

SYSTEM DYNAMICS MODELLING FOR TOURISM CARRYING CAPACITY IN SABA BUDAYA BADUY

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Article Info	Abstract
Keywords: Sustainable Tourism, System Dynamics, Tourism Carrying Capacity, Tourism Policy, Visitor Limitation Model.	Saba Budaya Baduy serves as a significant tourist destination contributing to the local economy of the Baduy community. However, the substantial surge in tourist arrivals poses potential long-term challenges for the local Baduy community. The issues arising from tourism activities encompass cultural shifts, environmental changes, and impacts on the local economy. This research aims to propose a sustainable visitor limitation model to ensure that elements linked to the interests of tourism business activities remain unaffected by visitor restrictions. Quantitative methods apply the Tourism Carrying Capacity (TCC) approach to determine visitor benchmarks and System Dynamics (SD) for simulating visitor limitations over ten year. Model 3, proposed as a policy, yields sustainable visitor limitation policies. The proposed measures include phased visitor limitations annually, price adjustments, agreements between managers and tour operators, and feedback agreements between managers and local businesses. Simulation results from Model 3 project that the TCC-defined visitor limitation value will be achieved by the 10th year (2030), totaling 16,406 visitors annually, compared to an Effective Carrying Capacity (ECC) of 15,612 visitors annually. These measures enhance the local socio-economic resilience through the assurance of annual income stability.
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INTRODUCTION

Tourism plays a significant role in fostering the economic growth of a country. As one of the fastest-growing industries globally, tourism has experienced various disruptions. Mass tourism emerged due to changes in socio-economic patterns in modern society resulting from the Industrial Revolution in the 18th century. The existence of a consistent wage system has led modern society to spend part of their income on traveling out of town and vacationing in places such as beaches. Mass tourism is observed based on the large number of people traveling to a destination for leisure (Butcher, 2020). The emergence of mass tourism has sparked several criticisms, including critiques regarding the perceived superiority of one culture over the culture of the destination concerns related to mass consumerism, which can lead to social and environmental inequality issues (Butcher, 2020). The criticisms have led to a counterculture known as alternative tourism, which prioritizes morality in travel. One concept within alternative tourism is cultural tourism, which is supply-oriented. This concept emphasizes the experiences gained by tourists when visiting destinations with different cultures. Thus, the tourism concept no longer follows the tide of globalization, which demands cultural uniformity (Jovicic, 2016). The concept of quality tourism is developed to ensure that tourists and the local community in tourist destinations have a positive and comfortable experience through tourism carrying capacity and conservation efforts (Haribudiman et al., 2023).

The disruption in the tourism sector has significant implications for several countries that rely on tourism as an economic driver. The emergence of the COVID-19 pandemic has restricted travel, effectively freezing this sector. According to the Organization for Economic Co-operation and Development (OECD), the tourism industry is among the hardest hit by these circumstances (Jha, 2022). The tourism sector is one of the pillars of the Indonesian economy. Data from 2016 to 2019 shows that the tourism sector contributed to the national GDP, accounting for 4.63% in 2016 and 4.97% in 2019. However, the COVID-19 pandemic had a negative impact on the Indonesian tourism sector, leading to a decline in its contribution to GDP in 2020 to 2.23% and in 2021 to 2.3% (Kemenparekraf, 2023).

To build the tourism ecosystem post-COVID-19, UNWTO, in the G20 summit 2023, suggested building the tourism economy from the most vulnerable strata, i.e., rural areas. Tourism guides the economic self-reliance of rural areas, thus enhancing the income of these vulnerable areas (UNWTO, 2023). However, the uncontrolled growth of rural tourism can also give rise to challenges and issues in achieving sustainable tourism goals (Xiang et al., 2020). Saba Budaya Baduy is one of the tourist destinations located in the Banten Province, Indonesia. This tourism destination exemplifies a rural - ecotourism destination that faces issues that need to be resolved to achieve sustainability.

The Baduy community is divided into the Inner Baduy and Outer Baduy, with the Inner Baduy adhering firmly to the cultural values and ancestral traditions, while also distancing themselves from modernization. The uniqueness of their culture and traditions make Saba Budaya Baduy an attractive tourist destination (Mutaqien et al., 2022). Mass tourism activities impact the environment and the local community, particularly in the Inner Baduy cultural heritage. In the Dimension of environment, tourist visitors leave non-biodegradable plastic waste: the higher the number of tourists, the higher the amount of plastic waste generated from tourism activities. It was identified in a study on tourism's

ecological, social, and cultural impacts (S. I. Prasetyo et al., 2021). The presence of tourism in Saba Budaya Baduy also results in a disruption of cultural transfer to the younger generation due to the influence of modern culture brought by visitors (Rohaendi, 2023). The number of visitors to Saba Budaya Baduy in 2019, before the COVID-19 pandemic, experienced a significant increase compared to 2018. Following the pandemic in 2022, this upward trend in visitor numbers has started to occur again. The escalation of mass tourism activities leads to the largest problems if there is no management based on tourism policies (Butcher, 2020).

The increase in visitor numbers also has a positive impact on the income of the village and local businesses. The presence of tourists visiting Saba Budaya Baduy increases the village's income, and local communities earn income from various sources such as selling agricultural products, crafting Baduy's dagger, and Baduy's weaving. Additionally, the presence of visitors also provides employment opportunities for local communities, such as working as tour guides (Mutaqien et al., 2022).

The positive and negative impacts resulting from the secondary data were further analyzed through in-depth interviews with the village office. The interview results confirmed that mass tourism has brought negative and positive impacts. The negative impacts include a change of the lifestyle of the local Baduy community, which is now leaning towards the modernity brought by visitors that violates cultural regulations for visitors that disrupt traditional culture taught by previous generations to the new generation. Regulations commonly violated by visitors include chemical substances such as shampoo, soap, toothpaste, and others. This change has negative impacts on the future of the Baduy indigenous community, considering the tourism appeal offered by the Saba Budaya Baduy, which is the authentic culture possessed by the Baduy indigenous community (Waluya et al., 2022). Furthermore, these chemical substances can damage the natural ecosystem there, considering that the Baduy indigenous community still relies on water sources and rivers for daily life (Asteria et al., 2021). In 2020, the Baduy tribal leaders proposed to the central government of the Republic of Indonesia to remove Saba Budaya Baduy as a tourist destination. This was due to the disproportionate negative impacts received by the local community compared to the positive impacts resulting from mass tourism activities (Intan, 2020). Figure 1 represents the number of tourists.

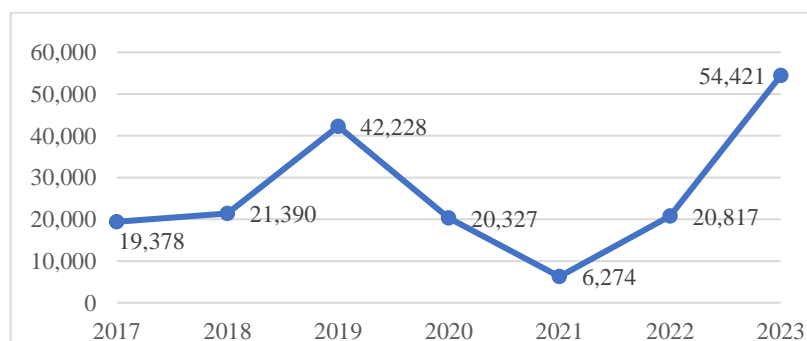


Figure 1. Tourists Amount of Saba Budaya Baduy 2017 – 2023
Source: Tourism Office of Lebak Regency, 2023

On the positive side, the presence of visitors has led to increased income for the village and improved the local economy. However, the management of the economy in

Saba Budaya Baduy still faces several challenges due to lack of unity between local communities, village office as tourism manager, and travel service as tourism operator. This lack of cohesion leads to price competition in travel services, resulting in unstable income for the local community, which ultimately contributes to social disparities. The village office, which should have authority over the tourist destination, cannot set visitor quotas due to the involvement of the local Baduy community, who have interests in tourism activities. As a result, travel services sometimes disregard the number of tourists visiting. The commercialization of tourism in the Saba Budaya Baduy cultural village is not the primary concern; rather, it is about how the local community can generate income while preserving the cultural heritage in the presence of tourism. Thus, tourism can encourage the local Baduy community to maintain the sustainability of their culture. One aspect of their culture is preserving the natural environment.

Control is crucial in any proposed development discussion, especially controlling the number of visitors engaging in tourism activities (Seraphin & Ivanov, 2020). Visitor restriction through carrying capacity in tourism has been implemented using formulas implemented by Cifuentes in 1992, such as physical carrying capacity (PCC), real carrying capacity (RCC), and effective carrying capacity (ECC). Tourism carrying capacity also contributes to sustainable tourism development, which refers to three frameworks. First, the recovery of natural resources, environment, and ecosystems is needed. Second, implementing integrated planning in land use, economic growth, socio-demographic strengthening, and environmental sustainability. Third, educate tourists to change their attitudes, behaviors, and ethics (Haribudiman et al., 2023). Several studies have utilized visitor limitations to achieve sustainable tourism, including Mijiarto and Rachmawati (2022), Rasidi et al. (2023), Mota et al. (2021), Sihombing et al. (2022), by implementing visitor restrictions through Cifuentes tourism carrying capacity method, the threshold of the number of visitors can be determined, ensuring that the environment and social aspects of the tourism destination are not disrupted.

The carrying capacity in a tourism system offers the advantage of reducing the risk of overtourism. It prioritizes the planet, people, partnership, prosperity and peace. However, on the other hand, stakeholders' income as a partnership within the tourism system may be disrupted, even decreasing their earnings. In this regard, the development of a system thinking-based model is highly significant, as it can encompass several components within the system holistically. System dynamic simulation has been widely employed in designing sustainable tourism models; this approach can simulate a cause-and-effect model over a specified period (Sedarati et al., 2021). Several studies have utilized system dynamics to build sustainable tourism, as will be outlined: Susanty et al. (2020), Sjaifuddin (2020), Mustafa and Hawari (2022), Tan et al. (2018). The results of system dynamic simulations, oriented towards sustainable tourism models, are utilized by addressing the root causes of tourism issues. For example, reducing private transportation emissions, such as CO₂ (Susanty et al., 2020), limiting the number of tourists for sustainability concerns (Sjaifuddin, 2020), enhancing tourism facilities and attractions (Mustafa & Hawari, 2022), and implementing visitor management based on the area's carrying capacity (Tan et al., 2018).

Previous research on the visiting model to the cultural tourism destination of Saba Budaya Baduy has predominantly focused on qualitative concepts based on the local customs and traditions, such as the determination of visiting regulations based on

customary regulations to ensure the sustainability of the tourism system. Several articles discussing the tourism visiting model include Waluya et al. (2022), Nugroho et al. (2024), Solikhah (2020). There is an unfilled gap in this research, particularly in technical field studies, such as the absence of determining the limit of the number of visitors allowed to visit and modeling visitor restrictions that still prioritize the local economy.

The objective of this research is to propose a tourism model for Saba Budaya Baduy to achieve sustainable tourism. Based on the above issues, the implementation of the Tourism Carrying Capacity (TCC) approach to limit tourist visitors must be carried out. The System Dynamics approach simulates visitor limitations to avoid negative impacts on elements within the tourism system. It is expected that the proposed tourism model will provide insights for implementing visitor limitation policies in Saba Budaya Baduy.

METHODOLOGY

The research was in the tourism destination of Saba Budaya Baduy, Kanekes Village, Lebak Regency, Banten Province, Indonesia, in 2023. The type of data used in this study are primary data. Primary data were obtained directly from key informants through in-depth interviews with several stakeholders who have interests in the Saba Budaya Baduy tourism system.

The primary data obtained is based on in-depth interviews with several stakeholders, including four individuals from the village apparatus, two from cultural and tourism activists of Saba Budaya Baduy, and five travel service owners who bring visitors for tourism purposes. Digital mapping or Geographic Information System used as primary data. Digital mapping determined the area of Kanekes Village, especially for Spacious, and the slope of tourism route of tourists area (Figure 2). Q GIS Software and Google Earth Pro used for this primary data collection.

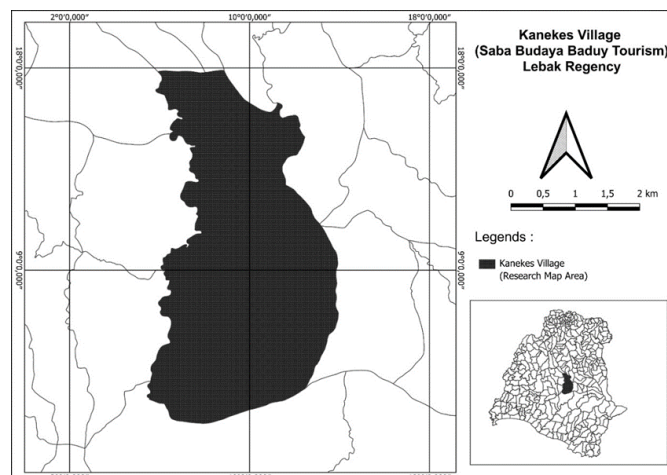


Figure 2. Research Object Map
Source: Authors' analysis, 2023

Several tourist areas have been identified based on in-depth interviews with various stakeholders as previously mentioned. There are five places where tourists gather, i.e., Kampong Balimbing, Kampong Marengo, Kampong Gajeboh, Kampong Cibeo, and Kampong Cikeusik. These locations are for resting during hiking activities and overnight

stays. Kampung Cibeo is the main priority due to its spaciousness and unique attraction, as the Baduy tribe resides here. The location of these tourist areas is in Figure 3.

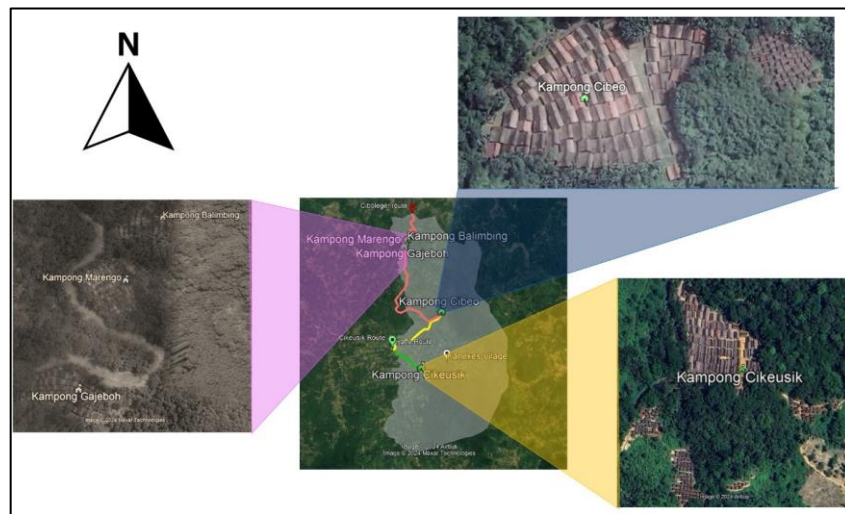


Figure 3. Tourist Area
Source: Google Earth Pro, 2023

The elements within the tourism system of Saba Budaya Baduy include: 1) the local Baduy community as owners of the tourist destination, divided into several parts, namely SMEs Local, Lodging owner, and Tourguide, 2) the village office as the tourism manager, and 3) travel services as tourism operators. The presence of a large number of visitors can significantly disrupt the lives of the local community (Butcher, 2020), and the problems that arise can also lead to an anti-tourism sentiment among the local community. This calculation is made to determine the threshold of the number of visitors or to determine the visitor quota allowed to enter Baduy. Research stages of the method used in this research are explained using a flowchart, as shown in Figure 4.

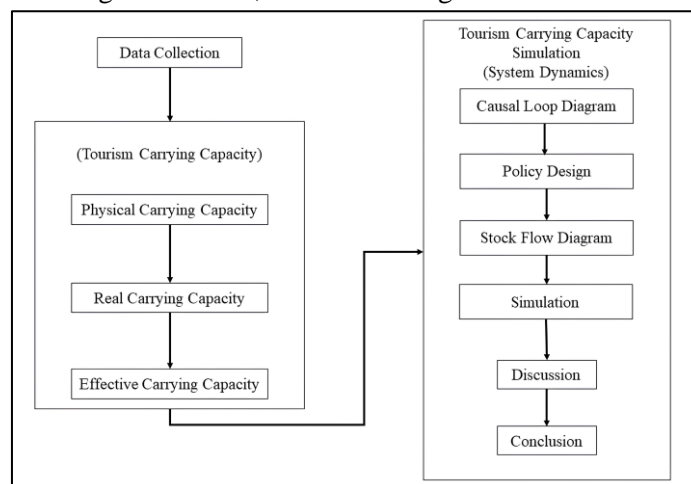


Figure 4. Research Stages
Source: Authors' analysis, 2023

Tourism Carrying Capacity

Tourism carrying capacity is a theory related to tourist destinations that influences the quality of the tourism experience. Tourism carrying capacity encompasses several

factors, including the capacity of the destination to accommodate visitors, weather conditions, terrain characteristics, the number of tourism managers, and biodiversity within the destination (Mijiarto & Rachmawati, 2022).

On the Cifuentes method of carrying capacity, Real Carrying Capacity (RCC) refers to the actual threshold value of visitors to a tourist destination to ensure the manageable capacity of the visited place. The formula employed in this study refers to the method proposed by Cifuentes (1992) and Sihombing et al. (2022). This factor is a key determinant in tourism destinations, as excessive visitors can lead to over-tourism phenomena (Dodds & Butler, 2019). RCC comprises various determining factors, such as physical carrying capacity (PCC), which represents the physical limits of visitor numbers in a given location, and other factors like rainfall, slope or steepness of the tourism routes leading to the attractions. The value of RCC can be determined using the following formula based on Cifuentes (1992):

$$RCC = PCC \times Cf1 \times Cf2 \times \dots \times Cf \quad \dots(1)$$

Cf1, Cf2, and Cfn represent the other factors previously explained. The value of PCC used the following formula:

$$PCC = A \times 1/B \times Rf \quad \dots(2)$$

A = Tourist area

B = Coefficient

Rf = Tourist rotation factor

The value of B is determined as 65m² based on Fandeli (2000) from Douglas and Isherwood (1979), and it represents the recommended distance between visitors (Sihombing et al., 2022). It is the coefficient. Meanwhile, Rf is the operating hours of the tourist site divided by the duration of visitor's stay, with Rf measured in hours.

$$Rf = \text{The duration of operation of the tourism} / \text{The duration of tourism activity} \quad \dots(3)$$

Several supporting factors are needed to determine the value of RCC. In this study, the supporting factors used are the value of rainfall (Cf1) and the slope of the tourism route (Cf2). The value of Cf1 is obtained through the following formula based on Cifuentes (1992):

$$Cfn = 1 - \frac{Mn}{Mt} \quad \dots(4)$$

Cfn is the supporting factors, Mn is the limiting magnitude of supporting factor, and Mt is the total magnitude of supporting factor. This research uses two of supporting factors, namely rainfall and average of slopes.

ECC represents the optimal management carrying capacity to accommodate tourists based on management considerations. We must know the Management Carrying Capacity (MC) to determine ECC. MC refers to the number of tourism management

personnel, including village officials and the staff required for the model. MC is determined using the following formula based on Cifuentes (1992):

$$MC = Rn/Rt \times 100\% \quad \dots(5)$$

Rn represents the total number of tourism management personnel, and Rt represents the required number of personnel. The formula for ECC is based on Cifuentes (1992).

$$ECC = RCC \times MC \quad \dots(6)$$

System Dynamics

System Dynamics is a methodology based on feedback or control theory that can address complex and dynamic problems (Hahn, 2019). System dynamic was initially created to design and simulate complex and dynamic cause-and-effect events based on time series. This approach is used to experiment with tourism management policy models (Baggio & Baggio, 2020).

The use of system dynamics in the tourism industry applies to security issues and the impact of visitors on the surrounding environment (Sedarati et al., 2019). The system dynamics framework commonly used in tourism systems is based on balancing systems or feedback.

System Dynamics has three stages. The first stage involves qualitatively analyzing the cause-and-effect relationships of each variable within the model, known as the causal loop diagram (CLD). The second stage involves formulating the model based on the cause-and-effect relationships identified in the CLD, known as the stock flow diagram (SFD) (Sedarati et al., 2021). This System Dynamics are through Vensim PLE 5.1. Software.

FINDINGS AND DISCUSSION

Determining Tourism Carrying Capacity

The data required to calculate PCC was obtained, and the number of visitors according to the PCC calculation is described in Table 1.

Table 1. Physical Carrying Capacity

Place	A (ha)	B (ha)	Rf (hours)	PCC (person/ day)
Cibeo	1.45	0.0065	0.8	178
Balimbing	0.84	0.0065	0.8	145
Marengo	1.46	0.0065	0.8	103
Gajeboh	1.18	0.0065	0.8	180
Cikeusik	1.15	0.0065	0.8	142
Total				748

Source: Authors' analysis, 2023

The area of tourist (A) is obtained from digital mapping or GIS by plotting polygon points to form an area for use in PCC calculations. B is a coefficient determined to ensure that tourists obtain a satisfying experience (Fandeli, 2000). Meanwhile, the value of Rf is from the opening hours of the tourist destination or the duration of the visit, the data

obtained from village administrative and travel service. According to the administrative village of Baduy, it is open 12 hours a day from 06.00 AM until 06.00 PM. The usual time used for tourism activities according to the travel service is 15 hours, for staying at lodging from 05.00 PM until 08.00 AM. The Rf value is the result of 12 hours operating divided by 15 hours duration of visitors.

$$Q = \frac{\Sigma \text{dry months}}{\Sigma \text{wet months}} \quad \dots(7)$$

$$\text{rainfall (Cf1)} = 1 - \frac{Q}{7} \quad \dots(8)$$

Q represents as limiting magnitude of rainfall factor (Mn), the formula based on Lakitan (2002). The value of 7 is the total magnitude (Mt) or represents the highest *Schmidt-Ferguson index* based on Lakitan (2002). Since the location of Saba Budaya Baduy is in Region 2 according to the Meteorology, Climatology, and Geophysics Agency (BMKG), the rainfall data used on the monitoring of weather stations in Region 2, specifically the rainfall data from 2018 to 2021 at the Kemayoran Jakarta station. From this data, the number of wet months from 2018 to 2021 was 32 months, while the number of dry months was sixteen months. Table 2 represents result of rainfall.

Table 2. Cf1 Rainfall

Number of wet months (2018 – 2021)	Number of dry months (2018 – 2021)	Highest Schmidt – Ferguson index as Mt	Cf1
32	16	7	0.9285

Source: Authors' analysis, 2023

The values for the number of wet and dry months from the data provided by the BMKG (Meteorology, Climatology, and Geophysics Agency) for Region II, specifically from the Kemayoran Station (BMKG, 2022). Region II was chosen because the Regency of Lebak falls within its coverage area according to the BMKG.

The average slope will be determined based on digital data using the Google Earth application, which allows for the calculation of the average slope between different points (routes) within the tourist destination. The value of the average slope will be classified based on the slope classification system provided by the Ministry of Agriculture in their guidelines, Decree of Minister of Agriculture Number 837/KPTS/UM/11/1998 (Putri et al., 2022). The formula used to determine Cf2 is as follows based on Cifuentes (1992) :

$$Cf2 = 1 - \frac{\text{Classification value of the average slope}}{100} \quad \dots(9)$$

Classification value of the average slope represents as limiting magnitude of supporting factor (Mn). The value of 100 is the total magnitude of supporting factor (Mt) or the highest value slope classification based on the Decree of Minister of Agriculture Number 837/KPTS/UM/11/1998. This formula determines the value of Cf2 based on the slope of the tourist site. The slope is calculated based on two tourist paths and two entrances in Saba Budaya Baduy. The result is in Table 3.

Average Slope (%)	Value	Cf2
7.5 - 15	40	0.6

The average slope is from digital mapping data or spatial GIS data. The results of the real carrying capacity values are in Table 4.

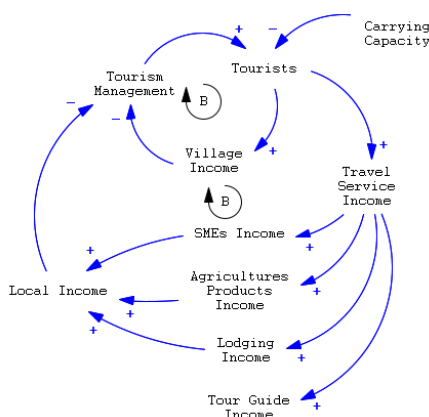
Cf1	Cf2	PCC (person/day)	RCC total (person/day)
0.9285	0.6	748	±417
RCC total (Person/Year)			±21,684

RCC total (person/day) calculated based on trip activity from travel service once a week. So, RCC total (people/year) calculated as RCC total (person/day) multiplied by the number of weeks/year (417*52).

Primary data was from an interview with the village administration regarding the tourism managers. Rn total is 26, including all village officials. During the interview, the village authorities planned to increase the number of tourism managers from each village to serve as tour guides and cleanliness agents, so Rt total is 36. The values of MC and ECC are in Table 5.

Rn	Rt	MC	RCC total (people / year)	ECC total (People / year)
26	36	0.72	±21,684	±15,612

System Dynamics Model



Source: Authors' analysis, 2023

The causal loop diagram (CLD) in Figure 5 explains the proposed policy model. The presence of tourists can have a positive impact on village income. The presence of carrying capacity aims to limit the number of visitors by controlling the travel service, so that the natural environment and the lives of the Kanekes Village community are not overly disrupted by excessively massive tourism.

The positive impact of tourist visits on village income can be utilized as a closed-loop system, where feedback occurs through tourism management, enabling it to attract tourists to continue visiting. This tourism management will also have a positive impact on travel service income. Here, through village policies and other influential stakeholders, regulations can be established for travel services. Travel services must adhere to carrying capacity policies, standardize tour trip prices, and bundle their tour packages with local residents who have businesses in tourism, ensuring that local income is well provided for. Village policies will also target businesses developed by local residents, requiring them to allocate part of their earnings for Tourism Management purposes. The concept of sustainable tourism can be achieved when this model is consistently implemented by the Village authorities.

To understand the implementation flow of the model depicted in the CLD in Figure 5, a Stock Flow Diagram (SFD) is created. It allows for a clear breakdown of the cause-and-effect flow and enables the simulation of the proposed sustainable tourism model. This proposal is explained gradually through several models over the next ten years from 2023, named Model 1, Model 2, and Model 3. However, before explaining these stages, it is necessary to create a simulation of the tourism system subject to Carrying Capacity treatment based on the ECC value.

The SFD in Figure 6 explains the simulation of the tourism system subjected to Carrying Capacity treatment with the ECC value.

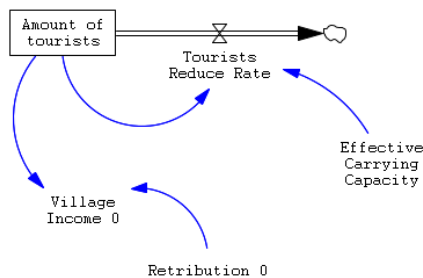


Figure 6. SFD Carrying Capacity Treatment
Source: Authors' analysis, 2023

Table 6. Information related to SFD Carrying Capacity Treatment

Components	Values Unit	Equation	Information
Number of tourists (Level)	Initial: 54,421 People	-(negative) tourist reduce rate	Initial tourists number in 2023. Stock
Tourists reduce rate (Auxiliary)	- People/Year	Number of tourists*Effective Carrying Capacity	Flow
Effective Carrying Capacity (Constant)	0.713 /Year	-	Percentage decrease from initial number of tourists in 2023 to ECC Value
Village Income (Supplementary)	- IDR	Number of tourists*Retribution	
Retribution	IDR 5,000/People	-	Baduy Village Retributions

Source: Authors' analysis, 2023

The implementation of Carrying Capacity with an ECC value has a negative impact on the number of tourists, consequently affecting village income negatively as well (Table 6). It can lead to a drastic decline in the income from visiting tourists. If the model only proposes Carrying Capacity treatment alone, it is not sustainable, especially in strengthening the local community's economy.

Carrying capacity treatment in the Baduy tourism system is enhanced through Model 1. This model simulates the implementation of village budgeting aimed at attracting visitors through tourism management, increasing the number of visitors. According to in-depth interviews with village authorities, they agreed to allocate 30% of the income from tourist visits for management purposes. The SFD Model 1 is in Figure 7.

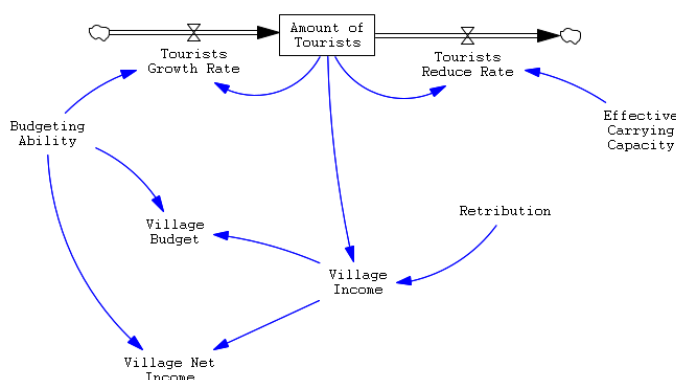


Figure 7. SFD Model 1 and 2

Source: Authors' analysis

Table 7. Information related to SFD Model 1

Components	Values Unit	Equation	Information
Number of tourists (Level)	Initial: 54,421 People	-(negative) tourist reduce rate	Initial tourists number in 2023. Stock
Tourists' growth rate (Auxiliary)	- People/Year	Budgeting ability*ability*Number of Tourists	Flow
Tourists reduce rate (Auxiliary)	- People/Year	Amount of tourists*Effective Carrying Capacity	Flow
Effective Carrying Capacity (Constant)	0.713 /Year	-	Percentage decrease from initial number of tourists in 2023 to ECC Value
Village Income (Supplementary)	- IDR	Amount of tourist*Retribution	
Retribution	- 5,000 IDR/People (Model 1). - IDR 10,000/People (Model 2)	-	Baduy Village Retribution
Village budget (Supplementary)	'- IDR/Year	Village income*Budgeting ability	
Budgeting ability (Constant)	0.3 / Year	-	
Village net income (Supplementary)	'- IDR/Year	Village income*(1-Budgeting ability)	

Source: Authors' analysis, 2023

From the SFD Model 1 above, village budgeting alone still cannot increase village income, so an improvement in the designed model is needed. Model 2, designed after the Model 1 stage, has the same SFD, but the fee for entering Baduy tourism increased from IDR 5,000 to IDR 10,000. The implementation of Model 2 can increase village income. Models 1 and 2 have higher values of number of tourists and village income compared to models that only apply carrying capacity treatment (Table 7). Model 3 is an improvement from Models 1 and 2. In Model 3, travel service providers are in the modeling system to make Model 3 more holistic. The SFD Model 3 is in Figure 8.

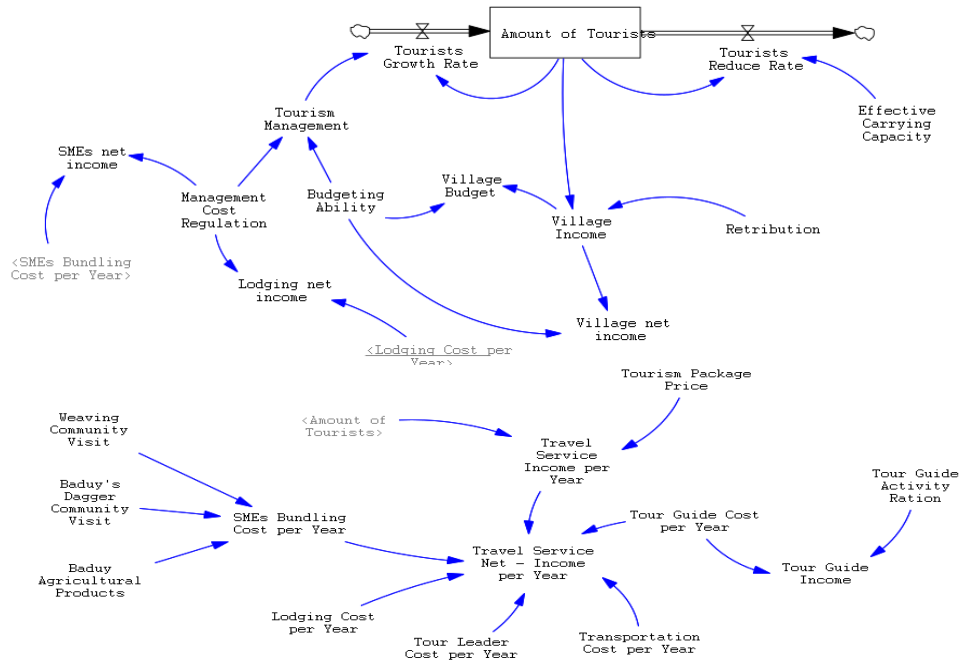


Figure 8. SFD Model 3

Source: Authors' analysis, 2023

Table 8. Information related to SFD Model 3

Components	Values Unit	Equation	Information
Number of tourists (Level)	Initial: 54,421 People	Tourists' growth rate - tourist reduce rate	Initial tourists amount in 2023. Stock
Tourists' growth rate (Auxiliary)	- People/Year	Tourism Management*Number of Tourists	Flow
Tourists reduce rate (Auxiliary)	- People/Year	Number of tourists*Effective Carrying Capacity	Flow
Effective Carrying Capacity (Constant)	0.713 / Year	-	Percentage decrease from initial number of tourists in 2023 to ECC Value
Village Income (Supplementary)	- IDR	Amount of tourist*Retribution	
Retribution	10,000 IDR/People	-	Baduy Village Retribution

Components	Values Unit	Equation	Information
Village budget (Supplementary)	- IDR/ Year	Village income*Budgeting ability	
Budgeting ability (Constant)	0.3 / Year	-	
Village net income (Supplementary)	- IDR / Year	Village income*(1-Budgeting ability)	
Travel service income per year (Supplementary)	- IDR	Amount of tourists*Tourism package price	
Tourism package price (Constant)	300,000 IDR/People	-	Price from policy (Assumption)
Travel service net income per year (Supplementary)	- / IDR	(Travel Service Income per Year - Lodging Cost per Year - Tour Guide Cost per Year - Tour Leader Cost per Year - Transportation Cost per Year - SMEs Bundling Cost per Year) /5	Travel service net income per year (Supplementary)
Lodging Cost per Year (Constant)	20,800,000 IDR	-	Price from policy (Assumption)
Tour Guide Cost per Year (Constant)	62,400,000 IDR	-	Price from policy (Assumption)
Tour guide activity ration (Constant)	26.4 /Year	-	Ration of each tour guide group per year
Tour guide income (Supplementary)		Tour Guide Cost per Year* Tour guide activity ration	Tour guide net income per group
Tour Leader Cost per Year (Constant)	26,000,000 IDR	-	Travel service employee costs
Transportation Cost per Year (Constant)	65,000,000 IDR	-	Price
SMEs Bundling Cost per Year (Supplementary)	- IDR	(Weaving community visit + Baduy's dagger community visit + Baduy's agriculturals product) *52	Bundling regulation from village to travel service. 52 is number of each week in year
Weaving community visit (Constant)	300,000 IDR	-	Price
Baduy's dagger community visit (Constant)	300,000 IDR	-	Price
Baduy's agricultural product	300,000 IDR		Price
Lodging net income (Supplementary)	- IDR	Lodging Cost per Year* Management cost regulation	Price
SMEs net income (Supplementary)	- IDR	SMEs Bundling Cost per Year* Management cost regulation	
Management cost regulation	0.3 / Year	-	Assumption
Tourism management	/ Year	Management cost regulation+ Budgeting ability	

Source: Authors' analysis, 2023



In Model 3, several regulations that must be consistently implemented by the village towards travel services and local businesses (Table 8). The regulations are as follows:

1. Travel services are required to set the price of tour packages as determined by the village, which is IDR 300,000 per person.
2. Travel services must include local SMEs and local accommodations in every tourism activity at the predetermined price.
3. Travel services must include local tour guides in every tourism activity at the predetermined price.
4. Local businesses must be part of an SME community under the village's umbrella.
5. The SME community must allocate 30% of its annual income for tourism management purposes.

The above regulations can be implemented if there is an agreement between travel services as tourism operators and the village authorities as tourism managers (Figure 9). Therefore, it is proposed that the village authorities only accept travel services from official travel agencies that have been approved or licensed by the responsible authority for tourism in Lebak Regency. In this case, the Tourism Office of Lebak Regency is from preference of Baduy's authorities. The main key to these regulations is social capital, which fosters mutual trust.

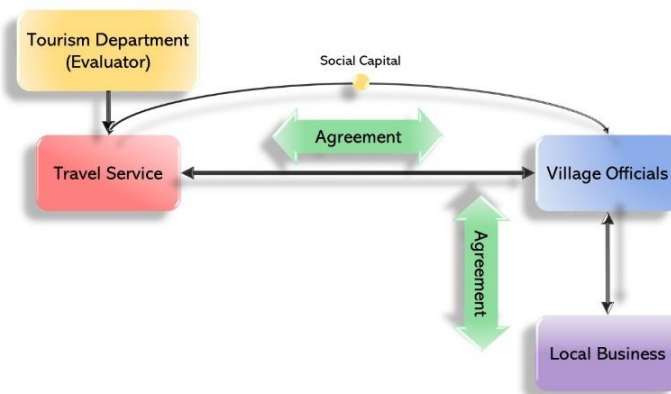


Figure 9. Model 3 Regulation
Source: Authors' analysis, 2023

Simulation Result

The results from Model 3 can minimize the significant decrease in village net income compared to models that only apply carrying capacity treatment. The decrease in village net income correlates directly with the decrease in the number of tourists, which is desired to resolve the issues in the tourism system of Saba Budaya Baduy Village. Based on the previously calculated ECC value, the annual number of tourist visits is 15,612 per year, which can be achieved by 2033. In the simulation of Model 3, the annual number of tourist visits is 16,406 per year.

The policies in Model 3 provide benefits for local income and travel services, as these policies ensure income certainty for both parties, thus avoiding trade wars that could harm the tourism system of Saba Budaya Baduy. Additionally, travel service income

experienced an increase because the average travel service rate was IDR200,000 per person previously. The overall results of the model are explained through Figure 10 to Figure 12 and Table 9.

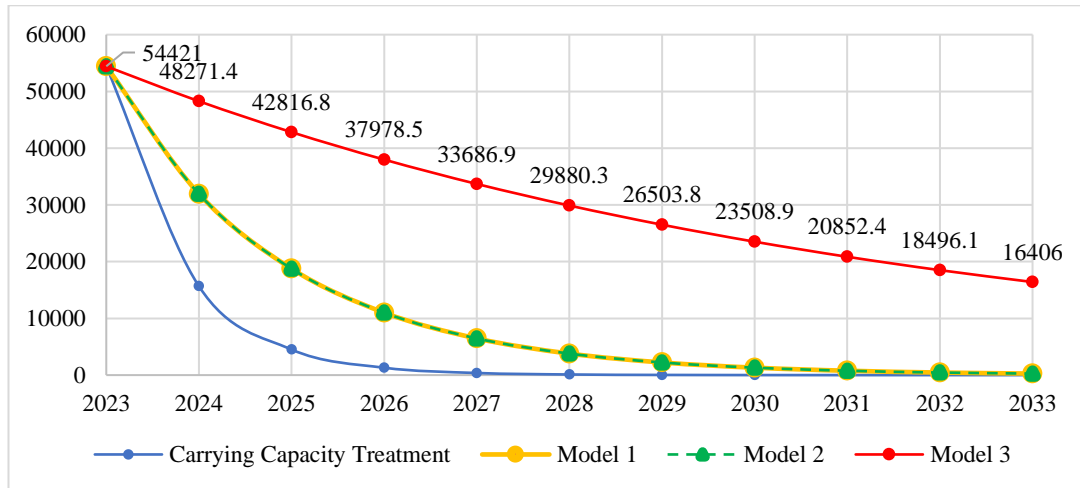


Figure 10. Number of tourists

Source: Authors' analysis, 2023

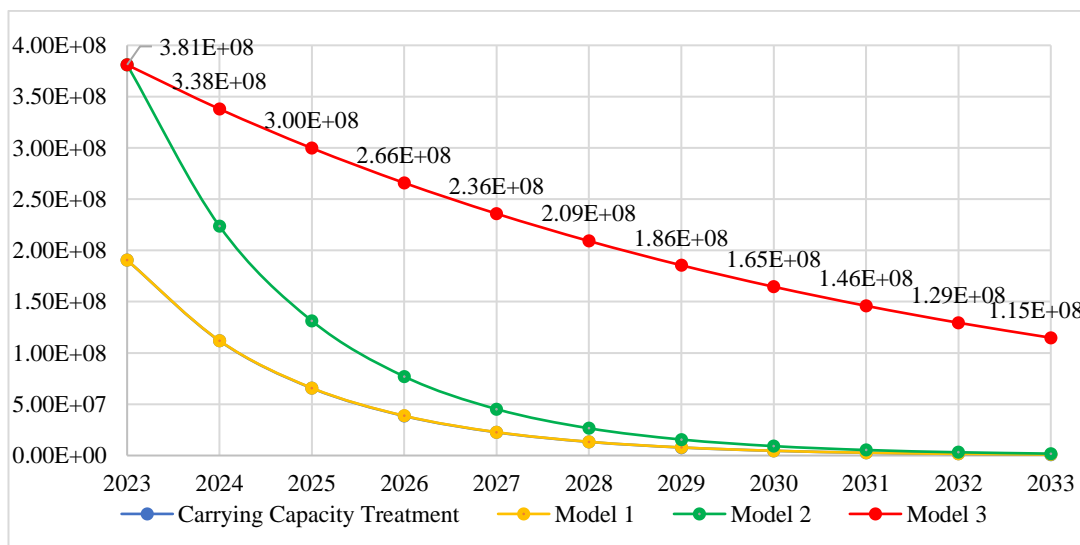


Figure 11. Village income

Source: Authors' analysis, 2023

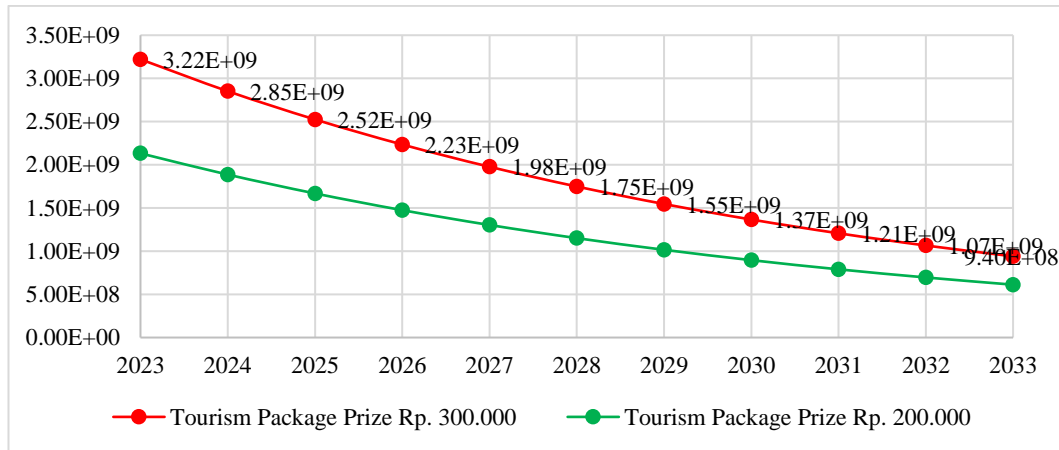


Figure 12. Travel Service Income with Model 3 implemented

Source: Authors' analysis, 2023

Table 9. Others elements result in 10-year simulation with Model 3 implemented

Components	Result
SMEs net income	IDR 32,760,000/Year
Lodging net income	IDR 14,560,000/Year
Tour Guide Income / Group (4 people 1 group)	IDR 31,680,000/Year

Source: Authors' analysis, 2023

Discussion

Visitor limitations at the Saba Budaya Baduy tourist destination were previously based solely on local wisdom or the ancestral traditions practiced by the Baduy community. This ancestral tradition, known as *Kawalu*, is conducted over three months and involves traditional ceremonies, environmental clean-up activities, and fasting for one day each month for the three months. During this time, no activities are permitted in the Kanekes Village area inhabited by the Baduy community, including visits by tourists from outside the village (Waluya et al., 2022). The existence of visitor limitations based on local wisdom is not sufficient to minimize the massive number of tourist visits. It is observed based on the tourist visit data from year to year, which increases drastically. There has been no attempt to impose a visitor limitation by controlling travel services.

The determination of visitor limitations in Model 3 is carried out gradually, allowing the elements associated with the system to adapt to the new policies. It is in line with the theory of tourism systems, which entails complexity and wicked problems (Baggio & Baggio, 2020). The Tourism Carrying Capacity (TCC) utilized in this study, based on the method by Cifuentes (1992), produces the value of PCC. This value is influenced by coefficient B, which ensures tourists achieve a satisfactory experience with a value of 65m² (Fandeli, 2000). The value of B may vary depending on preferences, where a higher B value leads to a smaller PCC value (Zacarias et al., 2011). This PCC value will affect the RCC value and subsequently impact the ECC value. In Model 3, by the 10th year (2033), the value of tourist visits is determined to be 16,406 per year, which closely approximates the calculated ECC value of 15,612 per year. Although the value of tourist visits in Model 3 in 2033 is still higher than the set ECC value, this is not an issue, considering that the ECC value is not an absolute requirement. The ECC value serves as a reference for efforts to limit the number of tourist visitors, ensuring comfort for tourism at the destination

(Sihombing et al., 2022). The goal of tourism carrying capacity at the Baduy destination is to determine the quota value of visitors as a reference for tourism management regarding travel services bringing tourists by controlling the travel service. It aligns with the tourism issues at the destination, where many travel services disregard the number of tourists they take and do not adhere to the customary regulations implemented by the local residents (Mutaqien et al., 2022).

Furthermore, determining the value of tourism carrying capacity must also be determined by decision-making approaches, which require large and interrelated variables that influence other dependent variables. Additionally, this requires identification by an expert who can estimate sensitivity analysis (Pásková et al., 2021). The limitation of variables significantly affects the assessment of tourism carrying capacity. These variables in the tourism carrying capacity method developed by Cifuentes fall into the category of correction factors. Many other correction factors cannot be fulfilled due to limited data, such as the number of endemic flora and fauna and their conditions, which affect tourist attractions (Sihombing et al., 2022).

The developed Model 3 possesses the characteristics of a closed-loop control system. According to sustainable tourism theory, good tourism is one that provides feedback to the elements within the tourism system. These elements, in this context, refer to stakeholders who have interests in tourism activities, allowing tourism to continue running and fulfilling these interests, considering that tourism falls into the category of complex businesses (Baggio & Baggio, 2020). If only viewed from one perspective, such as reducing visitor numbers to achieve environmental sustainability, other aspects, such as strengthening the local population through economic independence, will not be achieved. There needs to be a balance between the three main factors of sustainable tourism: nature environment, socio-cultural, and social strengthening with economic independence (UNWTO, 2023). An approach through system thinking, based on cause-effect relationships among variables, enables ecotourism to transform into profitable business practices that motivate stakeholders to practice ecotourism at a higher level while maintaining the integrity of the natural environment. In this case, the high number of tourist visits can cause environmental stress, hence the need for limiting tourist arrivals and raising prices (Roxas et al., 2020). In the simulation of Model 3, limiting tourist arrivals is gradually implemented to avoid negative effects that could decrease tourists' interest in visiting.

The strengthening of the local community in Model 3 is through income certainty from the regulations proposed in Model 3, such as travel services bundling their tour packages with local SMEs products and local agricultural products, utilizing local tour guides, and paying for accommodations provided by local residents at predetermined prices. With the local income generated from tourism, Model 3 suggests feedback from the local residents to tourism management through the variable of Management Cost Regulation. This feedback is not only provided by the local residents but also by the village officials as tourism managers. The officials are required to contribute materially through budget allocation for tourism management. This feedback refers to the fiscal policy standards set by the IMF in each country for tax collection, where the IMF's policy standard for tax collection is 15% of the total GDP (International Monetary Fund, 2023).

The research related to feedback from tourism budgeting is the study titled "Empowerment Model for Sustainable Tourism Village in an Emerging Country," where

the income generated from rural tourism is allocated as a budget for tourism management (Purnomo et al., 2020). The feedback in this research fulfills the needs of tourism management, which will have a positive impact on local income through increased tourist visits. It is highly influential because good tourism management will determine the level of visits, supported by the four-structure theory in tourism industrial management practices (4A), where three of the four levels named attraction, ancillary, and amenities heavily rely on tourism management that requires funding from the destination itself to manage it (Lee, 2015).

The regulations in Model 3 concerning the agreement between travel services as tourism operators and the village as tourism managers have also been applied in several case studies involving indigenous people. The study titled "Indigenous Knowledge in Marine Ecotourism Development: The Case of Sasi Laut, Misool, Indonesia" found that agreements built between tour operators and local residents, as well as the businesses developed by tour operators respecting the cultural values of the local population, can integrate with the protection of marine biodiversity in the area. The practices that preserve marine biodiversity can become tourist attractions, enabling local residents to earn income and even develop livelihoods in the tourism sector (N. Prasetyo et al., 2020). In the study "Indigenous Legacy for Building Resilience: A Case Study of Taiwanese Mountain River Ecotourism", social capital plays a crucial role for indigenous people in building resilience against threats to their territories as tourist destinations. In other words, it serves as their primary source of economy and livelihood. The social capital developed in Taiwanese mountain river ecotourism involves individuals trusted by the local indigenous community to develop ecotourism, particularly those who understand local knowledge or indigenous customs and culture (Shie, 2020). The social capital. The application of social capital in Baduy is similar to the two cases described in the articles above. The essence of implementing this is to prioritize the cultural life of the Baduy tribe itself, meaning that tourism development is based on the preferences of the local Baduy community, especially in terms of cultures and customs, so that ecotourism can be achieved based on indigenous customs and culture of the indigenous people of Baduy.

CONCLUSION

Model 3, as the proposed policy, gradually minimizes tourist arrivals while simultaneously strengthening the local economy. The practical implication of proposed policy includes the implementation of a gradual annual visitor limit from controlling travel service, increasing tourism levies, the village as tourism managers establishing agreements with travel services as tourism operators, the village forming agreements with local SMEs, lodging owners and tour guides, and providing feedback on tourism management from tourism business activities. The result of system dynamics simulation conducted over ten years on Model 3 show that the target number of visitors can be achieved by the 10th year, reaching a visitor limit of 16,406 people per year. The projected income of related elements includes village income of IDR 115,000,000 per year, travel service income of IDR 940,160,000 per year, local SMEs' income of IDR 32,760,000 per year, lodging income of IDR 14,560,000 per year, and tour guide income of IDR 31,680,000 per year. The managerial implications of this study lie in enhancing the sustainability of the Saba Budaya Baduy tourist destination. Implementing visitor limitations can mitigate the erosion of local

culture to preserve the natural environment, which is often influenced by the pervasive aspects of modern culture brought by visitors, such as the use of chemicals for cleaning purposes and the consumption of snacks packaged in plastic, which contributes to plastic waste. Moreover, local income experiences growth and stability due to standardized pricing resulting from agreements between the village as tourism managers and travel services as tourism operators.

Limiting visitor numbers through tourism carrying capacity in the Saba Budaya Baduy tourist destination is essential, given the significant surge in visitor numbers in 2023 and the need for immediate action. This research is still in its initial stages to determine the balance between the number of visitors and the income generated from tourism activities in the Saba Budaya Baduy tourist destination. Further research is expected to examine the perspectives of tourists on the increase in tourism levies for daily socio-cultural life preservation of Baduy and natural biodiversity resource protection, as well as to investigate cultural carrying capacity and other variables influenced by the number of tourist visits.

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