VISUALIZATION OF TRIP CHAINS OF INBOUND INTERNATIONAL TOURIST VISITING JAPAN

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Despite the drastic increase of inbound tourists to Japan, their trip chains are not empirically investigated enough. This study aims to investigate the trip-chain trends of international inbound tourists in Japan using the "Flow of Foreigners (FF-data by MLIT)." The study examines trip-chains and their trends together with transportation modes used in the trips. The trip chains are visualized with Sankey diagrams as well as graph theory. By visualizing the trip-chains and their patterns, we analyze the sequential movement of tourists, capturing their multimodal travel, uncovering key insights into popular routes, transportation modes, and visitation patterns. This research contributes to a better understanding of tourist behavior, enabling policymakers and tourism stakeholders to enhance destination planning, infrastructure development, and marketing strategies.

Keywords: FF-Data, Trip chaining, Travel behavior, Inbound tourists

1. INTRODUCTION

In the 2021 Travel and Tourism Development Index, Japan secured the top position, as reported by the World Economic Forum. The White Paper on Tourism in Japan for the year 2021 underscored that in 2019, Japan was globally ranked 12th in terms of the total number of inbound tourists, with a figure of 31.8 million visitors, placing it behind China and Thailand within the Asian region. Furthermore, Japan's international tourism revenue amounted to approximately $461 million, positioning it as the second-highest earner in Asia and the seventh globally.

Over the course of the last two decades, there has been a rapid increase in the total number of international visitors to Japan, underscoring the pivotal role that tourism plays in Japan's economic growth strategy. With the ambitious objective of attracting 60 million visitors by the year 2030, thereby rendering it imperative to intensify their efforts towards the development of the tourism sector. With the significant increase in number of foreign inbound tourist visiting Japan, it is necessary to understand the actual domestic movement across prefectures. Given this significant increase in the number of inbound foreign tourists visiting Japan, it is crucial to gain a comprehensive understanding of the actual patterns of domestic movement across prefectures.

2. ABOUT THE DATASET

The dataset employed in this research, referred to as the Flow-of-Foreigner-Data (FF-Data), constitutes a sampling survey of foreign individuals departing from Japan through airports or seaports. FF-Data is a composite of three distinct datasets: (1) the "Survey on Consumption Trends of Foreigners Visiting Japan" conducted by the Japan Tourism Agency (観光庁「訪日外国人消費動向調査」), (2) the "International Airline Passenger Dynamics Survey" administered by the Japan Civil Aviation Bureau (航空局「国際航空旅客動態調査」), and (3) the "Monthly Report on Immigration Control Statistics" provided by the Ministry of Justice (法務省「出入国管理

統計月報"). Each sample within this dataset is assigned a calculated magnification factor on a quarterly and annual basis, which reflects visitor rates based on their Origin-Destination (OD) in relation to the transportation mode employed for travel between domestic destinations.

Leveraging the FF-Data allows for a comprehensive understanding of various aspects, including the volume of domestic traffic, the purpose of travel, the modes of transportation employed by visitors when journeying to each prefecture, as well as the flow patterns and nationalities.

Table 1 Attributes will be used in this study.

Attribute	Detail
Entry/ Departure port	Asahikawa Airport, Hakodate Airport, Shin-Chitose Airport
	Akita Airport, Aomori Airport, Hanamaki Airport, Sendai Airport
	Haneda Airport, Ibaraki Airport, Narita Airport
	Chubu Airport, Komatsu Airport, Niigata Airport, Shizuoka Airport, Komatsu Airport
	Kansai Airport
	Hiroshima Airport, Okayama Airport, Sakai Seaport, Shimonoseki Seaport, Yonago Airport
	Matsuyama Airport, Takamatsu Airport
	Fukuoka Airport, Kagoshima Airport, Kitakyushu Airport, Kumamoto Airport, Miyazaki Airport, Nagasaki Airport, Naha Airport, Oita Airport, Saga Airport, Hakata Seaport, Itsukuhara Seaport
	Ishigaki Airport
	Other Air and Sea Ports
	Unknown Seaports
Nationality	China, Hong Kong, Korea, Taiwan
	Indonesia, Malaysia, Philippines, Singapore, Thailand, Vietnam
	India, Other Asia
	France, Germany, Italy, Russia, Spain, United Kingdom, Other Europe
	USA, Canada, Other North America, Other South America
	Australia
	Africa
	Other Oceania
	Unknown
Travel purpose	Sightseeing/Leisure, Visiting Family/Acquaintances, Business, Training/Academic conference, Study abroad, Transit, Other, Unknown

Attribute	Detail
Travel type	Group, Individual, Unknown
Number of visits Japan	1st time, 2nd time, 3rd time, 4th time, 5th time, 6-9th time, 10-19th time, Over 20th time, Unknown
Trip related attributes	Sample ID, Trip no., Number of trips
Origin/ Destination (prefecture)	North Hokkaido, East Hokkaido, Central Hokkaido, Southern Hokkaido, Unknown Hokkaido
Origin/ Destination (prefecture) Origin/ Destination (ports)	Akita, Aomori, Fukushima, Iwate, Miyagi, Yamagata
	Chiba, Gunma, Ibaraki, Kanagawa, Saitama, Tochigi, Tokyo
	Aichi, Fukui, Gifu, Ishikawa, Mie, Nagano, Niigata, Shizuoka, Toyama, Yamanashi
	Hyogo, Kyoto, Nara, Osaka, Shiga, Wakayama
	Hiroshima, Okayama, Shimane, Tottori, Yamaguchi
	Ehime, Kagawa, Kochi, Tokushima
	Fukuoka, Kagoshima, Kumamoto, Miyazaki, Nagasaki, Oita, Saga
	Okinawa
	Unknown
	Departure/Entry ports (Same with above)
Visiting period	Jan-Mar, Apr-Jun, Jul-Sep, Oct-Dec, Year (no specific period)
Length of visit	Total length (days), from entry to departure
Overnight stays	Overnight stay at one location (prefecture)
Transport mode	Bus, Railway, Taxi/Car service, Rental car, Other Passenger Cars, Domestic flight, Other, Unknown

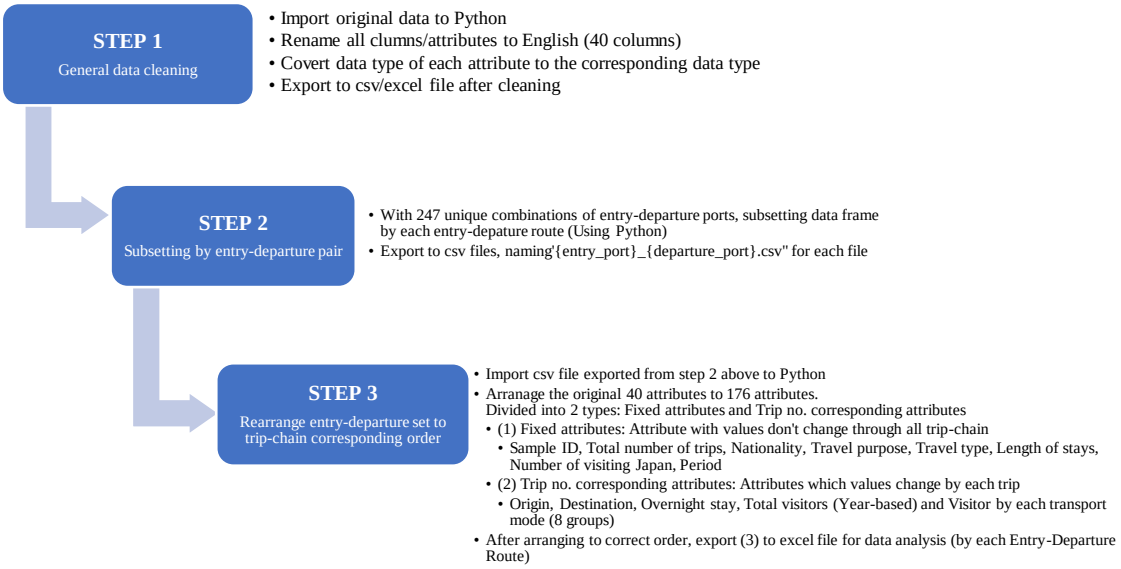


Fig. 1 Methodology for data preparation

3. DATA PREPARATION

(1) Trip-chain definition for FF-Data

The International Air Passenger Statistics Survey and the Consumption Trend Survey for Foreigners Visiting Japan provided data on domestic destinations visited by travelers. This data was then compiled and organized into a series of trip chains.

Each sample ID corresponds to a full trip, which consists of a series of these trip chains, from entry port, to visiting prefecture, and departure port information. FF-Data, in essence, provides significant insights into both the point of origin and the destination of each trip.

(2) Data cleaning methodology

The dataset used in this study is FF-Data 2019, which was published in 2019 by the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT). Prior to conducting analysis, the dataset went through a data-cleaning approach, the details of which are presented in **Fig. 1**.

4. RESULT

(1) About FF-Data 2019

Fig. 2, 3, 4, 5 show the proportions of inbound visitors according to 4 attributes: travel purpose, travel type, visiting period (season), and nationality. It is worth noting that a significant number of inbound visitors, 77.12%, identify sightseeing as their primary reason for visiting Japan, while a far lower proportion, 13.34%, refer to a business-related reason for their visit. 80.61% of them prefer to go to Japan by themselves, while 17.32% prefer to travel in groups or through travel agencies.

The review of visiting periods segments the data into four unique periods of time, with the results indicating a fairly similar distribution. The top five inbound visitors are from China (27.61%), Korea (19.11%), Taiwan (15.12%), Hong Kong (7.26%), and the United States (5.60%), as shown in **Fig. 5**.

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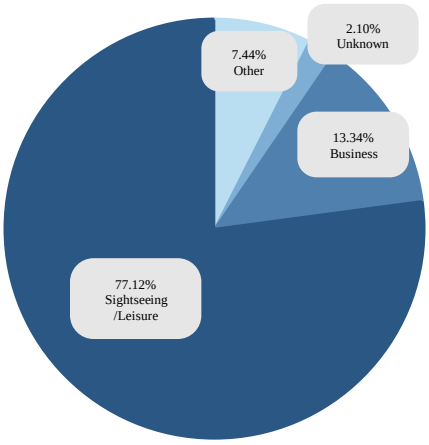


Fig. 2 Visitors by travel purpose

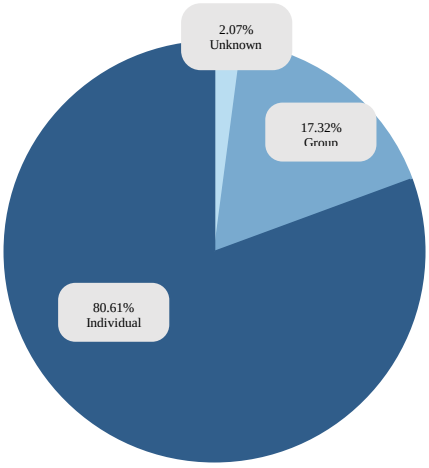


Fig. 3 Visitors by travel type

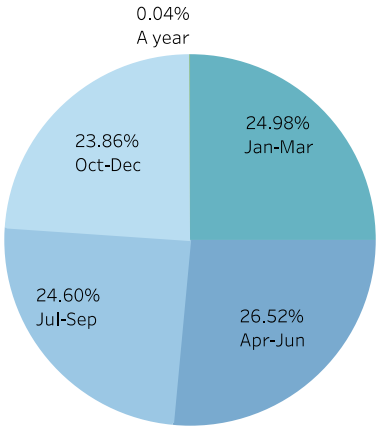


Fig. 4 Visitors by season (%)

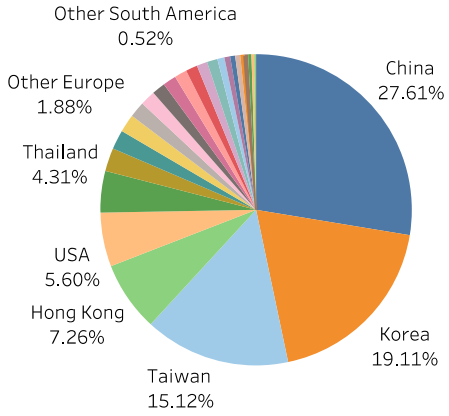


Fig. 5 Visitors by nationality (%)

Table 2 summarizes the total number of journeys taken during visits to Japan. It is vital to remember that each journey includes both the origin point O (either an air/sea port or prefecture information) and the destination point D (also an air/sea port or prefecture information). According to the data, 33.10% of visitors took two trips during their stay in Japan, which generally comprised their entry into Japan, exploring a visiting prefecture, and finally their departure (entry → visiting prefecture → departure). Following that, 20.67% of tourists went on three trips, 18.53% went on four journeys, and 12.87% went on five outings throughout their stay.

Table 2 Visitors per each Total number of trips

Total number of Trips	(Y) Sum of all visitors	Percentage
2	10,247,315.61	33.10%
3	6,400,277.29	20.67%
4	5,737,094.29	18.53%
5	3,983,686.89	12.87%
6	2,588,404.24	8.36%
7	1,043,810.75	3.37%
8	506,374.96	1.64%
9	251,251.84	0.81%
10	105,093.76	0.34%
11	44,184.19	0.14%
12	21,127.06	0.07%
13	14,687.83	0.05%
14	17,195.30	0.06%

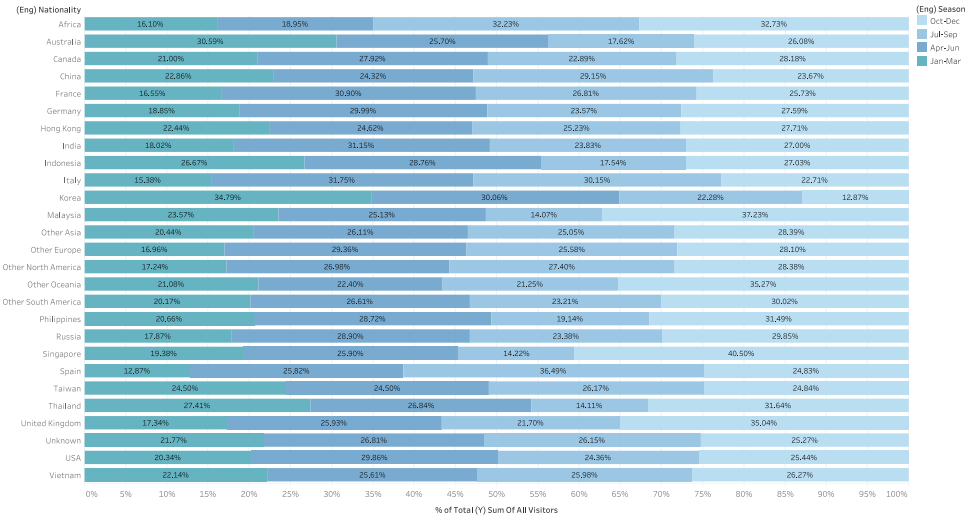


Fig. 6 Visitors by season and nationality

1st time visiting

(Eng) Nationality	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec
China	152,780	183,873	132,665	96,900
Taiwan	33,501	27,115	28,357	20,989
Korea	73,004	44,356	20,982	8,613
USA	83,555	130,634	78,178	82,967
Thailand	23,394	20,699	14,779	24,883
Hong Kong	17,741	22,375	17,366	13,066
Philippines	22,341	31,153	20,178	22,301
Other Europe	11,658	26,830	17,788	18,483
Australia	26,712	33,843	19,115	25,284
Other Asia	9,447	16,411	12,071	8,318
Canada	15,311	24,136	18,023	19,048
Vietnam	37,363	38,228	31,244	31,186
Malaysia	21,737	24,340	10,827	23,959
Indonesia	19,745	19,143	12,372	14,702
United Kingdom	11,357	23,568	14,165	28,184
Singapore	5,245	8,049	5,004	8,018
India	7,796	22,905	12,204	16,854
France	8,507	19,142	15,039	13,047
Russia	4,766	9,974	6,577	8,899
Other South America	9,736	10,643	7,524	12,158
Italy	5,203	11,507	9,036	7,774
Germany	12,436	18,748	12,916	16,438
Spain	5,131	9,525	8,766	8,553
Other Oceania	2,559	4,382	2,101	6,817
Other North America	4,792	3,746	3,739	1,640
Africa	341	2,234	1,111	3,569

Repeater-Visiting Japan

(Eng) Nationality	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec
China	181,222	193,384	110,331	124,936
Taiwan	192,459	189,115	134,393	136,822
Korea	202,967	232,002	107,398	68,497
USA	95,349	103,633	76,537	76,264
Thailand	62,351	65,177	41,068	54,781
Hong Kong	123,085	138,360	111,677	125,412
Philippines	35,224	45,749	29,269	39,732
Other Europe	11,802	13,849	10,566	9,050
Australia	24,387	20,176	14,758	17,162
Other Asia	8,740	8,621	8,726	6,277
Canada	14,913	14,311	11,366	13,418
Vietnam	25,350	22,565	22,461	22,497
Malaysia	28,628	29,368	24,391	38,544
Indonesia	15,039	19,676	12,101	16,824
United Kingdom	13,235	13,208	13,428	14,468
Singapore	22,456	22,486	18,605	24,622
India	13,301	12,194	11,663	11,791
France	12,254	10,129	8,073	9,248
Russia	7,775	8,959	7,599	6,294
Other South America	3,850	3,152	1,914	4,434
Italy	5,647	6,012	3,426	4,241
Germany	12,703	15,917	13,064	11,683
Spain	3,098	3,844	3,076	2,663
Other North America	1,720	2,163	1,286	1,293
Other Oceania	341	4,080	1,486	4,157
Africa	163	1,261	331	2,243

Fig. 7 Number of visitors by nationality (1st-time-visitor and repeater)

Fig. 6 addresses the relationship between visitors' nationality and the season of visit. While **Fig. 4** demonstrates a similar distribution throughout visiting times, various nations have diverse preferences for when they visit Japan. People from Korea (34.8%) and Australia (30.59%) like the months of January to March, whilst the French (30.90%) and Italians (31.75%) prefer the months of April to June. The months of July and September are the most popular for Spanish visitors (36.49%). Surprisingly, the October to December timeframe is the most often chosen period among the 26 nationalities.

The differences between first-time visitors and recurring visitors are also investigated in **Fig. 7**. While there are no major differences in the numbers of Chinese and American tourists, a higher proportion of people from Taiwan, Korea, Thailand, and Hong Kong have visited Japan at least once before. This observation highlights Japan's attractiveness as a fascinating tourist destination for multiple visits.

The major airports of Japan are comprised of seven airports: Narita Airport, Haneda Airport, Kansai Airport, Shin-Chitose Airport, Chubu Airport, Fukuoka Airport, and Naha Airport. In this study, up to 90% used major airports to enter and depart Japan.

The top 20 most popular entry-departure port combinations from 347 combinations are listed in Table 3 below. International tourists tended to come and exit from the same airports, especially the three largest main airports

(Narita Airport, Kansai Airport, and Haneda Airport) accounting for up to 56% of all visitors.

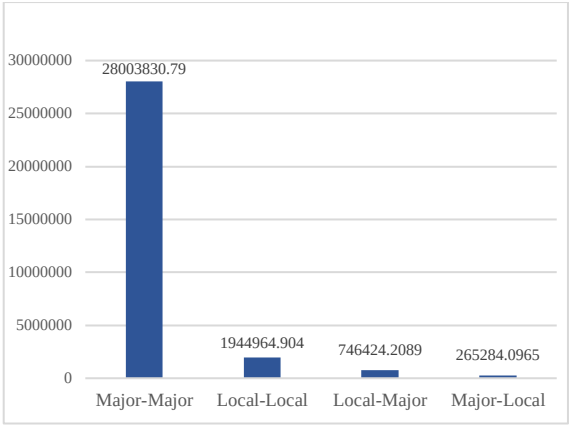


Fig. 8 Number of visitors by Entry-Departure ports

Table 3 Number of visitors by each entry-departure route (FF-Data 2019 - Top 20)

Entry port	**Departure port**	**Number of visitors**	**Percentage (of total)**
Over 347 Entry-Departure routes		**Total: 30,960,504**	
Narita Airport	Narita Airport	7,232,717	23.36%
Kansai Airport	Kansai Airport	6,904,610	22.30%
Haneda Airport	Haneda Airport	3,255,737	10.52%
Fukuoka Airport	Fukuoka Airport	1,989,667	6.43%
Naha Airport	Naha Airport	1,590,083	5.14%
Shin-Chitose Airport	Shin-Chitose Airport	1,558,385	5.03%
Chubu Airport	Chubu Airport	1,292,560	4.17%
Kansai Airport	Narita Airport	854,074	2.76%
Narita Airport	Kansai Airport	811,536	2.62%
Haneda Airport	Narita Airport	574,452	1.86%
Narita Airport	Haneda Airport	492,326	1.59%
Unknown Seaports	Other Air and Sea Ports	380,362	1.23%
Haneda Airport	Kansai Airport	359,345	1.16%
Kansai Airport	Haneda Airport	312,308	1.01%
Unknown Seaports	Narita Airport	141,173	0.46%
Kagoshima Airport	Kagoshima Airport	138,428	0.45%
Takamatsu Airport	Takamatsu Airport	113,115	0.37%
Chubu Airport	Kansai Airport	110,553	0.36%
Kitakyushu Airport	Kitakyushu Airport	107,250	0.35%
Kansai Airport	Chubu Airport	100,171	0.32%

(2) Case study on Entry-Departure routes

We will examine two entry-departure routes to acquire a better understanding of how visitors travel throughout their visit to Japan: (a) Narita Airport - Narita Airport, and (b) Kansai Airport - Kansai Airport.

a) Narita Airport – Narita Airport

Table 4 demonstrates the top ten most popular journeys while visiting Japan (with arrival and departure from Narita Airport). The majority visit Tokyo directly and then ends their journey with a total of two trips (Narita → Tokyo → Narita).

Fig. 9 shows the distribution by nationality for the whole Narita – Narita route whereas **Fig. 10** focuses on the Narita - Tokyo - Narita route. The nationality distribution on the Narita - Narita route and the Narita - Tokyo - Narita route is very close to that of the whole FF-Dataset. They also mainly took the train, followed by the bus, to get from Narita Airport to Tokyo and vice versa (**Fig. 11**).

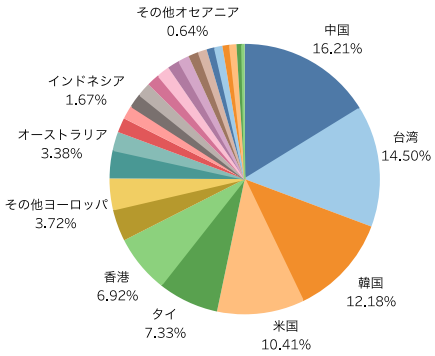


Fig. 9 Visitors by nationality (ED=Narita Airport)

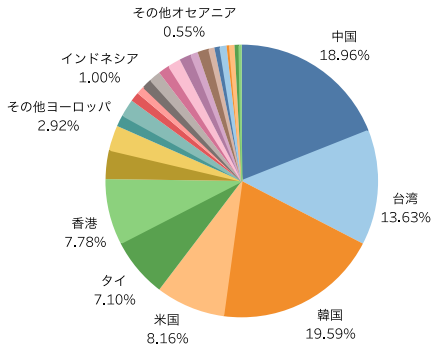


Fig. 10 Visitors by nationality (Narita-Tokyo-Narita)

Table 4 Top 10 trip-chains (ED = Narita Airport)

O trip 1	D trip 1	D trip 2	D trip 3	D trip 4	Number of visitors
Narita	Tokyo	Narita			2473085.406
Narita	Chiba	Narita			213577.565
Narita	Tokyo	Chiba	Narita		208141.212
Narita	Tokyo	Tokyo	Narita		184457.635
Narita	Tokyo	Kanagawa	Narita		184369.501
Narita	Tokyo	Tokyo	Tokyo	Narita	131025.740
Narita	Tokyo	Yamanashi	Narita		127451.542
Narita	Kanagawa	Narita			115501.652
Narita	Chiba	Tokyo	Narita		98041.699
Narita	Tokyo	Kyoto	Narita		75687.075

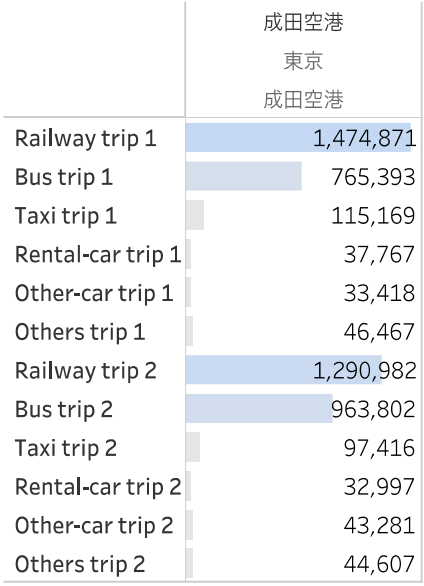


Fig. 11 Visitors by transport modes (Narita-Tokyo-Narita)

A deeper review of the path from Narita Airport to Tokyo and Yamanashi, followed by a return to Narita Airport, reveals unexpected findings. A significant number of Thai tourists took this path, as demonstrated in **Fig. 12**. It is worth noting that, while most tourists prefer to take the train from Narita Airport to Tokyo and from Yamanashi back to Narita, a notable preference for bus travel develops while traveling from Tokyo to Yamanashi, as

illustrated in **Fig. 13**.

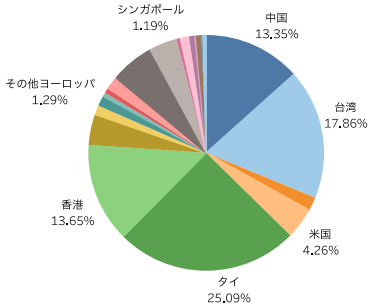


Fig. 12 Visitors by nationality (Narita-Tokyo-Yamanashi-Narita)

	成田空港 東京 山梨 成田空港
Railway trip 1	76,262
Bus trip 1	39,405
Taxi trip 1	5,881
Rental-car trip 1	1,946
Other-car trip 1	1,694
Others trip 1	2,264
Unknown trip 1	0
Railway trip 2	54,025
Bus trip 2	70,058
Taxi trip 2	0
Rental-car trip 2	0
Other-car trip 2	0
Others trip 2	3,368
Unknown trip 2	0
Railway trip 3	74,735
Bus trip 3	52,716
Taxi trip 3	0
Rental-car trip 3	0
Other-car trip 3	0
Others trip 3	0
Unknown trip 3	0

Fig. 13 Visitors by transport mode (Narita-Tokyo-Yamanashi-Narita)

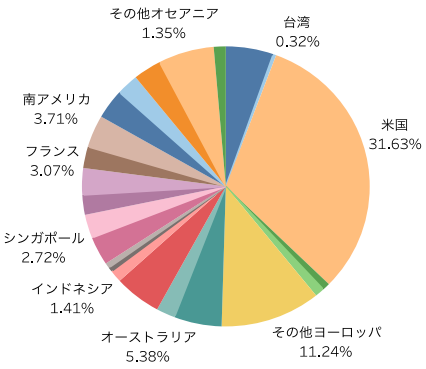


Fig. 14 Visitor by nationality (Narita-Tokyo-Kyoto-Narita)

	成田空港 東京 京都 成田空港
Railway trip 1	45,665
Bus trip 1	23,110
Taxi trip 1	3,449
Rental-car trip 1	1,141
Other-car trip 1	994
Others trip 1	1,328
Flight trip 1	0
Unknown trip 1	0
Railway trip 2	61,750
Bus trip 2	11,610
Taxi trip 2	337
Rental-car trip 2	138
Other-car trip 2	224
Others trip 2	0
Flight trip 2	1,628
Unknown trip 2	0
Railway trip 3	43,287
Bus trip 3	28,371
Taxi trip 3	0
Rental-car trip 3	0
Other-car trip 3	0
Others trip 3	0
Flight trip 3	4,029
Unknown trip 3	0

Fig. 15 Visitors by transport mode (Narita-Tokyo-Kyoto-Narita)

Another case is considered [Narita Airport → Tokyo → Kyoto → Narita Airport] showed that, most people are from the US (31.63%), other Europe (11.24%) and Australia (5.38%) (**Fig. 14**). This might happen due to the limitation in international inbound-outbound flights' arrangements.

b) Kansai Airport – Kansai Airport

Table 5 demonstrates the top ten most popular journeys (with arrival and departure from Kansai Airport). Similarly, to (a), the majority visit Osaka first and then conclude their journey with a total of two trips (Kansai → Osaka → Kansai). When the entire entry-departure path is analyzed, visitors from China make up the most (36.79%) (**Fig. 16**). However, the tour Kansai Airport → Osaka →Kansai Airport attracted an increased percentage of Korean tourists (39.24%) (**Fig. 17**).

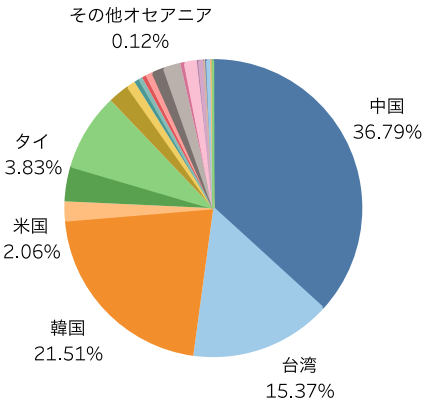


Fig. 16 Visitors by nationality
(ED = Kansai Airport)

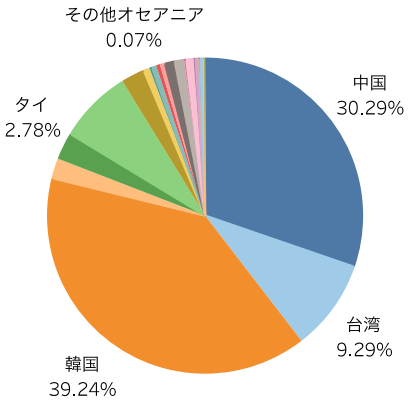


Fig. 17 Visitors by nationality
(Kansai-Osaka-Kansai)

Table 5 *Top 10 trip-chains*
(ED = Kansai Airport)

O trip 1	D trip 1	D trip 2	D trip 3	D trip 4	Number of visitors
Kansai	Osaka	Kansai			1479126.605
Kansai	Osaka	Kyoto	Kansai		969388.576
Kansai	Osaka	Kyoto	Nara	Kansai	578088.569
Kansai	Kyoto	Osaka	Kansai		405605.612
Kansai	Kyoto	Kansai			200287.241
Kansai	Osaka	Kyoto	Hyogo	Kansai	169350.255
Kansai	Kyoto	Nara	Osaka	Kansai	164861.582
Kansai	Osaka	Nara	Kansai		135087.544
Kansai	Kyoto	Osaka	Nara	Kansai	132055.007
Kansai	Osaka	Nara	Kyoto	Kansai	113154.684

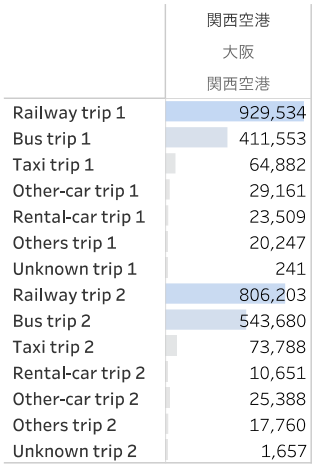


Fig. 18 Visitors by transport modes
(Kansai-Osaka-Kansai)

The same tendency was observed on the Kansai Airport – Osaka – Kyoto – Kansai Airport route, with 37.43% of tourists coming from Korea (**Fig. 19**). **Fig. 20** additionally shows the distribution of visitors by mode of transportation.

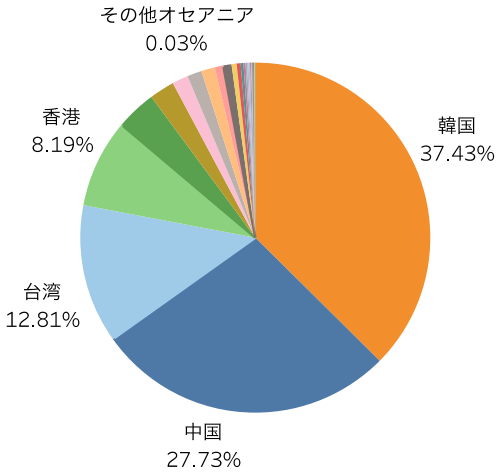


Fig. 19 Visitors by nationality
(Kansai-Osaka-Kyoto-Kansai)

	関西空港 大阪 京都 関西空港
Railway trip 1	611,240
Bus trip 1	270,817
Taxi trip 1	40,985
Other-car trip 1	17,771
Rental-car trip 1	15,300
Others trip 1	13,276
Unknown trip 1	0
Railway trip 2	680,278
Bus trip 2	233,733
Taxi trip 2	31,522
Rental-car trip 2	11,678
Other-car trip 2	9,574
Others trip 2	2,604
Unknown trip 2	0
Railway trip 3	576,594
Bus trip 3	328,132
Taxi trip 3	43,467
Other-car trip 3	10,906
Rental-car trip 3	9,797
Others trip 3	0
Unknown trip 3	493

Fig. 20 Visitors by transport modes (Kansai-Osaka-Kyoto-Kansai)

5. CONCLUSION AND FUTURE STUDY

In this research, we examine various factors associated with the creation of trip chains by international inbound tourists in Japan. Our analysis is based on FF-Data from the year 2019, enabling an investigation into the patterns related to trip chains. The key findings of this study are as follows:

(1) Japan is not only an appealing destination for first-time visitors but also holds considerable attraction for repeat visits by tourists.

(2) The primary motivation for international visitors to come to Japan is sightseeing, and a significant majority prefer to travel independently.

(3) Among the available options, the routes involving major international airports are the most frequently chosen by travelers.

For future study, we intend to explore specific cases involving different entry-departure routes in greater detail, thereby enhancing our understanding and documentation in this area.

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