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Assessing the Effectiveness of Environmental Training for Diving Tourists Using the DEA Model

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Abstract: This study proposes an approach based on data envelopment analysis to assess the effectiveness of environmental training for tourists. Most studies have considered only outcomes (i.e., the continuance or halting of improper behavior towards the environment) to represent the effectiveness of environmental training but this approach does not consider the amount of resources that have been applied in the process. The model utilizes input and output factors to estimate the index of effectiveness. We used a survey of underwater tourist activity to test the proposed model in the empirical evaluation and explored both the internal and external influences on the effectiveness.

Keywords: tourist behavior; environmental training; data envelopment analysis; diving activity; effectiveness measurement

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1. Introduction

The ecological environment is being damaged by rapid industrial development over the past few decades. However, people have begun to attach importance to environmental sustainability after experiencing the effects of pollution, climate change, and eco-catastrophes. The concern of humans towards the environment requires not only reducing pollution or saving resources but also paying more attention and developing a higher degree of environmental literacy. Environmental training has been considered a priority for developing environmental literacy and is one of the most crucial tools for facilitating a more sustainable world [1]. Environmental education is also playing an important role towards sustainability and preparing the future generation for a green society [2]. In addition, through environmental training, ecological consensus, knowledge, attitudes, beliefs, and environmental sensitivity can be cultivated in the lifestyle of humans, and environmental conditions can be further improved.

Environmental training can be regarded as one of the fundamental bases for successfully practicing environmental management and conservation, as well as recycling resources [3]. Environmental training is used to teach industrial environmental policies to workers and it can change people's behavior to build a permanent relationship with a balanced environment [4]. Accessing education to develop sustainable methods for using cleaner and more efficient technologies for natural resources is included in environmental training [5]. Industries can reduce emissions, produce recyclable goods, and consume resources more efficiently by using training to pass on the concept of environmental sustainability to workers. Environmental training has become a substantial concern among industries for promoting sustainable and eco-friendly production, and it is also identified as an essential activity in the assessment of corporate social responsibility (CSR).

The importance of environmental training to tourism sustainability has been emphasized by researchers. The purpose of environmental training is to promote minimal impact on the environment and to advance the sustainability of the natural environment [6]. Marine tourism sustainability relies on developing positive environmental perspectives and fostering pro-environmental behaviors among tourists [7]. To increase the public awareness of biodiversity, the public sector provides training and education at tourist attractions, which aim at informing visitors about improper behaviors that damage natural features they encounter [8,9]. Donmez-Turan and Kiliclar [10] indicated that environmental training enables individuals to change their knowledge about the environment and to exhibit a voluntary pro-environmental behavior. In addition, environmental training has been associated with conservation, environmental quality outcomes, recycling, and regional competitive advantage [11–13].

The aim of this study is to develop an approach based on the data envelopment analysis (DEA) to assess the effectiveness of environmental training for underwater activities. This is regarded as important because water-related recreational activities such as diving and boating can cause damages to coral reefs and the marine ecosystem, which is already under due stress from anthropogenic activities. Effective environmental training has been considered as having a positive impact on tourism and ecological sustainability by previous studies. For example, Macris and Georgakellos [14] as well as Bogoliubov et al. [15] indicated that effective environmental training must be easily known, understood, and accepted by trainees; da Silva et al. [16] suggested that effective environmental training with better indicators is helpful to achieve environmental goals; and Stefanelli et al. [17] argued that to be effective, an environmental training program needs to be carefully organized. While a few prior studies have focused on establishing methods for effectiveness measurement, such as the work conducted by Erdogan and Tosun [18], and Walker and Weiler [19] who used trainees' behavior as indicators to measure the effectiveness of environmental training, previous studies only defined the effectiveness indicators from the perspective of output (i.e., trainees' behavior) but did not consider the resources invested in environmental training. According to Gronroos and Ojasalo [20] as well as Keh et al. [21], "effectiveness" refers to the use of minimal resources to maximize the output. The performance indicators evaluated using the DEA model have been frequently defined as the effectiveness index in previous studies [22–24]. Therefore, the approach developed by this study further incorporates environmental training resources and trainees' behavior into the effectiveness measurement to capture a more holistic view.

This study also aims to explore internal and external influences on the effectiveness of environmental training. The influences on training effectiveness have been discussed in vocational training studies. The training process, program content, knowledge, skill acquisition, and trainee attitudes have considered as the influences on training effectiveness [25]. Training site, trainee's experience, gender, and motivation can also affect training effectiveness [26–28]. However, similar discussions for influences on effectiveness are limited in environmental training studies. This study will use the slack variables solved by the DEA to establish indices to measure the internal influences on effectiveness. The external influences are then estimated by using the truncated regression model. Through this study, the internal and external factors that cause low performance in environmental training can be identified and therefore lead to improvements.

The empirical evaluation used the data collected from 246 diving tourists in North Taiwan to examine the developed approach and revealed several practical implications for underwater activity tourism. The remainder of this paper is organized as follows. The literature on environmental training is reviewed in Section 2; the empirical model is described in Section 3; the empirical results and their discussions are presented in Sections 4 and 5, respectively; and the conclusions, implications, limitations, and future research are outlined in Section 6.

2. Literature

Previous studies of environmental training have predominantly emphasized how the environmental education offered by educational institutions can prepare environmental experts for professional careers in environmental sustainability. For instance, Macris and Georgakellos [14] applied a prototype model to design and develop training approaches to help students understand contemporary global environmental issues. Bogoliubov et al. [15] investigated teaching materials used in Ukraine for the environmental training for sustainable development.

Many studies have discussed environmental training from the viewpoint of industries, focusing on the effect of training on environmental or financial performances in businesses. For instance, del Brio and Junquera [29] mentioned that a poor level of environmental awareness exists in small and medium-sized enterprises because of the shortage of environmental training among their employees. Cole et al. [30] identified environmental training as a positive influence on environmental performance. Cloquell-Ballester et al. [31] developed a methodology for designing environmental training programs for enterprise workers. Teixeira et al. [32] contributed a theoretical framework that presents the evolutionary stages of green management and the relationship between green management and environmental training in companies. In a study conducted by Gangadharan [33], environmental training provided to employees working in a firm had been identified as essential for improving environmental performance. Chen et al. [34] analyzed environmental training from a cost-effectiveness perspective and revealed how environmental training for specific teams and workers can be enhanced to reduce consumption and increase profits. Li [35] investigated the effects of environmental education and evaluated positive effects of environmental education on environmental awareness and attitude.

Environmental training is not universally considered effective for environmental performance. Perron et al. [36] suggested that the level of environmental awareness between companies that offer and those that do not offer environmental training is similar. Unnikrishnan and Hegde [37] showed that although universities and research institutes have well-developed facilities, they had not played an active role in environmental training because of the practical gap between academia and industry. Jabbour [38] reviewed the literature on environmental training to determine the characteristics and constraints of successful environmental training in an organization and concluded that a significant positive relationship between environmental training and the maturity of environmental management exists. Jorgenson et al. [39] discovered that environmental education can promote energy conservation behavior.

A few studies have considered both the influences and effectiveness of environmental training. Arcury [40] suggested a direct relationship between people's environmental attitude and knowledge, indicating that training is closely associated with environmental attitudes. Jacobson [41] considered that the aim of environmental training is to encourage people to have more sustainable lifestyles by developing awareness, participation, knowledge, and attitudes. Booth et al. [42] indicated that increasing environmental education could help improve the understanding of conservation activities and minimize the environmental impacts of recreation. Sakurai et al. [43] indicated that environmental training programs must be designed to help people understand how they can take care of the environment for future generations. Varela-Candamio et al. [44] mentioned that environmental education can be used as a powerful tool to generate green behavior among citizens. Sukma et al. [45] discussed the importance of environmental education integration in elementary schools. Although the information provided in these studies appears to be relatively straightforward, it is difficult to translate it into "input factors" underlying reciprocal causation, even if some of the research findings can be viewed and assessed from the perspective of training effectiveness.

As a practical contribution, this study will use the DEA model to examine the effectiveness of on-site environmental training.

3. Materials and Methods

This study involved a two-step process, as presented in Figure 1.

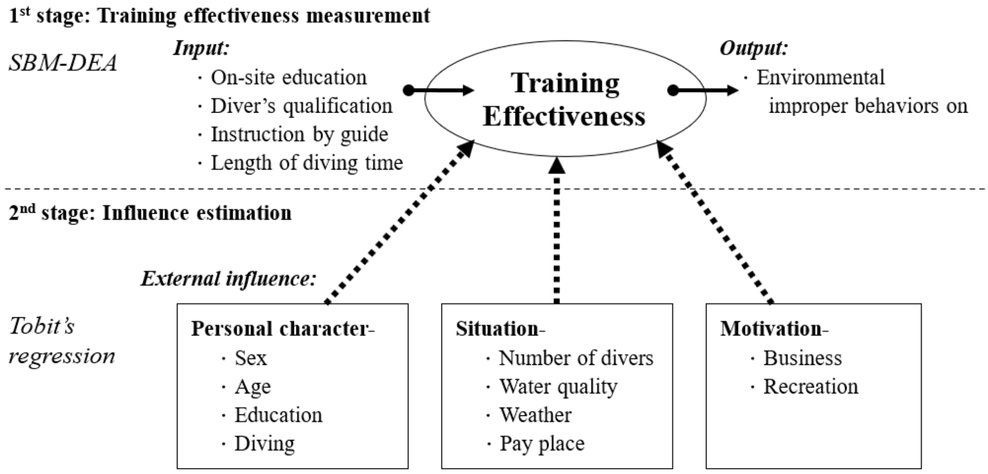

Figure 1. Research framework for environmental training effectiveness.

3.1. DEA Model of Effectiveness Evaluation

In the first step, this study used the DEA model to assess effectiveness. The basic DEA model, which measures an efficiency index by using multiple inputs and outputs, was primarily adopted from Charnes et al. [46] and Banker et al. [47]. To identify excessive input use and an output deficit, Färe and Lovell [48], Charnes et al. [49], and Färe et al. [50] subsequently modified the DEA model by using the non-radial mathematical planning technique and developed the slack-based measure DEA (SBM-DEA). Tone [51] introduced a calculation that confines the performance indicator into the range of 0–1.

The DEA was used to evaluate the performance for production activities without the request for the assumption to the production possibility set and it was appropriate for non-manufacturing. Furthermore, the DEA has been applied in various tourism industry analyses, such as hotel performance [23], tourism supply chain [52], culture tourism [53], tour operator [54], and tourism eco-efficiency [55]. In the empirical model of this study, we used the SBM-DEA to measure the environmental training effectiveness for underwater activity tourism in the first stage.

The empirical model for training effectiveness in our study is described as follows. Suppose that the data consist of n observations and an N-dimensional set denoted as N, where obs_o represents the observation under evaluation, which is subject to $obs_o \in N$. The inputs and outputs are defined as $x_p \in R_p^+$ and $y_q \in R_q^+$, respectively. For programming the DEA model, we defined the non-negative intensity variable λ_n, which is an unknown variable. Then, the set of the effectiveness index, E, can be formulated as follows:

$$E\{\left(x_{pn}, y_{qn}\right): \sum_{n=1}^{N} \lambda_n x_{pn} \leq x_{po},\ p = 1, \cdots, P,\ \sum_{n=1}^{N} \lambda_n y_{qn} \geq y_{qo},\ q = 1, \cdots, Q,\ \sum_{n=1}^{N} \lambda_n = 1,\ \lambda_n \geq 0,\ n = 1, \cdots, N\} \tag{1}$$

Consistent with the definition of the set, a radial mathematical planning program can be formulated as follows:

$$\theta^* = Min\ \theta\ subject\ to{:}\ \sum_{n=1}^{N} \lambda_n x_{pn} \leq \theta x_{po},\ p = 1, \cdots, P;\ \sum_{n=1}^{N} \lambda_n y_{qn} \geq y_{qo},\ q = 1, \cdots, Q;\ \sum_{n=1}^{N} \lambda_n = 1,\ \lambda_n \geq 0,\ n = 1, \cdots, N. \tag{2}$$

To solve slacks, we redefined the set of effectiveness by using the non-radial measure as follows:

$$E\{\left(x_{pn},y_{qn}\right):\sum_{n=1}^{N}\lambda_n x_{pn}=x_{po}-s_p^-,\ p=1,\cdots,P,\ \sum_{n=1}^{N}\lambda_n y_{qn}=y_{qo}+s_q^+,\\ q=1,\cdots,Q,\ \sum_{n=1}^{N}\lambda_n=1,\ s_p^-,\ s_q^+\geq 0,\ \lambda_n\geq 0,\ n=1,\cdots,N\} \tag{3}$$

The radial mathematical planning program, which is assumed based on Function (3), can then be formulated as follows:

$$\varepsilon^*=Min\ \varepsilon\ subject\ to:\ \sum_{n=1}^{N}\lambda_n x_{pn}=x_{po}-s_p^-,\ p=1,\cdots,P\\ \sum_{n=1}^{N}\lambda_n y_{qn}=y_{qo}+s_q^+,\ q=1,\cdots,Q\ s_p^-,\ s_q^+\geq 0,\ \sum_{n=1}^{N}\lambda_n=1,\ \lambda_n\geq 0,\\ n=1,\cdots,N. \tag{4}$$

In (3), the slack variables, s_p^- and s_q^+, represent excessive input use and a deficit of output, respectively, which can be solved through the optimization process. The model uses the frequency of improper environmental behaviors (defined in the next section) as the output variable and assumes that a lower frequency means a better output. Therefore, the output variable must be transformed into the undesirable variable and the model can be reformed as follows:

$$\varepsilon^*=Min\ \varepsilon\\ subject\ to:\ \sum_{n=1}^{N}\lambda_n x_{pn}=x_{po}-s_p^-,\ p=1,\cdots,P\\ \sum_{n=1}^{N}\lambda_n y_{q_1 n}^d=y_{q_1 o}^d+s_{q_1}^+,\ q_1=1,\cdots,Q_1\\ \sum_{n=1}^{N}\lambda_n y_{q_2 n}^u=y_{q_2 o}^u-s_{q_2}^+,\ q_2=1,\cdots,Q_2\\ s_p^-,\ s_{q_1}^+,s_{q_2}^+\geq 0,\ \sum_{n=1}^{N}\lambda_n=1,\ \lambda_n\geq 0,\ n=1,\cdots,N \tag{5}$$

The outputs, $y_{q_1 o}^d$ and $y_{q_2 o}^u$, represent desirable and undesirable outputs, respectively, and are subject to $Q_1+Q_2=Q$. The objective value ε is defined as $\varepsilon=\sum_{q_1=1}^{Q_1}s_{q_1}^+ +\sum_{q_2=1}^{Q_2}s_{q_2}^+ +\sum_{p=1}^{P}s_p^-$. The optimal values of slacks are denoted as s_p^{-*}, $s_{q_1}^{+*}$, and $s_{q_2}^+$. By using the solved slack variables, the effectiveness index is defined as

$$Eff=\left[1-\frac{1}{P}\cdot\sum_{p=1}^{P}\frac{s_p^{-*}}{x_p}-\frac{1}{Q_2}\cdot\sum_{q_2=1}^{Q_2}\frac{s_{q_2}^{+*}}{y_{q_2}}\right]\cdot\left[1+\frac{1}{Q_1}\cdot\sum_{q_1=1}^{Q_1}\frac{s_{q_1}^{+*}}{y_{q_1}}\right]^{-1} \tag{6}$$

To explore the internal influences on training effectiveness, we further defined the internal influence indices based on the solved slack variables as follows.

Input influence index:

$$\delta_p^{In}=\frac{s_p^{-*}}{x_p} \tag{7}$$

Desirable output influence index:

$$\delta_{q_1}^{D-Out}=\frac{s_{q_1}^{+*}}{y_{q_1}} \tag{8}$$

Undesirable output influence index:

$$\delta_{q_2}^{U-Out} = \frac{s_{q_2}^{+*}}{y_{q_2}} \tag{9}$$

A higher influence index implies that the input or output causes a higher negative impact on the training effectiveness index. For example, if the input influence index is assessed to be higher than anything else, then the low effectiveness index is mainly due to excessive input use.

3.2. Truncated Regression of External Influences

In the second step, this study used the truncated regression model to estimate the external influences on the effectiveness index. A general expression of truncated regression is

$$Eff_n^* \approx \boldsymbol{z_n b} + \varepsilon_n,\ n = 1, \cdots, N \tag{10}$$

where Eff_n^* indicates the effectiveness index measured using the SBM-DEA, $\boldsymbol{z_n}$ is the vector of external factors, and $\boldsymbol{b}$ is the vector of coefficients, which can reveal the relationship between the influence and effectiveness indexes. The symbol ε_n epresents the random error in the regression model and is characterized by $\varepsilon_n \sim N\left(0, \delta_\varepsilon^2\right)$ such that $\varepsilon_n \geq 1 - \boldsymbol{z_n b}$, $n = 1, \cdots, N$.

The influences on training effectiveness can be classified into three aspects: personal character, situation, and motivation (Figure 1). The factors that influence the personal characters of divers include sex (*SEX*), age (*AGE*), educational background (*EDU*), and diving experience (*EXP*). We followed the assumptions of Angilella et al. [56] as well as Fersterer and Winter-Ebmer [57] to use a quantitative indicator for the educational variable to explore the relation between education level and effectiveness. The second aspect involves the environmental situation while diving: number of divers (*NUM*), water quality (*WAT*), weather (*WEA*), and pay place (*PAY*). The third aspect concerns divers' motivation, whether business (*BUS*) or recreational (*REC*).

We also classified the coefficients of influences into three sets:

$$\begin{aligned} Eff_n^* = {} & \beta_0 + \beta_{SEX}^P \cdot SEX_n + \beta_{AGE}^P \cdot AGE_n + \beta_{EDU}^P \cdot EDU_n + \beta_{EXP}^P \cdot EXP_n \\ & + \beta_{NUM}^S \cdot NUM_n + \beta_{WAT}^S \cdot WAT_n + \beta_{WEA}^S \cdot WEA_n + \beta_{PAY}^S \cdot PAY_n \\ & + \beta_{BUS}^M \cdot BUS_n + \beta_{REC}^M \cdot REC_n + \varepsilon n \end{aligned} \tag{11}$$

3.3. Empirical Data

Empirical data were collected using questionnaires; 346 diving tourists were selected at Taiwan's Bitoujiao and Longdong coasts to participate, and 246 questionnaires were regarded as valid. Diverse topics relevant to underwater activity tourism have been discussed in former studies, such as divers damaging coral reefs [58], the management of pre-dive briefings [59], ocean law and policy concerning coastal recreation [60], conservation awareness of coral reefs [61], and ocean biodiversity monitoring [62]. The variable definitions and the descriptive statistics are presented in Tables 1 and 2 below.

Table 1. Description of input and output variables.

	Description
Input	
Diver's qualification	Skill level of diver: level 7 is the highest and level 1 is the lowest.
On-site education	Duration of environmental education delivered to divers by the environmental trainer before the diving activity, measured in minutes.
Instruction by guide	Whether divers observe scuba diving trainers actively stopping any environmental improper behavior under the water. This was measured using a Likert-type scale.
Output	
Environmental improper behaviors	Frequency of a diver performing actions that are directly harmful to the marine environment, such as touching or breaking a coral, picking up sea creatures, or stirring seabed gravel.
External influence	
Sex	Gender distribution of divers. This is a dummy variable in which 1 represents male and 0 represents female.
Age	Divers' age distribution.
Education	Divers' level of education: "graduate" is 5, "undergraduate" is 4, "high school" is 3, "junior high school" is 2, and lower than that is 1.
Diving experience	How many years the diver has participated in the scuba diving activity.
Number of divers	Number of people in a scuba diving group.
Water quality	Visibility of seawater while diving. This is a dummy variable where 1 is "clear" and 0 is "turbid."
Weather	Sky condition while diving; this is a dummy variable where 1 represents "clear day" and 0 represents "cloudy or rainy day."
Pay place	Whether divers must pay for admission to a scuba diving site; this is a dummy variable where 1 represents "need to pay" and 0 represents "free."
Business motivation	Scuba diving for practical reasons such as practicing the diving skill, taking photos for business, or fishing. This is a dummy variable where 1 represents the presence and 0 the absence of business motivation.
Recreational motivation	Scuba diving for recreation; this is a dummy variable where 1 represents the presence and 0 the absence of recreational motivation.

Table 2. Descriptive statistics for variables.

	Mean	Standard Deviation	Minimum	Maximum
Input				
Diver's qualification	3.45	1.67	1.00	7.00
On-site education	14.39	8.96	10.00	50.00
Instruction by guide	4.22	0.97	1.00	6.00
Length of diving time	64.07	32.10	25.00	165.00
Output				
Environmental improper behaviors	2.91	2.20	0.00	5.00
External influence				
Sex	0.71	0.45	0.00	1.00
Age	33.86	6.87	16.00	55.00
Education	4.16	0.62	3.00	5.00
Diving experience	4.50	5.63	0.00	30.00
Number of divers	5.36	2.83	2.00	10.00
Water quality	0.24	0.43	0.00	1.00
Weather	0.43	0.50	0.00	1.00
Pay place	0.43	0.50	0.00	1.00
Business motivation	0.38	0.49	0.00	1.00
Recreational motivation	0.64	0.48	0.00	1.00

4. Results

In the first stage of the evaluation, the SBM-DEA was applied to assess the training effectiveness indices (Eff_n^*); the distribution of intervals is listed in Table 3. Of the 246 observations, 19 have an evaluated index equal to 1; this indicated that the environmental training was completely effective in preventing improper behavior in these 19 cases. The index interval of the most assessed observations was between 0.599 and 0.500. The intervals of 0.499–0.400 and 0.399–0.300 each have 40 observations. Moreover, the index interval of 31 observations was lower than 0.300; environmental training was largely ineffective for these divers. The average training effectiveness index was 0.549, with 48.4% of observations being higher than the average. These results suggest that environmental training effectively reduced the improper environmental behaviors of only half of the observed divers.

Table 3. Training effectiveness index distribution.

Index Interval	Number of Observation	Percent
1.000	19	7.7%
0.999~0.900	2	0.8%
0.899~0.800	20	8.1%
0.799~0.700	19	7.7%
0.699~0.600	33	13.4%
0.599~0.500	42	17.1%
0.499~0.400	40	16.3%
0.399~0.300	40	16.3%
0.299~0.200	23	9.3%
0.199~0.100	8	3.3%
0.099~0.000	0	0.0%

To determine the internal influences on the effectiveness index, we evaluated the input influence index (δ_p^{In}) and the undesirable output influence index ($\delta_{q_2}^{U-Out}$) for the observation. The averages of the influence index are listed in Table 4 and were examined for statistical significance by using the Kruskal–Wallis test. The input with the highest influence was diving duration at 0.469, followed by instruction by guide at 0.397. A longer diving time was assessed as the main factor resulting in poor environmental training effectiveness. Results showed that a longer dive time enabled divers with a longer interaction duration with the reef and might cause more accidental or deliberate coral touches [63,64]. Moreover, scuba diving trainers' attempt to stop improper underwater behavior did not help environmental training effectiveness. The average diver's qualification was 0.319, which was not much lower when compared with instruction by guide and length of diving time. Findings revealed that divers who had obtained a high level of scuba diving skill could also behave improperly towards marine ecology. On-site education had the lowest value at 0.138. This indicated that on-site education was a more effective mode of environmental training than underwater monitoring by trainers.

Table 4. Results of Kruskal–Wallis test for internal influences.

	Mean	Standard Deviation	Chi-squared Value	*p*-Value
Diver's qualification	0.319	0.268	123.227	0.000 *
On-site education	0.138	0.253		
Instruction by guide	0.397	0.477		
Length of diving time	0.469	0.247		
Environmental improper behaviors	0.353	0.534		

Note: * denotes significance at the 0.01 level.

For the output, the influence index was 0.353, which suggested that improper behaviors should be decreased by 35.3% to improve the effectiveness of environmental training.

In the second stage of the empirical evaluation, a truncated regression model was used to estimate the relationship between the effectiveness index and external influences; the results are presented in Table 5. With regard to divers' personal character, age was estimated as a significant positive coefficient at a 99% statistical degree. This implied that environmental training was more effective for older divers than younger ones. The variable of diving experience was estimated to have a significant negative coefficient. The estimation showed that for more experienced divers, training was less effective. Conversely, for divers with little scuba diving experience, the environmental training effectiveness was higher. Divers' gender and education level were not significantly related to the effectiveness index.

Table 5. Results of Tobit's regression for external influence.

Variables	Coefficient	Standard Error	*p*-Value
Constant	0.502	0.112	0.000 *
Personal character			
Sex	−0.030	0.025	0.240
Age	0.007	0.002	0.000 *
Education	0.012	0.019	0.539
Diving experience	−0.008	0.002	0.000 *
Situation			
Number of divers	−0.017	0.004	0.000 *
Water quality	−0.008	0.028	0.785
Weather	−0.091	0.024	0.000 *
Pay place	0.092	0.024	0.000 *
Motivation			
Business motivation	0.020	0.024	0.399
Recreational motivation	−0.122	0.024	0.000 *
Sigma value	0.177	0.008	0.000 *

Note: * denotes significance at the 0.01 level.

Regarding the diving situation, the number of divers had a significant negative relationship with training effectiveness; the presence of many people diving at the same time could have resulted in more inappropriate behaviors that disturb marine ecology. Weather was also estimated as a significant negative coefficient. Under clear weather conditions, training effectiveness was lower and divers were more likely to engage in improper underwater behaviors. The variable of pay place was estimated as a significant positive coefficient, implying that training effectiveness was higher at scuba diving sites that charge for admission, which had lesser improper diver behaviors displayed.

In terms of diving motivation, the estimation found that the recreational motivation variable had a negative coefficient with a statistical significance higher than 99%. The business motivation was identified as having an insignificant influence on the effectiveness index. This finding suggests that when visitors were diving for recreation, environmental training was less effective in preventing damage to marine ecology.

5. Discussion

The empirical evaluation used the data of 246 diving tourists to examine the proposed approach and assess the effectiveness of environmental training, and explored several empirical findings. First, among the 246 observations, the effectiveness index was higher than 0.900 for only 8.5% of the divers and 45.2% of the divers scored lower than 0.500. Although there is no comparable evaluation in literature to compare the results, the indices reveal that the environmental training effectiveness does not perform highly in the observations. This finding implies that the environmental training offered from the public sector had not been effective to reduce improper behavior in marine activities.

Second, the factor influence indices explored the internal sources causing the ineffectiveness and identified a longer diving time as the most obvious factor resulting in low training effectiveness. If divers were to stay under the water for a longer time duration and became familiar with the underwater environment, they were more likely to display improper behaviors that disturb the ocean biology. Another finding was that the training was less effective for divers with higher qualifications. One possibility was that qualified divers were overconfident in their diving skills and neglected their obligations to prevent damage to the ocean ecology. Results also showed that while on-site education could be effective, guide instruction (i.e., trainers actively stopping improper behavior underwater) might not. This finding suggests that offering education to visitors before activities could be more effective than monitoring and correcting improper underwater behaviors on the spot.

Third, the investigation of external influence revealed that when the number of divers was high and the weather conditions were good, the environmental training offered to tourists would be less effective. When there were many people underwater, divers might think that their actions were not easily noticeable by instructors and therefore behave improperly. Furthermore, tourists might be motivated by the high visibility to touch underwater creatures when the weather conditions were good. We have also found that in places where tourists had to pay for permission to dive, training was more effective than at those sites that were free.

Fourth, results of the external influence estimation also showed that the environmental training was more effective for older tourists than younger ones. Older tourists typically behaved more maturely than youths in tourist activities. However, divers who had more experience were associated with lower environmental training effectiveness. Thus, environmental training for tourists seemed ineffective for young and experienced divers. One possible explanation could be that young people were less concerned about following the instructions offered during on-site training and experienced divers were both more confident in their own experience and more likely to ignore training content. This study also found a significant negative relationship between recreational motivation and training effectiveness; in other words, the training effectiveness was lower for recreational divers.

6. Conclusions, Implications, Limitations, and Future Research

In conclusion, this study established the DEA model to assess the effectiveness of environmental training on tourist activity and explored external influences on effectiveness by using the regression model. In the empirical evaluation, we applied this model to the data gathered from the questionnaire to analyze the environmental training effectiveness in scuba diving activities.

There were two main theoretical contributions in this study. First, the study assessed the effectiveness of training by considering both the environmental training resources and trainees' behavior by using the DEA approach. Second, our model considered both internal and external influences by using the DEA and regression model to investigate the inner sources of ineffectiveness as well as the effect of external factors on the performance indicator.

This study suggests that the public sector was supposed to charge appropriate fees and limit both the length of diving time and the number of divers in the management of a marine activity place. The content of on-site training should not only guide activity safety and publicity of rules but also emphasize the importance of conservation ecology towards ocean sustainability and biodiversity. For tourists with recreational motivations, they should be clearly informed during environmental training that they should not damage natural landscapes and collecting creatures in diving activities. In addition, diving qualifications should not only focus on diving skills but also highlight the importance of ecological ethics and responsibility to maintain fragile marine ecosystems.

There were two key limitations in this study. Firstly, this study mainly focused on selected diving sites where the empirical data collected could be limited. Another limitation was the lack of references in the selection of variables as there were limited prior studies conducted. Future research can be extended to other diving sites so that a larger sample can be gathered for more conclusive findings. Replicating this study in other countries can also be considered in the future and this provides the opportunity to make cross-country comparisons to determine if there are any similarities and/or differences.

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