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Carrying Capacity in Tourism and its Measurement Methods

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Abstract
Tourism, like any activity, leaves different effects, and sometimes it has left irreparable natural and human damage in tourism areas. Each tourist site has a certain capacity to attract tourists according to its potential and if these limits and thresholds are exceeded, the negative effects of tourism will appear. The increasing development of tourism and the increase in the number of tourists during the past decades have had irreparable consequences for tourism destinations. In the meantime, nature tourism destinations have been damaged more than other attractions due to their fragile nature and the high attention of tourists. This issue has drawn the attention of managers and officials to managing visitors and reducing the effects of these visits. In recent years, various techniques have been presented to manage the effects of visitors, and one of these tools is "carrying capacity". The carrying capacity determines the limits that by crossing it, the destroyed resources or the damage to the ecosystem becomes irreparable.

Keywords: Carrying capacity; Methods of measuring carrying capacity; Tourism.

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1. Introduction

In recent decades, the growth and development of the tourism industry and its adoption as one of the major economic activities by developed and developing countries and the competition of major tourist destinations to attract tourists have prompted planners to increase their income. From tourism activities, pay attention to two important categories: firstly, increasing the satisfaction of tourists and improving the pleasure and quality of the tourism experience, and secondly, trying to protect the interests of the host communities. Tourists pay attention to different places as tourist destinations, which include residential or non-residential destinations. Non-residential areas such as mountains and high peaks, forests, lakes, special geological areas, etc. Non-residential areas include urban and rural areas (Soleimani et al., 2018).

The sustainable development of tourism has a key concept called capacity. The term "capacity" is derived from the science of ecology. Capacitance shows the fact that every environment, whether natural or artificial, has a specific capacity and a certain amount of loading (Tolaei, 2006). The study of carrying capacity as a management approach to recreation reached its peak in the 1970s and 1990s, when the growth of recreational use in the United States raised concerns about the amount of use and types of activities at recreational sites. Became. Therefore, it is necessary to estimate and determine the limits of development and measure the carrying capacity of the environment to maintain the stability of the economic, social, and environmental system in the host region. The study of the available sources shows that so far most of the research has been focused on the environmental carrying capacity, while the social carrying capacity and facilities have been neglected as one of the important issues in the tourism industry (Soleimani et al., 2018).

The carrying capacity determines the limits that by crossing it, the destroyed resources or the damage to the ecosystem becomes irreparable. The carrying capacity provides a mathematical relationship that tells us how many tourists are enough. Therefore, the measurement of carrying capacity is a powerful concept that can be used for sustainable tourism planning and management (Soleimani et al., 2018). Based on this, one of the ways to reduce the pressure on the environment is to determine the carrying capacity of different tourism areas and determine the amount of space required by the users based on this capacity. Determining the amount of space required for each user depends on various factors, the most important of which is the

number of tourists and travelers who use tourist sites for different purposes. Determining the number of tourists allowed to enter the place is also determined according to the carrying capacity of tourist complexes (Shar Consulting Engineers, 2014).

2. Literature review

2.1. Definition and concept of tourism

Tourism is a French word derived from the root (tour). Tour in French has the following meanings: circular motion (rotation), the act of walking, going around, touring, and touring. According to Pirlaros, tourism is the act of traveling for fun and pleasure, and a tourist is someone who travels for pleasure and pleasure. Based on common meanings, tourism refers to the activities that tourists and those who provide facilities for them. A tourist is also a person who goes on excursions and seeks to see different sights (Raisi, 2016). Also, according to Paul Ruber, tourism is the act of traveling and going somewhere other than the usual and conventional place of life to enjoy, even if this work is accompanied by a small movement, or the main purpose of this movement is non-fun and pleasure-seeking. A tourist is a person who does this, that is, he goes on a trip because of curiosity or leisure, enjoyment, or to claim that he has traveled (Asaadi, 2016).In Persian culture and literature, tourism or world travel refers to traveling on a world train for recreation, sightseeing, pilgrimage, and traveling to return to the place of residence, and includes short and temporary trips for purposes other than the place of residence. It also means travel (Assadi, 2016).

The term tourism was first mentioned in 1811 in an English magazine called Sporting Magazine. At that time, this word was used to mean traveling to see historical monuments and natural scenery for pleasure. In 1963, the United Nations International Conference on Trade and Development in Rome proposed, (a tourist or temporary visitor is someone who comes for recreation, rest, vacation, sightseeing, medical treatment, treatment, business, sports, Pilgrimage, visiting family, missions and participating in conferences, travels to a country other than his own country, provided that the duration of stay is not less than 24 hours and not more than 3 months, and the acquisition of a job or profession is not considered (Asaadi, 2016).

2.2. Tourism carrying capacity and its history

In the process of development of environmental management, the concept of carrying capacity was initially focused on the biological and biophysical concepts of this concept. So that until the early 1970s, the discussion of

estimating carrying capacity was mainly used in the management of pastures and pastures and to estimate the ecological capacity of pastures. This concept in forestry is also defined as the acceptable amount of wood production (harvest) in terms of cubic meters per hectare per year, and in the case of aquaculture, it is defined as the acceptable amount of harvest from the fish stock per year. In this way, the carrying capacity was initially considered equivalent to biological production due to the limitation in how to calculate it. With the emergence of the concept of sustainable human development in the early 1970s and the formation of the concept of sustainable economic and environmental development in the 1990s, which proposed three basic indicators, namely welfare, economic efficiency, and a healthy environment, as the main pillars of sustainable development, the concept of carrying capacity It was considered as a suitable tool for estimating each of the above three indicators along with other methods of measuring development indicators. At the same time, the increasing trend of indiscriminate exploitation of natural resources, intensification of pollution, environmental destruction, and the emergence of environmental crises, necessitates the use of methods to transform backward (man-made) ecosystems into adaptive ecosystems, it makes the found necessary. In such a situation, estimating the carrying capacity of the land and optimizing or adjusting the change threshold was used as one of the methods of controlling and monitoring the changes in the natural resources of the land and the balance of origin and destination. With the application of the concept of carrying capacity in development planning in the second half of the 1990s, significant progress was made in this field and a new concept called social and psychological carrying capacity was added to the environmental assessment literature, which was a turning point in the application of this concept to It counts (Hajizadeh, 2013).

2.3. Importance of carrying capacity of tourism

The World Tourism Organization (2005) emphasized that tourism operations in protected areas require careful planning and management and monitoring to ensure long-term sustainability, otherwise tourism operations will have negative consequences and the area will deteriorate. . It mainly includes environmental and social parameters such as environmental quality and visitor experience. Carrying capacity should not be considered a scientific concept or a formula to accurately obtain tourists, but should only be considered as a flexible management tool for sustainable tourism development that allows for reaching the level Optimum of the region's capacity (Hajizadeh, 2014).

2.4. The concept and definitions of tourism carrying

One of the concepts and methods of sustainable measurement that is usually mentioned in tourism planning sources is carrying capacity. This concept was adopted by researchers and managers in the field of tourism and environmental sciences to prevent negative social and environmental effects (Hajizadeh, 2013). The World Tourism Organization defines carrying capacity based on the following:

a) Levels should be maintained in such a way that they do not damage the physical environment and do not create cultural, social, and economic problems for society.

b) It is possible to establish a balance between the development and protection of natural resources.

c) The number of visitors should be consistent with the general goals and plans of tourism activities, as well as the type of environmental and cultural experiences that these visitors are looking for.

In the classification of the types of carrying capacity, the classification provided by Hunter has been more important than other classifications, which are:

Physical carrying capacity: This expresses the actual and physical number, capacity, and volumes without considering the functioning of the ecosystem and includes a limit of an area or region beyond which changes, disturbances, or environmental issues occur.

Psychological (perceptual) carrying capacity: It is the lowest degree of desirability and pleasure that new users of a developed area are ready to accept before starting the search to find another location option for the same user.

Social carrying capacity: the level of carrying of the host population in a developing area to accept the presence and behavior of the population of new users or the degree of readiness to accept density and crowding by new users.

Economic carrying capacity: the ability to attract and accept new development activities without displacement or disturbance in local desirable uses and activities.

Apart from Hunter's classification, two other definitions have been used in some evaluations:

Ecological carrying capacity: which considers the structure, function, role, and ecological processes in estimates.

Environmental carrying capacity: which finally gives an integrated and continuous estimate of the inherent and inherent carrying capacity by considering the types of carrying with a consolidated and consensus method.

Sometimes the carrying capacity is increased and adjusted by using services, which in such a case is defined as exogenous or service carrying capacity (Hajizadeh, 2013).

The concept of carrying has different definitions, but all the definitions of this concept have one point in common, and that is the change in the effect. In other words, what is more, important in estimating carrying capacity is a kind of compromise between maximization and optimization to achieve an acceptable level of change in thresholds and effect indices (Hajizadeh, 2013).

In the initial efforts in the field of tourism planning to determine the carrying capacity of the areas where tourists intended to travel, the important issue was how many tourists can be attracted to an area, without unacceptable environmental and social changes in the area. be created there. The following factors affect the carrying capacity of tourism destinations (Hajizadeh, 2013):

- Fragility and vulnerability of the landform against development and change
- The current level of tourism development and supporting infrastructure, such as sewage facilities
- Number of visitors, especially during peak hours
- The type of tourists and how they behave
- The amount of emphasis on environmental education for tourists and local people
- Economic differences and reliance on tourism
- The level of unemployment and poverty in the region
- Local people's opinion towards the environment and their willingness to take advantage of short-term benefits from it
- The effectiveness of cultures and societies against external influences and other new ways of life;
- The degree of organization of destination management

3. Materials and methods

The research method in this article is library and internet sources. Therefore, research materials and methods are a combination of library work and the use of internet resources.

4. Indicators in the capacity of tourism

Indicators provide important opportunities for defining and applying TCC. Indicators are often considered a prerequisite in developing a tourism strategy. The use of estimating indicators requires their application according to the set goals and the sensitivity of the places under study. In

this context, three types of indicators have been proposed in TCC compositions, which vary according to the type of place and tourism goals, and the priority, and importance of each of the indicators (Fayazi, 2013).

1. Physical-ecological indicators
2. Socio-demographic indicators
3. Economic-political indicators

4.1. Tourism carrying and its application

Every region or country has a limited ability to attract tourists and related activities, and these limitations are often explained by the carrying capacity technique in the framework of the theory of sustainable development of tourism. But first of all, it should be mentioned that providing a clear and understandable definition of tourism carrying capacity (TCC) requires examining it as a process within the planning process of tourism development. This category has two parallel and complementary processes that can be a general framework to guide local communities, planners, and decision-makers. All tourism capacity evaluations do not only include determining the number (threshold), such as determining the number of visitors. Even if these thresholds are achieved, these limits may not necessarily follow the goals of establishing realistically acceptable criteria. TCC formulation should provide not only a maximum level, but also a minimum level of development, i.e. the most sustainable. The level that sustainable local communities need. In addition, TCC may include different limits of carrying capacity in three combinations (physical-ecological, social-demographic, and political-economic). Each tourism board's capacities is not only a numerical value, but also requires a management tool (Fayazi, 2012).

Carrying capacity is a basic concept for policy making, there are many issues related to the estimation of capacities (thresholds and limits) and these problems are rooted in the multidimensional dimensions of the concept and inherent limitations in the estimation of human and natural ecosystems. Nowadays, the tendency to use range capacity has changed from setting thresholds to creating a favorable state of optimal policy for decision-making and planning, and it is suggested to replace other concepts in management goals. Also, usable tools that can facilitate the work of planners and decision-makers in the direction of controlling tourism development are growing and developing. However, there are limitations not only in the application of range capacity but also in its estimation. Therefore, the concept of the acceptance capacity of a tourist destination is based on the assumption that sooner or later a tourist destination will reach a point from which decline will await the destination. In other words, the number of

tourists will destroy the resources and attractions of the destination, therefore, the analysis of the acceptance capacity is a basic method in the planning process, which ultimately determines the development and limits of the visitors' use. Determining the capacity of acceptance in tourism is a necessary policy in planning, which is usually based on the analysis of the characteristics of the place, the development of the place, and the places used by tourists, and it is also feedback for the analysis of tourism markets (Qaderi, 2013).

4.2. Criteria for measuring carrying capacity

Generally, carrying capacity is determined by the following three items: (Table 1).

- Types of recreational activities: levels of use, temporal and spatial changes, the behavior of users and their different and reciprocal social and cultural effects on each other, and the type of perception of the quality of recreational places.
- Ecological features: natural processes and human effects on plant growth, soil, water, animals of the region, etc.
- Economic-social impacts: the scope of the imposed changes and the benefits obtained by the host society Naharli & Rezaei (2008).

Table 1. Measurement criteria and types of resort carrying capacity

Physical	▪ Development density (hectare/bed) ▪ Degree of user use (hectares/visitors) ▪ Ratios (residents/number of visitors)
Psychological	▪ The feeling and perception of crowding or the quality of the space (user/level) ▪ Incompatibility with other people's recreation (behavioral studies and travel behavioral models)
Ecological	▪ Analysis of environmental impacts, environmental pollution, damage to plant growth ▪ Wildlife distribution ▪ Changes in land use ▪ Impact assessment and environmental monitoring
Sociocultural	▪ Interactions between tourists and local people ▪ The acceptable level of tourist influences in the host society (survey and social studies)
Economic	▪ Damages and negative effects ▪ Obtainable profits ▪ Job opportunities (direct and indirect) ▪ The benefits of society from appropriate economic models

Infrastructure (structural)	▪ Benefits to the local community ▪ Cost of infrastructure procurement (per capita cost) ▪ Available capacities

Source: Naharli & Rezaei (2008).

4.3. Methods of estimating carrying capacity

The common chapter of all range capacity estimation methods is recognizing and determining the acceptable limits of changes in the applied knowledge (profiles), which is considered the main basis for the estimates. If the purpose of using land range capacity estimation methods is the sustainability of development activities in one area and a specific planning period, attention should be paid to the coordination of policies, preventive planning, acceptance of growth limitations, and commitment to one eye. The long-term plan will be a prerequisite for achieving goals that should be given serious attention in the early stages of planning (Fayazi, 2013).

To estimate the physical, ecological, social, and psychological range capacity, various methods have been used. Among these methods, we can mention the weighted valuation method, multi-criteria rating of capacity, adaptive ecosystem management model, ecological footprint measurement models, and other simple and combined methods. The aforementioned methods are used for leveling or grading the intensity of activities for one or a combination of compatible uses in a specific area and for a specific time, or considering changes in the area over time. Become some methods, such as the multi-criteria rating method of capacity in the planning stage for undeveloped areas or a proposal for development and the adaptive management model of the ecosystem, have been used to manage the adverse effects of development in developed areas. One of the practical methods for estimating carrying capacity is the guidelines proposed by the World Union for Conservation of Nature and Natural Resources, which was presented in 1996 mainly to calculate the carrying capacity of areas or zones suitable for tourism development within protected and managed areas. has been Estimating the range capacity in the framework of the aforementioned guidelines, like any other planning process, consists of six related and consecutive steps, in the last step of which, the range capacity is calculated at three different levels. The six steps in the above-proposed method provide the data and information needed to determine the limits and thresholds of the use and benefit of resort resources to the decision-makers and planners of protected and natural areas.

Step 1- At this stage, the policies related to environmental protection and tourism development within the natural or protected areas are examined and analyzed and the differences, potential possibilities, and contradictions

between them at the national, regional, and or are identified and determined locally.

Step 2- In this step, it is determined whether the patterns of exploitation and recreational activities are by the management goals of the areas under management or not.

Step 3- At this stage, an analysis of the current situation of the region is done in terms of natural power and the suitability of favorable areas for the development of social and cultural activities (including extensive or concentrated recreation).

Step 4- This step includes explaining or proposing new policies for administrative units or areas, or adjusting and improving existing policies, which, by combining the results of the previous steps, try to set a suitable and reasonable model of exploitation according to the ability and the potential suitability of the area for recreational activities and the type and quality of existing use of that area.

Step 5- At this stage, all the factors (factors) effective in the public use of the resorts, including physical, biological, social, and cultural factors, are identified and their characteristics and effects are identified to determine the sensitivity or vulnerability of the area for development is evaluated.

Step 6- In this step, the range capacity of the zones or areas suitable for recreation is calculated and determined. For this purpose, the range capacity of susceptible areas or zones is determined and estimated at three levels:

A) Physical carrying capacity (Pcc): The physical capacity of this instruction is the maximum number of visitors who can be physically present at a given place and time. The physical board capacity is calculated by the following equation.

$$Pcc = A \times V/A \times Rf$$

(Eq.1)

Where A is the area suitable for tourists, V/A is the amount of space that each visitor needs to be able to move easily and not interfere with other physical phenomena or people, and RF is the number of daily visits to a place. And is calculated based on:

$$RF = \frac{The\ time\ of\ place\ availability}{The\ Average\ time\ of\ a\ visit} \quad \text{(Eq.2)}$$

b) Real carrying capacity (Rcc): The real range capacity is the maximum number of visitors to a tourist place who are allowed to visit it according to the limiting factors caused by the special conditions of that place and the

effect of these factors on the physical range capacity. Place of visit. These limiting factors are obtained by considering biophysical, ecological, social, and managerial conditions and variables. Rcc is calculated based on the following formula:

(Eq.3)

$$Rcc = Pcc - cf1 - cf2 - \ldots - cfx$$

Where cf is a limiting factor expressed as a percentage. Therefore, this formula can be expressed as follows:

$$Rcc = Pcc \times \frac{100-cf1}{100} \times \frac{100-cf2}{100} \times \frac{100-cfx}{100}$$

(Eq.4)

c) Effective carrying capacity (Ecc): The maximum number of visitors to a place that the existing management can manage sustainably is called effective capacity. Management capability includes the set of conditions that the management of a region needs to achieve the desired goals and functions (Busby et al., 1996). This number is obtained based on the following formula:

(Eq.5)

$$Ecc \times \frac{100 - FM}{100}$$

Management capabilities include the set of conditions that the management of a region needs to achieve the required goals and functions. In the quantitative estimation of these capabilities, many variables are involved, such as policies and policies, laws and regulations, infrastructure facilities and equipment, required manpower, financial resources, etc. The lack of these management capabilities is one of the most serious issues in the management of tourist areas in developing countries. In any case, it should be noted that the effective range capacity never exceeds the actual range capacity and the existence of management capabilities can cause the use of an area up to the actual range capacity and not higher than that (Fayazi, 2019).

The management adjustment coefficient is obtained from the product of the ideal management capacity (IMC) and the actual or existing management capacity (AMC).

(Eq.6)

$$FM \times \frac{Imc - Amc}{Imc} \times 100$$

IMC number of ideal facilities for sustainable management of tourism (ideal management capacity)

AMC, the number of available facilities (actual or available management capacity)

5. Conclusion

To achieve sustainable tourism, an approach should be adopted that has the least negative effects and consequences. An approach that takes into consideration all economic, social, cultural, and environmental dimensions together. The philosophy of sustainable tourism originates from sustainable development, and therefore, considering that sustainable development is one of the principles and foundations of economic, social, cultural, and political progress in the world, and due to the role, that tourism can play in this field, especially in countries like Iran, it is very important to pay attention to sustainable tourism. Sustainable tourism uses tools and techniques to achieve the desired goals; one of its effective and important tools is the capacity to bear tourism. Carrying capacity determines the limits and thresholds of the tourist acceptability of each tourist site by using the determined criteria and criteria, according to the environmental capabilities. In such a way that the carrying capacity of each site can be increased by the maximum number of tourists who can visit a site at the same time without having negative consequences and feeling a decrease in tourist satisfaction. Currently, carrying capacity is the most common framework that is used to manage issues related to recreational uses and the resulting destruction of social benefits and features. The carrying capacity is at the center of the sustainability approach and is rooted in the management of tourism resources. This concept becomes more important especially when tourism destinations are under increasing pressure from users.

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