Developing Accessibility and Connectivity on Gili Iyang Island, Indonesia

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Gili Iyang island is a tourist destination recognized for developing a health-focused industry to attract visitors. Transportation and infrastructure challenges in the tourism sector are important areas to examine for the industry's progress. Therefore, this research aimed to determine the right strategy to promote health tourism in Sumenep, East Java, Indonesia. Data analysis included a comprehensive examination using qualitative descriptive methods, Importance-Performance Analysis (IPA), and a connectivity index. The results showed that the optimal strategy for Gili Iyang Island is to focus on increasing accessibility, ensuring affordable travel costs, and maintaining convenience. Aspects of accessibility to improve include road networks and modes of transportation. Furthermore, the connectivity aspects that must be maintained are road access, seaport, and ferry port. The health tourism development strategy was implemented with a participatory approach and media technology convergence. The main originality of the research includes health tourism, natural conditions, and infrastructure. Additionally, the research recommends that tourists explore natural destinations characterized by unpolluted air and high oxygen levels.

KEY WORDS
~ Accessibility
~ Connectivity
~ Gili Iyang island
~ Oxygen island
~ Health tourism
~ IPA

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1. INTRODUCTION

Indonesia, as one of the largest archipelagic countries in the world, is known for its extraordinary natural wealth, with 17,502 and 17,508 islands reported by Sukmawani Bela Pertiwi (2020) and E. Djunarsjah et al. (2021), respectively. According to the Geospatial Information Agency, the land and water areas are 1.905 million km² and 3.257 million km², respectively, making the total area of the country 5.180 million km² (Hasanah, 2020). With a coastline length of 81,000 km, Indonesia ranks second after Canada for the longest coastline in the world (Pertiwi, 2020). This results in a diverse array of islands, with the majority having an area of less than 2,000 km² or even 100 km² (Delinom, 2007), and 99.8% of the 17,508 islands have an area under 2,000 km² (Djunarsjah et al., 2021). The diversity groups islands into six categories: Continent, Volcanic, Lowland, Coral, Atoll, and Artificial Islands (Graziati, 2023; Sathiendrakumar & Tisdel, 1989). An overview of Indonesia as the largest archipelagic country in the world is shown in Figure 1 below.

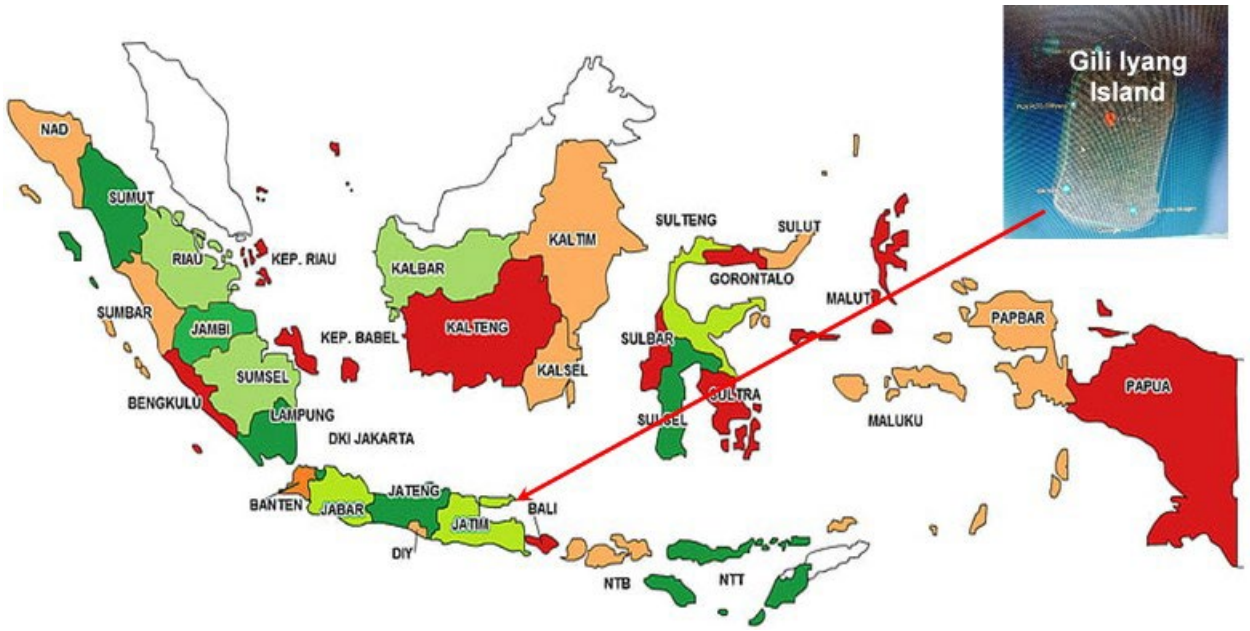

Figure 1. The Unitary State of the Republic of Indonesia consists of more than 17,500 islands (Djunarsjah et al., 2021; Pertiwi, 2020) is the largest archipelagic country in the world (Source: https://www.pxfuel.com/en/desktop-wallpaper-hqxzk)

East Java Province plays an important role in the wealth of the island. Indonesia has a total coastline of 3,498.12 km and numerous small islands, such as Nusa Barong Island in Jember Regency, Sekel Island, and Panikan Island in Trenggalek Regency. However, as an archipelagic region, East Java Province faces connectivity and accessibility challenges that must be addressed to improve the economy and regional competitiveness (Kurniawan, 2023).

Gili Iyang Island in Sumenep Regency, East Java Province, has an area of 9.15 km² and high oxygen levels, earning it the nickname "Oxygen Island." Although the area has great tourism potential, several limitations remain in terms of accessibility, connectivity, and adequate infrastructure (Musleh, 2023).

To optimize its tourism potential, the island can be developed into an international health tourism destination. This concept includes three main components: medical, wellness, and spa tourism. With high oxygen levels and natural beauty, the island has the potential to attract both domestic and international tourists in the health tourism sector (Wibisono et al., 2021).

Health tourism facilities can include spas, saunas, hyperbaric oxygen therapy, and various natural activities such as fishing, diving, and enjoying beach views. This development follows the "Green Architecture" concept to maintain the sustainability of the island's environment (Setiawan & Eunike Kristi Julistiono, 2014). Furthermore, Gili Iyang Island can host sports tourism events, such as the annual Fun Bike. Research on medical tourism shows that such development has succeeded in attracting foreign tourists to similar destinations. In this context, marine tourism can become both a primary and secondary source of livelihood for local communities (Bahukeling et al., 2019).

Limited accessibility and connectivity remain the main obstacles. Development of transportation infrastructure, including sea access and connectivity with other islands, needs to be prioritized to increase accessibility (Shabrina et al., 2023).

By developing infrastructure and facilities in line with the concept of health tourism and the island's natural beauty, Gili Iyang Island has great potential to become a popular tourist destination for both domestic and international visitors. Therefore, this research identifies potential obstacles to developing accessibility and connectivity. Strategies and recommendations to improve infrastructure supporting health tourism are also formulated.

The results can make a positive contribution to academics, local governments, tourism industry stakeholders, and communities. Increasing accessibility and connectivity is expected to open new opportunities, enhance competitiveness, and have a positive impact on the local economy and community welfare.

2. METHOD

The research employed both qualitative and quantitative methods. Qualitative methods were used to explore and understand the complexity of the subjects. To provide insights and a comprehensive understanding of the topic, data were collected from various sources, including interviews, manuscripts, and official documents. This approach is cyclical rather than linear, emphasizing the dynamic interaction between data collection and analysis with the objective of interpreting the findings. Methods such as respondent observation and in-depth interviews helped explore human behavior and social dynamics, fostering a distinct understanding of the phenomenon under study (Batubara, 2017; Indriastuti et al., 2020).

The quantitative method used connectivity and accessibility matrices to identify the highest index, as a higher connectivity and accessibility index indicated that the routes linked to the ports or areas under investigation (Mustakim et al., 2017). Another quantitative method involved using a Likert scale to assess respondents' transportation experiences to and from the tourist area of Gili Iyang Island through a questionnaire. Respondents included regional government officials, independent tourism business owners, travel bureaus, travel agents, airline pilot associations, tourists, academics who had conducted research on Gili Iyang Island tourism, and individuals aged 20–65 years with at least a high school education residing in East Java.

2.1. Literature Review

Health tourism is divided into three categories: recreation orientation, health promotion, and medical orientation. Recreation orientation includes risky activities and new experiences, while health promotion involves improving exercise habits, reducing stress, and increasing physical strength. Medical orientation focuses on the treatment of disease and the restoration of health (Lee & Li, 2019).

The development of infrastructure can increase tourism income and improve the quality of the environment and tourism destinations (Megawati et al., 2023). Infrastructure is a crucial issue in developing health tourism (Razti et al., 2022). Facilities support and facilitate tourism activities to run smoothly (Ghani & Brahmanto, 2015), such as transportation (Ghani, 2017). In this context, tourism infrastructure includes roads, terminals, bridges, and accessibility (Fisu et al., 2022).

Accessibility refers to the connection between zones through roads and transport networks, including ferry transport (Litman, 2023). This factor is important in the travel process, as the ease of reaching a tourist area depends on accessibility, such as road conditions and the availability of transportation modes (Jamei et al., 2022). Road topography can be a barrier to smooth interaction in an area. Based on the theoretical description of accessibility, the indicators include (1) availability of road networks, (2) availability of transportation modes, (3) number of transport vehicles, (4) road quality, (5) travel time, (6) travel costs, (7) location distance, and (8) ease of achieving objectivesor level of convenience (Vulevic, 2016; Priyambodo et al., 2024). Limited accessibility has a major impact on the economy and community activities, which are highly dependent on transportation infrastructure.

Additionally, connectivity is key to building a good system in Indonesia. Opening access to centers in Indonesia is essential for development (Priyanta & Anasya, 2023). The country must prioritize connectivity between regions to reduce poverty, promote development, and enhance competitiveness (ESCAP, 2014; Priyambodo, 2016). Efficient connectivity requires a well-connected transportation system, making infrastructure a crucial component (Priyambodo, 2016). This results in increased access to goods and services at lower and stable prices, as well as efficient and reliable transportation services. Connectivity refers to the relationship between nodes or points linked by lines or links. In sea transportation, these points are ports or stopover places for ships (Mustakim et al., 2017).

To analyze the potential strength of interaction between regions in terms of the road network structure as transportation infrastructure, graph theory is used by comparing the number of cities or regions with different routes. The strength of the interaction is determined by the connectivity index. A higher connectivity index value indicates more road networks linking the cities or regions (Junaidi et al., 2022).

The most common use of connectivity refers to local road links for specific multimodal access: (1) access to the toll road system, (2) local public transport stations, (3) train terminals, (4) airports, (5) seaports, and (6) ferry ports. The steps from transit feeder connectivity, rail, or air to the nearest distance can be determined. In a more concise sense, connectivity is a form of access that exists between two systems (Putri, 2017; Priyambodo et al., 2024).

Foreign and local tourists can visit Gili Iyang Island by sea (Resdiana et al., 2021). However, accessibility and connectivity to and from the island are still very limited (Musleh, 2023). In this context, transportation facilities and infrastructure must be built and developed. Health tourism will attract many tourists when there is good and easy accessibility and connectivity (Musleh, 2023; Wibisono et al., 2021).

The introduction of transportation can promote the development of the health tourism industry (Setiawan & Eunike Kristi Julistiono, 2014). Transportation also influences the economic growth of the region by shortening travel time, reducing costs, and increasing accessibility and connectivity (Putri, 2017). Similar mechanisms have been empirically verified regarding the economic impacts of other modes of transport, such as aviation services and the development of road networks.

Figure 2 shows the tourism industry networks and the interaction mechanism between the tourism and transportation sectors (Budiartha, 2011; Warpani, 2017). Tourism shares features with several industries that provide goods and services needed at the destination. Tourism services have wider coverage; however, they have no economic value if they do not reach the market and consumers. In this case, transportation plays a vital role in moving industrial products, supporting tourism, and serving as a bridge between producers and consumers.

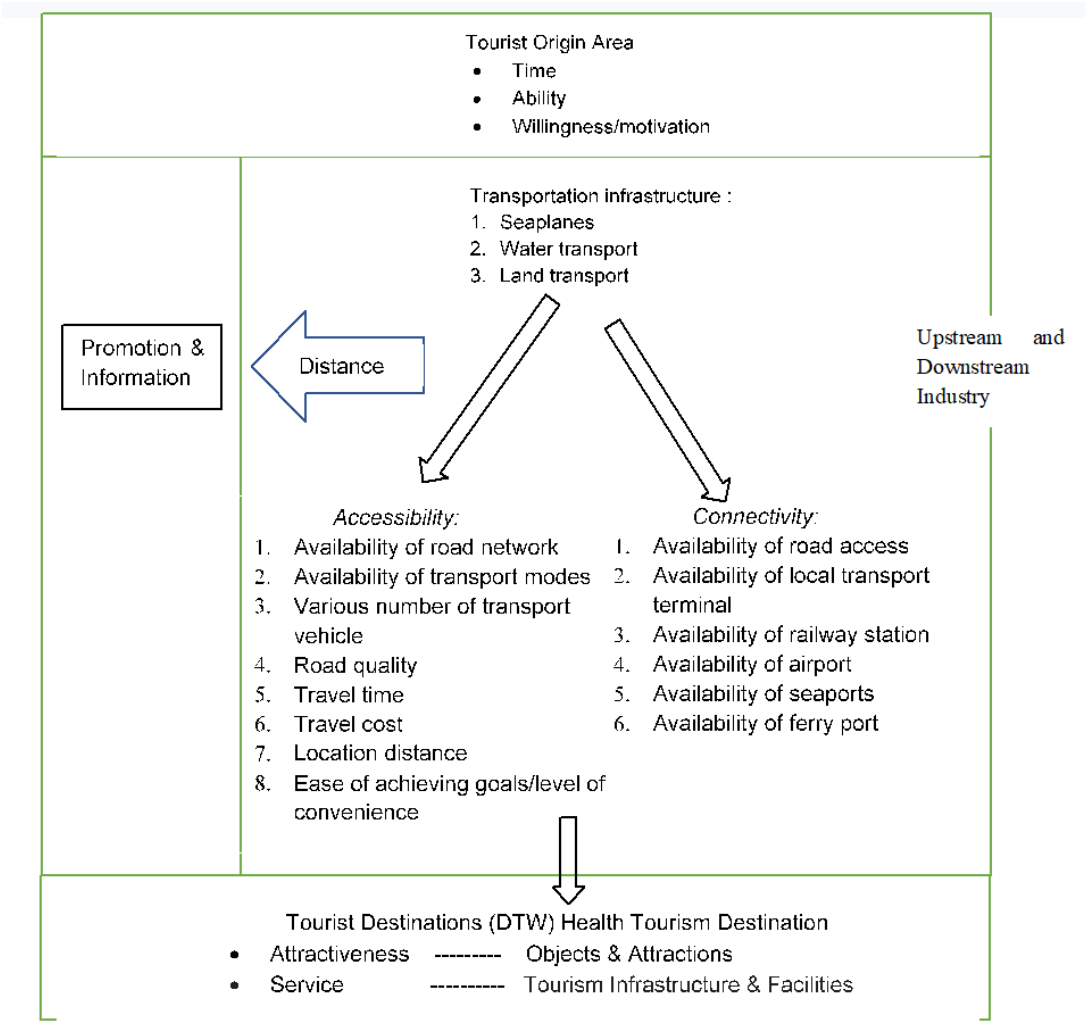

Figure 2. Theoretical framework for the growth of health tourism destinations through transportation development (Source: (Budiartha, 2011; Warpani, 2017))

Tourism destinations are separated by distance from the tourist's current location. This distance is covered by operating a transportation system—land, sea, or air—depending on the conditions and connectivity to the destination. From

this perspective, various economic activities and business opportunities from different sectors can grow along the connecting corridor.

Tourism is dominated by service industries, including banking, catering, tour guiding, transportation, and other services, which has led to the creation of tourism bureaus and travel agency businesses. Agencies have extensive information about destinations throughout the world (at least in the tourism destination areas they represent), tourist attractions, accommodation facilities at the destination, information regarding political conditions, currency exchange rates, and transportation networks. To achieve perfect service, tourism bureaus and travel agents are highly dependent on the transportation industry. Similarly, the upstream and downstream industries depend to varying degrees on the transportation system.

2.2. Data

The research was conducted from March to November 2023 and utilized both primary and secondary data collection methods. Primary data collection involved distributing questionnaires and conducting in-depth interviews, both face-to-face and by telephone. The interviews aimed to analyze the informants' experiences and motivations related to tourism development.

Primary data was collected through purposive sampling, selecting individuals as informants based on the research objectives. The selection criteria included stakeholders directly involved in tourism development and transportation infrastructure, representing various sectors such as central and regional government bodies, independent institutions, the Indonesian Tourism Association, and academics with relevant research experience. Observations were made through direct observation of the tourism development implementation process and socialization efforts.

The importance and performance of primary data were evaluated by measuring the perceptions of 77 respondents regarding the accessibility and connectivity of transportation to health tourism destinations. Accessibility indicators included: (1) availability of road networks, (2) availability of transportation modes, (3) number of transport vehicles, (4) road quality and highway conditions, (5) travel time, (6) travel costs, (7) location distance, and (8) ease of achieving objectives/level of convenience.

Connectivity indicators included: (1) availability of road access, (2) availability of local public transport terminals, (3) availability of train stations, (4) availability of airports, (5) availability of seaports, and (6) availability of ferry ports. The accessibility and connectivity questionnaire forms are shown in Tables 1 and 2.

Level of Importance					**Nb.**	**Statements/Question**	**Performance Level**				
5	4	3	2	1			5	4	3	2	1
					1	What are **the availability of road network** if you want to travel to Gili Iyang Islands and vice versa?					
					2	What is **the availability of transportation modes** if you want to travel to Gili Iyang Islands and vice versa?					
					3	What **Various number of transport vehicle** are available if you want to travel to Gili Iyang Islands and vice versa?					
					4	What is **the quality of the roads** if you want to travel to Gili Iyang Islands and vice versa?					
					5	What is **the travel time** if you want to travel to Gili Iyang Islands and vice versa?					
					6	What are **the travel costs** if you want to travel to Gili Iyang Islands and vice versa?					
					7	What is **the location distance** if you want to travel to Gili Iyang Islands and vice versa?					
					8	How **easy it is to travel** if you want to travel to Gili Iyang Islands and vice versa?					

Definition :
Level of Importance ------ 5 = Very important; 4 = Important; 3 = Quite important; 2 = Not important; 1 = Very unimportant
Performanve Level --------5 = Very satisfied; 4 = satisfied; 3 = Quite satisfied; 2 = Not satisfied; 1 = Very dissatisfied

Table 1. Accessibility: Put a tick mark (√) in the column that you think is appropriate

Level of Importance					Nb.	Statements/Question	Performance Level				
5	4	3	2	1			5	4	3	2	1
					1	What is **the availability of road access** if you want to travel to the Gili Iyang Islands and vice versa?					
					2	What is **the availability of local public transport terminals** if you want to travel to Gili Iyang Island and vice versa?					
					3	What is **the availability of train stations** if you want to travel to Gili Iyang Island and vice versa?					
					4	What is **the availability of airports** if you want to travel to the Gili Iyang Islands and vice versa?					
					5	What is **the availability of sea ports** if you want to travel to the Gili Iyang Islands and vice versa?					
					6	What is **the availability of ferry ports** if you want to travel to the Gili Iyang Islands and vice versa?					

Definition :

Level of Importance ------ 5 = Very important; 4 = Important; 3 = Quite important; 2 = Not important; 1 = Very unimportant

Performanve Level --------5 = Very satisfied; 4 = satisfied; 3 = Quite satisfied; 2 = Not satisfied; 1 = Very dissatisfied

Table 2. Connectivity: Put a tick mark (√) in the column that you think is appropriate

The sample size was considered sufficient, as a size greater than 30 and less than 500 is appropriate for most research (Sekaran, 2006). Respondents included road transport users, foreign and domestic tourists, representatives from the Sumenep Regency and East Java Province Transportation Services, travel agent associations, tourism sector experts, and transportation experts from universities.

Secondary data was obtained from documentation, including previous research results, news clippings, mass media articles, annual reports from the Ministry of Transportation, and books. Informants were involved in the process of developing and promoting tourism development. The research objects included accessibility, connectivity, transportation infrastructure, tourism potential, tourism development, and outreach on Gili Iyang Island, Sumenep Regency, East Java Province.

This research focused on Sumenep Regency, Madura, East Java, specifically Gili Iyang Island. Primary data collection involved gathering respondents' perceptions regarding personal expectations and the performance of eight accessibility and six connectivity indicators, as shown in Tables 1 and 2. These indicators were key elements in assessing the tourism conditions of Gili Iyang Island. Primary data was obtained by assessing the perceptions of 77 respondents regarding transportation modes. The total sample of 77 respondents, which is greater than 30 and less than 500, met the analysis requirements (Sekaran, 2006). A probability sampling method was used, providing an equal opportunity for each member of the population to be selected, considering the wide coverage of the Madura Islands area, especially the tourist areas of Gili Iyang and East Java Province. The Kruskal-Wallis test was conducted between the independent variables in the numerical data (range/proportion) and the ordinal scale in the dependent variable, as shown in Tables 3 and 4 below.

Nb.	Variable	Mean	Sig
1	Road network	-1.65	0,000
2	Modes of transortation	-1.84	
3	Transport vehicle	-1.91	
4	Road quality	-1.57	
5	Travel time	0.13	
6	Travel cost	-0.13	
7	Location distance	0.13	
8	Ease of achieving goals	-0.13	
	P value		Significant

Source : Primary data was processed using SPSS, 2023.

Table 3. Kruskal-Wallis Test for Accesibility

Nb.	Variable	Mean	Sig
1	Road access	-0.56	0,000
2	Local transport terminal	-2.26	
3	Railway station	-3.19	
4	Airport	-2.9	
5	Seaports	-0.38	
6	Ferry port	0.56	
P value			Significant

Source : Primary data was processed using SPSS, 2023.

Table 4. Kruskal-Wallis Test for Connectivity

A total number of 77 respondents from 12 data sources were used, namely Sumenep Regency Tourism Office, Sumenep Regency Transportation Service, Sumenep Regency Regional Development Planning Agency, East Java Provincial Tourism Office, East Java Provincial Transportation Department. Random selection was also carried out at East Java regional development planning, Academics, Airline pilots association, Elements of independent institutions involved in the tourism business at the regions (Pokdarwis and Budesma), Tourism Bureau, Travel agents, Domestic and foreign tourists. The largest number of respondents was recorded from both domestic and foreign tourists (16). The reminding was evenly distributed, around 4 – 8 respondents as seen in Figure 3.

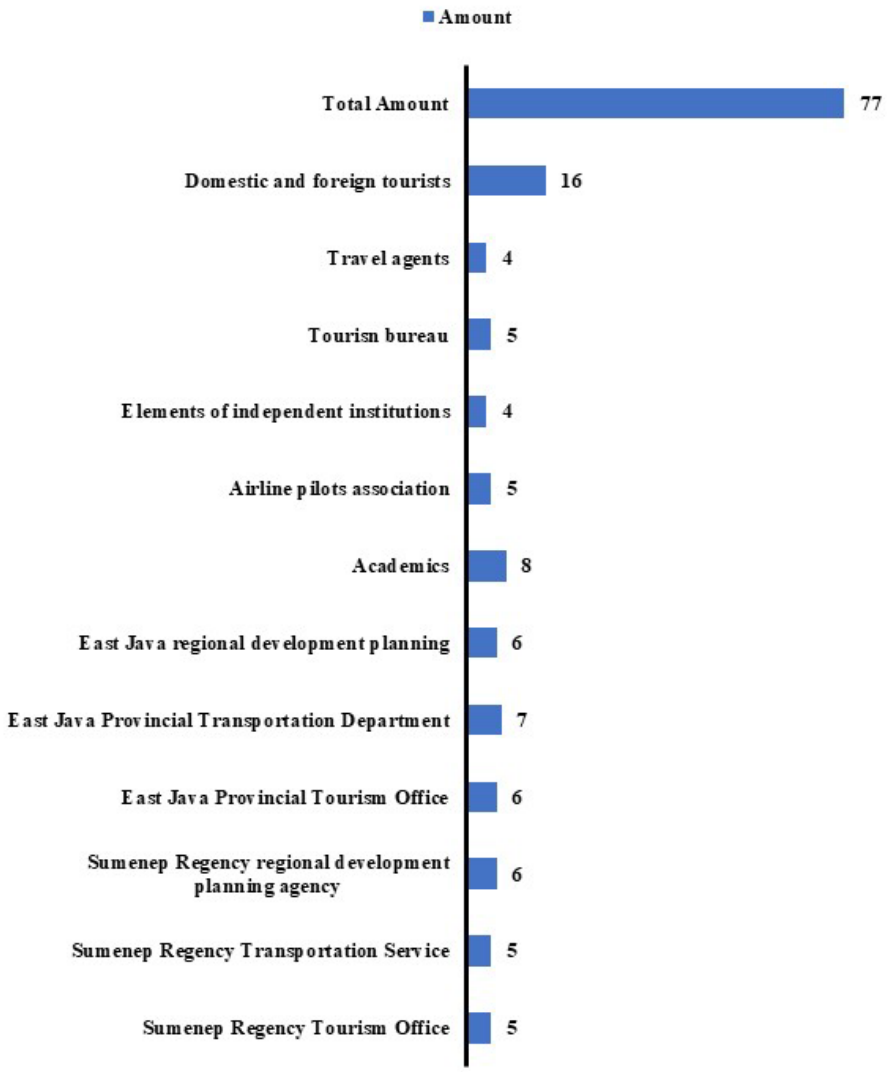

Figure 3. Number of Respondents

The age and gender composition of the 77 respondents were expressed as follows, male and female were evenly distributed, the age range varied from 23 to 56 years with majority at 40 years and above as shown in Figure 4.

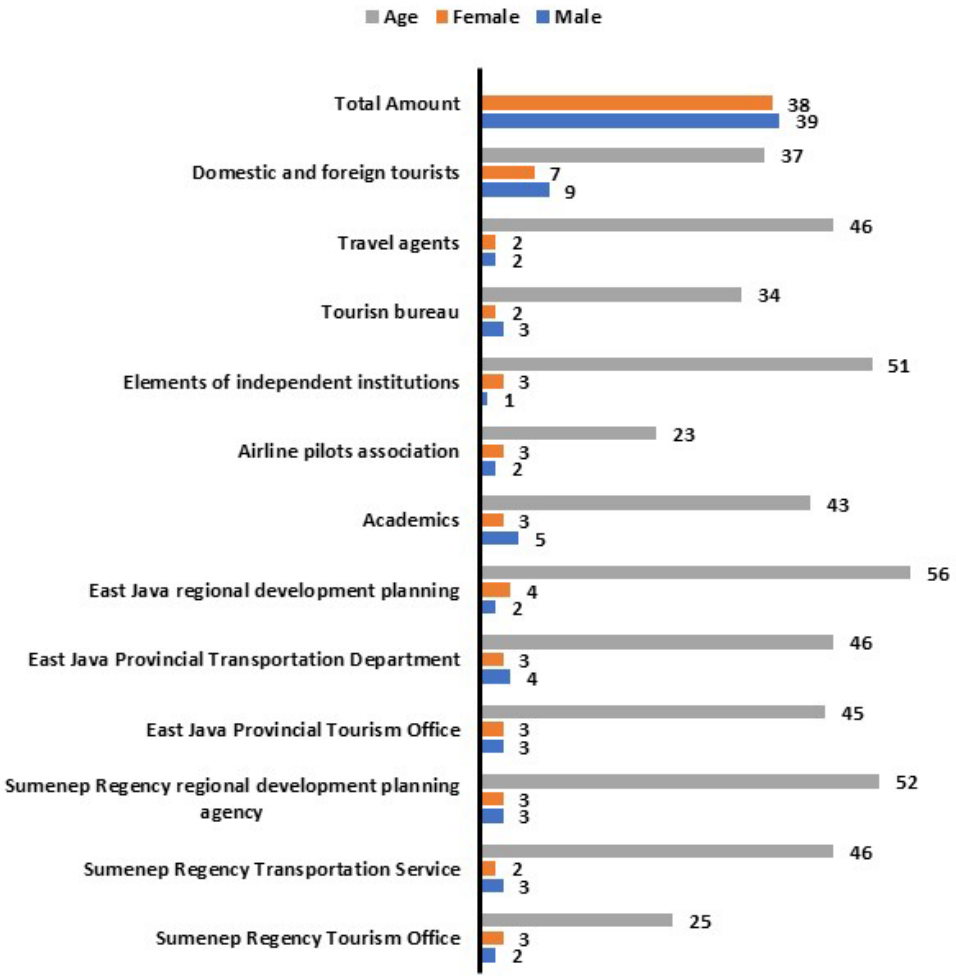

Figure 4. The Age and Gender of Respondents

The educational composition of respondents included the doctoral degree, Master Bachelor, and High School levels as shown in Figure 5. The education level of respondents was dominated by bachelor's and master's degrees, subsequently high school and doctoral certification.

In Table 4, the matrix shows the connectivity between 5 locations connected by 3 sea and 2 ferry piers. The three sea piers are Kalianget, Situbondo Jangkar and Surabaya, while the 2 ferry piers are Dungkek on Madura Island and Bancamara on Gili Iyang Island. Where the Bancamara, Dungkek, and Kalianget pier were connected and scheduled while the others were not.

The distance matrix shown in Table 5 explains the distance between each pier and Bancamara pier on Gili Iyang Island. The furthest distance was Surabaya and Situbondo Jangkar pier, which was more than 82 km. Meanwhile, the shortest distance was Dongkek and Kalianget pier, which was between 9 km to 39 km.

Table 6 of the travel time matrix shown below explains the journey time to Gili Iyang Island (Bancamara pier). Departure was via 4 piers, namely from Dungkek, Kalianget, Situbondo Jangkar, and Surabaya. The fastest time to arrive at Gili Iyang Island (Bancamara Pier) was via Dungkek Pier, only 30 – 40 minutes. Meanwhile, when en route via Kalianget, Situbondo Jangkar, and Surabaya pier, it could take more than 7 hours.

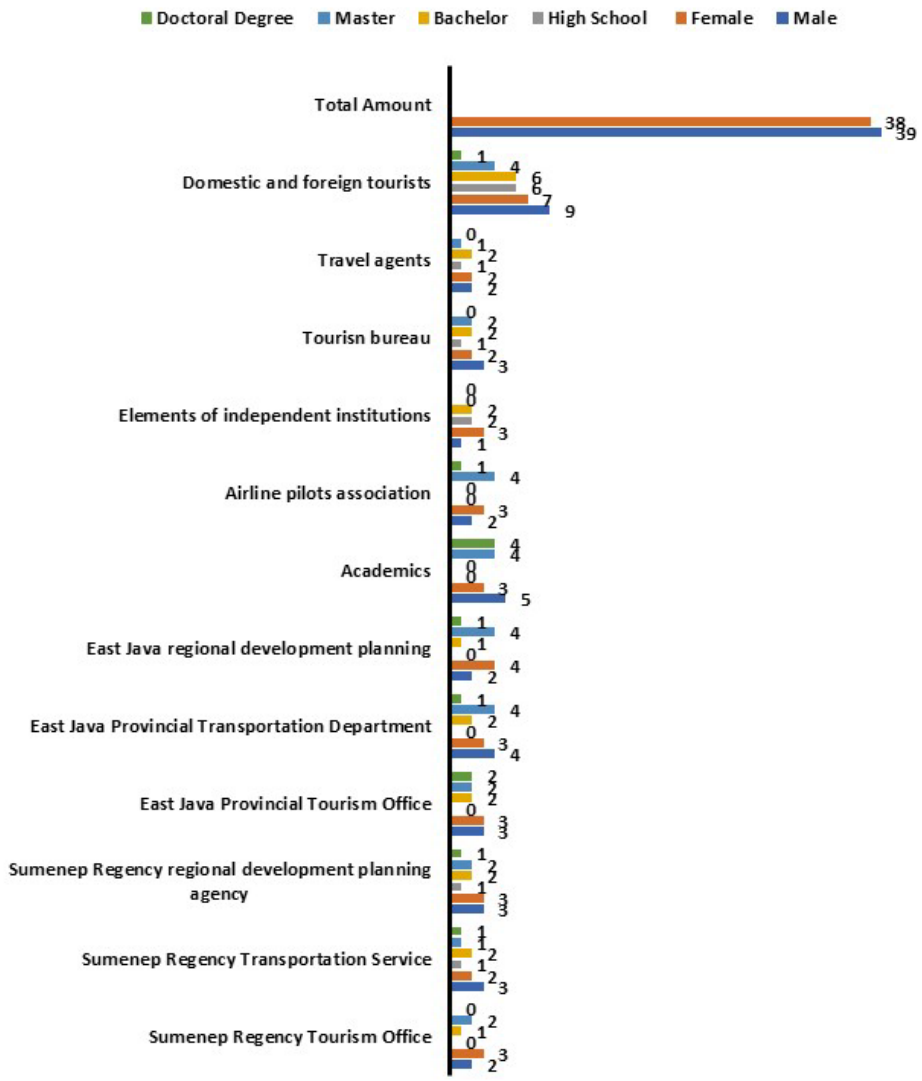

Figure 5. The Education of Respondent

	Gili Iyang Island (Bancamara pier)	Dongkek Pier	Kalianget Pier	Situbondo Jangkar Pier	Surabaya Pier
Gili Iyang Island (Bancamara pier)	1	1	1	0	0
Dungkek Pier	1	1	0	0	0
Kalianget Pier	1	0	1	1	1
Situbondo Jangkar Pier	0	0	1	1	1
Surabaya Pier	0	0	1	1	1

Table 4. Connectivity matrix (Source: Primary data, 2023.)

	Gili Iyang Island (Bancamara pier)	Dongkek Pier	Kalianget Pier	Situbondo Jangkar Pier	Surabaya Pier
Gili Iyang Island (Bancamara pier)	0	9 km	27 km	81,6 km	161 km
Dungkek Pier	9 km	0	38,3 km	116 km	195,7 km
Kalianget Pier	27 km	38,3 km	0	109 km	176 km
Situbondo Jangkar Pier	81,6 km	116 km	109 km	0	199 km
Surabaya Pier	161 km	195,7 km	176 km	199 km	0

Table 5. Distance Matrix (Source: Primary data, 2023.)

	Gili Iyang Island (Bancamara pier)	Dongkek Pier	Kalianget Pier	Situbondo Jangkar Pier	Surabaya Pier
Gili Iyang Island (Bancamara pier)	0	0,7 hours	1 hour	1 hour 12 minutes	5 hours 12 minutes
Dungkek Pier	0,7 hours	0	0,9 hours	8 hours 23 minutes	4 hours 43 minutes
Kalianget Pier	1 hour	0,9 hours	0	6 hours 23 minutes	4 hours 17 minutes
Situbondo Jangkar Pier	7 hours 12 minutes	8 hours 23 minutes	6 hours 23 minutes	0	5 hours 23 minutes
Surabaya Pier	5 hours 12 minutes	4 hours 43 minutes	4 hours 17 minutes	5 hours 23 minutes	0

Table 6. Travel time (Source: Primary data, 2023.)

2.3. Analysis

The analysis was conducted using qualitative descriptive and gap analyses, measuring the difference between performance and the importance of accessibility and connectivity. The importance and performance values were obtained from the average value of the variable (Sudarno et al., 2011). This analysis identifies gaps in service quality dimensions. The greater the gap score, the higher the priority of the variable or dimension for improvement (Sudarno et al., 2011).

According to Rangkuti (2002), the Importance–Performance Analysis (IPA) method is an analytical tool used to assess consumer satisfaction with company performance. This method compares the performance or service experienced by consumers with their desired level of satisfaction. Additionally, the technique measures the importance and implementation of attributes for developing effective marketing programs (Simamora, 2004).

From the assessment of importance and performance in the field, a calculation is made regarding the level of suitability between importance and the service perceived by consumers. The level of suitability is the result of comparing implementation performance with the importance value. Therefore, the level of suitability determines the priority scale for addressing factors influencing consumer satisfaction. IPA is used to obtain information on consumer satisfaction with product or service attributes by measuring performance. In addition to IPA analysis, connectivity index analysis is also used.

3. RESULTS AND DISCUSSION

3.1. Potential of Gili Iyang Island

Gili Iyang Island is also known as Gili Iyang, Giliyang, or Gili Elang. This small island is located at the eastern tip of Madura Island as seen in Figure 6. Administratively, the island is included in the Sumenep Regency, Dungkek District with an area of 9 km2, consisting of Banra'as and Bancamara villages (Sumaryati, 2015).

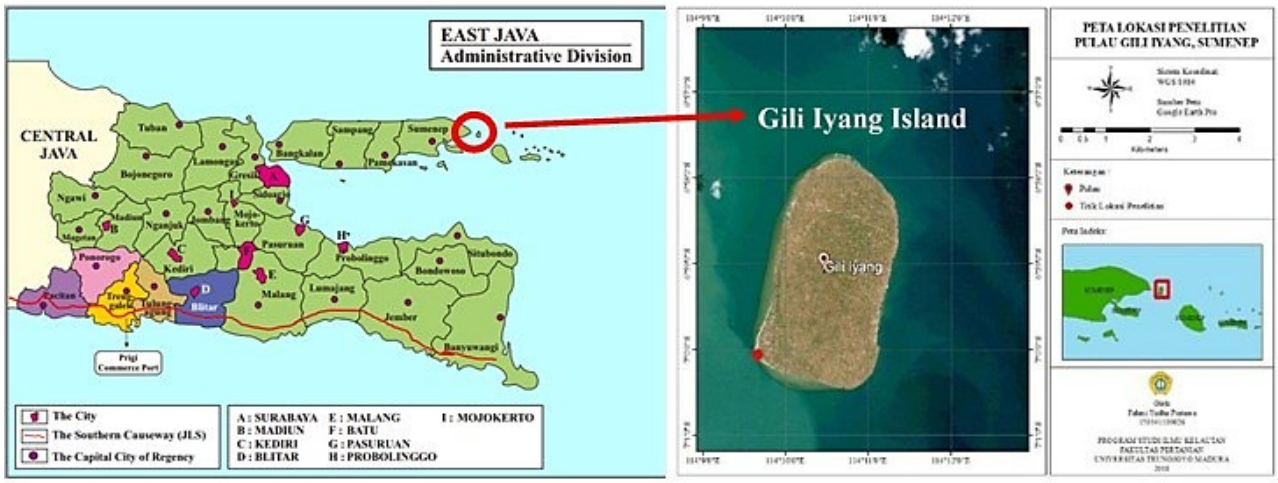

Figure 6. Gili Iyang Island is located to the east of Madura Island Source: (Pratama & Romadhon, 2020; Priyambodo, 2022)

Gili Iyang Island, also known as "Oxygen Island," has natural tourism potential due to its reportedly high oxygen levels, which are above the normal threshold of 20% compared to other regions. Oxygen, an essential gas for human life, serves as a foundational element for developing the island as a health tourism destination.

The assessment of oxygen levels involves multiple agencies. Field measurements by the National Institute of Aeronautics and Space (2006) indicate that oxygen levels on the island remain within normal conditions at 20.9%. The perception of fresh air is attributed to the absence of air pollutants. However, caution is advised due to potential risks associated with high oxygen levels, such as hyperoxia and an increased risk of fire when measurements from other agencies show areas with levels exceeding 22%. Therefore, promoting the island as a health tourism destination solely based on purportedly high oxygen levels requires comprehensive investigation and analysis (Sumaryati, 2015).

Clean air conditions with high oxygen levels, along with tourist attractions such as beaches, the presence of many local residents over 100 years old, and unique culture, offer great potential. With strategic management and thoughtful development, positioning Gili Iyang as an iconic destination for island and beach tourism holds significant promise, as shown in Figures 7 and 8.

Figure 7. Gili Iyang Island has an area of 9.15 km2 with a population of 7,832 people, consisting of 2 villages: Bancamara and Banra'as, in Dongkek District, Sumenep Regency, Madura, East Java Province (Rachmawati, 2021) (Source: https://www.tribunnews.com/travel/2019/08/02/gili-iyang-pulau-di-sumenep-dengan-kadar-oksigen-tertinggi-di-indonesia)

Figure 8. The enchanting appearance of Gili Iyang Island with its stretch of white sand beaches in Sumenep Regency, Madura, East Java Province (Source: https://radarjogja.jawapos.com/nusantara/652960247/pulau-gili-iyang-salah-satu-pulau-dengan-kadar-oksigen-terbaik-kedua-di-dunia)

Gili Iyang Island has the potential to attract both domestic and international tourists. Developing a quality health tourism area can positively impact the local community (Pratama & Romadhon, 2020). Health tourism supports the Sumenep Regency Government's initiative to establish a prominent global destination, primarily due to the island's elevated oxygen levels. This facility serves tourists seeking oxygen therapy and offers an environment for relaxation and leisure travel (Musleh, 2023).

Facilities on the island include a spa, sauna, water aerobics, water sports, hyperbaric oxygen therapy, and natural tourism activities such as fishing, diving, and enjoying natural views of coral, trees, the sea, beaches, and bays (Musleh, 2023). A "Green Architecture" approach with a "Healthy with Nature" design concept is used to develop the facility while preserving the island's condition (Setiawan & Eunike Kristi Julistiono, 2014). The design incorporates locally sourced, healthy, and natural materials and follows the existing topographical contours (Setiawan & Eunike Kristi Julistiono, 2014). Enhancing the character of the space provides detailed design elements and creates an atmosphere that supports comfort and relaxation (Setiawan & Eunike Kristi Julistiono, 2014).

3.2. Transportation Infrastructure and Facilities

Sports tourism, often categorized under health tourism, includes activities that promote physical well-being and recreational engagement. In August 2023, a fun bike program is scheduled to be carried out, as an annual occurrence. In this context, foreign and local tourists are provided the opportunity to access the island through sea routes (Resdiana et al., 2021). The access is facilitated by ferry crossings through Dungkek People's or Kalianget Harbor in Sumenep, as shown in Figure 9.

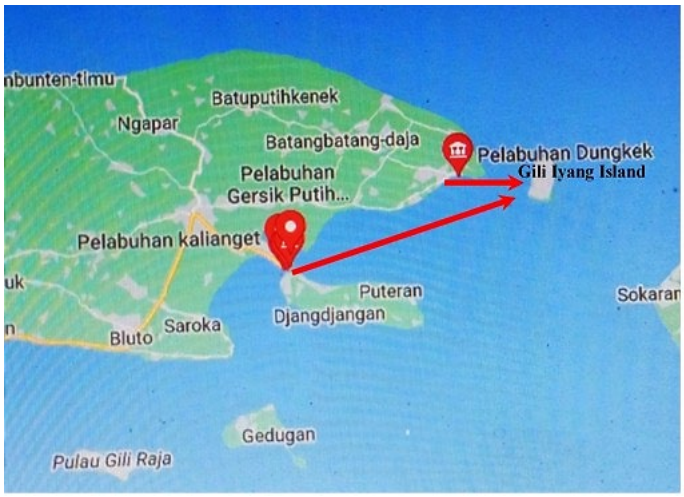

Figure 9. Two crossing routes from Dongkek People's Harbor and Kalianget Sea Harbor lead to Gili Iyang Island (Source: Modification of https://id.wikipedia.org/wiki/Berkas:Peta_Sumenep_Kepulauan.png)

Accessibility and connectivity to and from Gili Iyang Island remain very limited (Musleh, 2023). Therefore, transportation facilities and infrastructure must be built and developed. Health tourism will experience significant growth and attract many tourists when there is convenient and efficient accessibility and connectivity to the destination (Chika et al., 2018). Synchronizing shipping schedules is an important factor in achieving synergy within the region's transportation system (Kumalawati et al., 2023).

In addition to ships and ferries, other transportation methods to be developed include seaplanes and road transportation. To this end, the government plans to introduce seaplanes to facilitate tourist movement. Tourism can showcase the unique cultural diversity of the people of East Java. The introduction of seaplanes for tourists aims to transform Sumenep Regency, which comprises 126 islands, into a water tourism destination offering pristine air quality with zero emissions.

The introduction of seaplane flights requires a comprehensive, integrated design approach, starting with development planning and infrastructure procurement. Establishing facilities for seaplane operations includes providing Cessna Caravan Amphibian 208 A and Twin Otter (DHC-6 Series 400) aircraft. Essential infrastructure components include a water runway (operating area), taxiways, mooring (anchorage) facilities, lighting systems, aviation navigation radio facilities, aviation communications facilities, flight surveillance equipment, visual landing aid facilities, aviation meteorological facilities, and aviation security and safety infrastructure.

Facilities are tools, media, or requirements to achieve an objective. A facility can be a vehicle, road, or similar means to achieve a purpose. Infrastructure, meanwhile, supports the implementation of a business process or project (Salim & Salim, 2002). Facilities are generally objects or equipment such as motorbikes, sedans, jeeps, station wagons, buses, and trucks.

Daily transportation facilities or vehicles include two-wheeled motorbikes and three-wheeled Viar, Tossa, or "odong-odong" vehicles, as shown in Figure 10. Public transport, terminals, trains, and railway networks are not available. There are also no four-wheeled vehicles; the only means of transportation are two-wheeled motorbikes and three-wheeled Viar, Tossa, or "odong-odong" vehicles. The road infrastructure consists of paving material with a width of 3–4 meters.

Figure 10. Three-wheeled vehicles of the Viar or Tossa type as well as two-wheeled motorbikes plying on the 3-4 meter wide road on Gili Iyang Island (Source: personal document, 2023)

Infrastructure is shown more for immovable objects within the scope of land transportation, including roads, terminals, bus stops, counters, and platforms. In the scope of sea transport, the facilities include shipping lanes, docks, weighbridges, postal gates and counters, storage warehouses, rigid pavement, concrete rigid roads, rigid pavement causeways, trestle, water reservoirs, pipe facilities to the pier, garage buildings & closed spaces, and circuit television or CCTV. For air transportation, the facilities required are flights, airports, and navigation aids.

Infrastructure is traffic space (roads, sea and water channels, air routes), terminals, and road equipment, channels, and routes. The different routes are markings, signs, traffic signaling devices, navigation, coastal radio, user control, safety devices, road monitoring, and security equipment. The existing support for transportation facilities and infrastructure is the pier in Dungkek and solar-powered public street lighting (PJUTS). The following is an excerpt from an interview with the Sumenep Regency Transportation Service:

"In 2023, the Sumenep Regency transportation service has carried out several developments to support infrastructure such as piers and building PJUTS. The newly built docks are public and special ferry docks. The Regent of Sumenep Regency also recommended paying attention to supporting facilities on Gili Iyang Island.

Electricity is also limited, and the infrastructure is built on Gili Iyang Island. Meanwhile, the construction of the seaplane has not yet been built, due to budget constraints and location."

Some transportation facilities and infrastructure are not ready as stated in the interview with the Sumenep Regency Transportation Service:

"On Gili Iyang, which is an oxygen spot, the homestay facilities have not been built thoroughly and evenly in the interior, only near the Banra'as pier where homestays have been built as seen in Figure 11. In the interior, what is built is still a gazebo for resting and cannot be used for sleeping like a homestay as seen in Figure 12. Similarly, electricity is still limited using generators where usage is regulated since it is only used at night".

Figure 11. Homestay built near Banra'as Pier for visitors to stay on Gili Iyang Island under construction (Source: personal document)

Figure 12. Gazebos for visitors to rest on Gili Iyang Island was built in spots with high oxygen content (Source: personal document 2023 and Sumaryati, 2015)

3.3. Connectivity Index

To arrive at the tourist island of Gili Iyang which has Bancamara ferry pier facilities, visitors tend to cross three sea piers and one ferry pier, namely Surabaya sea, Situbondo Jangkar sea, Kalianget sea, and Dungkek crossing. Figure 13 below shows that the Dungkek ferry pier has the highest connectivity level index, namely 34.74% compared to others.

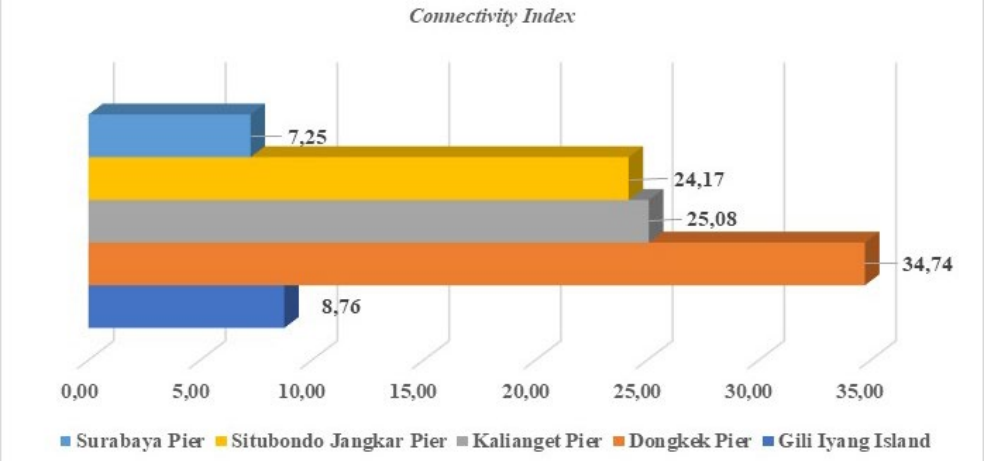

Figure 13. Connectivity Index

3.4. IPA for Connectivity

Sumenep Regency, which has about 126 islands, lacks comprehensive connectivity, especially with its island areas. However, Gili Iyang Island can be reached by ship via Kalianget Harbor, which is managed by the government, or by ferry via Dungkek People's Pier, managed by the local community. Additionally, there are no four-wheeled vehicles available on Gili Iyang Island; the only means of transportation are motorbikes and pedicabs known as odong-odong. Meanwhile, within Sumenep Regency City, various economic, industrial, trade, residential, tourism, shopping, and government centers are connected by a network of roads, local public transport terminals, Trunojoyo Airport, Kalianget, and Dungkek People's Ferry Harbor.

Figure 14 IPA for Connectivity shows that variable 1 (road access), variable 5 (seaports), and variable 6 (ferry ports) are in quadrant 1. This indicates that respondents consider these three variables important and performing well, so they must be maintained. Variables 2 and 4 are in quadrant 2, indicating that the local transport terminal and airport for seaplanes are considered important but have lower performance because these forms of transportation do not yet exist on Gili Iyang Island. Furthermore, variable 3, the railway station, is in quadrant 3, signifying that respondents consider it unimportant. Therefore, attention should be given to the variables in quadrants 1 and 2, while those in quadrants 3 and 4 can be ignored, as they are considered unimportant by respondents.

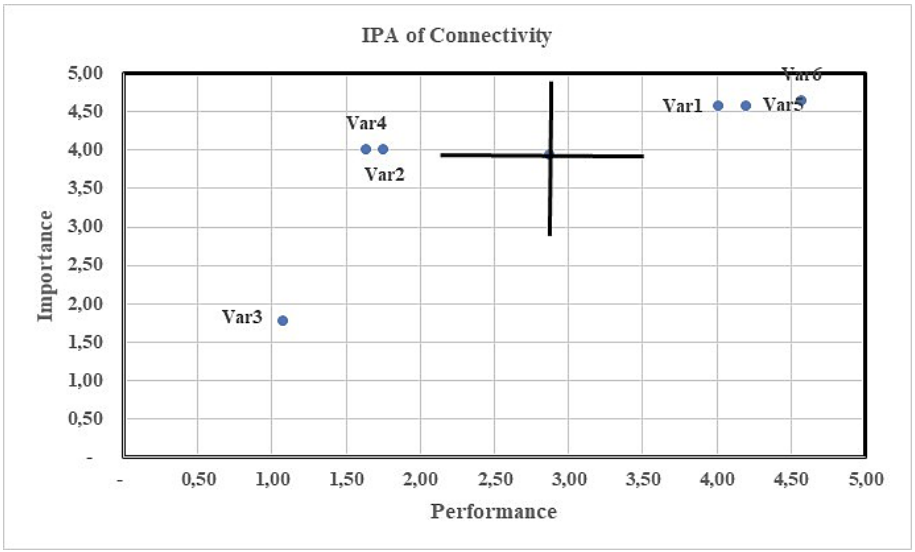

Figure 14. IPA for Connectivity

Figure 15, Importance-Performance for Connectivity, shows that only the ferry port variable produces the best gap because it has the smallest negative value and is closest to positive, at -0.08. This indicates that the ferry port variable demonstrates the best and most consistent performance. Respondents considered the ferry port an important instrument that showed the best performance, while the other five variables had larger negative values. The most significant negative values are found in the variables for local transport terminals, train stations, and airports, which are not present on Gili Iyang Island and its surroundings. One important factor to consider is the presence of airports or water facilities for seaplane flights.

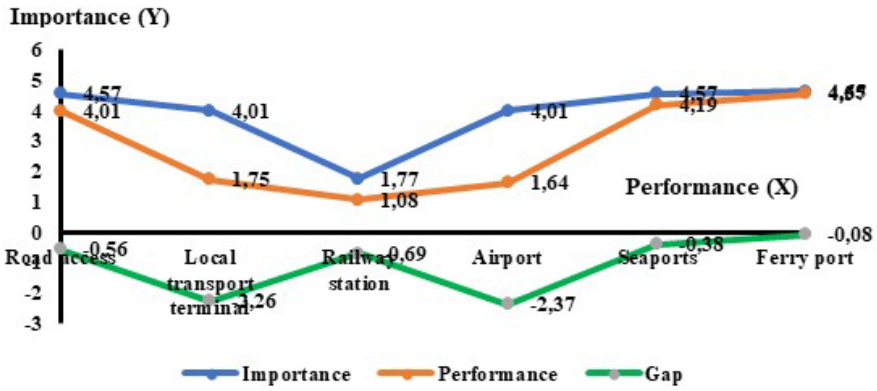

Figure 15. Importance - Performance of Connectivity

Table 7 shows the analysis and evaluation of the condition or quality of connectivity as follows: the level of importance of connectivity variables or indicators is relatively high, with an average of 3.93, while the level of performance is relatively low, namely 2.87, so there is a gap of -1.06. In this context, respondents consider variables such as road access, availability of local transportation terminals, presence of train stations, airport accessibility, as well as availability of seaports and ferry ports, to be significant variables. However, performance in these aspects is still low, namely 2.87.

Nb.	Variable	Importance	Performance	Gap
1	Road access	4.57	4.01	-0.56
2	Local transport terminal	4.01	1.75	-2.26
3	Railway station	1.77	1.08	-0.69
4	Airport	4.01	1.64	-2.37
5	Seaports	4.57	4.19	-0.38
6	Ferry port	4.65	4.57	-0.08
	Average	3.93	2.87	-1.06

Table 7. Importance - Performance - Gap for Connectivity

Of the six connectivity variables or indicators, only the ferry port indicator shows a gap that is nearly positive, while the other five indicators show large negative gaps. The ferry port indicator is closest to positive because of the presence of two ports that facilitate access: Rakyat Dongkek port and Kalianget port. Among the indicators, seaports (-0.38) and road access (-0.56) outperform the others with better gap values. This improved performance is due to the island's connection to the port and existing road access. The indicators for local transport terminals (-2.26), train stations (-0.69), and airports (-2.37) show larger negative gaps due to their absence. Therefore, there is an urgent need to develop and establish local transport terminals and seaplane airports to improve connectivity. Maintaining the quality and performance of ferry ports is important, while efforts should also focus on improving road access and port indicators to achieve positive values.

3.5. IPA for Accessibility

In Sumenep Regency, a well-established network connects various areas within the district, including economic, industrial, trade, residential, tourist attractions, shopping, and government centers. The availability of diverse transportation modes and favorable road conditions ensures convenient and easy access to different areas within the district, as well as to neighboring islands such as Masalembu, Kangean, and Sapudi. However, access to smaller islands, such as Gili Island, remains considerably restricted.

Figure 16, IPA for Accessibility, shows the travel time for variable 5 and the distance to location 7 in quadrant 1. This indicates that respondents considered these variables important and well maintained. Consequently, variable 1 (road network), variable 2 (modes of transportation), variable 3 (transport vehicles), and variable 4 (road quality) are in quadrant 2, showing that these variables were considered important but have poor performance. Therefore, these variables should be moved into quadrant 1 for improvement to yield a positive value. Variables 6 (travel cost) and 8 (ease of achieving goals/convenience) were ignored because they were considered unimportant.

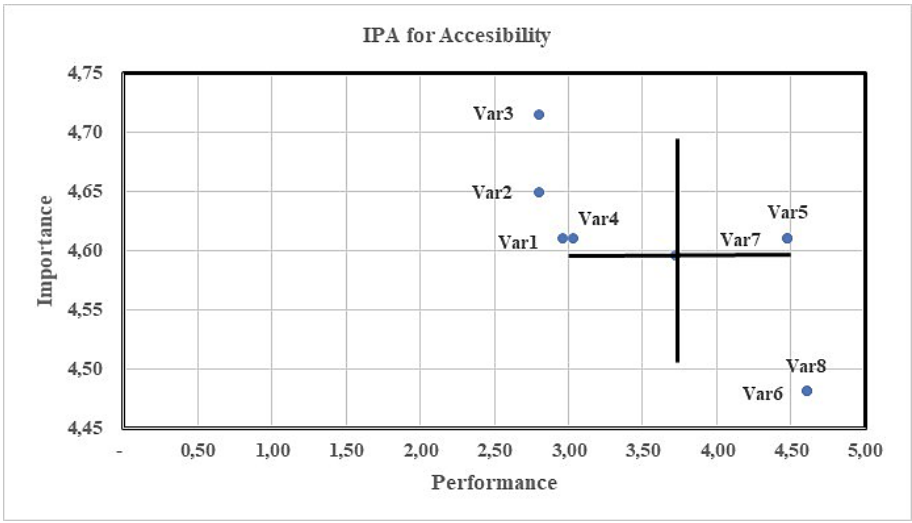

Figure 16. IPA for Accesibility

Figure 17, Importance - Performance for Accessibility, shows that, among the 8 accessibility variables, only the travel time and location distance produced a positive gab, namely 0.13, denoting that the respondents considered these variables to be important and must be maintained. The largest negative values are found in the road network, modes of transportation, vehicles, and road quality variables, which need improvement.

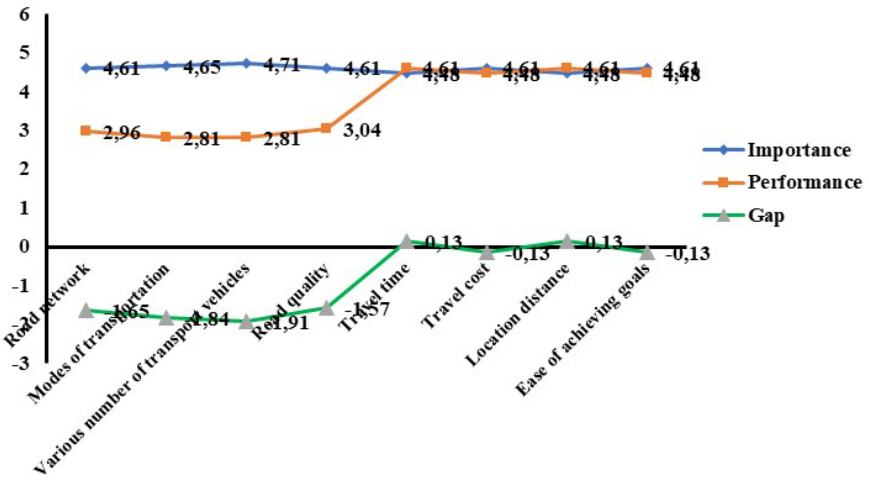

Figure 17. Importance - Performance of Accesibility

Table 8 below shows the analysis of the condition or quality of accessibility as follows the level of importance of accessibility was high, with an average of 4.60, while the level of performance was low, namely 3.72, resulting in a Gap of -0.87 which indicated that the respondents perspectives of the variables were significant. However, the performance was low and the level of accessibility was minimal, but the conditions and qualities are superior to connectivity. The quality of accessibility is known by measuring indicators or variables.

Figures 15, 17, and Table 8 present the condition or quality of accessibility, analyzed and evaluated as follows: the level of importance for the variables or indicators is very high at 4.60, while performance is low at 3.72, resulting in a gap of -0.87. Respondents consider the indicators or variables—road network, modes of transportation, number of transport vehicles, road quality, travel time, travel cost, location distance, and ease of achieving goals/convenience—to be very important. Although performance is low, the quality of accessibility is better than that of connectivity.

Nb.	Variable	Importance	Performance	Gap
1	Road network	4.61	2.96	-1.65
2	Modes of transportation	4.65	2.81	-1.84
3	Various transport vehicles	4.71	2.81	-1.91
4	Road quality	4.61	3.04	-1.57
5	Travel time	4.61	4.48	0.13
6	Travel cost	4.48	4.61	-0.13
7	Location Distance	4.61	4.48	0.13
8	Ease of achieving goals/convenience	4.48	4.61	-0.13
	Average	4.60	3.72	-0.87

Table 8. Importance - Performance - Gap for Accessibility (Source: processed from primary data, Surabaya, 2024)

Among the eight variables or indicators of accessibility, travel time and location distance have positive values. The remaining six have negative values, which are small and better than those for the connectivity indicator. Furthermore, the gap value is only -0.87, which is higher than the average connectivity gap of -1.46. Among the eight accessibility indicators, road network, modes of transportation, number of transport vehicles, road quality, travel costs, and ease of achieving convenience should be improved due to their negative gap values. The quality and performance of indicators with positive gap values, such as travel time and location distance, must be maintained.

3.6. Facilities and Infrastructure Development Strategy

There are three stakeholders in the development of seaplanes, water transport, and land transport infrastructure: the government, the private sector, and the community. Water and land transport airports are needed in Sumenep Regency as a strategy for cooperation and synergy among these stakeholders to achieve the development and construction of seaplanes.

First, to develop seaplanes, the Central Government must promptly finalize regulations related to the Draft Regulations (RPP) on Water Airports, initiated in 2020. On September 16, 2021, the Director General of Civil Aviation issued Decree Number KP 206 of 2021 concerning Technical Standards and Operational Civil Aviation Safety Regulations Part 139 (Manual of Standard CASR Part 139) Volume III Water Aerodrome. The Draft Academic Paper for the Preparation of Government Regulations for Maritime Airports is also being continued as government regulations (PP).

The East Java Provincial Government and the Sumenep Regency Government must prepare and determine the locations of water airports in their regions. The necessary steps include developing a water airport master plan that covers forecasts of passenger service demand, facility requirements, facility layout, stages of development, land needs and use, work environment areas, environmental areas of interest, and flight operations safety areas. Preparations should then be made for the fundamental infrastructure of the maritime airport, including safety and security facilities, airside and landside facilities, airport requirements, water airport requirements, supporting facilities, areas of environmental concern, safety zones for flight operations, and safety zones specifically designated for water airport flight operations.

Second, the coordination between the East Java Provincial Government and the Sumenep Regency Government results in connected work programs. The integration of each policy program is realized through the joint implementation of new piers at Dungkek Harbor and on Gili Iyang Island. The construction of these piers aims to increase connectivity between islands. East Java Province has approximately 427 islands, mostly on the north and east sides. Connectivity between islands is a key issue in equalizing development outcomes.

The construction of the new pier provides significant benefits by enabling the efficient distribution of essential goods needed by the community, including daily necessities, fuel, and telecommunication resources. Additionally, the establishment of the pier, along with supporting infrastructure, is expected to increase tourist visits. Although some community groups, such as ferry boat operators, have expressed resistance, the construction of the pier has been accepted by the broader population. These operators view the new pier as a potential threat to their businesses, raising concerns about competition, fare regulations, passenger preferences, and possible revenue declines during the construction period.

However, there is hope for government guidance and support from relevant agencies, including the provision of life-saving equipment such as vests and first aid kits, as well as educational initiatives to enhance safety awareness during crossings.

Land transportation facilities and infrastructure are also essential for the development of Gili Iyang Island. Transportation modes should be adapted to the unique characteristics of the island's terrain. The most common daily transportation includes two-wheeled motorbikes and three-wheeled Viar or Tossa-type vehicles, known locally as "odong-odong." These vehicles serve as the primary means of daily transport for island residents.

A small, electric-powered vehicle with a maximum capacity of four passengers is suitable for further development. To accommodate local road conditions, the infrastructure features well- constructed paved roads ranging from 3 to 4 meters wide. Given the environmental conditions on Gili Iyang Island, which has high oxygen levels due to the absence of industrial pollution and fossil fuel-based manufacturing, electric vehicles have been chosen for transportation. This choice aligns with the commitment to preserve the island's natural environment, which is rich in greenery and vegetation.

4. CONCLUSION

In conclusion, health tourism has been reported to thrive within Indonesia's archipelagic landscape, which consists of thousands of large and small islands. Indonesia has 17,508 islands with significant tourism potential, and Sumenep Regency in East Java Province has acted as a pioneer in promoting health tourism. This research was an initial effort to identify appropriate strategies for promoting health tourism, focusing on the high oxygen levels found on Gili Iyang Island. Qualitative descriptive methods and IPA were used to determine the strategic tourism and transportation infrastructure facilities that should be built and developed. The results indicated that developing accessibility and connectivity through seaplanes, water transport, and land transport modes is an effective strategy for advancing health tourism.

Transportation accessibility aims to address critical aspects such as affordable travel costs and ease of reaching Gili Iyang Island. Other aspects requiring attention and improvement include expanding road networks, increasing transportation modes, providing modern vehicles, and ensuring high-quality roads. Additionally, maintaining connectivity through easy road access and the presence of sea and ferry ports is essential. The development of land transportation infrastructure, such as train stations and local transportation terminals, is also recommended.

Other recommended solutions include: (1) developing community participation, communication, and media convergence; (2) collaborating with schooland educational institution tour guides under the supervision of the East Java Province Tourism and Culture Office; (3) partnering with tourism and handicraft sectors to train tour guides in health tourism; (4) collaborating with the Maldives to build an international health tourism network; (5) promoting health tourism and working with the private sector to organize tours and exhibitions; (6) integrating ecotourism with a focus on nature; (7) integrating the intermodal transportation network of seaplanes, seaports, water transport, and land transport; and (8) developing environmentally friendly land vehicles powered by electricity and prohibiting the establishment of factories and industries that could produce waste.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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