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Quantitative Zoning of Ecotourism Potential in Oshtorankouh Protected Area Using Delphi Method, Analytic Hierarchy Process, and Weighted Overlay Methods

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ABSTRACT

Aims Zoning is applied to achieve a scientific and appropriate management based on efficient criteria to make possible the proper use of the resources.

Materials & Methods Zoning of the areas in order to study ecotourism potential, as an approach based on multi-criteria evaluation (MCE), prevents personalized high-handed management and leads to identify appropriate recreational spots according to their natural capacities. Oshtorankouh protected area, located in Lorestan province, has been recognized as a protected area since 1966. This study has introduced a quantitative, weighted, and native model and Delphi method for this area by using Delphi questionnaire and hierarchical analysis in order to determine its ecotourism potential. The layers of gradient, direction, land type, water, fault, residential areas, land coverage, and road were overlayed by applying the weights resulted from AHP.

Findings The final output is a map, in which zero has the lowest value and 5 is considered the highest value (0-100% efficiency). Only 2 hectares of this area gained a score of 5, and there was not any zero point in the region. The largest area has the score of 2 (40% efficiency), which includes more than 55% of the total area.

Conclusion We are succeeded to determine the ecotourism potential of Oshtorankouh, using the AHP, Delphi method, and weighting by GIS software. Combining different methods and quantifying effective criteria by using different maps and tools reduce the impact of personal opinions on management decisions and provide appropriate results in accordance to the potential of the area.

Keywords Prioritization; Multi-criteria Evaluation; Geographical Information System; Oshtorankouh

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Introduction

Unsustainability in the exploitation of nature originates from a misconception about the ability of natural resources to be renewed, and as a result, the biodiversity losses, and the catastrophic reduce of fundamentals resources, on which local people are extremely dependent, occurs. In order to create sustainability, the level of exploitation must be reduced and it should not be allowed that the satisfaction of local people for using the natural resources leads to an increase in their desire for more exploitation [1].

Sustainability, as a goal, is often criticized as being vague and a paradox. The conflicting problem of economic development and ecological conservation is often well-explained as following sentence: we cannot save the environment without development and we cannot continue to develop anywhere unless we save the environment [2].

Assessment of the potential of ecotourism as a multi-criteria evaluation (MCE) approach is trying to prevent personalized, high-handed management, and invalid exploitation. MCE, which is identical to the multi-criteria decision-making (MCDM) concept, has been used in several ways since the 1970s [3]. MCE techniques are good tools for studying complex phenomena and improving the planning processes.

The combined use of GIS and MCE, which is generally called the Spatial Decision Support System (SDSS) and is widely used to study and analyze complex spatial problems, is a suitable method for decision making [4]. The lack of ecosystem analysis and planning based on the ecological structure is evident in planning models [5, 6]. Zoning for ecotourism issues in protected areas based on ecological structure is a step towards solving these deficiencies, separating the zones, and creating appropriate programs in order to achieve a scientific management for protected areas.

Objective: Oshtorankouh protected area has been recognized as a protected area since 1966, and it is classified in IV category of International Union for Conservation of Nature (IUCN) classifications of protected areas [7]. Oshtorankouh protected area is a mountainous region with limited use. The proximity to Doroud and passing the important Doroud-Azna connection axis through the region have caused some incompatible uses against with management objectives of a protected area. The beautiful Gahar Lake has also added more advantages to the tourism attractions of this area. The identification of recreational zone in protected areas has 2 basic features: First of all, protection.

As the main purpose of distinguishing these areas, protection makes the managers to limit pervasively the utilization and access to these areas applying severe protection rules. So, it would diminish the services, which are usually offered to ecotourism.

The second aspect is the need of ecotourism to more virgin lands with higher ecological values, with different sub-objectives as a general recreation purpose, which can be catastrophic in the lack of attention to the area's capacity range. So, the zoning of nature-tourism potential in a quantitative format, in the first step, can be in line with the identification of capabilities, and in next steps, by resorting to preparation methods, the final zoning based on the ecological constraints, is the facilitator of the area management plan [7].

In Iran, potential evaluation, compared to assessment of development effects, has had a slower trend in quantifying models and zoning. This study provides basic material for weighting overlay in the GIS setting by defining a local model to determine the potential of ecotourism in the region, improving it from qualitative to quantitative one, determining the weights of information layers by using hierarchical analysis, and preparing the maps for weighting overlay.

This multivariate research is based on the use of various methodologies such as Delphi questionnaire, hierarchical analysis, and weighting overlay in the format of GIS software. Delphi method was presented by experts from various disciplines in the late 1940s in order to obtain an efficient agreement on future developments. This methodology is an approach based on collecting opinions and ideas of experts without any communication between them.

So far, Delphi method has been used in various researches to predict future events such as health care, marketing, resource allocation, and tourism. This methodology helps to reach out a consensus among a group of experts [8] and has been proven to be a valuable guide in determining the priorities of recreation and tourism management [9].

In a study in 2006, Briquel discussed the key issues in the development of the border of Alps according to current and future conditions and problems, and analyzed relevant processes affecting its future development, using the Delphi method [10]. Brown [11] used the Delphi method to provide a sustainable ecological, economic, and social model for managing protected areas, and invited two groups of protected areas professionals from the American and Australian universities as well as industry experts and government agencies of Park Management in Australia to participate in this study [11].

Siegrist [12] has studied Alpine areas with an unsuitable prospect to identify successful and unsuccessful criteria for the sustainable development of ecotourism and tourism, using the Delphi method. Through several years of research and by analyzing the models and criteria for sustainable management of ecotourism and tourism, he has presented a set of suggestions for sustainable ecotourism observation [12].

Stein *et al*. used the Delphi method to improve ecotourism programs in Florida State [13]. Spenceley presented his Ph.D. thesis entitled "Managing sustainable nature-based tourism in southern Africa: A practical assessment tool with the aim of creating an assessment tool for sustainable ecotourism and tourism". The researcher used the Delphi method to identify social, economic, and environmental factors, which South African experts consider vital to sustainable nature-based tourism. By reviewing the literature and the study, appropriate evaluation techniques were integrated and Sustainable Nature-based Tourism Assessment Toolkit (SUNTAT) mechanism was developed to assess the economic, social, environmental, and cumulative values, etc. Then, it was tested by 4 commercial nature companies that provide wildlife tourism in protected areas and recognized as a valuable mechanism for sustainable tourism and ecotourism management [14].

Abidin presented his Ph.D. thesis in 1998 entitled "The identification of criteria and indicators for the sustainable management of ecotourism in Taman Negara national park, Malaysia: A Delphi consensus". In this research, data from public surveys were combined with Delphi expert opinions to provide sustainable ecotourism criteria and indicators, which resulted in the identification of 15 criteria and 58 indicators of sustainable development of ecotourism in Taman Negara National Park. Based on selected indicators and criteria, an evaluation process and an evaluation system were developed to assess sustainable ecotourism management. Finally, 25 management objectives were defined for this park [15].

Makhdoum [16, 17], Makhdoum and Dehdar Dargahy [18], and Majnounian [19] used simple overlay technique, in which the main form is qualitative, combined with system approach-based analysis in their researches. Yavari and Bahraini [20], Ahmadi Zadeh [21], Ma [22], and Markopoulos and Butler [4] used weighted overlay method for a variety of locating and zoning. In this technique, the value of each zone for locating is determined by the final score of that area after the weighted overlay of all layers.

The hierarchical analysis method was designed by Saaty in 1977. He rewrites the basic concepts of this method in 1995 [23]. Various practical approaches to analyze the hierarchical analysis have been presented by Kangas [24], Carver [25], Westman [26], Pullar [27], and Vangenot [28]. In this way, at the lowest decision-making level, decision-making items are compared to their own characteristics, and the extraction of high-value items leads to prioritization [24]. This method is one of the most comprehensive methods designed for decision-making with multiple criteria or, in other words, MCE. In this method, the problem firstly must be divided into smaller components hierarchically. These components include defining objective, criteria, and items. Then, using the paired comparison method, the weight of each item is obtained and the best item is chosen [29]. Furthermore, weighted overlay is a method for measuring and unifying variables with different scales and inconsistent inputs for an integrated analysis [30].

One of the main difficulties of this method is experts' high involvement in determining the relative importance of the factors [24]. The set of these methods demonstrates ecotourism potential in Oshtorankouh area.

Studying and comparing the national and international researches on the feasibility of ecotourism and tourism development show that the international researches have emphasized vegetation criteria, paths, gradients, natural, and cultural attractions,

while the national researches have mostly emphasized the other criteria like slope, vegetation, natural attraction, and path. Studying similar researches shows the lack of surveys and information regarding to potential assessments.

So, in this study, we have used different methods to be able to evaluate ecotourism potential of this protected area. We have used the results of the recent projects to create the proper ecotourism criteria; then, we applied Delphi questionnaire and in order to estimate the value of the criteria, we have used hierarchical analysis (AHP).

At the end, we have integrated information layers generated in the GIS setting considering their acquisitive values. The purpose of the present study is zoning of Oshtorankouh protected area, and specifying its different degrees of potential for ecotourism, its importance, and its power in a specific breadth.

Materials and Methods

Oshtorankouh protected area is located in N 33° 10′ 50″ to N 33° 35′ 17″, E 48° 58′ 10″ to E 49° 27′ 33″. This region with an area of 104,355 hectares is located in the south and south-east of Doroud and in the western part of Azna in Lorestan province while passes through the connection axis of Doroud-Azna. The whole zone of Oshtorankouh protected area, which includes parts of Oshtorankouh Mountains and other mountains in the Zagros mountain range, is located in Lorestan province and comprises several villages [7].

Using the pastures is the main land use of this protected area. It consists of various species like milkvetch and the forest areas mostly covered by the oak trees. Pastures and forests cover about 68% and 17% of the land, respectively. There are the sites in some parts of Oshtorankouh protected area, protection of which is highlighted because of genetic reserves with more protection value. Due to the potential and the proportion of this area, the extension of agricultural and horticultural land use is very limited [7]. Figure 1 shows the map of the location of Oshtorankouh protected area in Iran and Lorestan province along with its span.

Weighting overlay is a powerful tool in the geographical information system, which can be used to increase the quality of land evaluation methods through the combination of questionnaire and AHP techniques. And, it also displays the value of tourism and ecotourism in the Oshtorankouh protected area in a quantitative system.

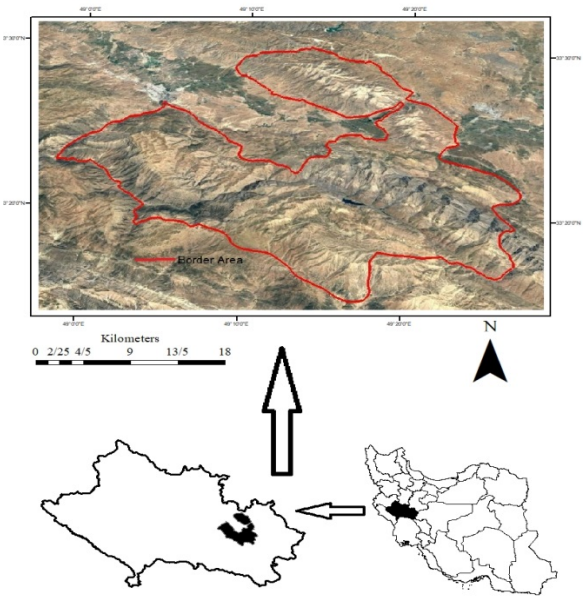

Figure 1) Map of the location of the Oshtorankouh protected area in Lorestan Province, Iran

Identifying the layers and mapping parameters in this study are based on the Delphi questionnaire technique. The Delphi method was used to identify and evaluate the parameters by a panel of experts in 3 steps. In the first step, members of the Delphi group are individually asked to respectively and reasonably identify the important criteria in determining the potential of ecotourism. In the second step, the questionnaires are arranged in a table of criteria based on the feedback report, and respondents are asked to rank and limit the range of the selected criteria in the first step in a 5-point scale (0-5) and re-determine the priority of the criteria. In the third step, a summary of the second-level responses is provided as a feedback report and provided to the Delphi group and it is requested to rank the selected indices according to the other experts' opinions from 0 to 5.

At this stage, the model includes standardized parameters (in a quantitative format from 0 to 5) that the Delphi panel has determined by consensus. On the other hand, the criteria priority model is obtained by using hierarchical analysis and weighting of the layers. This method is a powerful and flexible tool for quantitative and qualitative examination of multi-criteria issues and its main characteristic

is based on paired comparisons of layers [31].

For this purpose, the initial matrix consists of rows and columns with paired similar parameters that makes possible their comparison. The range of scoring parameters in the initial matrix in this study is from 0.2 to 5, which 5 is highest value and 0.2 is the lowest one. After completing the initial matrix, a matrix called the normal matrix is created in the form of an initial matrix. In each column of the initial matrix, the numbers are divided by the sum of the matrix column, and the result is entered in the corresponding cell in the normal matrix. In the normal matrix, the sum of columns equals to 1. After completing the normal matrix, the horizontal mean of each of the factors reflects the significance of that factor. Thus, a low weight model is obtained. Finally, the corresponding maps are generated in the GIS environment and by their overlay, the final map of the ecotourism potential of the study area is created.

Findings

By forming a panel of 19 experts of different disciplines such as geology, ecotourism, science, and environmental management, a quantitative model was designed and developed. The information layers related to ecotourism and mapping capabilities were identified based on experiences of panel members and available development facilities in the protected area. Then, these layers were graded and spanned by a 5-point scoring system (0 is the lowest value and 5 is the highest value). The results of this technique are presented with the full consensus of the Delphi group in Table 1.

The last item needed for weighted overlay was the weights of the layers in the quantitative model, which was derived from an AHP. The initial matrix, the normal matrix, and the weights of the layers are presented in Tables 2 to 4.

Table1) Quantitative model derived from the Delphi panel

Variable	0	1	2	3	4	5
Gradient*	> 65	15-65	10-15	5-10	2-5	0-2*
Water Resources (buffer) **	> 4000	2000-4000	1000-2000	500-1000	100-500	100
Geographical Direction	-	-	West	North	South	East
Coverage Density	< 20	> 80	20-30	30-40	40-60	60-80
Road (buffer)	> 4000	2000-4000	1000-2000	500-1000	100-500	0-100
Geomorphology	Residential	Types 8 and 9	Type 1	Type 2	Type 3	Type 4
Proximity to Residential Areas	> 6000	4000-6000	2000-4000	1000-2000	100-500	500
Fault (buffer)	100	100-500	500-1000	1000-2000	2000-4000	> 4000

* The gradient unit is in percent and meters; ** Streams with top-five degrees are known as permanent water sources and springs

Table 2) Initial matrix for determining the weights of layers

Variable	Gradient	Land type	Direction	Water	Coverage	Residence	Fault	Road
Gradient	1	2	2	2	3	5	2	4
Land type	0.5	1	0.5	1	2	3	1	2
Direction	0.5	2	1	2	3	4	2	3
Water	0.5	1	0.5	1	2	2	1	3
Coverage	0.33	0.5	0.33	0.5	1	0.5	0.5	1
Residence	0.2	0.33	0.25	0.5	2	1	1	1
Fault	0.25	1	0.33	1	2	1	1	2
Road	0.25	0.5	0.33	0.33	1	1	0.5	1
Total	3.53	8.33	5.24	8.33	16	17.5	9	17

Table 3) Normal matrix for determining the weights of layers

Variable	Gradient	Land type	Direction	Water	Coverage	Residence	Fault	Road
Gradient	0.28	0.24	0.38	0.24	0.19	0.285	0.23	0.24
Land type	0.14	0.12	0.1	0.12	0.125	0.17	0.11	0.12
Direction	0.14	0.24	0.19	0.24	0.19	0.23	0.23	0.17
Water	0.14	0.12	0.1	0.12	0.125	0.11	0.11	0.17
Coverage	0.1	0.06	0.06	0.06	0.06	0.25	0.05	0.06
Residence	0.06	0.04	0.06	0.06	0.125	0.06	0.11	0.06
Fault	0.07	0.12	0.12	0.12	0.125	0.06	0.11	0.12
Road	0.07	0.06	0.04	0.04	0.06	0.06	0.05	0.06
Total	1	1	1	1	1	1	1	1

Table 4) The weights of information layers based on hierarchical analysis method

Information layers	Gradient	Direction	Land type	Water	fault	Residence	Coverage	Road	Total
Weights of layers	0.26%	0.20%	12.5%	12.5%	10%	7%	6%	6%	100%

It should be noted that the priorities of the layers relative to each other is derived from the results of the Delphi panel. To perform weighted overlay, the map format is transformed from vector to raster or cell map after drawing the initial maps and quantifying them based on the quantitative model. In this study, the pixel sizes of the cell maps is 20 square meters in real size (one of the preconditions of weighted overlays is that the pixel sizes have to be equal to the maps, which are used). By overlaying the created layers, the layer output consists of 6 categories with the values from 0 to 5, which 5 is the highest value and 0 is the least value for scoring system of tourism potential. Values are as integral number in this method. For example, 5≤value<4 is considered as a value of 5.

Table 5 represents the area of the zones with 6 points, and Figure 2 shows the map of zoning of ecotourism potential in Oshtorankouh protected area.

Table5) Number, area, and relative percent of scores

Class	Numbers of units (cells)	Area (hectare)	Relative percent
0	0	0	0
1	41832	1673.28	1.6%
2	1455080	58203.2	55.798%
3	1014297	40571.88	38.9%
4	96179	3847.16	3.7%
5	52	2.08	0.002%
Total	2607440	104297.6	100%

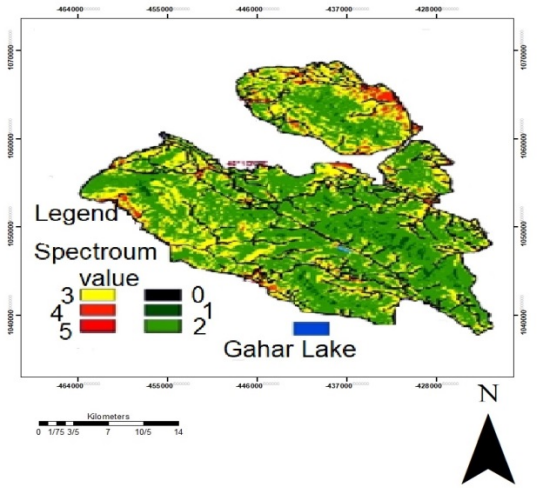

Figure 2) Oshtorankouh quantitative zoning map for ecotourism potential

Discussion

Weighted overlay is one of the displays of cellular GIS applications. Since its introduction, the cellular GIS has revolutionized information analysis of different sectors [32]. Simple overlay technique, in which the main format is qualitative, has been widely used in combination with a system-based analysis in Iran [33, 17]. Unfortunately, the common models were so general that are developed for the whole country; hence, the need for local models was strongly felt. The Delphi technique is a simple and suitable method for screening the various layers and parameters, which can properly represent the actual situation based on expert's views. After identifying each of the criteria, a certain weight should be given in terms of relative importance and the effect of each of them in determining the studied parameters. However, determining the weights of involved factors is becoming rapidly a problem with the increase in the numbers of studied criteria [34]. The AHP method is simple and effective, and can solve the problem of weighting the parameters. By using this method, it has become possible to determine the potential of the Oshtorankouh protected area for ecotourism use.

Recreational evaluation is a complex process that requires simultaneous consideration of several factors, including climatic, geomorphologic, environmental, economic, and social criteria. GIS system, along with the methods that are used for determining the value of criteria, which are related to each other, creating the background of data, data analysis, and modeling are a good platform for spatial analyzers in the field of locating and recreational evaluations [35]. The use of the ANP and AHP model by Yamani *et al*. [36] was carried out to examine the development of tourism potential of Oshnaviyeh. In system analysis, identification of the sources of information leads to produce the information layers. Among the effective factors in this research including elevation, slope, slope direction, soil, lithology, land cover, communication roads, fault, flood potential, and landslide potential, the slope factor has the highest value. Even in Oshtorankoh protected area, slope has the

highest weight of 26%. Most of Sorkhe Hesar Forest Park has a first-class outdoor recreation potential. Even Taheri in a study has shown that the most part of Abbas Abad Veresk region (53%) has the first-class outdoor recreation potential [37]. In Oshtorankoh, 57% and 38% of the total area were placed in 2 and 3 utility classes. These results can indicate the role of slope in the natural tourism of Iran. In another study conducted by Bijhani *et al*., the altitude factor among the other factors affecting tourism like slope, direction, vegetation, precipitation, and temperature has the highest value, while slope has the least weight value in the selection of ecotourism activities in Siah-Roud basin in Gilan province [38].

Conclusion

Tourism, of course, has a close relationship with the environment; hence, if the assessment of environmental capability is properly done, it can modify the plans and prevent failures in sustainable tourism development. It will prevent unforeseen destruction of the environment and ultimately it improves environmental quality, increases living standards in local communities, and reduces the costs [38]. Utilizing and combining different methods, as well as using maps and software that are able to quantify the criteria, reduce dependency to qualitative criteria. So, it can prevent the impacts of personal opinions on decision-making, and it will help to achieve to a better and more reasonable assessment. It makes possible more logical evaluation based on ecological capabilities of the area and facilitates decision-making processes to achieve a sustainable and efficient use of the areas. According to quantitative zoning map of Oshtorankouh protected area for ecotourism use, the areas with the highest ecotourism potential in the Oshtorankouh protected area include:

In the northwestern part of Oshtorankouh: Masoud Abad, the outskirts of Agapiraneh shrine, Bawki area, the outskirts of Pir Khalil shrine, Darijan Sofla; in the north of Oshtorankouh: the outskirts of Tian village in the vicinity of the Maribor River; in the northeast part of Oshtorankouh: the outskirts of Dareh Asir village;and in the western part of the region: the outskirts of Dareh Takht village.

The mentioned areas have so beautiful views. In addition, the proximity of some of these areas to a local shrine and the river has increased their potential for tourism and ecotourism. Unfortunately, in these areas, there is not any infrastructures and facilities for ecotourism. In the western part of the protected area, the Kamandan valley and the outskirts of Gahar Lake in the center of Oshtorankouh are also suitable for ecotourism. This beautiful lake has the potential to attract a large group of Iranian and foreign tourists every year.

In other studies, regarding ecotourism potential in protected areas like Sojasi *et al*. [39], Sharifi [40] and Mahdavi *et al*. [41] Delphi and AHP methods are used. The results of the Delphi questionnaire and weighting have shown that gradient, climate, distance, and road access are effective criteria for ecotourism capability assessment, while in a study carried out by Shojaee *et al*. [42], access and proximity to dwelling places is one of the most important criteria. Water resources, including river, springs, and lakes also play an important role in attracting tourists and they are even used by other researchers as important factors in the evaluation of ecotourism capability [43, 44], confirming the results of the present study and, of course, the land type is a criterion with higher score in the set of criteria for the assessment of ecotourism capabilities [39].

The lack of attention and improper management, particularly insufficient necessary controls, can seriously damage this beautiful land. Considering these points, some suggestions have been proposed to stabilize the condition of ecotourism in accordance with the existing capabilities without damaging the region:

- Tourism has to be well-organized in the Oshtorankouh protected area. Precise studies of ecotourism have to be carried out by the department of environmental of Lorestan province as the only responsible of this protected area. Environment organization has to limit the authority of other organizations considering the priorities of environmental and biodiversity issues of the region. In next steps, the tourism sites in the Oshtorankouh protected area designated by environmental organization will be applicable even by the private sector in a large-scale management, while the department of environmental of Lorestan province keeps under control the environmental situation of the Oshtorankouh protected area.

- Paying a particular attention to the protection aspects of the Oshtorankouh protected area in a way that protection be prior to the boom of the tourism industry.
- Using a unified management for the Oshtorankouh protected area between 3 cities: Azna, Doroud, and Aligudarz (Doroud has more priority compared to other 2 cities in terms of equipment and facilities and specialist forces).
- Establishment of an Environmental Research Center of the province in Doroud, near the Oshtorankouh protected area to conduct precise researches on wildlife and regular limnological sampling to have a permanent control on the quality of Gahar Lake.
- Changing the types of inappropriate land uses in the region that are not compatible with conservation purposes, which is the most important objective of the Oshtorankouh protected area.
- Considering pedal boats, fishing hooks, and bicycles in the zone will be kind of good ideas to increase its potential for eco-tourists.
- Locating landfills in Oshtorankouh protected area and forecasting the treatments to be able to remove the waste from the lake (this should be followed and implemented as soon as possible by the department of environmental of Lorestan province)

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