Modeling Maritime Container Trailer Route-Choice Behavior using Traffic Application Data for Oversize/Overmass Vehicles

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Abstract: Container trailer traffic in road transport has increased with use of maritime containers in international trade. Smoothing large truck traffic, such as container trailers, is necessary in order to strengthen the nation's international competitiveness, but their movement has not been examined yet. Using data from electronically processed traffic applications of large vehicles, this study has simulated their nationwide routes, particularly for international maritime container trailers, in order to analyze travel conditions and route-choice behavior. We have identified locations with high traffic of international maritime containers and have analyzed the effects of road structure on the route-choice behavior of container trailers. A route-choice model to maximize the overlap ratio of routes on applications and estimated routes was then established using the route-choice model for international maritime container trailers. Finally, this study has examined the effects of road measures such as development of the road network and improvement of intersections.

Keywords: Route-Choice Behavior, Maritime Container, Maximum Overlapping Ratio Model

1. INTRODUCTION

Recently, the volume of container trailers in road transport has increased with use of maritime containers in international trade. To strengthen the nation's international competitiveness, smoothing large truck (e.g., container trailer) movement is necessary. However, mechanism of truck transport has not been sufficiently analyzed.

In Japan, for large vehicles that exceed the road weight limit, such as international maritime container trailers, a traffic application for road operators is required in order to drive on roads. These applications are currently being processed electronically by simple GIS software, and data may include routes chosen, such as "passing intersections." This study simulates routes chosen by international maritime container trailers nationwide in order to investigate these trailers' actual conditions and to analyze their route-choice behavior.

First, we analyze the current status of use of maritime containers in terms such as volume and size.

Next, we generate a road network and international maritime container trailers route data using traffic applications of oversize/overmass vehicles, and we analyze the effects of road structure on the route-choice behavior of international maritime container trailers. Route choice models for "Maximizing Overlap Ratio" of routes on applications and estimated routes have been established for analysis.

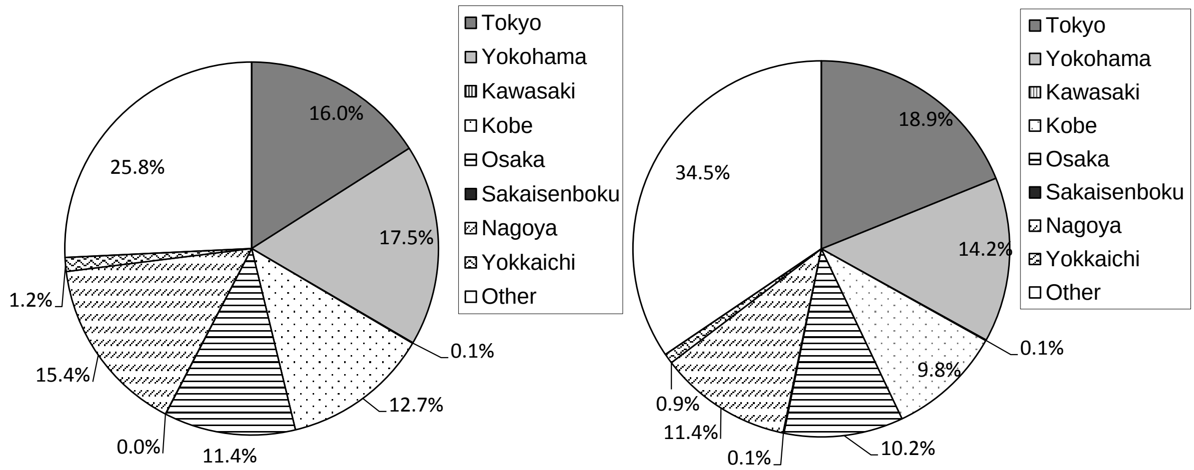
Finally, this study examines the effects of road measures, such as the development of road networks and improvement of intersections, using the route-choice model for international maritime container trailers.

2. Traffic Restrictions of Maritime Container Trailers and Traffic Applications of Oversize/Overmass Vehicles in Japan

2.1 Use of Maritime Containers

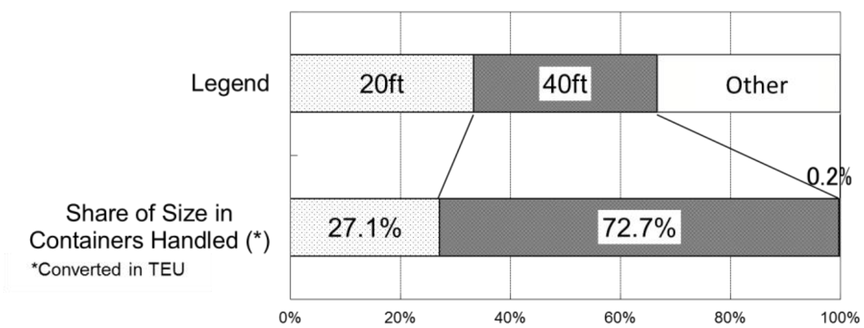
Containers used in maritime container traffic are standardized in size by the International Organization for Standardization. Most containers used for inland transport in Japan are either 20 ft or 40 ft in length. Figure 1 illustrates foreign containers handled in our country by ports. The Port of Tokyo is ranked first with approximately 19% and the Port of Yokohama is ranked second with approximately 14% of the total container traffic for foreign trade. Figure 2 shows the share of maritime containers for foreign trade by size in Japanese ports, being approximately 73% for 40 ft containers.

Volume of cargo handled in containers (tons/year)   Number of containers handled (TEUs/year)



Source) Calculated using Port Statistics (2009)

Figure 1. Share of Handling Containers for Foreign Trade by Ports (2009)



Source) Calculated using Port Statistics (2009)

Figure 2. Share of Maritime Containers for Foreign Trade by Size in Japanese Ports (2009)

2.2 Traffic Restrictions on Maritime Container Trailers

General limits for vehicles weight, height, etc. have been summarized in Table 1. Vehicles within these limits are able to run on roads without a permit. Vehicles exceeding any of these general limits of length, height, or weight are classified as oversize/overmass vehicles, and they require applying for a traffic permit to a ministerial body that issues vehicle permits.

Table 1. General Limit of Vehicles and Exceptions

Width		2.5 m
Length		12.0 m *Exception for combined trailers on national expressways: 16.5 m for semi-trailer and 18 m for full trailer without load extensions
Height		4.1 m on height-designated roads 3.8 m on roads other than height-designated roads
Weight	Total weight	20–25t on weight-designated roads 20 t on roads other than weight-designated roads *Exception for full or semi-combined trailers such as van, container, tank, according to their innermost turning circle: 25–36 t on national expressway, 25–27 t for weight-designated ordinary road, and 24–27 t for other roads
	Axle weight	10.0 t
	Axle weight of adjacent axles	18.0 t for less than 1.8 m of adjacent axle spread 19.0 t for greater than or equal to 1.3 m adjacent axle spread, less than 5 t wheel load 20.0 t for 1.8 m of adjacent axle spread
	Wheel load	5.0 t
Minimum turning radius		12.0 m

3. Traffic Application of Oversize/Overmass Vehicles

3.1 Generating Road Network Data using Traffic Application Data

Sugiyama et al. (2009) analyzed route choices of maritime containers by collecting road hindrance sections for maritime containers using “Road information manual” data (Figure 3). This manual is used for the traffic application system of oversize/overmass vehicles, providing data of road hindrance by a network link (called “span” in the “Road information manual”) and a node (called “intersection” in the “Road information manual”), taken from oversize/overmass applications. This manual compiles road hindrance data of links and nodes by direction at passing nodes. As network data, links are not distinguished by direction but are treated as points. To use this manual data in model estimation, span data need to be connected. In addition, intersections need to be spread using turning direction to express regulation by turning direction at intersections. Next, intersections were described as links with directions (straight/right turn/left turn), and then processed to express turning restrictions on the road network (Figure 4).

Information on traffic hindrance for maritime container trailers compiled in the “Road information manual” data is set forth on the basis of vehicle width and length. Sugiyama et al. (2009) categorized the current vehicle size of maritime container trailers according to the container trailer classification in “Road information manual” data as 20 ft and 40 ft. The present study has followed the method used in Sugiyama et al. (2009). It has collected data on traffic hindrance on the basis of vehicle size, and it has set data on turning hindrance for maritime container trailers from the “Road information manual” of 2008 for the analysis in addition to road network data (Table 2). In the “Road information manual,” the turning restrictions at intersections are classified by vehicle category as follows: “able to turn without violating opposite direction,” “able to turn with violating opposite direction,” and “not able to turn even with violating opposite direction.”

Though the “Road information manual” data covers the entire country, this study utilizes only route data of maritime container trailers departing from the Ports of Tokyo and Yokohama, and the road network for the Kanto region (prefectures of Tokyo, Kanagawa, Saitama, Chiba, Ibaraki, Tochigi, and Gunma, Figure 5). The number of nodes and links for both directions and expanded intersection links in the Kanto region are 81,048 and 126,758, respectively.

1) Span data

Span info	Span length, road type, administrator, designation of weight, height, etc.
Narrow width points	Length of narrow width, width, presence of limit sign, etc.
Curvature hindrance point	Curvature hindrance length, curvature radius, width, etc.
Bridge info	Bridge length, presence of limit sign, structure name, design load, etc.
Space above hindrance point	Hindrance length, presence of limit sign, structure name, space height, etc.
Traffic regulation	OD Intersection No., regulation period, time period, vehicle width, vehicle length, etc.

2) Intersection data

Intersection info.	Address, border, intersection name, intersection hindrance category note) etc,
Intersection turning hindrance	From span no., To span no., Permission of turning by vehicle category, etc.

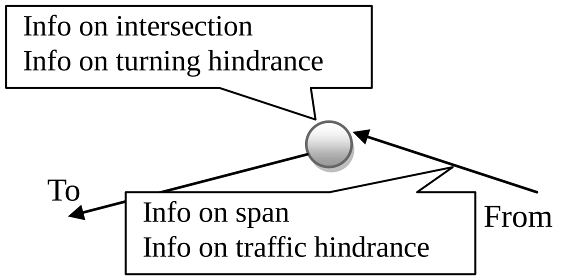


Figure 3. Overview of “Road information manual”

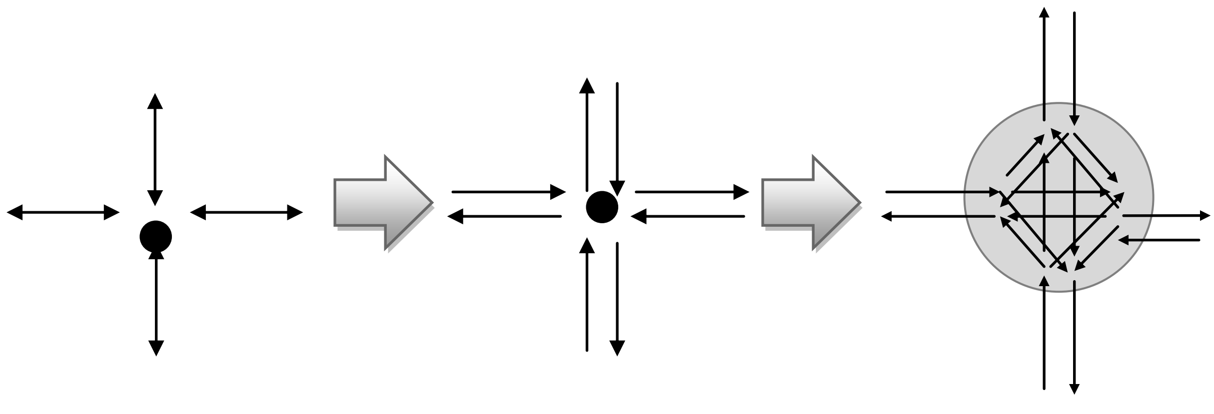


Figure 4. Processed Data Image of “Road information manual”

Table 2. “Road information manual” Vehicle Category and Corresponding Container Size

	Consider as 45 ft			Consider as 40 ft			Consider as 20 ft		
Vehicle category	0			I			II		
	1	2	3	1	2	3	1	2	3
Width	2.5	3.0	3.5	2.5	3.0	3.5	2.5	3.0	3.5
Length	≦ 20.0	≦ 19.0	≦ 18.0	≦ 17.0	≦ 16.0	≦ 15.0	≦ 14.0	≦ 13.0	≦ 12.0

Info on turning at intersections	Vehicle category XX able to turn without violating opposite direction
	Vehicle category XX able to turn with violating opposite direction
	Vehicle category XX not able to turn even with violating opposite direction

Source) Analysis of loss by traffic regulation and detour in domestic transport of international maritime containers. Shibazaki (2005a)

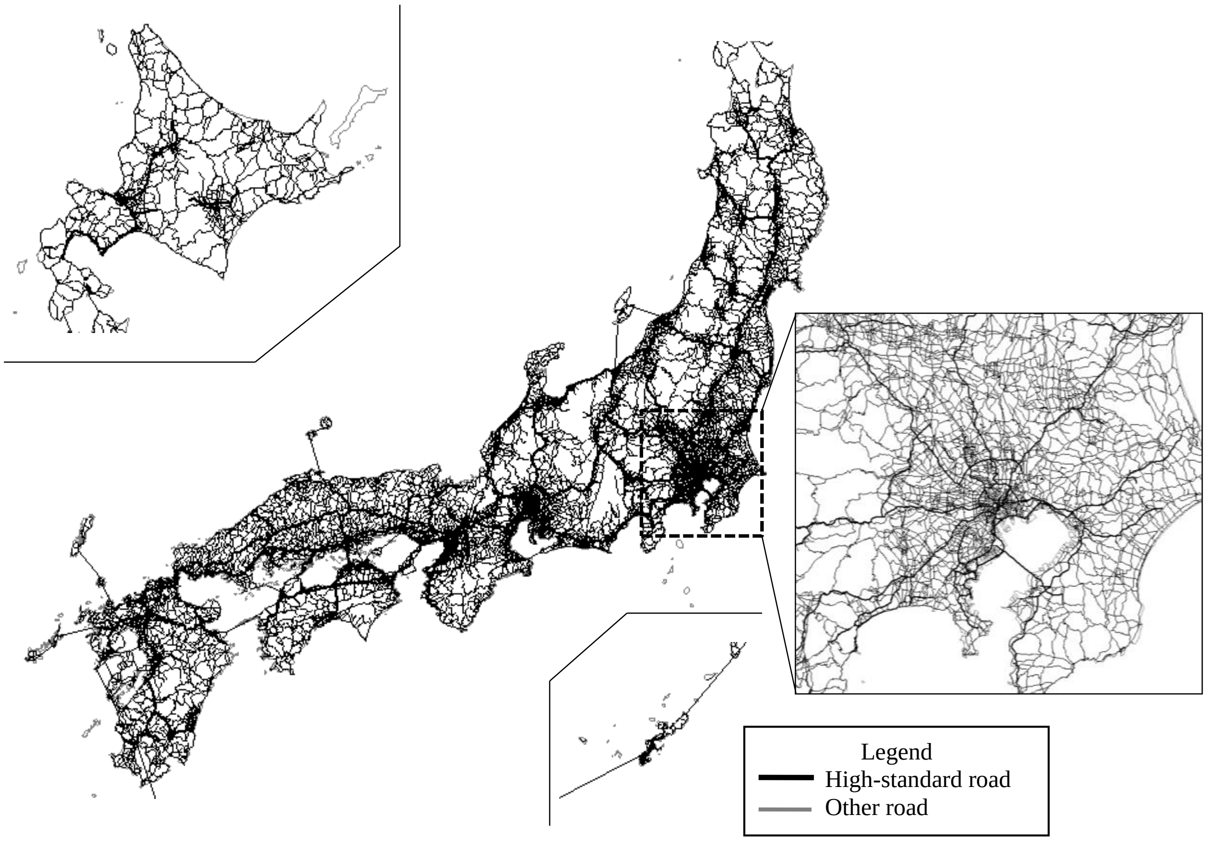


Figure 5. Road Network Created on the basis of Road Traffic Application Data

3.2 Generating Route Data of Maritime Container Trailers

In the “Traffic Application System,” intersections applied by users are stored as electronic data. These intersection data can be identified with those in the “Road Information Manual;” therefore, applied route data can be generated from traffic application data by matching these data with the road network in the “Road Information Manual,” as shown in Figure 5. This study has generated and analyzed route information of maritime containers in 2008 using

maritime container applications of oversize/overmass vehicles with origin or destination at the Port of Tokyo, which have been recently increased. Traffic applications of maritime container vehicles reached 15,895 in 2008. Of these applications, the data set used in this study with both origin and destination within the seven prefectures (Tokyo, Kanagawa, Saitama, Chiba, Ibaraki, Gunma, and Tochigi) had 3,763 samples for road hindrance sections on the road network. Of these, 1,580 samples (applications) were high-cube containers.
Figure 6 shows route data of maritime containers with origin and destination at the Port of Tokyo produced in this study. In “Traffic Application,” high-cube containers (over 3.8 m in height) are separated, but vehicles cannot be separated on the basis of length, such as 40 ft or 20 ft. A container trailer can apply for multiple routes simultaneously; therefore, the applicant may not actually use all routes that he/she has applied for. In addition, we should also keep in mind that “Traffic Applications” do not contain information such as cargo volume or the number of maritime container vehicles.

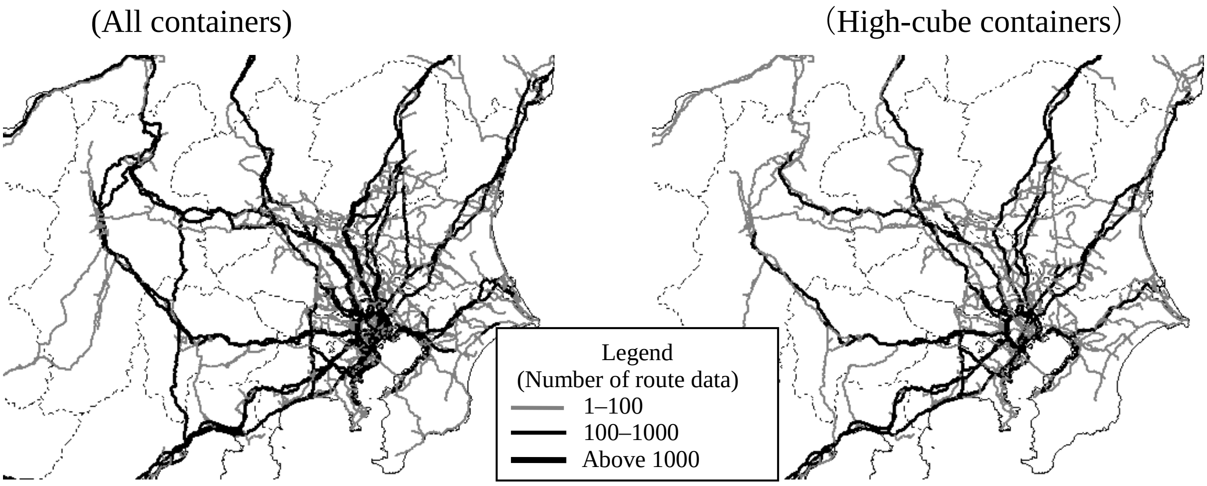


Figure 6. Route data of maritime containers with origin and destination at the Port of Tokyo

4. Flow of Maritime Containers

4.1 Road Development to Handle Maritime Container Trailers

Road development in the Kanto region was analyzed in terms of handling maritime containers. The following figures show the “weight-designated” roads, where vehicles with a total weight of greater than or equal to 20 t are able to drive without a traffic permit (Figure 7).
For major local roads and higher, there are many weight-designated sections, but for national expressways and higher, these sections are not widely available for large trucks except those at the periphery of the Kanto region. National expressways and higher standards have been developed to cope with maritime containers. Besides, height-designated roads, where vehicles with a height of greater than or equal to 3.8 m can drive among national expressways and higher, are not as available as weight-designated roads such as Metropolitan Expressway in central Tokyo (Figure 8).
Figure 9 shows intersections with turning restrictions. In this figure, roads before and after intersections are weight-designated, and intersections where 40 ft containers are not able to turn even with violating opposite direction are illustrated. Obviously, there are multiple turning directions for one intersection. Here intersections with at least one disallowed turning direction are shown. This implies that links (road sections) may be adequate for maritime container trailers, but corresponding nodes (intersections) may not be adequate.

Major Local Roads

National Expressways

Figure 7. Weight-Designated Roads (bold line)

Figure 8. Height-Designated Roads: National Expressways (bold line)

Figure 9. Intersections on Weight-Designated Roads where 40 ft containers are not able to turn

4.2 Characteristics in route choice of maritime containers

In Figure 10, composition of road length by road type for the entire network and traffic application of maritime containers is depicted. Length of expressways and directly controlled national highways account for approximately 40% of the entire network, but comprise approximately 90% of traffic application of maritime containers. Figure 11 shows weight- and height-designated roads; roads without any designation account for approximately 60% of the entire network, but 90% of routes for traffic application of maritime containers are either weight- or height-designated. This implies that maritime containers prefer to drive on higher standard roads that can accommodate large trucks.

In Table 3, intersections with turning restrictions in traffic application of maritime containers are classified. Almost all applications of maritime containers list “intersections that are able to turn without violating opposite direction,” such intersections comprise approximately 40% of the entire network. This suggests that maritime containers may choose routes taking into account “ease of turning at intersections.”

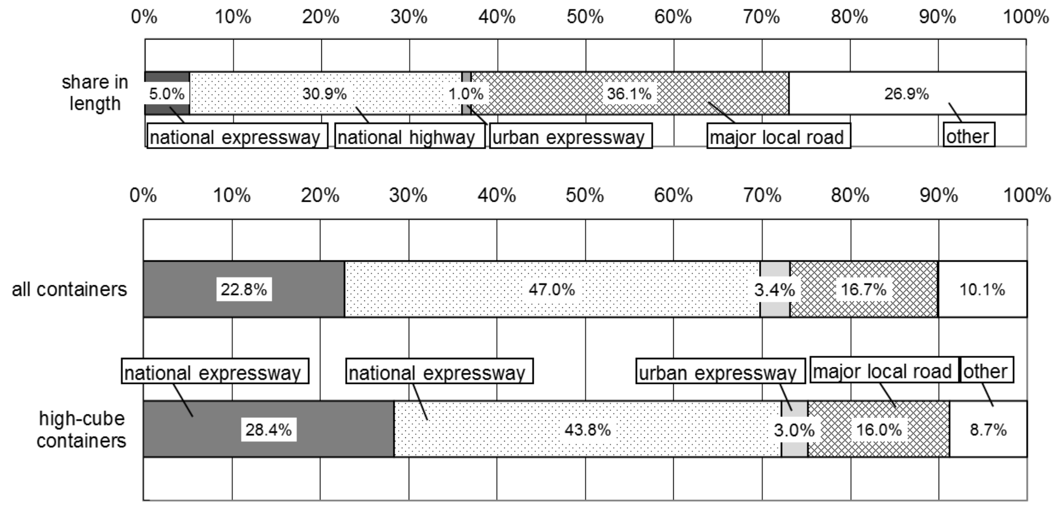


Figure 10. Share of length by road type in applied routes

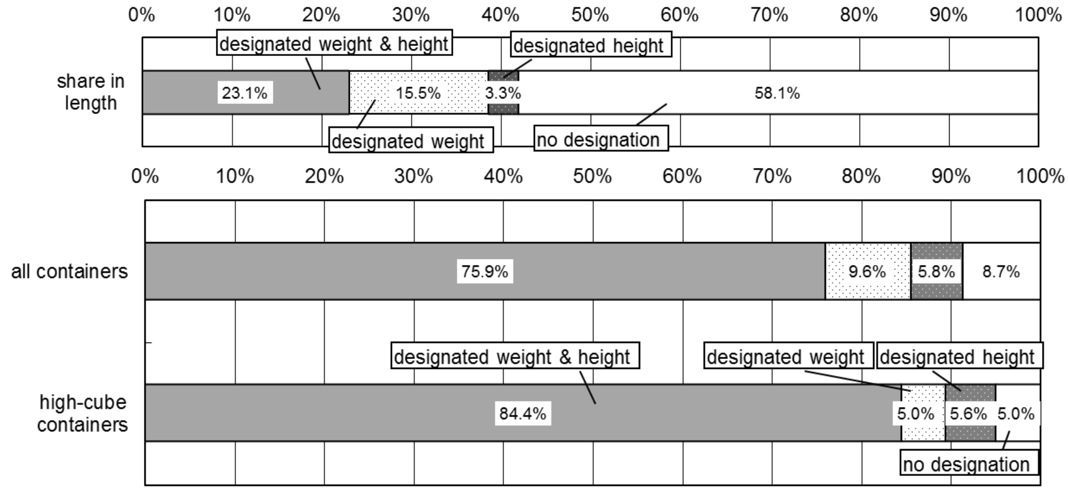


Figure 11. Share of Length by Weight/Height-Designated Roads in Applied Routes

Table 3. Share of Traffc Applications in Use of Intersections by Hindrance Type

Category of intersection	Use of intersection link on application		Number of intersection links on the road network
	All containers	High-cube containers	
Able to turn without violating opposite direction	168,597	67,701	50,294
	97.6%	97.5%	58.7%
Able to turn with violating opposite direction	3,996	1,704	25,064
	2.3%	2.5%	29.3%
Not able to turn even with violating opposite direction	120	54	10,249
	0.1%	0.01%	12.0%
Total	172,713	69,459	85,607
	100.0%	100.0%	100.0%

5. Route-Choice Model of Maritime Container Trailers

5.1 Formulation of a Route-Choice Model using the Maximum Overlapping Ratio Model

This study has formulated a maritime container route-choice model to analyze characteristics of route chosen by maritime containers.

In this study, the route-choice models are estimated with unknown parameters, including value of time, to maximize overlapping ratio of estimated and actual routes without handling choice sets. Ease of driving based on road structure is one of the factors in route choice by a large vehicle, as well as time and cost. This study has assumed that drivers do not usually recognize the generalized costs of "road sections with ease in driving;" therefore, the model assumes that they would choose routes to minimize the "recognized generalized costs." "Recognized generalized costs" in the maximum overlapping ratio model are expressed in the following equation.

$$\mathrm{GC}_a^*(\beta) = (\mathrm{Cost}_a + \omega \cdot \mathrm{Time}_a) \cdot \prod_k \beta_k^{Z_{ak}} \tag{1}$$

Here, GC^*_a expresses the recognized generalized costs when driving on link a. Cost_a is the driving cost of link a (sum of toll and fuel), and Time_a is the required time of link a. Fuel cost is obtained by multiplying the length of link a and fuel efficiency. Fuel efficiency was set at 0.25 [l/km] on the basis of the "fuel efficiency per km of a regular commercial truck" of the "2005 Annual Report of Road Transport Statistics Ministry of Land, Infrastructure, Transport and Tourism (MLIT)," and the light oil price was set at JPY107/l on the basis of the average price in November, 2005 (the Oil Information Center). Z_{ak} is the k^{th} attribute and dummy variable of generalized costs. β_k is an unknown parameter for the k^{th} variable. We estimate Z_{ak} with a factor assumed to affect route choice of maritime containers, and consider the turning hindrance at intersections. The objective function for parameter estimation is the overlap ratio ($D(\omega,\beta)$) of the actual and recognized routes with the minimum generalized costs in (2). Unknown parameters (ω, β) should be obtained to maximize the objective function.

$$D(\omega,\beta) = \frac{\sum_n X_n \cdot D_n(\omega,\beta)}{\sum_n X_n} = \frac{\sum_n \sum_a \delta_{na} \cdot \delta^*_{na}(\omega,\beta) \cdot l_a}{\sum_n X_n} \tag{2}$$

where, X_n : actual distance of n^{th} route, $D_n(\omega,\beta)$: overlap ratio of n^{th} route's actual and recognized route, δ_{na} : dummy variable (=1, if n^{th} route passed a^{th} link), (=0, otherwise), $\delta^*_{na}(\omega,\beta)$: dummy variable (=1, if recognized route passed a^{th} link), (=0, otherwise), and l_a : distance of a^{th} link

5.2 Parameter estimation of the Maximum Overlap Ratio

Unknown parameters (ω, β) of the maximum overlap ratio can be obtained by maximizing equation (2). However, network attribution variables such as the shortest path are discrete; therefore, it is impossible to differentiate the overlap ratio by appropriate variables as well as to calibrate the gradient of objective function. Thus, the parameter value was moved within a given range, and estimated combination of each parameter which has maximum overlap ratio using Genetic Algorithm (GA). In this paper, each parameter is converted into 7 bits resolution, and parameters are connected to one gene. We made 20 genes for one generation and crossed them for 50 generations with mutation rate 3%.

The route-choice model was estimated with two explanatory variables: weight-designated road (where vehicles with a weight of greater than or equal to 20 t can drive without permission), and height-designated road (where high-cube containers can drive without permission). These parameters are dummy variables, and are set to 1 if roads are designated, and 0 otherwise. Thus, when a parameter reaches 0, recognized generalized costs are small. Moreover, from the viewpoint of traffic application analysis of maritime containers, the turning limitation was used as an explanatory variable as it affects the route choice of maritime containers. Concretely, we assume a 40 ft container at an intersection. If it is able or not able to turn with violating opposite direction, there is a hindrance and the dummy variable is set to 1, and 0 otherwise. The route-choice model was estimated only with samples of high-cube containers.

Table 4 shows estimated results of the route-choice model of maritime containers with the following dummy variables expressing road structure: weight-designated road, height-designated road, and intersection turning hindrance. The estimated value of time is appropriate value. Moreover, the bottleneck at intersection (Intersection-hindrance dummy) is essential variable for understanding the behavior of maritime container route choice.

Table 4. Estimation Results

	Model 1	Model 2	Model 3	Model 4	Model 5
Value of time (JPY/min.)	288.125 (2.93)	206.875 (2.32)	175.625 (3.98)	203.75 (2.21)	228.75 (2.24)
Weight-designation dummy	0.11875 (1.32)	-	-	0.18125 (1.83)	-
Height-designation dummy	-	0.18125 (2.81)	-	-	0.18125 (2.18)
Intersection-hindrance dummy	-	-	1.15625 (0.40)	10.4531 (4.53)	8.10938 (2.84)
Overlap ratio	0.46687	0.47255	0.36314	0.47508	0.46778
Sample size	371	371	371	371	371

*Numbers in parentheses are the evaluation indexes of parameters, obtained by "Bootstrap Method."

6. Simulation using the Route-Choice Model for Maritime Containers

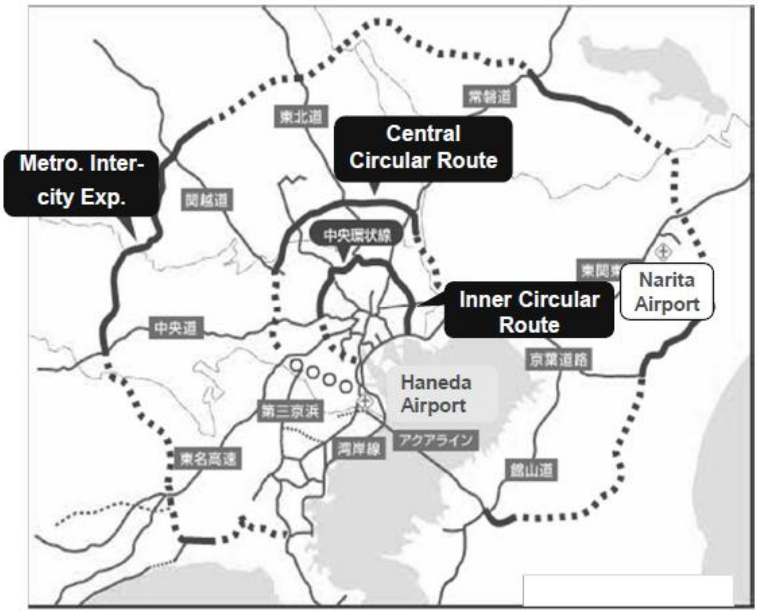
6.1 Simulation Case

The simulation was conducted for three of the five cases. Case 1 assigns traffic to the current road network. Case 2 assumes the current road network and three ring roads under planning in the Tokyo Metropolitan Area (Figure 12). Case 3 assumes the current road network with improvement measures of intersections to remove hindrance for 40-ft-high-cube containers.

The route-choice model used for the simulation was Model 4 in Table 4.

Table 5. Assumptions of simulation cases

	Traffic	Road network
Case 1	Traffic between OD pairs of route data (2008) high-cube containers depart and arrive at the Port of Tokyo	Current road network (2008)
Case 2		Current road network and three ring roads in TMA (Figure 12)
Case 3		Improvement of intersections to resolve hindrance on the current road network



Source) Kanto Regional Development Bureau, MLIT HP

Figure 12. Examined Network

6.2 Simulation Results

1) Effects of building three ring roads

Cases 1 and 2 assignment results for high-cube container traffic are shown in Figure 13, and the difference between assignment results of Cases 1 and 2 are shown in Table 7. Table 8 shows the situation (number of lanes and level of congestion) of major roads that bring disparities in traffic between Cases 1 and 2.

Flow of departing and arriving of high-cube containers at the Port of Tokyo was calibrated to increase in Kanetsu Expressway and Tohoku Expressway, with improved convenience of expressway or urban expressway because of building three ring roads (Figure 14). On the other hand, flow of departing and arriving on ordinary roads decreased in sections, for instance, on Route 4 with usual high traffic or Route 294 with four lanes. This indicates that building three ring roads diverts high-cube container traffic toward roads with more appropriate standards; therefore, travel conditions improve for high-cube containers (Figure 14 and Table 6).

According to the interview survey for shipping business conducted by MLIT, the reason for decrease in travel on Route 294 by maritime containers was "Between the Port of Tokyo and the northern Kanto region, the route with Tohoku Expressway has not enough time reduction considering the toll level compared to the route with Joban Expressway and Route 294." Simulation results of this study indicate that developing three ring roads would improve the expressway network; therefore, hindrance to expressway access by maritime containers would be also improved.

In addition, results in ton–km by road type show that use of expressways has increased (Table 7). Expressways and urban expressways have more lanes than other types of roads, but developing three ring roads would enhance use of more appropriate roads for high-cube containers as well as improve the risk of traffic accident. Besides, reduction in use of major local roads with high level of accidental fatalities and injuries (number of traffic accidents per vehicle kilometer) suggests that it may assist the reduction of traffic accidents as well (Table 8).

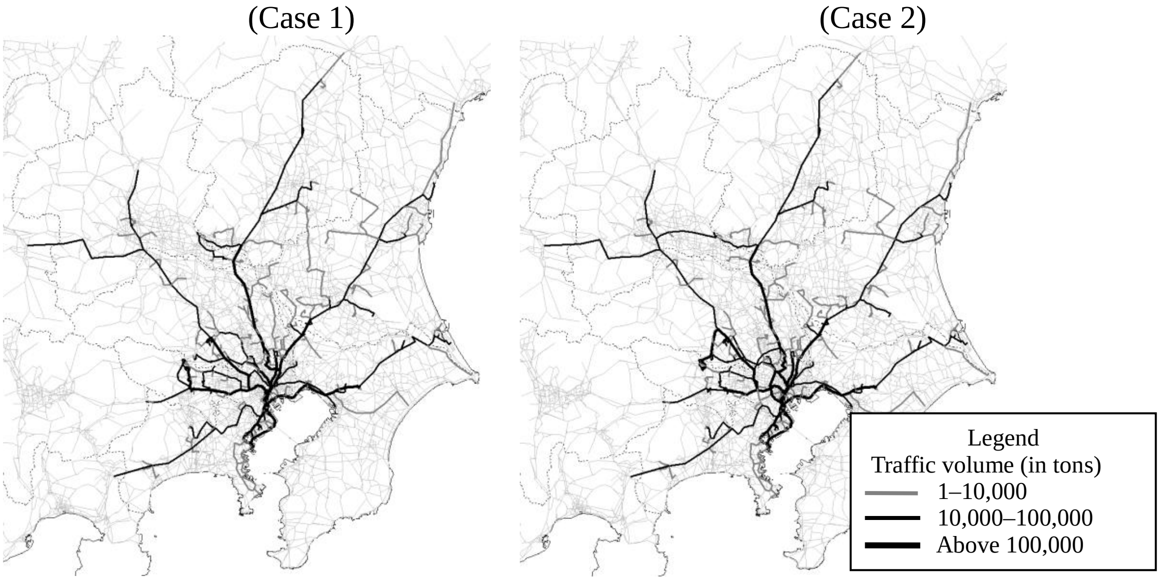


Figure 13 Results of Traffic Assignment for High-cube Container Trailers

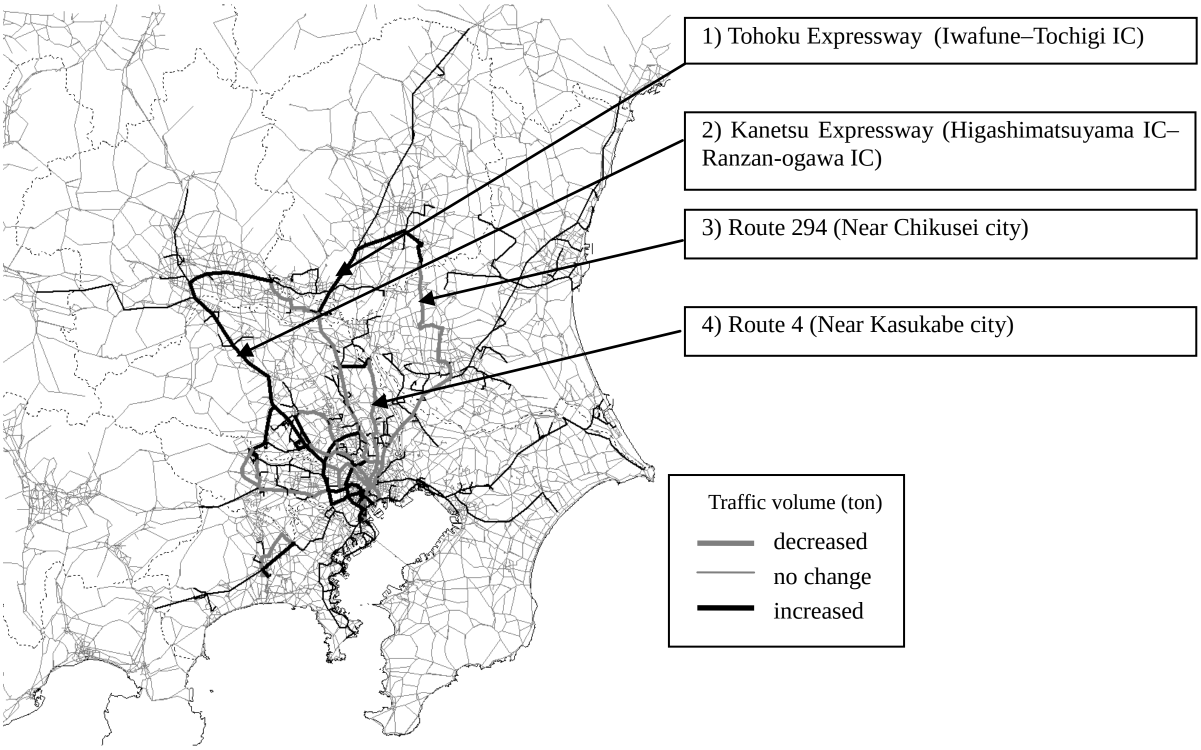


Figure 14. Differences in Traffic due to Building Three Ring Roads (Case 2 − Case 1)

Table 6. Differences in traffic in major sections due to building three ring roads

	Results of traffic assignment for high-cube container trailers (tons/year)			Current status of roads*	
	Case 1 (a)	Case 2 (b)	(b)/(a)	Number of lanes	Congestion level
1) Tohoku Expressway	88,941	93,189	105%	6	0.51
2) Kanetsu Expressway	66,422	81,573	123%	6	0.69
3) Route 294	4,248	0	0%	4	0.83
4) Route 4	5,997	0	0%	4	1.17

* Number of lanes and congestion level: 2005 Road Traffic Census

Table 7. Differences in traffic of high-cube container trailers by road type (ton–km)

	Traffic by high-cube container trailers (estimated value) (1,000 ton–km/year)				
	Expressway, urban expressway	National highway	Major local road	Prefectural, municipal, and other roads	Total
Case 1 (a)	73,414	41,881	20,641	7,088	143,025
Case 2 (b)	80,314	44,304	16,212	7,188	148,019
Change (%) (b − a)/a × 100	9.4%	5.8%	-21.5%	1.4%	3.5%

Table 8. Traffic Situations by road type
(average number of lanes, average congestion level, and traffic accident ratio)

	Expressway, urban expressway	National highway	Major local road	Prefectural, municipal, and other roads	Total
Average number of lanes	4.73	4.01	3.57	3.29	3.80
Average congestion level	0.78	1.17	1.08	0.98	1.05
Average level of fatal and injury accidents (accidents/ 100 million vehicle kilometers)	-	104.02	134.34	82.64	89.62

Source) Number of lanes and congestion level: 2005 Road Traffic Census
Average level of fatal and injury accidents: 2008 ITARDA. It does not include accident data on expressway and urban expressways.

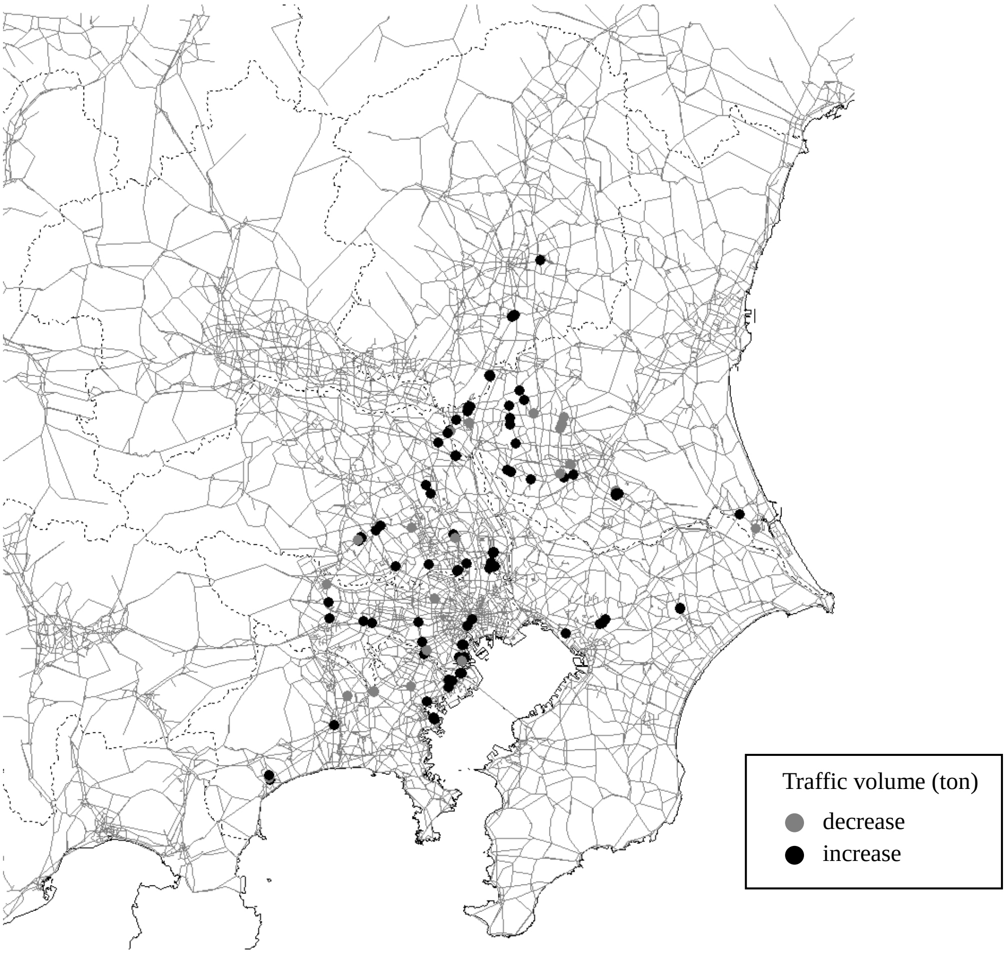
2) Improvement in Intersections with Turning Hindrance

Two cases of improvement measures of intersections were calibrated: the turning hindrance for 40 ft containers at intersections was resolved (Case 3), and traffic of high-cube containers was assigned (Case 2).

Figure 15 shows the difference in traffic of high-cube containers at intersections between Case 1 (the current network) and Case 3. In Table 9, road types connecting to intersections were classified, and then numbers of intersections with increased/decreased traffic were indicated. Among roads connecting to intersections, road types with higher standards were selected. Of these, intersections with greater than or equal to 5,000 tons/year of load estimated to increase were described in Table 9.

At intersections calibrated with increased traffic by removing turning hindrance for 40-ft-high-cube containers, roads either entering or exiting such intersections were often expressways or national highways (Table 10). This suggests that roads with high standards, such as expressways or national highways, are affected by turning hindrance.

Table 10 shows the traffic for 40-ft-high-cube container trailers in tons–km by road type when turning hindrance at intersections were resolved (Case 3). By resolving barriers at intersections, use of mainly expressways and urban expressways was estimated to increase.



*Intersections with turning hindrance that had changes by traffic assignment are shown.

Figure 15. Intersections with changes in traffic by traffic assignment (Case 3 − Case 1)

Table 9. Intersections with changes in traffic by road type
(Road either before or after intersections having higher standards)

Road either before or after intersections having higher standards	Intersections with increased traffic		Intersections with no change in traffic	Intersections with decreased traffic	
	Increase 5,000 tons/year and above	Increase less than 5,000 tons/year		Decrease less than 5,000 tons/year	Decrease 5,000 tons/year and above
Expressway, urban expressway	11 sites (27%)	9 sites (17%)	4 sites (2%)	0 site (0%)	0 site (0%)
National highway	18 sites (44%)	18 sites (34%)	56 sites (31%)	5 sites (42%)	11 sites (85%)
Major local road	7 sites (17%)	14 sites (26%)	67 sites (37%)	5 sites (42%)	2 sites (15%)
Prefectural, municipal, and other roads	5 sites (12%)	12 sites (23%)	55 sites (30%)	2 sites (17%)	0 site (0%)
Total	41 sites (100%)	53 sites (100%)	182 sites (100%)	12 sites (100%)	13 sites (100%)

Note) Numbers in parentheses are composition of road types for intersection ra nks. Numbers may not tally with totals because they are rounded.

Table 10. Change in traffic of high-cube container trailers (ton–km) (Case 1, Case 3)

	Traffic of high-cube container trailers (1,000 ton–km/year)				
	Expressway, urban expressway	National highway	Major local road	Prefectural, municipal, and other roads	Total
Case1 (a)	73,414	41,881	20,641	7,088	143,025
Case 3 (c)	77,938	37,443	21,285	6,705	143,371
((c) − (a))/(a) × 100	6.2%	−10.6%	3.1%	−5.4%	0.2%

7. Conclusion

This study explores route information for maritime container trailers using electronic data from traffic applications to develop a series of analytical techniques for freight network evaluation, and then focuses on an analysis of an international freight arterial network.
Since the network for large trucks significantly affects freight efficiency and urban environment, it is also analyzed as a part of the Tokyo Metropolitan Freight Survey, but its sample size was several hundreds. With a sample of hundreds of thousands of "Traffic Applications," collecting nationwide route data was possible.
Such a large sample allows more detailed examination of current traffic situations as well as possible contribution to improved analytical techniques through various comparisons and model analyses.
Truck route data used in this study were the output of the Working Committee ("Committee on Establishing Efficient Freight Network on Road, FY2009") in which the authors served as committee members. It was established by the Institute of Behavioral Sciences for a project commissioned by the Ministry of Land, Infrastructure, Transport and Tourism.

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