{j=1, j\neq O}^{n} \lambda_j y_{ij} \geq y_{rj} \quad r = 1,2,\dots,t \\
&\sum_{j=1}^{n} \lambda_j = 1 \\
&\qquad u_r, v_i \geq \varepsilon \quad \forall \quad r \quad and\ i
\end{aligned}
\tag{2}
$$

Slack-based Measure (SBM) Model

"Performance evaluation based on auxiliary variables" is the name of this methodology. In the slack-based model, each input and output are given a unique ratio, and the amount of input reduction (output increase) is carried out disproportionately. These models concentrate on non-zero covariates. The goal of this model is to zero out the auxiliary variables s_i^-, s_r^+ (Banker and Thrall, 1992):

$$MaxZ = \left(1/_S\right)\sum_{r=1}^{s}\theta_r - \varepsilon\sum_{r=1}^{s}s_r^- \quad (3)$$

$$S.t:$$

$$\sum_{j=1}^{n}\lambda_j x_{ij} + s_r^- = x_{i0} \qquad i = 1,2,\dots,m$$

$$\sum_{j=1}^{n}\lambda_j y_{rj} = \theta_r y_{r0} \qquad r = 1,2,\dots,s$$

$$\theta_r \geq 1 \qquad r = 1,2,\dots,s$$

$$\lambda_j \geq 0 \qquad j = 1,2,\dots,n$$

Output-based SBM model

$$MinZ = \left(1/_m\right)\sum_{i=1}^{m}\theta_i - \varepsilon\sum_{i=1}^{m}s_r^- \quad (4)$$

$$S.t:$$

$$\sum_{j=1}^{n}\lambda_j x_{ij} = \theta_i x_{i0} \qquad i = 1,2,\dots,m$$

$$\sum_{j=1}^{n}\lambda_j y_{rj} - s_r^+ = y_{r0} \qquad r = 1,2,\dots,s$$

$$\theta_r \geq 1 \qquad r = 1,2,\dots,s$$

$$\lambda_j \geq 0 \qquad j = 1,2,\dots,n$$

Input-based SBM model

The following relations represent the slack-based measurement model for each input and output:

$$\hat{x}_{io} = \theta_i^* x_{io} \quad , \hat{y}_{ro} - y_{ro} = S_r^+$$

$$\hat{y}_{ro} = \theta_r^* y_{ro} \quad , \hat{\hat{x}}_{io} - x_{ro} = S_i^-$$

Most Productive Scale Size Model

Banker established the idea of MPSS for data envelopment analysis for the first time in 1984, stating that a decision-making unit is an MPSS if and only if the inputs are decreased by α and the outputs β are increased, there are still production possibilities in the set, and we have $\beta \geq \alpha$. To put it another way, if the decision-making unit that is being evaluated is efficient under the BCC model, it will also be efficient under the CCR model with constant returns to scale. The MPSS refers to the shared portion of the CCR and BCC efficient frontier that applies to this property. The MPSS consists of the decision-making units that are efficient under the optimistic (CCR) envelopment model. Additionally, the decision-making unit (Xo, Yo) is MPSS if—and only if—it has the optimal value of 1 among all DMUs for the objective function of the data envelopment analysis model. The decision-making unit (Xo, Yo) is the worst efficiency measure (WPSS), according to the MPSS idea, if and only if the optimal value of the objective function of the pessimistic CCR model is equal to one. Finding the best decision-making unit,

however, suggests MPSS and optimistic and pessimistic assessments can separate the decision-making units that are MPSS (Banker et al., 2004).

Results and Discussion

The purpose of this study is to evaluate the efficiency of ecolodges in rural areas of Iran's provinces. As a result, the Ministry of Handicrafts, Cultural Heritage, and Tourism provided the country's 31 provinces with the required data in 2019. The efficiency has been estimated in the DEA package of the Games software using several methods and the most recent data. Two inputs, "the number of ecolodge units and the number of beds," are used in this model, and two outputs, "the number of visitors (persons/year) and the amount of money from ecolodges (million Tomans[1]/year)," are also used.

A. Input-oriented BCC model in envelopment form mode

As shown in Table 1, the model output indicated that out of the 31 provinces of Iran, only 6 provinces, including "Tehran, Isfahan, Qom, Mazandaran, Kurdistan, and Golestan" are efficient, and other provinces have not been able to operate efficiently in the field of ecolodge services in villages. However, it should be mentioned that "Razavi Khorasan, Khuzestan, and Lorestan" are among the provinces that had an efficiency above 90% and were on the verge of reaching efficiency and have operated extremely close to the efficiency frontier.

[1]. Toman is a unit of official currency of Iran, one million Toman equals 16.6 dollars in February 2024.

Table 1. Outputs from Efficiency Estimation by Input-Oriented BCC Method in Envelopment form Mode

No.	decision-making unit (country)	efficiency (z)	Inputs excess		Outputs excess		Reference-set
			Input 1 (unit)	Input 2 (room)	Output 1 (income)	Output 2 (tourist)	
1	East Azarbaijan	0.75	68.14	0	0	982.94	Tehran- Mazandaran
2	Western Azerbaijan	0.68	4.83	0	0	0	Tehran- Mazandaren- Qom
3	Ardebil	0.79	17.08	0	0	81.34	Tehran- Mazandaran
4	Isfahan	1	0	0	0	0	Isfahan
5	Alborz	0.65	24.15	0	0	7.67	Tehran- Qom
6	Ilam	0.77	18.9	0	0	0	Tehran- Mazandaren- Qom
7	Boushehr	0.68	0	0	0	0	Tehran- Mazandaran- Qom- Kurdistan
8	Tehran	1	0	0	0	0	Tehran
9	Chaharmahal and Bakhtiari	0.62	16.43	0	1074.95	0	Qom- Mazandaran
10	Southern Khorasan	0.67	0	0	0	0	Isfahan- Tehran- Kurdistan- Mazandaran
11	Khorasan Razavi	0.9	0	0	20958.99	0	Isfahan- Kurdistan- Golestan
12	North Khorasan	0.73	0	0	41.93	0	Isfahan- Kurdistan- Golestan
13	Khouzestan	0.95	0	0	1616.02	0	Isfahan- Qom- Kurdistan
14	Zanjan	0.87	25.97	0	3457.83	0	Qom- Mazandaran
15	Semnan	0.58	0	0	0	0	Isfahan- Tehran- Kurdistan- Mazandaran
16	Sistan and Balouchestan	0.67	0	0	0	112.14	Isfahan- Tehran- Mazandaran
17	Fars	0.83	0	0	0	1052.42	Isfahan- Tehran- Mazandaran
18	Qazvin	0.89	0	0	608.56	0	Isfahan- Qom- Kurdistan
19	Qom	1	0	0	0	0	Qom
20	Kurdistan	1	0	0	0	0	Kurdistan
21	Kerman	0.84	0.34	0	0	2490.36	Isfahan- Mazandaran
22	Kermanshah	0.7	2.34	0	0	0	Tehran, Qom, Mazandaran
23	Kahgiloyeh	0.68	0	0	0	0	Isfahan- Tehran- Qom- Kurdistan
24	Golestan	1	0	0	0	0	Golestan
25	Guilan	0.88	0	0	0	225.72	Isfahan- Tehran- Mazandaran
26	Lorestan	0.9	0	0	246.66	0	Isfahan- Qom- Kurdistan
27	Mazandaran	1	0	0	0	0	Mazandaran
28	Markazi	0.56	0.17	0	0	0	Tehran- Qom- Mazandaran
29	Hormozgan	0.8	3.12	0	0	353.11	Tehran- Mazandaran
30	Hamedan	0.7	0	0	0	0	Tehran- Qom- Kurdistan
31	Yazd	0.64	0	0	0	708.64	Isfahan- Tehran- Mazandaran

Source: Research finding.

Table 2. Optimum Values Based on the Outputs of the BCC Model of the Envelopment Form

No	decision-making unit (province)	Inputs excess		Outputs excess		No.	Province	Inputs excess		Outputs excess	
		Input 1 (Unit)	Input 2 (room)	Output 1 (income)	Output 2 (tourist)			Input 1 (unit)	Input 2 (room)	Output 1 (income)	Output 2 (tourist)
1	East Azarbaijan	103.75	379.22	53107	2975.94	16	Sistan and Balouchestan	34.03	236.19	32672	1342.14
2	Western Azerbaijan	15.84	58.91	8269	422	17	Fars	133.42	742.16	9.456	4730.42
3	Ardebil	34.77	155.54	25095	1071.34	18	Qazvin	8.02	32.96	2972.52	216
4	Isfahan	453	4900	516300	24500	19	Qom	3	9	711	45
5	Alborz	4.23	21.93	3569	109.67	20	Kurdistan	22	99	9190	690
6	Ilam	14.38	66.56	107.84	430	21	Kerman	270.57	1459.9	172000	9474.36
7	Boushehr	34.9	139.6	20493	1020	22	Kermanshah	24.3	94.66	13738	690
8	Tehran	9	72	14633	360	23	Kahgiloyeh	5.42	30.47	3725	160
9	Chaharmahal and Bakhtiari	14.01	46.75	5723.95	356	24	Golestan	126	590	48944	4109
10	Southern Khorasan	44.32	177.27	21439	1320	25	Guilan	98.96	516	65609	3377.72
11	Khorasan Razavi	109.77	703.2	66248.85	4236	26	Lorestan	7.32	41.53	4024.33	230
12	North Khorasan	28.56	135.5	12380.84	925	27	Mazandaran	236	808	106800	6627
13	Khouzestan	7.64	46.78	4584.01	255	28	Markazi	12.06	57.28	9376	360
14	Zanjan	8757	299	39218.83	2434	29	Hormozgan	40.05	172.66	27239	1217.11
15	Semnan	52.26	234.6	33823	1634	30	Hamedan	21.81	96.39	10034	673
–	–	–	––	–	–	31	Yazd	99.09	568.97	70647	3565.64

Source: Research finding.

Table 3. The Efficiency of Ecolodge Accommodations and Inputs Excess with the SBM Model

No	decision-making unit (province) DMU	Efficiency (w)	Input-Excess		Reference-set	No	decision-making unit (province) DMU	Efficiency (w)	Input-Excess		Reference-set
			Input 1 (unit)	Input 2 (room)					Input 1 (unit)	Input 2 (room)	
1	East Azarbaijan	0.44	166.1	193.21	Tehran-Mazandaran	16	Sistan and Balouchestan	0.59	26.01	108	Isfahan- Tehran
2	Western Azerbaijan	0.56	15.61	30.88	Tehran-Mazandaran	17	Fars	0.64	87.69	154.4	Isfahan- Tehran
3	Ardebil	0.62	34.7	48.21	Tehran-Mazandaran	18	Qazvin	0.78	1.31	10.66	Mazandaran
4	Isfahan	1	0	0	Isfahan	19	Qom	0.57	1.4	3.51	Mazandaran
5	Alborz	0.3	41.2	15.44	Tehran-Mazandaran	20	Kurdistan	0.98	0	3.57	Isfahan- Golestan-Mazandaran
6	Ilam	0.53	29.35	21.31	Tehran-Mazandaran	21	Kerman	0.61	186.6	349.2	Isfahan- Tehran
7	Boushehr	0.68	16.43	66.73	Tehran-Mazandaran	22	Kermanshah	0.65	14.56	42.56	Tehran- Mazandaran
8	Tehran	1	0	0	Tehran	23	Kahgiloyeh	0.55	4.92	13	Isfahan- Tehran
9	Chaharmahal and Bakhtiari	0.41	36.32	32.59	Mazandaran	24	Golestan	1	0	0	Golestan
10	Southern Khorasan	0.66	19.06	102.53	Tehran-Mazandaran	25	Guilan	0.81	42.84	0	Isfahan- Tehran-Mazandaran
11	Khorasan Razavi	0.88	29.61	0	Isfahan-Golestan	26	Lorestan	0.77	3.75	0	Isfahan
12	North Khorasan	0.72	21.9	0	Isfahan	27	Mazandaran	1	0	0	Mazandaran
13	Khouzestan	0.82	2.85	0	Isfahan-Golestan	28	Markazi	0.51	14.75	31	Isfahan- Tehran
14	Zanjan	0.76	44.32	48.23	Mazandaran	29	Hormozgan	0.57	28.99	68.28	Tehran- Mazandaran
15	Semnan	0.57	57.67	86.85	Isfahan-Mazandaran	30	Hamedan	0.69	7.99	50.76	Golestan- Mazandaran
						31	Yazd	0.5	98.7	318.6	Isfahan- Tehran

Source: Research finding.

Table 4. Results of Input-Oriented Super-Efficiency Model Based on BCC

No	decision-making unit (province) DMU	Efficiency (w)	Reference-set	No	decision-making unit (province) DMU	Efficiency (w)	Reference-set
1	East Azarbaijan	0.75	Tehran- Mazandaran	16	Sistan and Balouchestan	0.67	Isfahan- Tehran- Mazandaran
2	Western Azerbaijan	0.68	Tehran- Mazandaran	17	Fars	0.83	Isfahan- Tehran- Mazandaran
3	Ardebil	0.79	Tehran- Qom- Mazandaran	18	Qazvin	0.89	Isfahan- Qom- Kurdistan
4	Isfahan	Infeasible		19	Qom	4.08	Alborz- Qazvin- Qom
5	Alborz	0.65	Tehran-Qom	20	Kurdistan	1.02	Tehran- Qom- Golestan- Mazandaran
6	Ilam	0.77	Tehran- Qom- Mazandaran	21	Kerman	0.84	Isfahan- Mazandaran
7	Boushehr	0.68	Tehran- Qom- Kurdistan- Mazandaran	22	Kermanshah	0.7	Tehran-Mazandaran-Qom
8	Tehran	1.91	Isfahan- Tehran- Qom- Hormozgan	23	Kahgiloyeh	0.68	Isfahan- Tehran- Qom- Kurdistan
9	Chaharmahal and Bakhtiari	0.62	Qom- Mazandaran	24	Golestan	1	Isfahan, Mazandaran, Kurdistan
10	Southern Khorasan	0.67	Isfahan- Tehran- Kurdistan- Mazandaran	25	Guilan	0.858	Isfahan- Tehran- Mazandaran
11	Khorasan Razavi	0.9	Isfahan- Kurdistan- Golestan	26	Lorestan	0.9	Isfahan- Qom- Kurdistan
12	North Khorasan	0.73	Isfahan- Kurdistan- Golestan	27	Mazandaran	1.39	Isfahan- Golestan- Zanjan
13	Khouzestan	0.95	Isfahan- Qom - Kurdistan	28	Markazi	0.56	Tehran, Qom, Mazandaran
14	Zanjan	0.87	Qom- Mazandaran	29	Hormozgan	0.8	Tehran- Mazandaran
15	Semnan	0.58	Isfahan- Tehran- Kurdistan- Mazandaran	30	Hamedan	0.7	Tehran- Qom- Kurdistan- Mazandaran
–	–	–	–	31	Yazd	0.64	Isfahan- Tehran- Mazandaran

Source: Research finding.

Table 5. Results of Most Productive Scale Size Model (MPSS) evaluation

No.	decision-making unit (province) DMU	(Z)	Model output (a province with the most efficiency or the most productive scale size)	No.	The decision-making unit (province) DMU	(Z)	Model output (a province with the most efficiency or the most productive scale size)
1	East Azarbaijan	1.62		16	Sistan and Balouchestan	1.62	
2	Western Azerbaijan	1.55		17	Fars	1.5	
3	Ardebil	1.32		18	Qazvin	1.37	
4	Isfahan	1	MPSS	19	Qom	1.64	
5	Alborz	1.83		20	Kurdistan	1.02	
6	Ilam	1.33		21	Kerman	1.57	
7	Boushehr	1.48		22	Kermanshah	1.46	
8	Tehran	1	MPSS	23	Kahgiloyeh	1.75	
9	Chaharmahal and Bakhtiari	1.75		24	Golestan	1	MPSS
10	Southern Khorasan	1.51		25	Guilan	1.2	
11	Khorasan Razavi	1.11		26	Lorestan	1.26	
12	North Khorasan	1.38		27	Mazandaran	1	MPSS
13	Khouzestan	1.18		28	Markazi	1.86	
14	Zanjan	1.16		29	Hormozgan	1.46	
15	Semnan	1.72		30	Hamedan	1.46	
-	-	-	-	31	Yazd	1.91	

Source: Research finding.

Table 6. A summary of some efficiency indicators of the tourism industry in Iranian provinces in 2019

Indicators/model type	An Envelopment BCC Model	Super-efficiency Model	Slack-based Measure	Most Productive Scale Size
Mean efficiency of total provinces	0.797	0.937	0.628	The provinces of Tehran, Isfahan, Mazandaran, and Golestan have worked with the most efficient scale.
Mean efficiency of inefficient provinces	0.749	0.749	0.635	
Minimum efficiency	0.5 (Markazi and Semnan)	0.13 (Markazi and Semnan)	0.2 (Alborz)	
super efficiency	1	4.08 (Qom)	1	
Number of efficient provinces	6	5	4	
Number of inefficient provinces	25	26	27	

Source: Research finding.

Six categories may be used to categorize the provinces of the country based on the results of the aforementioned table: (1) Provinces with 100% efficiency: Tehran, Isfahan, Mazandaran, Kurdistan, Golestan, and Qom (2) Provinces with 90% efficiency and above: Razavi Khorasan, Khuzestan and Lorestan (3) Provinces with efficiency between 80 and 89%: Zanjan, Fars, Qazvin, Kerman, Gilan, Hormozgan (4) Provinces with efficiency between 70 and 79%: East Azerbaijan, Ardabil, Ilam, North Khorasan, Kermanshah, Hamedan (5) Provinces with efficiency between 60 and 69%: West Azerbaijan, Alborz, Bushehr, Chaharmahal and Bakhtiari, South Khorasan, Sistan and Baluchistan, Kohgiluyeh and Boyer-Ahmad, Yazd. (6) Provinces with an efficiency of 59 and below: Semnan, Markazi.

The provinces in the first category have effective rural ecolodge units, meaning that the ratio of input to output in these ecolodge units is appropriate. In other words, the income of ecolodge units is acceptable for the number of units and a reasonable number of tourists have been drawn to them. Tehran, Isfahan, Mazandaran, Kurdistan, Golestan, and Qom are among these provinces. According to the number of ecolodge beds, the high number of tourists has established the appropriate efficiency for these provinces. Mazandaran and Golestan provinces have villages close to urban areas and good weather, which makes it simple for the province to draw tourists because of the presence of the sea. The cities of "Khur and Biabanak" (because trekking in the desert is possible there) and "Kashan" (because the city has a large number of historically significant homes with lovely architecture) both have a lot of ecolodge accommodations in their villages. It has improved the efficiency of ecolodge units by drawing in the appropriate amount of visitors. Due to the small number of ecolodge businesses relative to the number of visitors who might be interested in visiting these regions, Kurdistan and Qom have been able to efficiently balance their inputs and outputs. The provinces of Razavi Khorasan, Khuzestan, and Lorestan, which have efficiency ratings close to one but have not yet reached 1, are included in the second group. The lack of revenue from ecolodge, which hasn't been able to provide a sufficient output concerning the number of ecolodge units, is the cause of this. Due to the climate of the province of "Razavi Khorasan and Khuzestan," the pleasant villages are spread out far from the cities, requiring additional travel time and expense to get to. In these provinces, settlements with favorable climates typically lack convenient access to highways. The province of "Lorestan and Khuzestan" is characterized by several shared characteristics, including a lower level of development and less infrastructure in the villages. Currently, it is difficult for ecolodge services to flourish due to a

shortage of water resources in the villages and a lack of piped water, particularly during the first six months of the year when ecolodge is at its peak. One of the causes for the decline in revenue from ecolodge, which has rendered it inefficient, is the location of the villages in these provinces at a considerable distance from the metropolitan centers and the difficulties of access to the villages in a short period. Cases with an efficiency rating of between 70 and 90 percent fall into the third and fourth groups. These are mostly the western provinces of Iran, which have a good natural setting, are situated in a mountainous area, have given rise to pleasant-weathered villages, and have a suitable potential for developing an ecolodge unit, which justifies the development of ecolodge accommodations. However, it is also observed in the provinces of "Kerman and Hormozgan" that the presence of the mountainous city of "Jiroft" in "Kerman" and historical sites in its cities (such as Bam, Rafsanjan, and Babak) facilitates tourist attraction and promotes the development of ecolodge accommodations in rural areas. The two cities of "Shahdad" and "Jiroft" in the province of Kerman offer the greatest lodgings for ecotourists. The availability of the desert in "Shahdad" for desert travel experiences and the presence of lovely natural surroundings in "Jiroft" have led to a growth in the number of lodging options in these places. Hormozgan province receives more visitors than other provinces since it has a sea.

Fifth and sixth categories: These provinces all have the trait of having a population that does not have a strong desire to visit ecolodge or experience living in rural and natural settings. Compared to other provinces, it is nevertheless vibrant and well-preserved, and the urban population is not very congested. Due to the climate in a province like "Yazd," where most historical homes are in high demand for habitation and the surrounding villages lack an appropriate climate and weather to draw tourists, the desire to live in a village and use ecolodge is not very prosperous. As a result, the development of ecolodge units has been positioned on the verge of inefficiency or low efficiency.

To improve their efficiency, inefficient provinces might utilize the reference sets in the final column of Table 1 as a proper model for ecolodge services. For example, when it comes to service delivery, East Azerbaijan province could look to Tehran and Mazandaran. As a result, this province can adopt the Mazandaran and Tehran models.

The optimal values for input and output numbers in this research are according to Table 2. This table shows that the provinces of Iran, in order to face efficiency in ecolodge units, must have a balance between inputs (number of ecolodge units, number of beds) and outputs (income and number of tourists) as

shown in the table above and to be able to function optimally. For example, it is necessary for province East Azerbaijan that the number of ecolodge units should be 103 and 379 beds so that they will come to 53107 million tomans income and 2975 tourists.

B. Slack-based Measure (SBM) Model

Table 3 shows that slack-based measurement of efficiency shows that the provinces of "Isfahan, Tehran, Mazandaran, and Golestan" are efficient provinces in the field of rural tourism services, and other provinces are considered inefficient and the value of this inefficiency varies between 0.30 and 0.98.

Because the method of calculating efficiency in the formulas of the BCC model is different from the SBM model, there is a slight difference in the output of the models, which is related to the two provinces of "Qom and Kurdistan", which in Table 1, Qom and Kurdistan provinces were efficient, but in Table 3, the inefficient results are obtained. The reason is that in the SBM model, the Input-based model is used and only the surplus of inputs is considered and these two provinces have a small surplus in the inputs, but in the BCC model both inputs and outputs are considered and these two provinces are efficient.

Provinces that are inefficient since they spend more on ecolodge services than they produce in terms of outputs. Due to this problem, the government must give greater thought to planning in the area of the number of ecolodge licenses given as well as the quality of services.

C. Super-efficiency Model measurement

As shown in Table 4, the provinces of Qom, Tehran, Mazandaran, Kurdistan, and Golestan have the highest super-efficiency ratings of all the other provinces. The results indicated that the same provinces as before are regarded to be inefficient units in the super-efficiency model, and ecolodge units in these provinces have not been able to reach the requisite efficiency according to the ratio of inputs and outputs.

D. Most Productive Scale Size Model (MPSS) evaluation

Returns to scale (RTS) and most productive scale size (MPSS) of decision-making units and their estimate are two crucial topics in data envelopment analysis (DEA). Table 5 provides the MPSS model's results. In terms of other tourist-driven provinces, Tehran, Mazandaran, Golestan, and Isfahan have the highest levels of

output. These outcomes are in line with those attained from the estimate of earlier models.

Table 6 is an overview of some ecolodge units' efficiency indicators across the country's provinces.

After calculating the efficiency of the provinces from 4 methods, it can be said that almost the same output is observed in the results of these four models, and if the overlap of the results of the four models is considered, the provinces of "Isfahan, Tehran, Mazandaran, and Golestan" are efficient, and other provinces will need to review policies and decisions in ecolodge units to increase efficiency. The provinces of Iran are inefficient in offering ecolodge services for a variety of reasons, such as: (1) some villages have poor access to transportation infrastructure or poor telecommunication and internet coverage; (2) some villages in mountainous and inaccessible areas lack infrastructure, such as water, electricity, and gas; (3) there is insufficient training for the management of ecolodge accommodations, and the owners of rural homes have little experience interacting with tourists; (4) The existence of some unfavorable outcomes of the establishment of ecolodge units in rural contexts (for instance, the presence of too many tourists and more than the capacity of reception in some villages caused the effect of crowding and has caused issues for the local natives, particularly because of car parking in the village, waste production, damage to plant and animal species, conflict between the culture of tourists and villagers); (5) the high expense relative to other Iranian provinces of delivering tours to some border regions that are far from Tehran, including South Khorasan and Ilam; (6) Domestic visitors' lack of awareness of these units and not conducting adequate promotion to draw domestic tourists. The aforementioned incidents have affected the inefficiency of the ecolodge businesses in the communities. We may pay attention to these issues to address the inefficiency, and resolving them will encourage more travelers to stay at these establishments, boost revenue, and improve efficiency.

Conclusion and Recommendation

Following the issue of a competitive market, which resulted in competing companies entering the market to establish ecolodge units, the development of ecolodge units in Iranian villages began to increase starting in 2015. As a result, the number of ecolodge units in the majority of provinces tripled in number in 2021. This resulted in the fact that many ecolodge units in the summer of 2022 (1401), despite the end of the COVID-19 pandemic in Iran and the fact that summer is the most crucial season to draw tourists to these units, lacked sufficient

customers, and it was brought up that ecolodge units have not been as welcomed as it was thought. However, the same theoretical underpinnings of a competitive market apply to this product (or service) as well. As a result of several businesses entering this market, the profit of the units has virtually reached zero, and some businesses will inevitably quit this market in the future. On the other hand, some external factors, such as the service's novelty, the lack of public awareness of ecolodge, inadequate advertising, the failure to adhere to some requirements for training and standards in this area, as well as the recent decline in the purchasing power of Iranians (due to high inflation), have resulted in a decrease in the demand for lodging in these tourist units, which has fueled the inefficiency. Therefore, for ecolodge units to operate with the required efficiency in this sector, it is important to ascertain whether Iran's provinces have an excess of ecolodge units or have a shortfall in the number of visitors, as well as the precise number of units and tourists in each province. The data envelopment analysis model was employed in this study's estimation of the efficiency of the provinces' ecolodge units, and it was determined whether there was an excess of inputs (units or beds) or a shortfall of outputs (tourists or money).

According to the results, it is suggested that the provinces of "East Azerbaijan, Ardabil, Alborz, Ilam, Bushehr, Chaharmahal and Bakhtiari, South Khorasan, Zanjan, Semnan, Sistan and Baluchestan, Fars, Qazvin, Qom, Kerman, Kermanshah, Kohgiluyeh and Boyer-Ahmad, Markazi, Hormozgan, Hamedan and Yazd" take into account the reduction in these cases in the number of ecolodge units and the number of beds, and therefore the new license in more targeted ecolodge units. It is recommended that the licensing for the new tourist unit in the provinces of "Razavi Khorasan, North Khorasan, Khuzestan, Gilan, Lorestan and Kurdistan" be suspended and the caliber of services offered in the present units has to be improved.

If we look at the problem from another point of view and consider the lack of attraction of tourists according to the issues affecting the attraction of tourists, it is suggested that the training of active people in this field should be considered and this issue is one of the most important factors for attraction of tourists in the field of ecotourism accommodation in Iran. Because the construction of ecotourism residences is mostly in rural and historical areas. Due to the fact that life in these areas is more traditional and people are more sensitive to their culture and values, it is necessary for investors to be educated in these areas and to be fully familiar with the socio-cultural and environmental issues of the area in order to maximize the participation of the local community. Paying attention to the

participation of the local community and their benefit from the creation of ecotourism residences is one of the important issues that should be put on the agenda in this regard. The benefits obtained from the activities of these units should be fairly distributed among the local community. Otherwise, some people who do not benefit from the benefits obtained will stand against the progress of these residences and show a negative reaction, which will cause tension and conflict in the local community. Other ways to attract more tourists in ecotourism units are advertising or creating incentives to travel, so advertising with the help of television channels and introducing ecotourism accommodations is effective. Also, creating a commercial brand in the form of a cooperative for ecotourism units, as suggested in the study of Mic and Eagles (2019), reduces costs and increases efficiency. Another proposal is put forward at the macro level of the country and that is "strengthening the transportation and communication infrastructures" for the villages, which is the basis for attracting tourists in the village.

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