



Estimation of The Physical Carrying Capacity of Ria Kenjeran Tourism Area Surabaya City

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Abstract. The tourist area of Ria Kenjeran in Surabaya has seen an increase in the number of visitors year on year. The increase will affect both physical and nonphysical environmental conditions. Efforts are needed to mitigate negative impacts so that Ria Kenjeran can sustainably limit visitors to its carrying capacity. This study aimed to determine the maximum number of visitors that can be accommodated by the physical environment in The Ria Kenjeran Tourist Area, and to determine when it started to be enforced. The research was conducted in Ria Kenjeran Tourist Area, Surabaya City, which contains several attractions. This study employs a descriptive quantitative approach, utilizing a sample of 20 tourists in each area. The respondents were chosen through accidental sampling. Interviews are used to gather information on the length of stay and the needs of visitors in terms of activities in each destination. Measurements were also taken to determine the size of each attraction, observations were made to determine the length of time each tourist area was in operation, and documentation was collected to gather data on tourist numbers. The data has been analysed and incorporated into the Regional Carrying Capacity formula, which allows tourism growth to be predicted. The study shows that the physical carrying capacity of the Ria Kenjeran tourist area is 32,177 visitors per day. This figure is expected to be reached in 2042. Therefore, from 2042 it will be necessary to limit the number of visitors to a maximum of 32,177 per day.

Keywords: Tourists, Carrying Capacity, Impact, sustainable

1 Introduction

Anggreni, N.I.[1] explained that the development of tourism has various impacts, both positive and negative, on various aspects. The positive economic impact of tourism such as employment increases, business opportunities increase, local culture is maintained. However, there are negative impacts that need to be watched out for, namely the development of consumptive lifestyles, increased population pressure due to new arrivals from outside the region, the emergence of commercialization, disturbed environmental conditions. Negative impacts that arise as much as possible are avoided

or minimized, especially environmental conditions, both physical and non-physical environments so as not to cause losses.

Khrisnamurti, Utami, AND Darmawan [2] explained that the negative impacts of tourism on the environment on Tidung Island include 3 things, namely excessive accumulation of waste, visual changes in the landscape of tourist areas and decreased groundwater quality. Sutoyo, Adi, and Yanto [3] also explained that the negative impact can occur on the community's economy where there is a gap in income and community welfare between tourism actors and other communities that are not in direct contact with tourism, as well as the helplessness of local communities in terms of economic competition with investors from outside the region.

The development of tourist attractions is not only an economic aspect that must be considered but also an aspect of environmental sustainability. The development of sustainable tourism areas in a sustainable manner is widely launched by tourism developers today considering the negative impact caused by uncontrolled tourists who come to a tourist attraction. Various studies show that, so certain steps are needed to prevent damage that can befall tourist areas, as explained by Saptutyningsih [4] and Wahyuningasih [5].

There are various methods of tourism development that can reduce the negative impact of tourism that has developed, one of the development methods is from the perspective of tourists. In essence, tourists must feel comfortable, satisfied and happy while enjoying the attractions in the tourist area. This method is by limiting the number of tourists in the tourist area at a certain period of time, with a limited number of visitors, tourists who are in the place will be more free, satisfied and orderly in enjoying its attractions. In order to avoid or reduce the negative impact that arises, efforts are needed to limit the number of tourists who visit. The visitor restrictions still pay attention to economic factors, but with a reduced number of benefits. Therefore, certain methods are needed to get numbers of visitors that are still profitable but can still maintain maintained environmental conditions. The number of visitors who come must be adjusted to the capacity of the tourist destination area, that is the meaning of limiting the number of tourists.

Another definition of restriction is the development of tourism in accordance with its carrying capacity. The method of restriction is contrary to the economic aspect, because it will reduce the income that should be achieved, but if restrictions are not carried out there will be discomfort for tourists who visit. This is very influential on the number of visitors in the future, because tourists who do not feel comfortable visiting a tourist area will be a bad informant for the attraction, especially if there is damage. The next result is the decline in the number of tourists and the cost of repairing damage that is not small, which ultimately from an economic aspect will be detrimental.

To reduce the negative impact that can arise on tourist areas due to the development of tourism that has been carried out, it is necessary to measure the capacity of tourist attractions in accommodating a number of tourists in a certain time. The capacity limit is determined from the opinion of tourists about feeling comfortable, or satisfied during activities in the place. In general, the ability of tourist areas to accommodate tourist activities is called Carrying Capacity, as explained by Rini, Setyobudianti, Kamal [6], and Hidayat, *et al* [7] that the carrying capacity of tourism is the maximum number of

people who can visit one tourist spot at the same time without causing damage to the physical, economic and socio-cultural environment and a decrease in quality that is detrimental to tourist satisfaction

The carrying capacity of tourism can be determined through 3 factors, namely physical carrying capacity (PCC), real carrying capacity (RCC) and effective carrying capacity (ECC) which can be tested using a method developed by Cifuentes and has been suggested by the International Union for Conservation of Nature [8]. Tourism carrying capacity is also the biogeophysical, socio-economic and socio-cultural carrying capacity of a location or tourist site in supporting tourism activities without causing a decrease in environmental quality and tourist satisfaction in enjoying tourist locations and sites [7].

Oktavia, *et al.* [9] explained that the determination of physical carrying capacity through measuring tourist area (m^2), the space needed by tourists to carry out their activities (m^2 / person), and rotation factors. The size of the physical carrying capacity is influenced by the area of tourism, the area needed by each tourist to carry out their activities, the length of time tourists visits, and the length of time the tourist area is open for visit. The physical carrying capacity for each tourist area is not the same due to different environments, which causes the level of tourist satisfaction to also be different for different tourist locations.

Tourists who visit a tourist area will go to one of the spaces or places in the area to carry out their activities. Activities carried out by tourists will be freer and will feel comfortable in doing it if the place meets their needs. Physically the place is quite spacious and able to support the activities of all tourists and tourists still feel comfortable. Wahyuningsih [5] explained that physical carrying capacity is the area needed by tourists to freely and satisfactorily travel

The number of tourists visiting the Ria Kenjeran Tourism Area from year to year has increased, If there is a continuous increase in the number of tourists, at certain times in the future, the number of tourists visiting can certainly exceed its carrying capacity. Therefore, it is necessary to know the carrying capacity of the tourist area in accommodating visitors as the maximum limit of visits. With the restriction on the number of tourist visits, it is expected that economic benefits will be maintained even though the number is reduced, but environmental conditions are maintained so that costs for environmental improvements are also much reduced.

It is important to know when the capacity of the Ria Kenjeran tourist area is exceeded so that it can be known from when restrictions on the number of tourists are implemented. From the restrictions on tourist visits, environmental damage to tourist areas can be avoided. To find out this, you can use tourist visit data on an annual basis by calculating the growth rate of the number of tourists.

With the restriction on the number of tourist visits, it is expected that economic benefits will be maintained even though the number is reduced, but environmental conditions are maintained so that costs for environmental improvements are also much reduced. That background causes research on the maximum ability of tourist attraction areas to accommodate a number of tourists in a certain period of time needs to be carried out. Some tourists can still visit comfortably but the number of visitors needs to be limited.

Based on the problems that have been explained as above, the formulation of the problem that can be made is as follows.

1. What is the carrying capacity of the environment that occurs in the tourist area of Ria Kenjeran Surabaya City?
2. When is the carrying capacity of Ria Kenjeran's tourist environment exceeded by the number of tourists visiting?

2 Method

The type of research used is survey research with a quantitative descriptive approach. The research location is located in the Ria Kenjeran Tourism Area of Surabaya City which includes the following areas: 1) Atlantis Land, 2) Camping Area, 3) Tian Ti Pagoda, 4) Children's Play Ground, 5) Kwam Im Godden Statue, 6) Brahma Statue Art 7) Water Park, 8) Outbound Area. The population in this study is tourists who are visiting the location of Ria Kenjeran Beach, while the research sample of 20 respondents each was taken by accidental sampling in each tourist attraction area.

Interviews with tourists with the help of questionnaires are used to obtain data on the duration of tourist visits, the area needed to carry out activities in each attraction area, while to find out the area of tourist attractions, measurements are made on google map and field checks. Interviews with managers were also conducted to find out data on the number of tourist visits and the duration of operating hours of tourist areas. To find out the condition of tourist sites in general, field observations were carried out.

To determine the physical carrying capacity of each tourist area, equation (1) is used as follows:

$$PCC = \frac{A}{A_n} \times R_f$$

In this case:

PCC = Physical carrying capacity in units of the number of tourists/day

A = tourist area (m²)

A_n = area needed by tourists to do activities at the attraction location (m² per person)

R_f = rotation factor obtained from the average length of tourist visits divided by the duration of the tourist area opened every day.

Furthermore, to determine the physical carrying capacity of the Ria Kenjeran Tourism Area, an average calculation of the entire physical carrying capacity of all tourist areas on Ria Kenjeran Beach was carried out. To find out the estimated time when the carrying capacity of the Ria Kenjeran tourist area is exceeded by the number of tourists who come, equation (2) is used as follows:

$$P_n = P_0 (1 + \alpha)^n$$

In this case:

P_n = the number of tourists when carrying capacity is reached (= PCC)

P₀ = the number of tourists at the beginning of the calculation

α = the number of tourists at the beginning of the calculation

n = period (years) from the beginning of the calculation

3 Result and Discussion

3.1 Physical Carrying Capacity.

The calculation of the carrying capacity of each attraction location uses data on the length of visit at each attraction location, the needs of each tourist in carrying out activities at the location of the attraction and the area at the location of the attraction. However, for attractions with a certain duration, such as all attractions in Atlantic Land, it only calculates the capacity and duration of the attraction. The calculation of the physical carrying capacity of each tourist attraction uses equation (1).

3.1.1 Atlantic Land

It is a recreation area, especially children, consisting of several attraction areas, namely Kids Kingdom, Extreme Area, Dino Land, Water Land, Atlantis Mystery, Carousel, Tea Cup, Fountain, Globe Death, Bumper Car, Mini Coaster, Star Dancer. In these attractions, the duration of each attraction is certain but varies in length and maximum capacity to be used by visitors. From the results of the study it can be seen that the ability of the Atlantic Land area to accommodate tourists is 13,468 people every day

Atlantis Land which contains a variety of attractions, the number of visits every day at each attraction has not been maximized. Attractions that many visitors like are the Mini Coaster and Extreme Area, but the two places are not too large waiting rooms even though the capacity to accommodate visitors who want to enjoy them is quite large. The activity of visitors in large numbers is usually difficult to control so that it has the potential to have a negative impact on the environment, especially cleanliness and physical damage. This is in line with research by Untari, et al. [10] which states that the activities carried out by visitors result in a build-up of waste.

3.1.2 Outbond

Outbound activities in the Ria Kenjeran Tourism Area are not every day, on average there are only 3 days a week, even then not a full day. The absence of these activities is not because it is closed, but users have not used it much. Therefore, the outbound area in the Ria Kenjeran Tourism Area has not reached its maximum physical carrying capacity. Outbound activities are carried out in packages under the instructor of the tour manager, users can choose a package of 4 games or a package of 8 games. These game packages can be done during outbound operating hours, namely 08.00 to 15.00 or a duration of 9 hours every day. From the data obtained, it can be seen that the Physical Carrying Capacity of the Outbound Area is 120 people every day, or every day for activities 2 packages of 4 games or only the same 60 people for 1 package of 8 games.

Outbound development in the Ria Kenjeran Tourism area includes the expansion of areas and types of games. The choice of game type needs to consider games that can increase emotional and spiritual intelligence in interacting and can form a creative

mindset. Games that increase intelligence are embraced by many circles. Falah [11] explained that such games are needed by students, students and employees and they are a potential market.

3.1.3 Play Ground

It is a playground for children, which is open from 08.00 to 18.00 or for 9 hours every day, with a relatively small number of games. The area available to play is 270 m². The average area needed for children to play for 1 hour, while the area needed to play is 6 m² per child. From these data, it can be seen that the Physical Carrying Capacity for the Play Ground area is 450 children every day. Meanwhile, the average number of children playing in this place is 68 children every day. Thus the Play Ground area to date has not reached its carrying capacity, therefore the number of visitors can still be increased.

The Play Ground in the Ria Kenjeran Tourism Area is currently relatively narrow in size so it is not possible to use freely by children, especially in the future if the number of visitors increases. For this reason, proper development is needed so that it is beneficial in all aspects for children who use. Alamo [12] explained that safety and comfort aspects are important factors in the development of children's playgrounds, including the selection of appropriate materials, the existence of a game safety zone, visual scenery, and the right game layout. Baskara [13] also explained that in designing a playground children need to pay attention to aspects of safety, comfort, health, convenience, security and beauty. While the control component in its design must pay attention to location, layout, game equipment, construction, and materials.

3.1.4 Kwan Im Goddess Statue, Brama Statue Art, Cetiya Bhavana, Pagoda Tian Ti

The area of Kwan Im Goddess Statue, located on the seafront, consists of buildings for Buddhist prayers, especially Chinese, open areas for places to relax while seeing the Kwan Im statue and the open sea, and taking pictures. The total area is 1300 m², consisting of an open area of 900 m² and a building area of 400 m². The capacity of the building for a place of prayer together is very limited, limited to only 5 people simultaneously. In the building are stored various infrastructure and prayer facilities that occupy quite a lot of space so that people who pray at the same time are very limited in number. From the observations it can be seen that people who pray in the prayer room between 10 minutes to 20 minutes, the time difference is because it suits their individual needs, or an average of 15 minutes per person. If the duration of opening time is 9 hours every day (08.00-17.00), the capacity of the room to accommodate people praying is 180 people every day.

Meanwhile, the place outside the building consists of open space and trees, open space is commonly used for outdoor activities such as selfies covering an area of 400 m². From the interview results, it can be seen that each mountain on average requires an area of 12 m² to move comfortably in carrying out its activities, while each visitor

needs a long visit time between 15 to 35 minutes or an average of 30 minutes. If the duration of the attraction location is 9 hours every day, then the ability to outside the roar of the Kwam Im Goddess Statue area to accommodate visitors is 600 visitors per day. Thus the ability of the Kwam Im Goddess Statue area to accommodate tourists every day or Physical Carrying Capacity every day as many as 780 visitors.

Brama Statue Art area, is the place of the 4-faced Brahma statue. This place is often used by Buddhists to worship Brahma in a certain way on the edge of the statue. It consists of the main building where the Brahma statue is located, with a building area of 20 m², while around it is a courtyard and trees that are quite shady. The courtyard around the court has an area of 450 m² which is used to observe ptunag and photo spots.

Buddhist places of worship are carried out around the statue by standing in a row in a row if there are several people simultaneously praying. Simultaneously it can be used by 18 people to perform prayers. The duration of prayers is generally relatively short between 10 and 15 minutes per person, or an average of 12 minutes per person. If used continuously during the location is open, which is 9 hours, then the place can accommodate as many as 810 people in turn to pray. The open space around the statue is often used by followers of other religions to see the statue and take pictures. The time it takes visitors to do the activity is between 15 to 30 minutes, or an average of 20 minutes per person, while the area needed to carry out these activities is between 10 m² to 20 m² or an average of 15 m² per visitor. With this data, it can be seen that the ability of the open place at the location of the Brahma Statue Art Area has the capacity to accommodate as many as 1080 visitors. Overall, the Brahma Statue Art Area has a physical carrying capacity of 1890 visitors daily.

The place adjacent and part of Brahma Statue Art is Cetiya Bhavana, this place is a place of worship for Theravada Buddhists, Cetiya is the smallest form of worship space after arama and vihara, and is an object of veneration reminiscent of the Buddha, in this case Bhavana i.e. the 10 principal disciples of Buddha. Inside the room of the building there are also writings that are the teachings of Buddha Siddhartha Gautama.

The size of the building area is relatively small, approximately 50 m², and Buddhists can worship the available altar. The capacity of the building to accommodate Buddhists who will perform worship at the same time is 5 people, while the time available for worship is from 08.00 to 17 o'clock. 00 or for 9 hours daily. The time used to worship each person averages 15 minutes, thus the ability of Cetiya Bhavana to accommodate devotees to worship as many as 180 people every day. Meanwhile, visitors who do not worship can look at Buddhist writings and pictures related to Buddhism. The capacity of the room is only 10 visitors with an average visit duration of 15 minutes, so the carrying capacity of the building to be occupied by visitors is 360 people every day.

Tian Ti Pagoda complex occupies an area of 3,750 m², consisting of a building area and courtyard of 1300 m² and a garden area around it of 2450 m². Visitors carry out their tourist activities, namely looking around and taking pictures in the surrounding building or yard. Visitors who come need time to move between 20 minutes to 30 minutes or an average of 25 minutes, while the area needed to do activities is between 6 m² to 8 m² or an average of 7 m² per person and Tian Ti Pagoda is open for 8 hours every day. From these data, it can be calculated that the physical carrying capacity of the Tian Ti Pagoda area to accommodate tourists is 3702 visitors every day.

Religion, according to Pals [14], has 2 meanings, namely first is a religion related to God, second religion is part of culture to fulfill collective consciousness and as an identity. Religious tourism in the Ria Kenjeran tourist area in the form of buildings or statues of Buddhist religious figures such as Kwan Im Goddess Statue, Brama Statue Art, Cetiya Bhavana and Tian Ti Pagoda. These places are used as tourist attractions, but as tourist attractions have not been able to provide wider knowledge to tourists about the figures depicted. Various forms of narratives about the characters depicted can improve the quality of visitors' tours, which at the same time increases their tourist attraction. Visitors not only look around and take selfies but also gain knowledge from tourist activities.

3.1.5 Camping Area

The camping location in the Ria Kenjeran tourist area is a flat area and many trees are quite shady, the area for camping as a whole is 2.5 ha (Lt), but the area that can be used is only 2 Ha (Lp). To carry out various activities at the campsite, an average area of 50 m² is needed for each person or 200 people per hectare. At least, visitors camp for 1 day or 24 hours, this duration is the time spent camping (=Wp). In calculating the carrying capacity of the area for camping, the daily operational duration of the tourist area uses 24-hour data because campers will stay in the area for at least 24 hours. From these data it can be seen that the value of the carrying capacity of the camping area is 400 people every day.

The Camping Area in the Ria Kenjeran Tourism Area is still quite large, so it has the potential to be developed further. The conditions of the camping area are attractive, especially if glamping is developed, it will become an additional, more interesting attraction. More attractive tourist attractions will attract more visitors to come, as explained by Fitroh, Hamid, and Hakim [15] that tourist attractions will have a positive effect on a person's motivation to travel. This means that a more attractive tourist attraction will attract more visitors who come to a tourist attraction location.

3.1.6 Water Park

It is a family tourist spot with water games and swimming sports. This place is surrounded by trees that are quite shady so as to provide a shadier atmosphere. Water Park opening hours start at 08.00 and close at 17.00 or the duration is open for 9 hours every day. In the Water Park there are several water rides, namely Children's Pools, Adult Pools, Flow Pools and Water Sliders. The average time spent on activities in the swimming pool is 90 minutes and can simultaneously accommodate as many as 60 people, while in the lazy river it takes an average of 10 minutes and simultaneously as many as 30 people. On the water slider, visitors can feel the sensation of sliding in a dark place before finally falling into the swimming pool. The duration of gliding is approximately 1 minute, but for one launch with the next launch it is set every 10 minutes. With 2 launch sites and 5 people at each launch, the number of visitors who can launch is 540 visitors every day, while the swimming pool can accommodate 669

people, the lazy river is 1080 people, so that the Water Park has the maximum capacity to accommodate visitors to carry out their activities as many as 2229 people every day.

3.1.7 Culinary

Places to sell food and drinks in the Ria Kenjeran Tourism Area are quite extensive, and close to the sea, visitors who sit eating and drinking in that place can see views of the open sea. Food and beverage outlets are available for traditional foods such as racing rice cake, clam satay, as well as food products (snacks) from sea fish and there are also Chinese-style culinary delights such as Kia-kia. This culinary area is approximately 1 hectare and has the potential to become a Ria Kenjeran culinary tour. Visitors can sit back and relax in this place while eating while enjoying views of the sea and nearby mangroves. The average need for a place to relax in this place is 4 m² and the time needed is an average of 90 minutes. From these data it can be calculated that the capacity of places to eat and drink after deducting the area of service for visitors to all outlets is 6400 visitors per day.

Ratnasari, Levyda, and Giyatmi [16] explained that culinary tourism is developing not only to carry out tours followed by eating until full but also want to know the background of regional specialties being made so that people's culture can be known through these foods. One manifestation of the results of the community's work is food and drink which was originally a physical need but in its development has involved social needs as well as religious needs. Therefore, regional specialties and drinks can be used as an interesting culinary tour.

The Physical Carrying Capacity of the Ria Kenjeran Tourism Area is 32,177 tourists per day obtained from the total Physical Carrying Capacity of each attraction area as above. Meanwhile, the average number of tourists visiting tourist areas is 25,277 people every day. Therefore, the physical carrying capacity of the Ria Kenjeran Tourism area is currently not too old so there is still an opportunity to increase the number of visitors. One way to increase the number of visitors is by increasing the quality or quantity of attractions. Mauludin, [17] and Ananda, et al. [18] explained that attractions will have a positive effect on interest in visiting tourist objects.

3.2 Estimated carrying capacity exceeded

To find out when the physical carrying capacity of the Ria Kenjeran Tourism area can be exceeded by the number of visiting tourists, the growth in the number of annual visits is used based on data on the number of tourist visits from 2015 to 2019. The data for that year had to be used because in 2020 and 2021 the lockdown due to covid 19 so data on tourist visits in 2020 and 2021 cannot be used. From the calculation results it can be seen that the average growth in the number of tourists is 12.34 % or 0.1234. Furthermore, the estimation when the number of visitors to the Ria Kenjeran Tourism Area is equal to its physical carrying capacity can be determined by equation (2). The

calculation results show that it will be exceeded after 23 years since 2019 or the number of visitors to the Ria Kenjeran Tourism Area will exceed its carrying capacity in 2042.

Currently the number of visitors to the Ria Kenjeran Tourism Area is still below the maximum limit value (physical carrying capacity) so there are still opportunities for the development of tourist facilities and infrastructure so that there is an increase in the number of visitors safely. Simon, Narangajavana, and Marques [19] explained that the carrying capacity value can be used to determine the direction of tourism development. The carrying capacity of tourism reflects the maximum number of visitors that can be accommodated by a tourist area, if the capacity is exceeded it will create several negative impacts in the form of a decline in resources, detrimental to society economically and culturally which can ultimately reduce the number of visitors.

4 Conclusion

Based on the results of the research and discussion, it can be concluded that the condition of the Ria Kenjeran Tourism Area can be explained as follows.

At present, the Ria Kenjeran Tourist Board receives an average of 25,727 visitors per day, while the maximum capacity is 32,177 tourists per day. The maximum capacity to accommodate visitors varies between the attractions in the Ria Kenjeran Tourist Area, depending on the area of the attraction or the setting of the tourist spot. Abbreviations for technical terms will be explained when first used.

Ria Kenjeran is currently able to accommodate tourists. However, it is predicted that in 2042, the capacity of the tourist area will be balanced with the anticipated number of visitors or that the physical carrying capacity of the tourist area will be reached due to the growth in the number of tourists visiting.

Based on the results of the research and discussion, it is suggested to the Manager of the Ria Kenjerean Tourism Area as follows. Starting in 2042, the number of visiting tourists needs to be limited to as much as the capacity of its capacity, namely 32,177 visitors per day. Arrange visits to other attraction areas so that there is no accumulation in one of the attraction areas which is a favorite of visitors. Development of Culinary Tourism through arranging places to sell and adding Surabaya special food and drinks along with narratives about these foods and drinks.

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Author Contribution

This research is conducted by two researchers. Agus Sutedjo and Sri Murtini conceived and designed the analysis. Agus Sutedjo collected the data and contributed data or

analysis tool. Sri Murtini performed the analysis. Agus Sutedjo and Sri Murtini wrote the paper.

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