DIJEFA: Dinasti International Journal of Economics, Finance & Accounting
E-ISSN: 2721-303X
P-ISSN: 2721-3021
https://dinastipub.org/DIJEFA dinasti.info@gmail.com +62 811 7404 455
DOI: https://doi.org/10.38035/dijefa.v5i6

Enhancing Sustainable Tourism In East Nusa Tenggara Through Air Transport Connectivity

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Abstract: Air transport connectivity is a critical element in supporting tourism in archipelagic regions like East Nusa Tenggara (NTT). This article employs a Systematic Literature Review (SLR) approach to examine key variables in sustainable tourism development, including flight frequency, airport infrastructure, tourist accessibility, and environmental conservation. The analysis reveals that improved air transport connectivity significantly contributes to achieving several Sustainable Development Goals (SDGs), such as SDG 9 (Sustainable Infrastructure), SDG 11 (Sustainable Communities), SDG 13 (Climate Action), and SDG 15 (Biodiversity Conservation). This article provides strategic recommendations for inclusive and environmentally friendly air connectivity development to support tourism growth in NTT.

Keyword: Connectivity; Air Transport; Sustainable Tourism; Airport Infrastructure; SDGs.

INTRODUCTION

East Nusa Tenggara (NTT) is an archipelagic region with significant potential in the tourism sector, offering rich biodiversity, cultural heritage, and landscapes that attract both domestic and international tourists. Destinations like Komodo National Park, famous for its endemic Komodo dragons, the savannas of Sumba showcasing unique natural beauty, and the pristine beaches of Alor offering captivating marine tourism experiences are prime attractions. However, this potential remains underutilized due to the limitations in air transport connectivity. Airports in NTT face challenges in terms of capacity, infrastructure quality, and the lack of direct flight routes (Aisyah Astinadia Siregar, 2023). Literature highlights air transport connectivity as a major driver of tourism growth. According to Anindita (2020), robust air connectivity enhances tourist mobility and expedites access to destinations. Waka & Arida (2022) argue that transport development must prioritize sustainability by minimizing negative environmental impacts. Furthermore, Kapu (2020) emphasizes that sustainable tourism contributes to achieving SDGs, particularly in terms of infrastructure development (SDG 9) and environmental preservation (SDG 15). Airports in NTT, such as Komodo Airport in Labuan Bajo and El Tari Airport in Kupang, face capacity challenges, especially during peak tourist seasons. Airport infrastructure, including passenger terminals, aircraft parking areas, and other facilities, often fails to meet the demands of increasing tourist numbers. Moreover, the limited direct flight routes often force tourists to transit through multiple cities, reducing the convenience and attractiveness of visiting NTT (Belabes, 2022).

Challenges Faced (1) Capacity Limitations: Many domestic airports in NTT lack updated passenger capacity data, indicating insufficient facilities. (2) Runway Infrastructure: Airports such as Wunopito and Tardamu have runways too short to accommodate large aircraft. (3) Regional Connectivity: Despite having numerous airports, inter-regional connectivity within NTT still needs improvement to support logistics and local mobility (Mude, 2018). According to Ringa (2020), strong air transport connectivity not only facilitates tourist mobility but also plays a crucial role in linking remote regions to economic and social hubs. In NTT, improved connectivity could broaden access to prime destinations, enhance travel efficiency, and accelerate the development of tourism-supporting infrastructure (Munawar et al., 2023). Lane (2019) emphasizes the importance of sustainability in transport development, especially in environmentally sensitive areas like NTT. Airports and airlines are expected to adopt eco-friendly technologies, such as low-emission fuels, and ensure that infrastructure development does not harm surrounding ecosystems. For example, the construction of new airports or expansion of existing facilities must be designed to minimize impacts on natural habitats and local communities (Puriningsih & KA, 2018).

Sustainable tourism plays a vital role in supporting the Sustainable Development Goals (SDGs) (Adi, 2022). In this context, better air transport connectivity can support: (1) SDG 9 (Sustainable Infrastructure): Through the development of modern airports and inclusive transport services, NTT can enhance accessibility to tourist destinations while adhering to sustainability principles. (2) SDG 15 (Biodiversity Conservation): Increasing tourist visits must be balanced with biodiversity protection efforts and effective management of conservation areas like Komodo National Park. (3)

Gap Analysis: Despite these opportunities, significant gaps remain in achieving sustainable air transport connectivity in NTT. Limited flight frequencies and direct routes restrict access for both domestic and international tourists, leading to longer travel times and higher costs. Smaller airports lack adequate runway lengths and terminal capacities to support growing tourist numbers or larger aircraft. Furthermore, the absence of sustainable practices in airport operations raises environmental concerns, particularly in ecologically sensitive areas like Komodo National Park. Addressing these gaps is critical to ensuring that NTT's tourism potential is realized in a way that aligns with SDG principles, balancing economic growth with environmental preservation.

El Tari International Airport (Kupang) and Komodo International Airport (Labuan Bajo) are the two largest airports in NTT, designed to handle millions of passengers annually. El Tari serves as the main gateway to the region, while Komodo supports tourism in Labuan Bajo. Other domestic airports, such as Umbu Mehang Kunda Airport (Waingapu) and Tambolaka Airport (Sumba), have relatively long runways (over 2,000 meters) but limited passenger terminal capacities, indicating potential for development to improve domestic connectivity. Smaller airports like Wunopito (Lembata) and Tardamu (Sawu Island) have shorter runways, restricting the type of aircraft they can accommodate. Passenger terminal capacities at these airports are generally unavailable or still under development. The table below summarizes the conditions of 14 airports in NTT, including passenger terminal capacities and runway lengths.

Table 1. Passenger Terminal Capacity and Runway Length of Airports in NTT

No	Airport Name	Location	Category	Passenger Terminal Capacity	Runway Length (meters)
1	El Tari International Airport	Kupang	International	2.8 million passengers/year	2,500
2	Komodo International Airport	Labuan Bajo	International	1.1 million passengers/year	2,650
3	Umbu Mehang Kunda Airport	Waingapu, Sumba Timur	Domestic	Not Available	2,300

4	H. Hasan Aroeboesman Airport	Ende	Domestic	180-200 passengers	1,650
5	Frans Seda Airport	Maumere	Domestic	Not Available	Not Available
6	Tambolaka Airport	Tambolaka, Sumba Barat Daya	Domestic	Not Available	2,300
7	Mali Airport	Alor	Domestic	Not Available	Not Available
8	Wunopito Airport	Lembata	Domestic	Not Available	1,200
9	Gewayantana Airport	Larantuka	Domestic	Not Available	Not Available
10	Frans Sales Lega Airport	Ruteng	Domestic	Not Available	Not Available
11	David Constantijn Saudale Airport	Rote Island	Domestic	Not Available	Not Available
12	Tardamu Airport	Sawu Island	Domestic	Not Available	900
13	A. A. Bere Tallo Airport	Atambua	Domestic	Not Available	2,300
14	Soa Airport	Bajawa	Domestic	Not Available	Not Available

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Air Transport Development

The development of air passenger traffic plays a crucial role in understanding the dynamics of population mobility and the performance of the transportation sector. Through this analysis, trends in domestic and international travel can be monitored, aiding in the identification of seasonal patterns or the influence of certain events on passenger movements (BPS, 2020).

Below is a table illustrating the development of passenger numbers through air transport from July to August 2024:

Table 2. Development of Passenger Numbers Through Air Transport (July–August 2024)

Description	August 2023	July 2024	August 2024	M-o-M Change (%)	Y-o-Y Change (%)
Domestic Arrivals (people)	101,151	114,125	103,192	-9.58	2.02
International Arrivals (people)	9,213	14,102	12,161	-13.76	32.00
Domestic Departures (people)	103,159	111,947	110,475	-1.31	7.09
International Departures (people)	10,031	11,031	12,618	14.39	25.79

Source: BPS

This data serves as a foundation for evaluating the performance of airline operators and relevant authorities in managing passenger volume fluctuations. It also provides guidance for planning and policy-making to support the development of air transportation infrastructure. Furthermore, the analysis helps measure the economic impact of changes in passenger numbers, considering the close relationship between air transport and the tourism, trade, and investment sectors. Increases or decreases in passenger numbers may indicate driving or inhibiting factors such as tourism promotion, travel restrictions, or global economic conditions. Therefore, this analysis not only supports strategic decision-making for governments and industry players but also contributes to improving services and the sustainability of the air transport sector.

METHOD

The Systematic Literature Review (SLR) method was employed in this study to identify and analyze relevant research on air transport connectivity and sustainable tourism. The process

began with the identification of literature using prominent academic databases such as Scopus, Google Scholar, and PubMed. Keywords including "sustainable aviation," "air transport connectivity," and "tourism in Nusa Tenggara Timur" were used to ensure a focused search on the topic. Following the identification stage, inclusion and exclusion criteria were applied to refine the selection of articles. The inclusion criteria required the articles to address topics related to air connectivity, sustainable tourism, or relevance to the Sustainable Development Goals (SDGs), with a publication range from 2015 to 2023. Conversely, articles that solely focused on economic aspects without linking them to sustainability were excluded to maintain the study's focus on the intersection of connectivity and sustainability. Thematic analysis was then conducted on the selected articles to uncover recurring and significant themes. These themes included flight frequency, airport infrastructure, environmental preservation, and tourist accessibility, which are critical factors influencing both air transport development and sustainable tourism. Finally, data from the analyzed literature were synthesized to draw meaningful insights. This synthesis identified the relationships between air transport connectivity, environmental preservation efforts, and the attainment of SDGs. By integrating these elements, the SLR method provided a comprehensive understanding of how improved connectivity can contribute to sustainable tourism development in the context of Nusa Tenggara Timur.

RESULTS AND DISCUSSION

Flight Frequency and Routes

The limited flight frequency to East Nusa Tenggara (NTT), along with the scarcity of direct routes, serves as a significant barrier to tourism development in the region. Enhancing direct routes from major cities such as Jakarta and Surabaya can reduce travel times, supporting SDG 9 (Sustainable Infrastructure) by providing inclusive transport services. Currently, tourists often have to transit through major cities like Denpasar or Makassar before reaching key destinations such as Labuan Bajo or Kupang. This prolongs travel time and diminishes the appeal, especially for international tourists seeking convenient access.

Data from the Ministry of Transportation (Kemenhub, 2022) reveals that El Tari Airport in Kupang serves only seven direct domestic routes, while Komodo Airport in Labuan Bajo offers five direct domestic routes. These numbers are relatively low compared to other major tourist destinations in Indonesia, such as Bali or Yogyakarta, which feature more than 20 domestic and international routes. Increasing flight frequency and opening direct routes from major cities like Jakarta, Surabaya, and Balikpapan would significantly reduce travel times and enhance efficiency. This step aligns with SDG 9, ensuring accessible and inclusive transport for all groups.

Improving direct routes is also a key strategy to integrate NTT into national and international tourism networks, enhancing its appeal as a sustainable and eco-friendly destination. The following table provides data on domestic and international flight frequencies to NTT in March 2024.

Table 3. Domestic and International Flight Frequencies to NTT (March 2024)

Airport	Domestic Flights	International Flights	Total Flights
El Tari Airport, Kupang	1,104	0	1,104
Komodo Airport, Labuan Bajo	502	0	502
Other Airports in NTT	1,130	0	1,130
Total	2,736	0	2,736

Source: BPS NTT (2022)

The table shows that, as of March 2024, all 2,736 flights in NTT were domestic. El Tari Airport in Kupang had the highest frequency with 1,104 flights, followed by Komodo Airport

with 502 flights. The remaining airports contributed 1,130 flights. Notably, no international flights were recorded at any NTT airports during this period, indicating a need to develop international connectivity to support tourism and economic growth in the region (Falo et al., 2020).

Airport Quality and Capacity

Airports such as Komodo Airport in Labuan Bajo must increase their capacity to handle rising tourist numbers, particularly after being designated as a super-priority destination by the government. This aligns with SDG 11 (Sustainable Communities)**,** ensuring better accessibility to tourist destinations without environmental degradation. Currently, the airport struggles to manage surges in tourist arrivals during peak seasons. According to the Central Statistics Agency (BPS NTT, 2020), Labuan Bajo saw 1.5 million visitors in 2019, while Komodo Airport's terminal capacity was designed for only 1 million passengers annually. This discrepancy results in overcrowded terminals, limited aircraft parking, and long queues, negatively impacting the tourist experience.

To address this, the following steps can be implemented: (1) Passenger Terminal Expansion**:** Building new terminals or expanding existing ones to increase capacity. (2) Runway Extension: Lengthening runways to accommodate larger aircraft, enabling direct flights from major domestic and international cities. (3) Eco-Friendly Infrastructure: Using renewable energy and waste management systems in airport operations to align development with sustainability principles.

These initiatives align with SDG 11**,** ensuring better access to destinations without harming the environment. Furthermore, adopting eco-friendly airport operations supports SDG 13 (Climate Action) by mitigating the negative impacts of airport operations. Proper development can position Komodo Airport as a model for modern, sustainable tourism infrastructure in Indonesia.

Environmental Conservation in Tourist Destinations

Transport connectivity improvements must be balanced with environmental conservation. Biodiversity hotspots such as Komodo National Park require strict management to prevent over-tourism, supporting SDG 15 (Biodiversity Conservation). Increased tourist numbers have placed significant pressure on ecosystems, including waste pollution, coral reef degradation from uncontrolled snorkeling and diving, and habitat disruption for Komodo dragons. According to the Komodo National Park Authority (2021), visitor numbers at key locations like Komodo and Rinca Islands exceeded the environmental carrying capacity, placing undue stress on local flora and fauna.

The following measures can mitigate these impacts:(1) Visitor Capacity Management: Implementing daily visitor limits and online ticketing systems to control tourist flow. (1) Sustainable Tourism Education: Educating visitors on eco-friendly practices, such as waste disposal and adherence to conservation regulations.(3) Ecosystem Monitoring and Restoration: Using technology to monitor environmental impacts and restore damaged ecosystems.

Additionally, the aviation sector plays a vital role in climate action. The adoption of Sustainable Aviation Fuel (SAF) can reduce carbon emissions by up to 80% compared to conventional fuels (ICAO, 2021). Airports and airlines serving NTT can adopt this technology to ensure that connectivity improvements do not compromise environmental sustainability. These actions align with SDG 15, protecting terrestrial and marine ecosystems, and SDG 13, reducing carbon emissions.

Tourist Accessibility and Mobility

Good air connectivity must be complemented by integrated ground transportation systems, such as shuttle buses connecting airports to major tourist destinations. This supports SDG 9 (Sustainable Infrastructure) by creating interconnected transport systems. However, in NTT, the lack of integrated ground transport poses a significant challenge. Most tourists rely on private vehicles or informal transport, which often lacks standardization. According to BPS NTT (2021), 75% of tourist trips in the region depend on private vehicles, creating difficulties for foreign tourists unfamiliar with local transport systems.

Strategic steps to improve accessibility and mobility include (1) Integrated Shuttle Bus Services: Providing scheduled shuttle buses from airports to major destinations like Komodo National Park, Rinca Island, and Wae Rebo village. (2) Digital-Based Public Transport: Developing digital platforms to enable tourists to book ground transport, integrating flight and land transport schedules.(3) Improved Road Infrastructure: Enhancing road quality to facilitate faster and safer transportation to remote destinations. (4) Inter-Island Transport: Developing ferry services and tourist boats to connect major islands like Flores, Sumba, and Alor.
These initiatives align with SDG 9, promoting efficient, interconnected transport infrastructure. They will also enhance the tourist experience, improve access to remote destinations, and boost local economic development.

Table 4. Direct Flight Routes to Komodo and El Tari Airports

Origin City	Origin Airport	Destination Airport	Airlines
Jakarta	Soekarno-Hatta	Komodo	AirAsia, Batik Air, Citilink, Garuda Indonesia
Jakarta	Soekarno-Hatta	El Tari	Batik Air, Citilink, Garuda Indonesia
Surabaya	Juanda	Komodo	Super Air Jet
Surabaya	Juanda	El Tari	Lion Air
Denpasar	Ngurah Rai	Komodo	AirAsia, Citilink, Garuda Indonesia, Wings Air
Denpasar	Ngurah Rai	El Tari	Lion Air
Makassar	Sultan Hasanuddin	Komodo	Wings Air
Makassar	Sultan Hasanuddin	El Tari	Lion Air

Source: FlightConnections (2020)

The data indicates that Komodo and El Tari Airports are directly connected to several major cities in Indonesia, served by various airlines. However, the limited number of routes highlights the need for further expansion to improve connectivity and support tourism growth in NTT.

The limited flight frequency to East Nusa Tenggara (NTT), along with the scarcity of direct routes, serves as a significant barrier to tourism development in the region. Enhancing direct routes from major cities such as Jakarta and Surabaya can reduce travel times, supporting SDG 9 (Sustainable Infrastructure) by providing inclusive transport services. Currently, tourists often have to transit through major cities like Denpasar or Makassar before reaching key destinations such as Labuan Bajo or Kupang. This prolongs travel time and diminishes the appeal, especially for international tourists seeking convenient access.

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CONCLUSION

Improved air transport connectivity can be a key driver for sustainable tourism development in East Nusa Tenggara (NTT). By increasing flight frequency, airport capacity, and tourist accessibility, NTT's tourism potential can be maximized. The implementation of sustainability principles is crucial to preserving the local environment and culture while supporting the achievement of the Sustainable Development Goals (SDGs).

Recommendations

1. Development of Direct Flight Routes: Open more direct routes from major cities to improve access to NTT.
2. Enhancement of Airport Capacity: Expand terminals and runways to accommodate larger aircraft.
3. Adoption of Eco-Friendly Technology: Implement low-emission fuels in air transportation.
4. Environmental Management in Tourist Destinations: Enforce visitor limits in conservation areas such as Komodo National Park.
5. Integration of Ground Transportation: Develop ground transportation systems directly connected to airports and major tourist destinations.

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