Evaluating Life Cycle Carbon Dioxide Emission from Alternative Inter-regional High Speed Passenger Transport Systems

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Is Shinkansen more environmentally friendlier than Air transport?

This paper aims to analyze the changes in CO₂ emission and Eco-Efficiency due to shift from Air transport to Shinkansen.

The energy consumption of Shinkansen running is much less than Air transport flying. But, are there other characteristics?

- No infrastructure between airports. (Thus, maintenance such as the railway is not necessary.)
- Operating by the straight route between Origin-Destination pair.
- The longer airplane cruises, the lower CO₂ emission per passenger-km is.

Airports

- 84 airports in the 35 prefectures.
- Most of the airport construction projects are already completed.

Shinkansen network

- Stations are located in only 23 prefectures.
- The operating route is 2,176 km (only 31% of the plan).

Air transport

- 45 airports in the 47 prefectures.
- Most of the airport construction projects are not completed.

System boundary:
“CO₂ from operation of Air transport” vs “Additional LC-CO₂ from newly constructed infrastructure and operation from Shinkansen”

500km long corridor

- Life time: 80 years
- Load factor: Air transport 65%, Shinkansen 50%
- Infrastructure of Shinkansen is specified to “Hokuriku Shinkansen”
- Access to airport is excluded

Changes in CO₂ emission and Eco-Efficiency by shift from Air transport to Shinkansen are analyzed by using real data of transport volume and distance for inter-prefectural OD pairs of existing Air transport routes.

Each inter-prefectural OD pair

1) CO₂ per passenger-km

1) The demand for Tokyo is so large that Shinkansen is almost advantageous mode for all the OD pairs that either start or end at Tokyo.
2) In the case of Aichi and Fukuoka, Shinkansen is advantageous for the OD pairs if they are using existing infrastructure.
3) For the pairs with Shikoku and Hokuriku region where Shinkansen does not exist but is planned, CO₂, generated for constructing the infrastructure is large and therefore Air transport is more advantageous.

2) Eco-Efficiency

1) The estimated Eco-Efficiency values show the same trend as CO₂ emission.
2) Factor increases in particularly in the OD from Aichi or Osaka region to Shikoku or Kyushu regions.