THE EFFECT OF BIOROCK CORAL REEF RESTORATION ON TOURIST TRAVEL DECISIONS AT PEMUTERAN BAY, BALI

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ABSTRACT
Coral reef degradation has been a major environmental issue in the world. Coral reef ecosystems are fragile to threats, especially from climate change and anthropogenic activities such as fisheries and tourism. In 1998, coral reefs in Pemuteran Bay were devastated by El Niño phenomenon and destructive fishing practices that caused by economic crisis. The degradation triggered Pemuteran Bay to start coral reef restoration with Biorock technology. The Biorock coral reef restoration succeeded to increase the ecosystem quality, which attracts tourist to visit Pemuteran Bay. This paper presents an analysis of the influence given by Biorock coral reef towards tourist travel decisions to Pemuteran Bay. The result of multiple regression analysis indicates Biorock coral reef has a significant effect towards travel decision. The effect is equal to 70,4% and the residual is equal to 29,6%. Implication of the result indicates Biorock coral reef restoration is applicable in another coastal area to increase coral reefs ecosystem quality. Moreover, it will provide valuable and vital ecosystem services, which also can gives economic benefits through marine ecotourism

Keywords: Biorock, coral reefs ecosystem, travel decision, marine ecotourism
INTRODUCTION

Coral reefs worldwide are significant sources for global ecosystem health and in economic value (Wielgus et al, 2003). Coral reefs are renowned for their diversity and spectacular array of life they support and for their provision of many important services to people (Barker & Roberts, 2004). They are an important source of income, providing food, raw materials, medicine, as well as marine tourism (Terlouw, 2012). Marine tourism is one of the fastest growing tourism market segments in the world for the last decade and has resulted in a multi-billion dollar industry (Orams, 2002). The rapid expansion of marine tourism has led to increasing popularity of tourism destinations harboring coral reefs. Technical advances in equipment have resulted in the increased popularity of coral reef recreation, such as self-contained underwater breathing apparatus (SCUBA) and passenger-carrying vessels (Orams, 2002; Barker & Roberts, 2004; Uyarra, et al, 2008).

Coral reefs are one of the oldest ecosystems on the planet, consisting of primitive corals and invertebrates were already in existence 600 million years ago (Garrod & Gössling, 2008). Coral reefs defined by Hatcher as a marine limestone structure built by calcium-carbonate secreting organisms, which, with its associated water volumes supports a diverse community of predominantly tropical affinities, at a higher density of biomass than the surrounding ocean (Dubinsky & Stambler, 2011). Coral reefs are for several reasons vulnerable to global environmental change, which make it fragile to threat (Garrod & Gössling, 2008). The coral reefs in global decline from great variety of threat, such as natural disturbances and anthropogenic stressors (Garrod & Gössling, 2008; Uyarra et al, 2008). Destructive fishing practices, chemical, climate change, weather patterns, and bioeroders threat have led to a decrease in growth, reproduction and survival rates of corals and other reef-associated species (Dubinsky & Stambler, 2011).

Aside from those threats, tourist also often collides with the reef while doing activities such as diving or snorkeling near the coastal area. The decline in reefs comes while the marine tourism is expanding. On the other hand, marine tourism is an important economic factor to elevate coastal population welfare and nature conservation efforts are hardly consistent with the development of tourism (Treeck and Schuhmacher, 1999). The dilemma posed by the restricted compatibility can be evaded by adopting unconventional approaches.

Indonesia is the largest archipelago country in the world, spanning 5,000 km from the Indian to Pacific Oceans and consisting of nearly 13,500 islands (Burke et al, 2012). Indonesia has the largest area of coral reefs and the highest marine biodiversity of any country in the world, it has sixteen percent of the world’s coral reefs and 95 percent of the total number of species recorded throughout the Coral Triangle Core (France, 2008). Bali is one of the islands that surrounded by the Coral Triangle Core. One of the greatest features of Bali is the diving spot that become top ten in the world (Garrod & Gössling, 2008).

In the northern part of Bali, there is a marine tourism destination located in the village of Pemuteran. Tourism started to develop in Pemuteran by the mid-1980s, when a small group of pioneer investors bought land there and created a hideaway for discerning tourists (Lin-Liu &
Lee, 2012). Those tourists usually went into Pemuteran Bay or Menjangan Island for diving (Berkmoes & Skolnik, 2013). The local economic relied on the sea especially tourism because the soil were too dry to grow rice, the staple food and almost impossible to cultivate vegetables except in certain month (France, 2008).

By the late 1990s, a catastrophic event of coral bleaching caused by El Niño and destructive fishing practices triggered by economic crisis had decimated the reefs at Pemuteran Bay (Pickell & Siagian, 2010). In a day, there were five to ten bomb blasts in Pemuteran Bay (France, 2008). Nurhayati (2014) noted the destruction on coral reefs at Pemuteran Bay in 1998 were around 40% - 60%. This made for a bleak outlook for the local residents, who relied on fishing for their own consumption and as a draw for marine tourists, divers, and snorkelers. Almost all business related to tourism collapse during this time due diving was no longer safe (France, 2008).

In June 1998, the Global Coral Reef Alliance (GCRA) works with community-based management efforts to restore severely damaged coral reefs and fisheries using its Biorock technology (France, 2008). The technology comes from GCRA’s Biorock Ecosystem Restoration Technology invented by Hilbertz and Goreau (France, 2008). Biorock itself is a form of artificial reef that uses low voltage electric current to create an excellent growing environment for corals, and counteracting the process of ocean acidification (Terlouw, 2012). This Biorock coral reef restoration uses low voltage electric to accelerate coral growth on metal frames and creating electrochemical precipitation of mineral from sea water (Precht, 2006) Based on Goreau’s research, corals on a Biorock grow three to five times faster and are more resilient with respect to natural and anthropogenic stresses (Terlouw, 2012).

In order to restore the coral reefs ecosystem, the community through government has proposed Pemuteran Bay as local marine protected area and legalized it with SK Bupati (Mayor’s Decree) Buleleng No. 523/630/HK/2011. The community also develop a marine ecotourism concept to protect the environment, especially coral reefs to ensure the long-term benefits. After years of restoration, Pemuteran success to get several achievement related to Biorock coral reefs, such as Kalpataru, Konas Award, Pata Gold Award, and Asianta Award (France, 2008). The latest achievement is Equator Prize in 2012 from United Nations Development Programme (UNDP). Following the success of Biorock coral reefs restoration, tourism in Pemuteran also growth rapidly. The growth of tourism in Pemuteran examined through tourist arrivals data from year 2000 to 2014, the data obtained from Badan Pusat Statistic Buleleng (Statistic Bureau of Buleleng). The tourist arrivals rates increase 24.8 percent each year, the highest tourist arrivals rate increased 257 percent in 2009. The village of Pemuteran itself has 52.65 percent of total tourists that come to Gerokgak subdistrict, Buleleng Regency, Bali. The increase of tourist arrivals indicates the Biorock coral reefs restoration attracts tourist to visit Pemuteran Bay. It can be predicted Biorock coral reefs restorations effects on tourist travel decisions to visit Pemuteran Bay.

The aims of this study were threefold. First, to analyze the influence given by marine ecotourism activities around the Biorock coral reefs on tourist travel decisions. Second, to analyze the influence given by Biorock coral reef ecosystems on tourist travel decisions. Finally, to determine if Biorock coral reefs restoration could be a solution to marine ecotourism destination.
LITERATURE ON BIOROCK CORAL REEF RESTORATION AND TOURIST TRAVEL DECISION

This section presents a brief discussion of the current literature about Biorock Coral Reef restoration and tourist travel decisions. To build a hypothesis, this study reviews the literature and past study about the similar case. This study has two hypotheses: (1) Marine ecotourism activities have a positive effect on tourist travel decisions; (2) Biorock coral reef ecosystem have a positive effect on tourist travel decisions.

To examine the effect between Biorock Coral Reef restoration and tourist travel decisions, we learned more about pull and push factors. Pull factors are destination-generated forces and the knowledge that tourists hold about a destination, while push factors are intrinsic motivators. Pull factors generate due to the attractiveness of a destination, including beaches (Woodside & Martin, 2008). Pull factors are considered more decisive in explaining destination choice, which is related to tourist travel decisions. Yoon and Uysal cited by Woodside & Martin (2008) investigate push and pull motivations in a structural model that integrated satisfaction and destination loyalty, one of the important pull factors are environment, natural resources and water activities. Moutinho (2000) explained briefly through travel decision model, one of the pull factor component is destination considerations, which contains attractions. Various studies on travel decisions have confirmed that the attraction is the main pull factor of tourist arrivals.

In this study, the attraction is Biorock coral reef restoration, which become the independent variables, while the dependent variable is tourist travel decisions. To measure Biorock coral reef restoration effects, we divided it into two variables. The first as already mentioned before, water activities become the main important pull factor. Based on the real condition of Pemuteran Bay that later we discussed, the activities we used is marine ecotourism activities. We used Cater & Cater (2012) classification of marine ecotourism activities. Those activities classified in two categories. First, in the water activities, which are swimming and snorkeling, scuba diving. Second, underwater observations, which is glass-bottomed boat. Those activities already tested related to Biorock coral reef at least tourist could see it from distance.

The second variable that attracts tourists is the ecosystem of Biorock coral reef. Probably the most relevant theory to examine the improvement of coral reef ecosystem related to coral reef ecosystem health. This study adapted the assessment of coral reef ecosystem health by English et al. (COREMAP, 2006). To measured coral reef ecosystem, we use four dimensions, the dimensions are the abundance of coral reefs, community structure of coral fishes, megabenthos, and the last dimension adapted from Wielgus et al (2003) is visibility of the seawater. The abundance of coral reefs are the variety of coral reefs and also included the coral cover on the area. The community structure of coral fishes divided into three categories, target fish (fish that has economic value), indicators fish (fish that sensitive to polluted water), and major group fish (small fishes in a group). Megabenthos are organisms usually invertebrate, the size is bigger than 1 cm, and lives in the coral reefs. The third variable is tourist travel decisions, which measured by tourist perception of their firm decision to visit Pemuteran Bay.
In application of variable the most similar study conducted by Wielgus et al. (2003). The study estimate the economic value of coral reef damage at Eilat Coral Beach Nature Reserve in Israel. Using stated preferences and videos to convey quality changes. The study estimate values for changes in a biological index as well as for changes in quality of water, coral cover, and diversity of species. Survey were conducted at dive centers.

**METHODS**

This study using explanatory approach, to explain how Biorock coral reefs restoration influenced tourists travel decisions to visit Pemuteran Bay. The Biorock coral reefs restoration measured by two different variables. First is through attractiveness of marine ecotourism activities in the area. Second is through the coral reefs ecosystem condition at the Biorock coral reef sites.

The study was carried out between June to July 2015 at Pemuteran Bay, Pemuteran Village, Gerokgak subdistrict, Buleleng Regency, Bali. The bay is located in a village (3033 hectare) lies approximately 160 km north west of Denpasar. The Biorock coral reefs itself located at one-hectare area, there are around 80 structures at Pemuteran Bay. The Biorock structure placed from the front of Adi Assri Hotel on the east and Taman Sari resort on the west. In the back of the beach there are a several resorts, so it make several area of the beach like semi private beach, eventhough there are not any sign to forbid visitor to walk in a front of the resort. The beach area that free accessible is the area in the front of Biorock Center, owned by Karang Lestari Community Group. The other beaches outside the Biorock coral reefs are not suggested for tourism activities because the rocky and deep shores.

Questionnaire were carried out from late June to early July 2015, which transition from low to high tourist seasons. For the purpose of this study, we required information from tourists who had completed their holiday to obtain full answer of the Biorock coral reef ecosystem. To ensure the respondent is qualified to answer the questionnaire, this study used some contingency questions. Contingency questions added on the questionnaire to check the knowledge of respondent about coral reefs. We carried the survey in the front of Biorock Center so not disturb other tourist in the resort. Time, budgetary, and external constrains limited our sample size to 72 respondents, 56 were returned and 12 were not returned. The sample used in the research was non-random, convenience sampling to assess tourist travel decisions.

We initially tested the questionnaire by distributing it to two sets of 30 respondents across the similar marine tourism destination that offer coral reefs as an attraction. The tested questionnaires were carried out in June 2015. The tested questionnaires were self-administered and timed. Respondents were asked how the questionnaire could be made clearer, more neutral, easier, more interesting and so forth. The validity and reliability of the questionnaire evaluated with Pearson correlation and Cronbach’s Alpha.

The questionnaire had four parts. The first section was aimed at characterizing the tourist at Pemuteran Bay. Respondents were asked to provide general information including gender, age, education level, occupation, purpose of travel, and number visit Pemuteran. In the second section, respondents were asked to indicate which marine ecotourism activities (swimming and snorkeling, scuba diving, and glass-bottomed boat) they prefer, they ranked as their most and
least favorite. Respondent were asked too about the attractiveness of the marine ecotourism activities using Likert scale. The third section, we provided a set of nine attributes about Biorock coral reef ecosystem using itemized-rating scale (the variety, coral cover, dead coral, target fish, indicators fish, major group fish, megabenthos non-bioeroder, megabenthos bioeroder, water visibility). The fourth section, we provided the respondent with statements with Likert scale answer about the travel decision. Besides, of those questionnaires we also conducted an interview with Karang Lestari Community Group, Conservation International, government and private sector.

Finally, to analyze the influence given by marine ecotourism activities and Biorock coral reef ecosystem on tourist travel decisions, this study carried out a multiple regression analysis. The multiple regression analysis also tested our hypothesis. We also changed some data to interval using Method of Successive Interval to avoid any mistake for the regression analysis. The multiple regression results we got should be Best Linear Unbiased Estimator (BLUE) or not bias. In order to get BLUE conditions this study used assumptions of linear regression. Those tests are normality test, heteroscedasticity test, multicollinearity, and autocorrelation, which are self-administered.

RESULTS AND DISCUSSION

The Brief History of Tourism Development

Pemuteran become tourism destination in the early of 1990s. Pemuteran is the most remote corner of Bali from tourist entry point in the south, it was the last coastal area to develop tourism (France, 2008). The large, lush, and current-free reefs made it an exceptional location for diving, and a small diving industry developled followed by small hotels. These deliberately avoided the large-scale mass tourism of the South, giving it a tranquil setting and attracting Indonesian and foreign residents of Bali and Java eager to escape the congestion of the south as well as tourists straying off beaten track to find peaceful surroundings. By the ends of 1980s and early of 1990s, Pemuteran was only a transit area for tourists that wanted to dive in Menjangan Island, West Bali National Park.

The pioneer of tourism development in Pemuteran is Chris Brown, a diver from Australia. He was tourist that open the first dive operator, Reef Seen Diver’s Resort in 1991. Besides the dive shop, he also opened sea turtle conservation center with name Turtle Project. The revenue he got from the business used for bought the turtle’s egg from villager and hatched it on hatchery. In 1992, a local tried to develop tourism by built an accommodation named Pondok Sari Hotel. The hotel owned by I Gusti Agung Prana, which is an owner of Karang Lestari Community Group. After those pioneers develop tourism in Pemuteran, several dive operators and accommodations started their business too, such as Easy Dive in 1998 which owned by French couple. While Pemuteran started the tourism development, the economic crisis and climate effects in 1998 destroyed it. During those years tourists lost their interest to visit Pemuteran which indicated by the collapse of tourism business. As already mentioned above, Biorock coral reef projects changed the condition in Pemuteran. It boosted the tourism development especially at Pemuteran Bay.

Tourist characteristics
In this section, we present the results of estimating a regression model of Biorock Coral Quality and travel decision model presented as equation. The sample consisted of 34 males (60.7%) and 22 females (39.3%), with the mean age of 28.96. In the level of education more than half respondents, 36 persons (64.28%) were joined university. The occupation of respondent, 18 persons (32.1%) were students. More than half respondents, 37 persons (66.1%) was visiting Pemuteran Bay for the primary purpose of holiday. Most of the respondents, 52 persons (92.9%) visit Pemuteran Bay for the first time. The origin country of the respondents, 19 persons (33.9%) are from United States of America. In order to test the hypothesis, all respondents already passed the contingency questions.

**Marine ecotourism activities**
In this study, tourist activities observed only those activities that related to Biorock coral reefs. Based on Pemuteran Bay status as Local Marine Protected Area, Pemuteran Bay has several different zone for each purpose. In formal regulation the zone protected by Buleleng Regency’s law, while for non-formal regulation the zone protected by Kelompok Masyarakat Pengawas (Pokwasmas) or local watching group. Based on those conditions there are three possible activities at Pemuteran Bay.

First, we examined the most preferred activity and the least preferred activity at Pemuteran Bay. The results obtained from grid analysis showed the most preferred activity with total score 139 is swimming and snorkeling and the least preferred activity with total score 69 is glass-bottomed boat. This results shows people more attracted to do swimming and snorkeling. The preference caused because swimming and snorkeling required only few equipmen rather than other activities. The tourists can be easier to enjoy the view of Biorock coral reefs by doing swimming and snorkeling too.

We also summarized the Likert scale result, the attractiveness of all activities is 84.1% perceived by tourist. The percentage obtained from the questionnaires located on the range 81% - 100%, so the activities had strong attractiveness.

**Biorock coral reef ecosystems**
The main concern of this study about the Biorock coral reef restoration can increase the coral reef ecosystem quality. Based on Bali Marine Rapid Assessment Program (Mustika et al, 2012) overall coral reef ecosystem in Pemuteran Bay, located at coordinate 08° 07.775’ S and 114° 40.007’ E identified as sites with high conservation value. The area also exhibit good microhabitat diversity and support relatively rich fish communities. The Pemuteran Bay was particularly rich for live corals and associated reef fishes. The reef complexes has excellent potential for no-take zonation.

The Pemuteran Bay dominated by branched coral *Acropora*, *Tabulate*, and foliose *Montipora*. The species are at Pemuteran Bay are *Agariciidae* such as *Leptoseris explanulata*, *Leptoseris mycetosEROI.D*, and *Pavona varians*. *Faviidae* such as *Favites abdita*, *Favia pallida*, *Goniastrea retiformis* and *Goniastrea aspera*. The Biorock technology collects the baby coral or coral fragments and attaches it on the Biorock structure. Several Biorock structure has a name, those name are Bumbung, Goa Karang, Ibu Karang, Nautilus, Taman Sari, Bicycle, Ball, Carpet, Goa, Coral goddess, Coral tent, Cuttle fish, Diamond, Dolphin, Donut, Fish Structure 1, Fish Structure

The fish species are wrasse (*Labridae*), Pomacentridae, Gobiidae, Apogonidae, Serranidae, Chaetodontidae, Acanthuridae, Scaridae, and Lutjanidae. Megabenthos also can be threat to the coral reefs such as crown thorn. The main threats of Biorock coral reefs right now is the existence of crown thorn. It rapidly spread into all Biorock structure and in 2015 the Biorock center already eliminated thousands of crown thorn. Pickell and Siagian (2010) explained that coral reefs at Pemuteran Bay are shallow and very near to the beach. This condition effected on the water visibility, sedimentation that come from the sand that drifted by waves effected the clarity of water.

The respondents assessed using questionnaire to measure the Biorock coral reef ecosystems. The results of itemized-rating scale showed the abundance of coral reefs has score of 84.55%, which is indicate very high variances of coral reefs at Pemuteran Bay. The community structure of coral fishes has score 81.86%, means the location has very high number of fishes at Pemuteran Bay. The megabenthos has score 89.28%, which is indicate very high number of megabenthos at Pemuteran Bay. The last dimensions is visibility and it has the lowest score 74.28%, which is indicate the visibility at Pemuteran Bay is less or equal than 15 meters.

*The multiple regression results*

The study purpose is to analyze the effect given by marine ecotourism activities ($X_1$) around the Biorock coral reefs and Biorock coral reef ecosystems ($X_2$) on tourist travel decisions ($Y$). The model has two independent variables (X) and one dependent variable (Y). The multiple regression method result shows constant $\beta_0$ is 4.683, it is means if the attractiveness of marine ecotourism activities and Biorock coral reef ecosystems are 0 then the value of tourist travel decisions is 4.683. Coefficients $\beta_1$ is 1.256, it is means if Biorock coral reef ecosystem value are constant and attractiveness of marine ecotourism activities increased by one, the tourist travel decisions will increase by 1.256. Coefficients $\beta_2$ is 0.590, it is means if attractiveness of marine ecotourism activities are constant and Biorock coral reef ecosystem increased by one, the tourist travel decisions will increase by 0.590.

F-test conducted to see if the overall result is significant. The F value from regression result is 63.035 and the F statistic is 3.171. The result shows F value > F statistic or 63.035 > 3.171, the null hypothesis is rejected. The conclusion is marine ecotourism activities and Biorock coral reef ecosystems have significant effect on tourist travel decisions.

T-test conducted to see if individually variable result is significant. The first variable tested is $\beta_1$, the T value from regression result is 2.164 and T statistic is 2.006. The result shows T value > T statistic, the null hypothesis is rejected. The conclusion is marine ecotourism activities have significant effects on tourist travel decisions. The second variable tested is $\beta_2$, the T value from regression result is 4.409 and the T statistic is 2.006. The result shows T value > T statistic or 4.409 > 2.006, the null hypothesis is rejected.
R-squared result obtained from multiple regressions is 0.704. The result shows the effect of independent variables, attractiveness of marine ecotourism activities and Biorock coral reefs ecosystem towards tourist travel decision is 70.4%. The residual 29.6% caused by another factor outside of the study.

CONCLUSION

The analysis results showed that marine ecotourism activities related to Biorock coral reef and Biorock coral reef ecosystem have effect on the tourist travel decisions. The Biorock technology success to become a sustainable tourism attraction. Biorock coral reef restoration has proven to improve coral reef ecosystem condition. In view of the worldwide degradation of coral reefs, the Biorock technology may be a realistic approach towards ensuring compatible coexistence between marine ecotourism and nature conservation that applicable in another coastal area. To our knowledge, the present study used respondents to assess the Biorock coral reef ecosystem. The limitation of secondary data of Biorock coral reef become the most important matter in this study. Studies to collect data of Biorock coral reef annually would complement the future study.

REFERENCES CITED


ATTACHMENT

Table 1 Summary of hypothesis testing results

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Test Results</th>
</tr>
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<tbody>
<tr>
<td>H₁</td>
<td>≠H₀</td>
</tr>
<tr>
<td>H₂</td>
<td>≠H₀</td>
</tr>
</tbody>
</table>

Hypothesis H₁: Marine ecotourism activities have a positive effect on tourist travel decisions
Hypothesis H₂: Biorock coral reef ecosystem have a positive effect on tourist travel decisions

Source: Author’s field observations.

Table 2. Sample Characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Percentage (%)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>60.7 % male (34)</td>
<td>-</td>
</tr>
<tr>
<td>Age</td>
<td>44.6% 25 – 34 years old (25)</td>
<td>28.96</td>
</tr>
<tr>
<td>Education</td>
<td>64.28% university (36)</td>
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</tr>
<tr>
<td>Occupation</td>
<td>32.1% student (18)</td>
<td>-</td>
</tr>
<tr>
<td>Purpose of travel</td>
<td>66.1% holiday (37)</td>
<td>-</td>
</tr>
<tr>
<td>Number of visitations</td>
<td>92.9% first time (52)</td>
<td>-</td>
</tr>
<tr>
<td>Country</td>
<td>33.9% USA (19)</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Author’s field observations.

Table 3. Multiple Regression Results

Regression Model: Y= β₀+β₁X₁+β₂X₂
Y'= 4.683 +1.256 X₁+ 0.590 X₂

<table>
<thead>
<tr>
<th>Ustandardized Coefficients (β)</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>4.683</td>
</tr>
<tr>
<td>Attractiveness of marine ecotourism activities (X₁)</td>
<td>1.256</td>
</tr>
<tr>
<td>Biorock coral reef conditions (X₂)</td>
<td>0.590</td>
</tr>
<tr>
<td>t Attractiveness of marine ecotourism activities (X₁)</td>
<td>2.164</td>
</tr>
<tr>
<td>Biorock coral reef conditions (X₂)</td>
<td>4.409</td>
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<tr>
<td>Sig. Attractiveness of marine ecotourism activities (X₁)</td>
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<td>Biorock coral reef conditions (X₂)</td>
<td>0.000</td>
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<tr>
<td>Anova F</td>
<td>63.035</td>
</tr>
<tr>
<td>Sig</td>
<td>0.000</td>
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Model Summary: R² = 0.704

Source: SPSS results.
BIOGRAPHICAL NOTES

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