Urban Freight Survey and Policy Measures with Respect to Urban and Transport Planning in Tokyo Metropolitan Area

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Abstract:
This paper aims to introduce the overview of the 5th Tokyo Metropolitan Freight Survey and government policy measures against logistics problems in Tokyo Metropolitan Area(TMA), which was clarified from the survey data analysis. We especially provide the detailed description on the measures for logistics facility locations, that is, support for logistics facilities to locate in the suburban areas along the expressways, reduction of adverse impacts induced by land use mixtures of logistics facilities and residences, and support for rebuilding of aging logistics facilities in the coastal area.
Keywords: Logistics Facility, Freight Transportation, Urban Freight Survey, Land Use

1. INTRODUCTION

Purpose of this paper is to introduce the overview of the 5th Tokyo Metropolitan Freight Survey and government policy measures against logistics problems in Tokyo Metropolitan Area (TMA), which was clarified from the survey data analysis.

This survey was conducted during the 2013-2014 fiscal year by the Transport Planning Commission of TMA. The Commission consists of the members from the Ministry of Land, Infrastructure, Transport and Tourism, seven prefectures and five major cities in TMA, three expressway companies and the Urban Renaissance Agency. From the viewpoints of urban and transport, the urban logistics system is considered to be composed of two factors: “logistics facilities (nodes)” and “freight transportation linking the facilities (links)”. Based on this concept, this survey collected information related to both factors in order to understand the current situations and logistics problems in TMA. As for “logistics facilities”, data obtained were their locational characteristics, logistics functions, site and total floor area, years established and constructed, number of employees, etc. As for "freight transportation", information including the origin/destination of freight flows, main transportation mode and freight vehicle route were collected.

Based on the survey findings of current situations and issues related to logistics in TMA, the Transport Planning Commission developed a report including suggestions of policy measures for TMA from viewpoints of urban and transport. This report was published in December 2015. The suggested policy measures are roughly divided into four themes: 1) measures to support for locating logistics facilities and to control the land use, 2) measures to form a logistics network to realize smooth, environmentally-friendly and safe large truck traffic, 3) measures to support bustling commerce and exchange in city centers by enabling more efficient delivery of goods to commercial facility or business office, and 4) measures to construct logistics network that is functional even in large-scale disasters.

In this paper, focusing on the first theme above, we describe the data analysis of recent trend

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and some issues of logistics facilities location within TMA and their functions, and introduce the Commission's policy suggestions from the following three perspectives. The first is the measure to support for logistics facilities to locate in the suburban areas along the expressways. The second is the measure to reduce or relieve adverse impacts induced by land use mixtures of logistics facilities and residences. The third is the measure to support for rebuilding and updates of aging logistics facilities in the coastal area.

The remaining of the paper is organized as follows. Section 2 explains an overview of the Tokyo Metropolitan Freight Survey, especially focusing on the latest 5th survey conducted during 2013-2014. In section 3, we give the overall outline of policy measures against logistics problems, which were suggested by the Transport Planning Commission of TMA based on the survey data analysis. In section 4, among the suggested policy measures, detailed description on the measures for logistics facility locations is provided. Finally, section 5 concludes.

2. OVERVIEW OF THE TOKYO METROPOLITAN FREIGHT SURVEY

The Tokyo Metropolitan Freight Survey is a survey on logistics that has been conducted by the Transport Planning Commission of TMA for a total of five times in 1972, 1982, 1994, 2003-2004 and 2013-2014. Through scientific analysis of logistics data obtained from the Survey, the Commission has clarified the current situations, trends and problems of logistics in TMA, and has made recommendations on the directionality of urban and transport planning for TMA from the viewpoint of logistics.

In section 3 and section 4, we will give descriptions on the current situations, trends and problems of logistics in TMA identified by the latest 5th survey conducted in 2013-2014 as well as measures recommended by the Commission for the administration to take in order to address the problems. Therefore, for the preparation, this section outlines the 5th Tokyo Metropolitan Freight Survey.

TMA investigated in the 5th Tokyo Metropolitan Freight Survey is the area colored in Figure 1. Hereafter, when we use the term "TMA" in this paper, it refers to the same area.

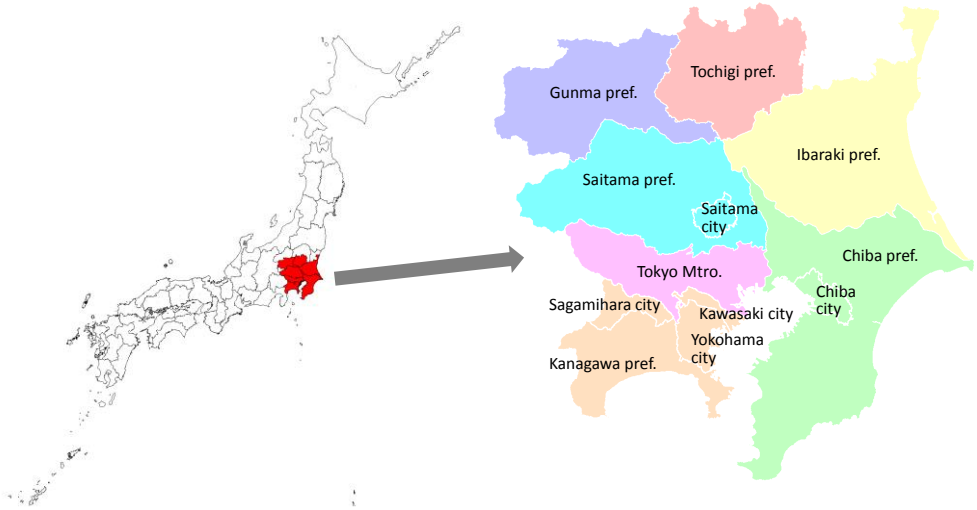


Figure 1. Tokyo Metropolitan Area (TMA) in the 5th Tokyo Metropolitan Freight Survey

2.1 Purpose of the Survey

Through the Tokyo Metropolitan Freight Survey, the Transport Planning Commission of TMA aims to understand the current situations and trends of logistics in TMA as well as to clarify the problems of logistics and make recommendations on logistics policy measures for

the Commission member prefectures, major cities and their municipalities to take in order to address the problems from viewpoints of urban and transport planning.

To fulfill its objectives, for three years from 2013 to 2015, the Commission conducted various analyses using the logistics data obtained from the 5th Freight Survey, and made deliberations on policy measures recommendable to the administration. In December 2015, the Commission summarized the results and published them in the final report "Towards Realization of Ideal Logistics in the Tokyo Metropolitan Area" (December 2015; Transport Planning Commission of Tokyo Metropolitan Area).

2.2 Important points of survey on "urban logistics"

The Tokyo Metropolitan Freight Survey was designed so as to understand the detailed current situations of logistics in TMA, with consideration for two important points of "urban logistics" presented by Kuse et al. (2006).

Firstly, in order for logistics network to work effectively in urban area, both "nodes" (i.e. logistics facilities for storing and sorting goods, distribution processing, etc.) and "links" (roads, railways, sea routes, etc. for transporting goods) are essential. Therefore, grasping of the current situations of urban logistics requires surveys focusing on both logistics facilities and freight transportation.

Second, the freight transportation near producers is different from that near consumers. Near producers, the main form is long-distance and large-lot transportation of goods using, for instance, trailers, large trucks and ships. Meanwhile, near consumers, the main form is frequent and small-lot transportation using medium and small trucks to deliver goods to their final destinations such as stores and offices. Therefore, grasping of the current situations of urban logistics requires surveys taking into account such differences in the form of transportation.

2.3 Content of the Survey

Based on these points, in order to understand urban logistics in detail, the 5th Tokyo Metropolitan Freight Survey adopted a system consisting of five different surveys as shown in Figure 2, namely, Questions to Establishment, Questions to Company, Interview Survey, Large Truck Route Survey, and Local Delivery Survey in CBD. Questions to Establishment, Large Truck Route Survey and Local Delivery Survey in CBD are briefly outlined below[1].

Questions to Establishment is a large-scale statistical survey targeting consignors (manufacturers, wholesalers, service providers, and retailers) and logistics business operators (transporters, warehousing companies) conducted for collect information on their logistics facilities, including their logistics functions, locational characteristics, volume of freight in/out, the origins/destinations of freight they handle, etc. (see Table 1 for question items). Questionnaires were distributed to approx. 140,000 establishments in TMA, and replies were received from approx. 44,000 establishments. The location information of logistics facilities obtained by this survey has been converted to GIS data. Using this data, it is possible to analyze the actual situations, trends and problems of location of logistics facilities (nodes).

Large Truck Route Survey is a survey conducted for collecting probe data of trucks from relevant companies in TMA. From the collected data, it is possible to understand the routes of trucks in detail and to analyze the actual situations and problems of the usage of roads (links)

[1] Questions to Company and Interview Survey were surveys conducted for understanding the corporate strategies relating logistics facilities location and transportation of products or commodities. For the former, questionnaires were distributed to approx. 60,000 establishments, and replies were received from approx. 20,000 establishments. For the latter, an interview survey was conducted targeting 38 companies and 3 associations in the industry including consignors, logistics business operators and realtors.

by large trucks.

Local Delivery Survey in CBD is a survey conducted for investigating the actual situations of logistics in terms of delivery of goods to commercial facilities and business offices in districts in 12 CBDs of TMA. The survey covers the situation of parking and stopping of trucks, loading, unloading and hand-carrying goods by truck drivers, as well as their influence on the traffic of people in the districts including pedestrians, bicycles, buses and cars. Therefore, it allows for analysis of the actual situations and problems of local deliveries in city centers.

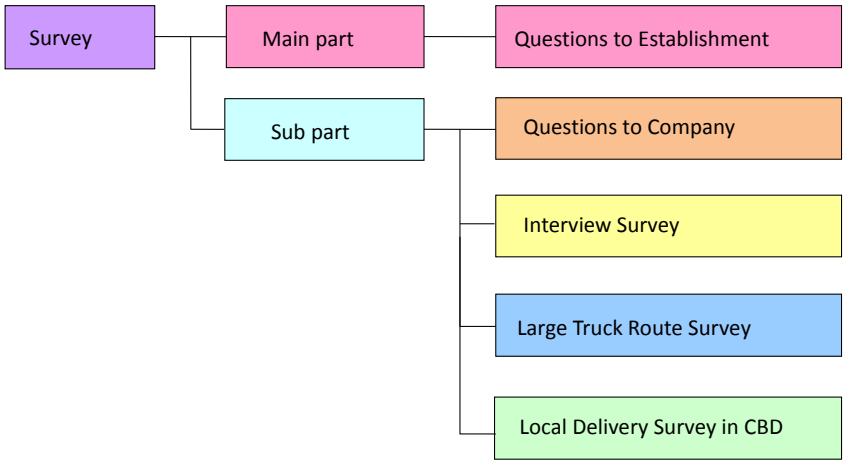


Figure 2. Structure of the 5th Tokyo Metropolitan Freight Survey

Table 1. Items for Questions to Establishment of the 5th Tokyo Metropolitan Freight Survey

Subject of Survey		Question item
Category I Character of Facility	Location	Address, Established year, Placed importance of location, Constructed year, Structure of building (reinforced concrete, steel, etc.)
	Scale	The number of employees, Site form, Ownership of land, Site area, Total floor area, The number of parking lots for truck
	Type/Function	Facility type (office, factory, warehouse, collection and delivery center, truck terminal, etc.), Facility function (manufacture, collection and delivery, distributive processing, etc.)
	Distribution character	Whether there is goods entering and exiting, Main transaction items, Category of freight (raw materials, manufactured goods, etc.), Main area of origin and destination, With or without using international container cargo
	Inventory	Volume of inventories, Average time period of storing goods
Category II Freight Generation and Attraction	Volume of freight in/out and the number of trucks in/out	Tonnage of freight carrying in/out, Tonnage of each transportation modes, The number of trucks going in/out, The number of trucks of each vehicle sizes
	Character of freight and trucks in/out	Ratio of cargo volume with appointed arrival time, Average loading ratio
Category III Origin and Destination	Origin and destination	Address of the origin/destination, The number of places carrying in/out, Category of business of the origin/destination, Facility type of the origin/destination, Tonnage of freight and the number of trucks from origin or to destination, Main items of freight, Main transportation mode, With or without using international container cargo Transshipment facility (port, airport, rail station, etc.)

3. LOGISTICS POLICIES RECOMMENDED BY THE TRANSPORT PLANNING COMMISSION OF TMA

In its final report "Towards Realization of Ideal Logistics in the Tokyo Metropolitan Area" (December 2015; Transport Planning Commission of Tokyo Metropolitan Area), the Transport Planning Commission of TMA recommended the following five logistics policies from viewpoints of urban and transportation planning.

1) Support for location of large-scale logistics facilities in the coastal and suburban areas with control of the land use
2) Promotion of adequate location of logistics facilities balancing with residential environment
3) Formation of logistics network for achieving both efficient freight transportation and good urban environment
4) Promotion of the measures relating to goods delivery to commercial facilities or business offices incorporated urban development in the central area
5) Establishment of logistics network that is functional even at the time of large-scale natural disasters

Among them, 1) and 2) are measures for logistics facilities location, 3) is a measure for freight transportation network, 4) for local deliveries in city centers, and 5) for disaster prevention and mitigation. Here, measures for freight transportation network, local deliveries and disaster prevention of mitigation are briefly described below. Measures for logistics facilities location are described in detail in Section 4.

3.1 Measures for freight transportation network

As described in Section 2, in the 5th Freight Survey, probe data of trucks were collected and analysis was made on the actual situations and problems of routes of large trucks including container trailers. We can show from the analysis results that road network for large trucks is insufficient in some areas in TMA. In those areas where the density of roads for large trucks is low, truck traffic problems are found to arise (see Figure 3). One problem is traffic congestion due to many trucks using specific arterial roads in the areas. Another problem is deterioration in living environment of local residents due to some large trucks choosing routes that run through residential areas.To address the problems above, the Transport Planning Commission of TMA recommended establishing of roads that enable large trucks to travel smoothly, safely and environmental-friendly. See the relevant reference [Oka et al. (2016)] for details of analysis and suggested measures.

3.2 Measures for local deliveries in city centers

It was found that street parking of trucks is observed in a majority of districts covered by the Local Delivery Survey in CBD for the 5th Freight Survey due to the lack in locations designated for them to handle goods. In some cases, such street parking occurred at places and time zones where traffic of people (e.g., pedestrians, bicycles, buses, cars) is concentrated, impeding traffic of people coming into or passing by such districts.

Based on the survey result above, the Commission listed a menu of measures (e.g., securing the parking/stopping space in such districts for vehicles to handle goods, time-sharing of parking/stopping spaces between trucks and passenger vehicles, joint transportation of goods, restricted entry of trucks for such districts) in its final report, and recommends stakeholders such as storekeepers, carriers, bus business operators, parking business operators, local residents, administrative bodies, etc. to coordinate and take initiatives that fit the characteristics of the relevant district.

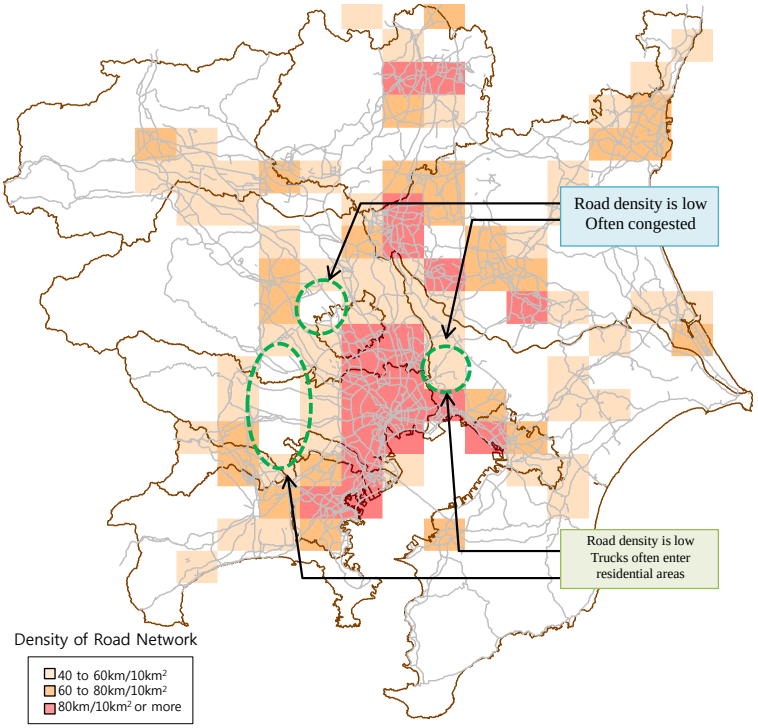


Figure 3. Correlation between road density and truck traffic problems

3.3 Measures for disaster prevention and mitigation

According to the Cabinet Office (2013), the probability of an M7 class "Tokyo Inland Earthquake" that may cause major damage to TMA within 30 years is approximately 70%. It is vitally important to establish a logistics network that functions not only at ordinary times but also in emergencies so that relief goods will be supplied to disaster-hit areas speedily and reliably or the supply chain for companies will not be completely severed when such a disaster occurs.

For the above concern, through analysis of Origin-Destination (OD) data obtained from Questions to Establishment, the Commission selected some ODs into where freight flows will be concentrated by the use of emergency or alternate freight transportation under the assumption that Tokyo Inland Earthquake happened. The Commission then made a recommendation stating that the administrative bodies should support formulation of logistics hubs and road network that are highly important in terms of supporting freight flows for the selected ODs.

4. Problems in location of logistics facilities and logistics policy measures

4.1 Current situations and trends of logistics facilities in TMA

Backed by the diversification in consumer needs and advancement in companies' initiatives towards enhancing the logistics efficiency, in late years, the location of the logistics facilities which have various logistics functions and large site area has been increasing in recent years in TMA. Comparison of functions of logistics facilities in TMA by opened year based on the results of the Questions to Establishment is shown in Figure 4. This exhibits that new logistics facilities have a higher rate of having multiple logistics functions such as storage, collection and delivery, and distribution processing, indicating that the multi-functionality of logistics facilities has been advancing with time. Comparison of site area of logistics facilities in TMA by opened year is shown in Figure 5. This exhibits that new logistics facilities have a higher

rate of having a site area of 3,000 m^2 or greater, indicating that the scale of logistics facilities is expanding with time.

One reason given for this trend is an increase in the number of delivery of goods by Internet shopping in late years[2]. Logistics facilities that deal with products or commodities traded by Internet shopping requires not only to store and collect/deliver goods but also to carry out distribution processing such as sorting, packing and wrapping. If one tries to equip one logistics facility with such multiple logistics functions, the facility requires adequate working space and therefore the scale of logistics facilities tends to be large[3].

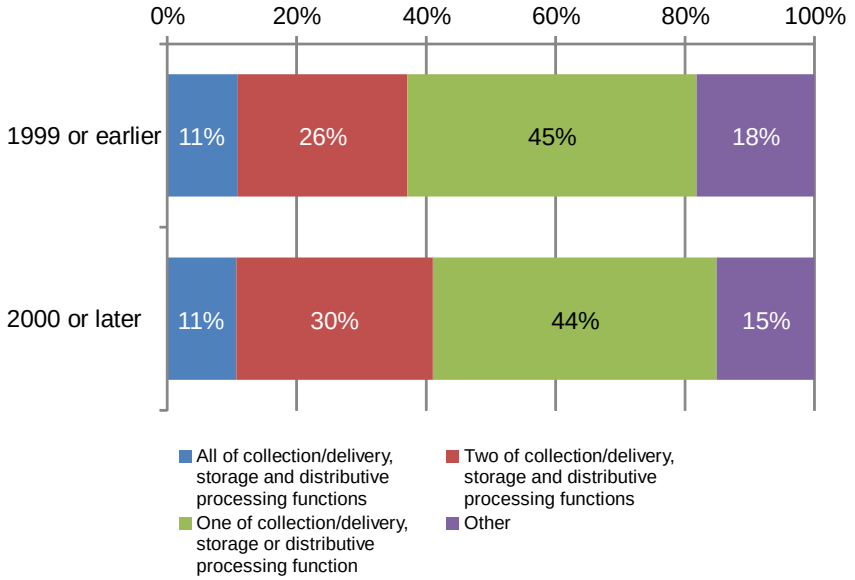


Figure 4. Number of functions of logistics facilities by opened year

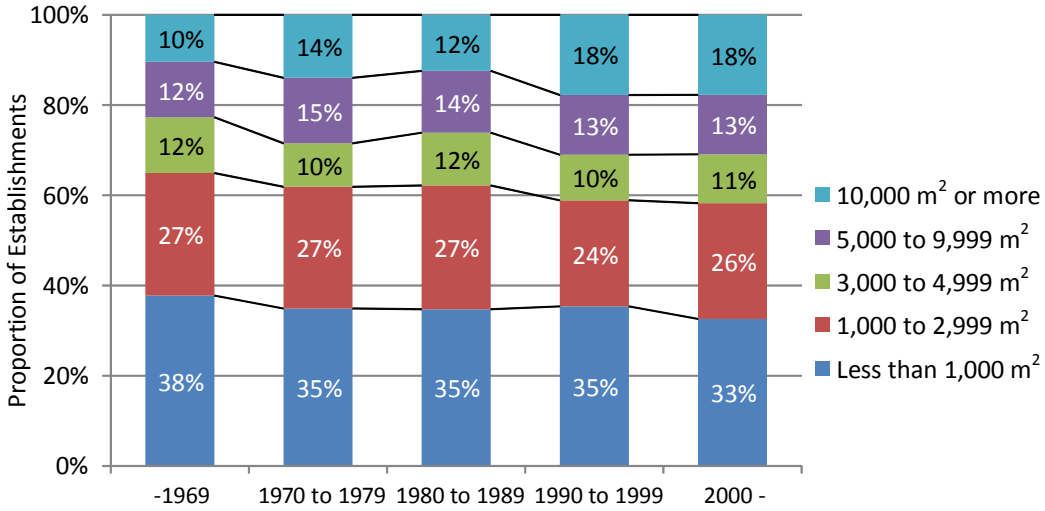
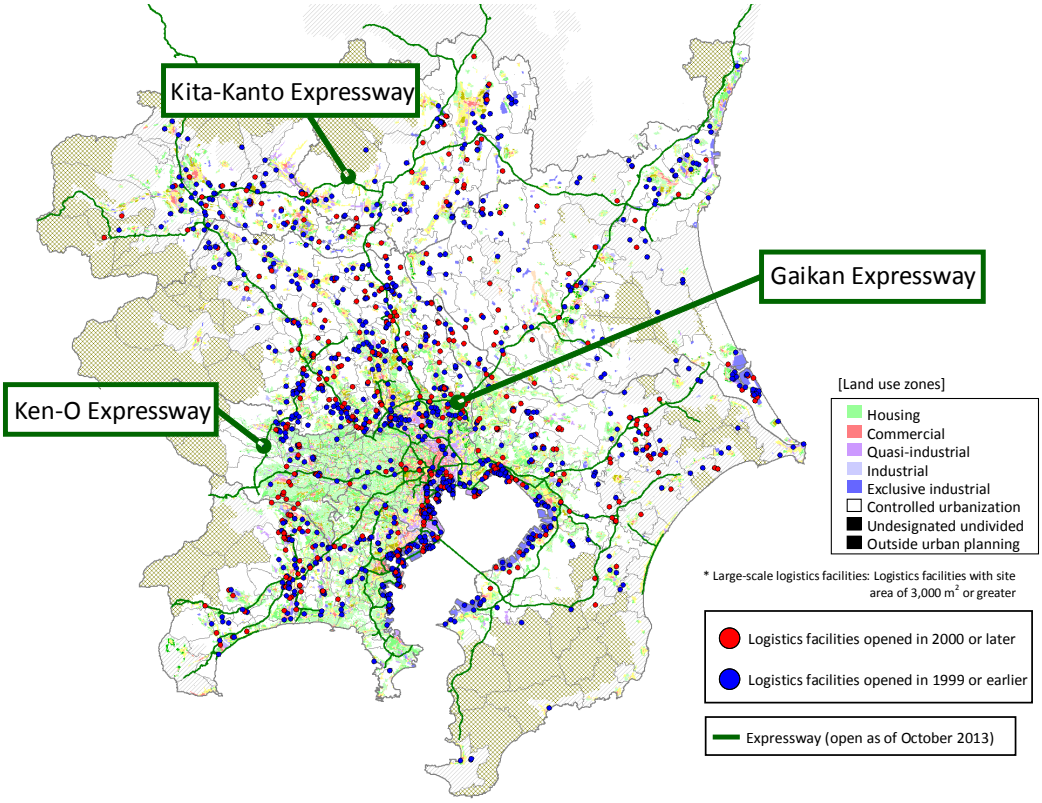


Figure 5. Site area of logistics facilities by opened year

[2] Results of the E-Commerce Market Survey (2014; Ministry of Economy, Trade and Industry) indicates that the market scale of E-commerce for consumers in Japan is in a trend of steady increase from 2010 over to 2014.

[3] Other reasons for the scale of logistics facilities being larger include the following two points. One is that many companies are proceeding with consolidation and reorganization of logistics facilities for the purpose of inventory compression and reduction of logistics costs. Companies are expanding the scale of each logistics facility instead of reducing the total number of logistics facilities. Another is the fact that the number of companies that use rental logistics facilities is increasing. Grasping such corporate needs, many realtors are developing large-scale logistics facilities that can house many tenants.

Location of large-scale logistics facilities (site area of 3,000 m^2 or greater) in TMA by opened year is shown in Figure 6. This figure indicates that many large-scale logistics facilities are located in the coastal area of Tokyo Bay near the Keihin Port and suburban areas along expressways, and an increasing number of large-scale logistics facilities have been established since 2000 along the Ken-O Expressway currently under development. According to the results of Questions to Company, some regions of TMA (e.g., coastal area of Tokyo Bay, areas along the Ken-O Expressway) have particularly high corporate needs for new establishment and relocation of logistics facilities in the future (see Figure 7).



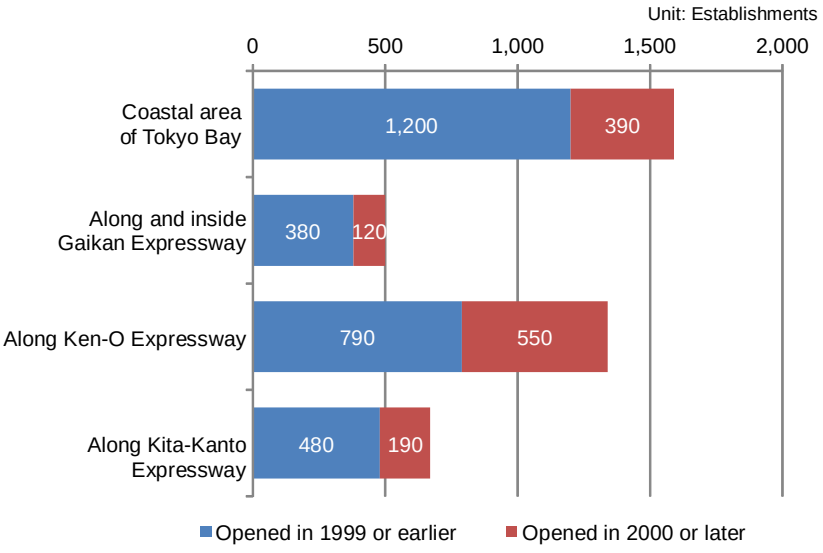


Figure 6. Location of large-scale logistics facilities

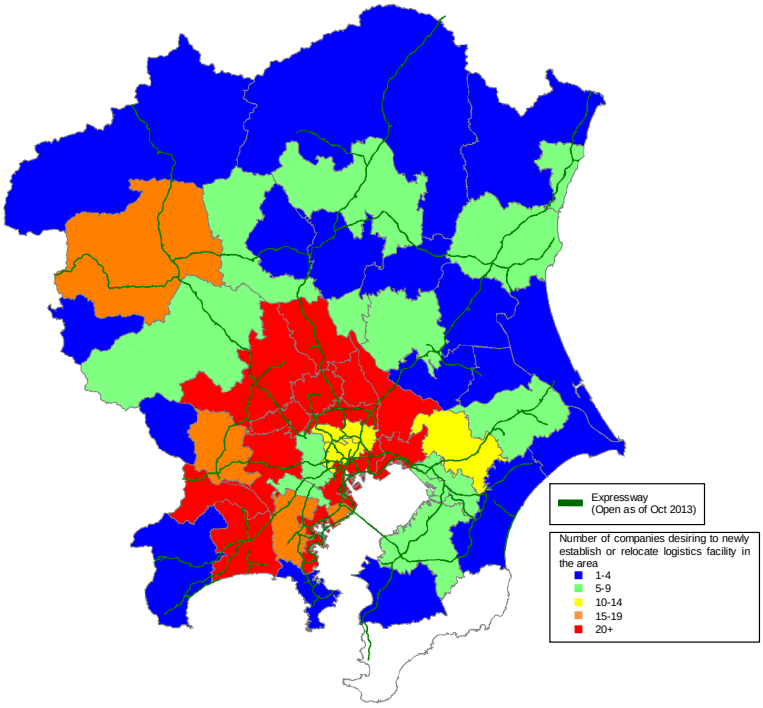


Figure 7. Candidate location of new logistics facilities

4.2 Problems in location of logistics facilities in TMA

As described in Section 3.1, from the analysis results of the 5th Freight Survey, location demands for logistics facilities in some areas of TMA such as the coastal area and along the inland expressways are expected to continue in the future. Therefore, appropriate responses need to be made in accordance with such location demands. In addition, there are other problems in location of logistics facilities in terms of improving urban environment and enhancing logistics efficiency. In the subsequent subsections, we describe the problems relating to logistics facilities location: "Response to location demands for logistics facilities in coastal and suburban areas", "Land use mixture of logistics facilities and residences", and "Response to aging of logistics facilities".

(1) Response to location demands for logistics facilities in coastal and suburban areas

Using the location data of logistics facilities obtained by Questions to Establishment, the Transport Planning Commission of TMA developed a logistics facilities location choice model[4]. Results of analysis using this model indicate existence of location demands for logistics facilities in the coastal area of Tokyo Bay and suburban areas along expressways. Location utility of large-scale logistics facilities (site area of 3,000 m^2 or greater) calculated using the location choice model by 1-km mesh is shown in Figure 8 in a form of deviation values[5]. Figure 8 shows that the coastal area of Tokyo Bay and suburban areas along expressways have higher location utility.

[4] See appendix for more information on the logistics facilities location choice model.
[5] For detail of location utility, see the appendix.

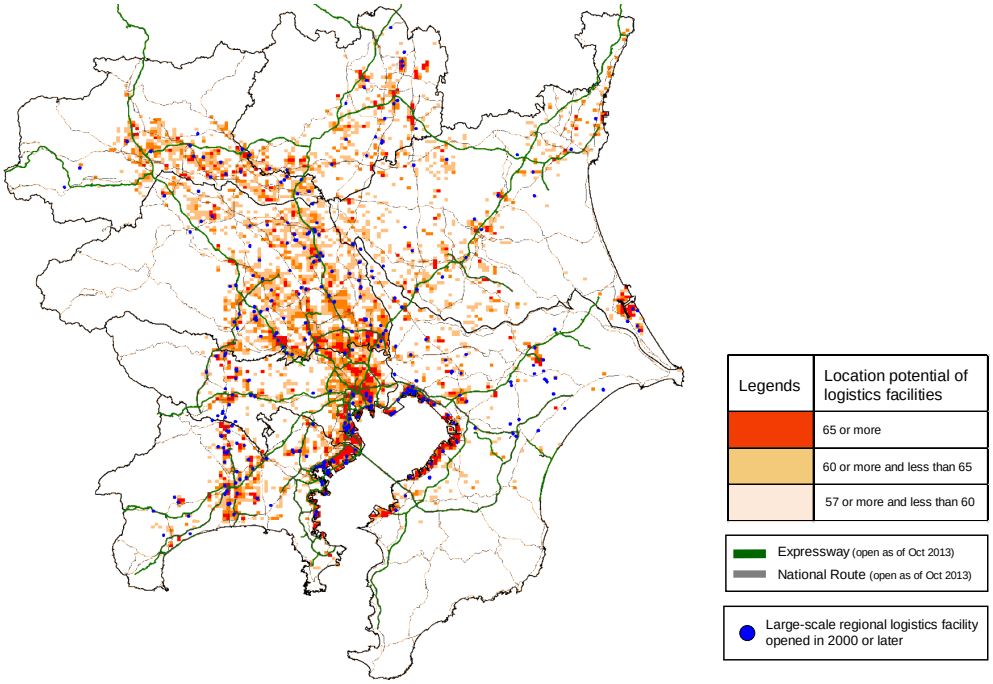


Figure 8. Location utility of logistics facilities estimated by location choice model

In the coastal area, many logistics facilities that deal with export cargos and import cargos are located with placing importance on the proximity to the Keihin Port (see Figure 9). For that reason, along with the advancement in the globalization of economy in the future, location demands for such logistics facilities are expected to continue. However, according to the Interview Survey of the 5th Freight Survey, some companies that desire to locate logistics facilities in the coastal area of Tokyo Bay are forced to give it up for the reason of not enough sites available in the area. Therefore, in the coastal area, it is necessary to make appropriate responses to location demands of logistics facilities under the condition that available sites are insufficient.

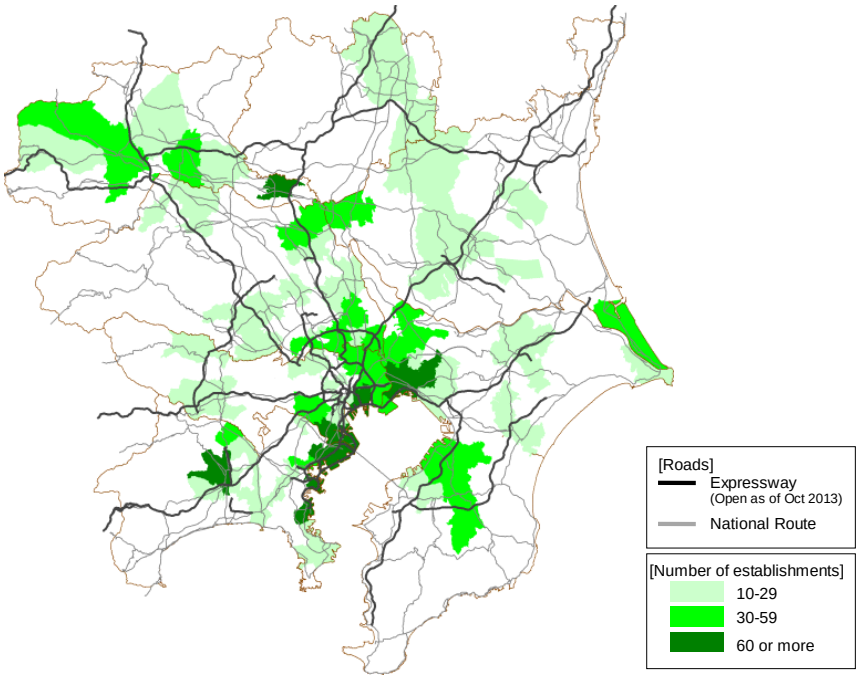


Figure 9. Location of logistics facilities whose main delivery destinations are overseas

In suburban areas, because establishment of ring expressways such as the Ken-O Expressway will continue to progress, location demands of logistics facilities are expected to become apparent mainly along the roads that will newly open in the future. Simulations using the location choice model suggest an increase of location utility along newly opened roads (see Figure 10). However, because controlled urbanization zones widely spread throughout suburban areas, areas estimated to have high location utility include many such controlled urbanization zones (see Figure 11). Therefore, in suburban areas, it is necessary to make appropriate responses to anticipated location demands for logistics facilities along new ring expressways while paying attention to the suppression of isolation of logistics facilities and the preservation of urban environment in controlled urbanization zones.

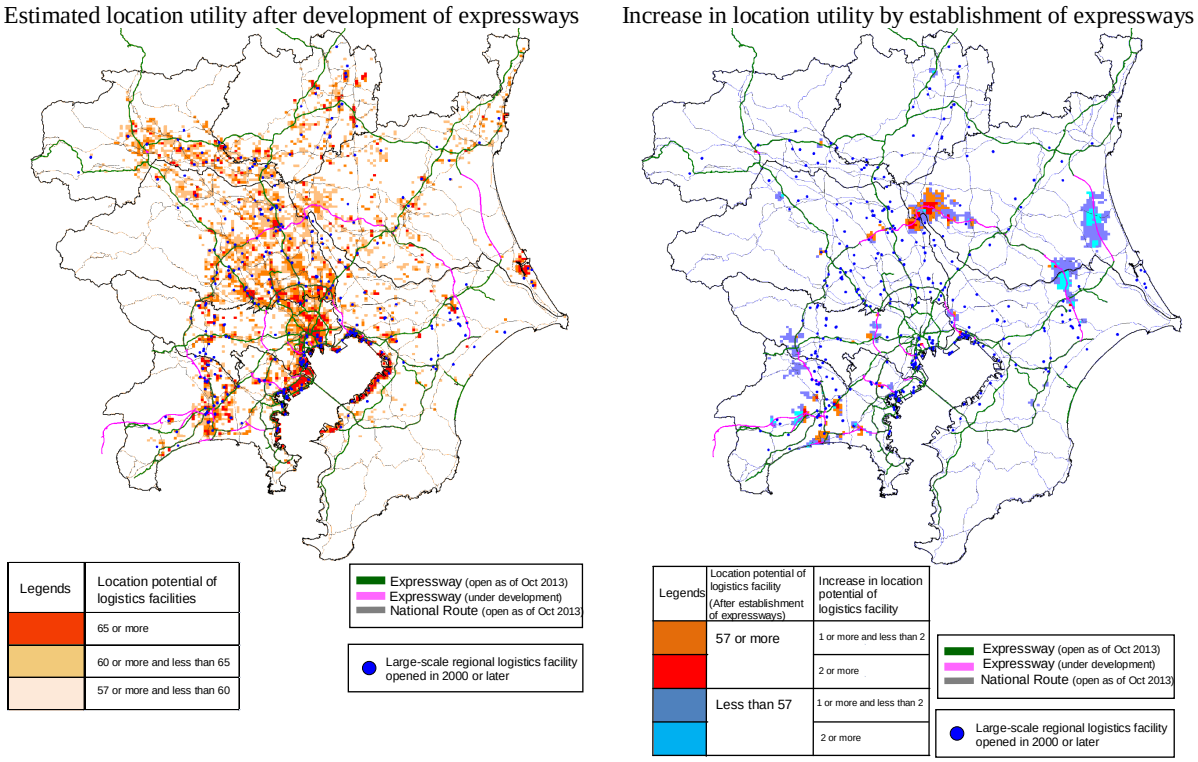


Figure 10. Estimated Location utility after development of expressways and increase in location utility by establishing expressways

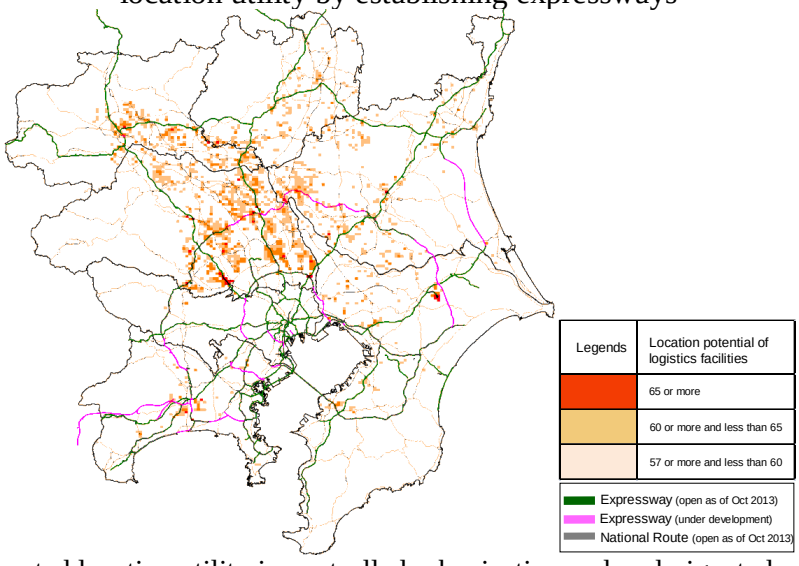


Figure 11. Estimated location utility in controlled urbanization and undesignated undivided zones

(2) Land use mixture of logistics facilities and residences

In some regions of TMA, land use is mixed for logistics facilities and housing. In such regions, logistics activities have adverse impacts on the living environment of residents, while business activities of logistics facilities are restricted and efficient logistics activities are hindered. Therefore, there is a necessity for deliberate land-use planning to avoid land use mixture.

Analysis of logistics facility location data obtained from Questions to Establishment found there seems to exist land use mixture of logistics facilities and residences in some parts of TMA. More than 30% of logistic facilities used by trucks with a maximum loading weight of 10 tons or more are located quasi-industrial or industrial zones that permit residential use (see Figure 12). Additionally, about 30% of areas (1-km mesh) with such logistics facilities have a population density of 1,000 people/km^2 or greater (see Figure 13).

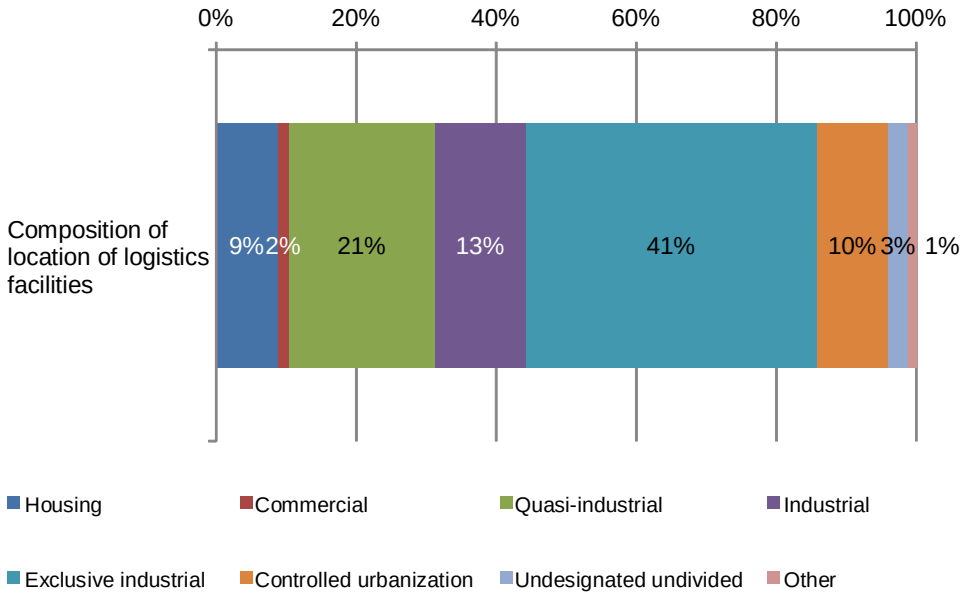


Figure 12. Land use category of location of logistics facilities used by large trucks

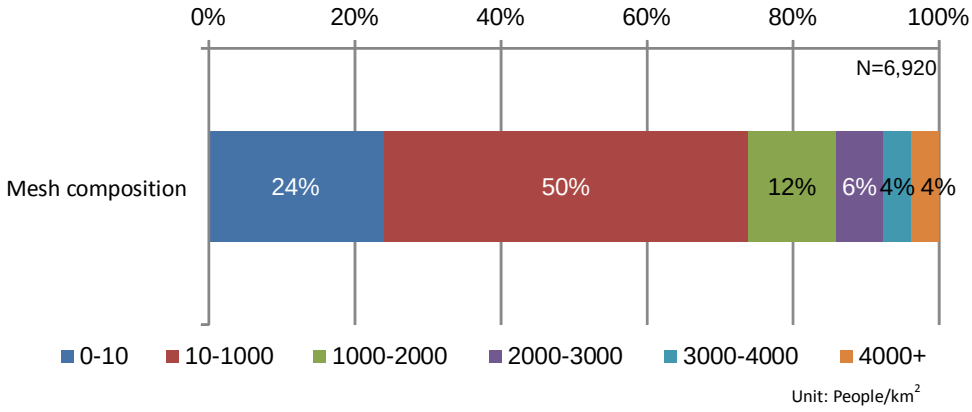


Figure 13. Population density of 1-km mesh area with logistics facilities used by large trucks

At places where the land use is mixed, local residents and logistics facilities affect each other negatively. For residents, there is a concern over deterioration of living environment due to noises or odors generated from logistics facilities and traffic of trucks in roads near the logistics facilities. For logistics facilities, limitation in corporate activities (e.g., inability to

operate during night for consideration to local residents) and hindrance to effective logistics would prove problematic.

In Interview Survey of the 5th Freight Survey, cases of land use mixture were collected from the interviewees. Analysis of the cases identified 2 patterns of land use mixture.

One pattern is where apartments and residences were built on former industrial sites in the quasi-industrial zones and industrial zones that permit residential use, causing a mixture of land use with the existing logistics facilities (Figure 14, left). This pattern is often observed in the coastal area among TMA, where logistics facilities have been located since long ago.

Another pattern is often observed in suburban areas, where the mixture of land use is caused by residential development advancing to a quasi-industrial zone or industrial zone that houses logistics facilities for transporting or warehousing products manufactured by a large-scale factory located in a nearby exclusive industrial zone (Figure 14, right). The Interview Survey discovered that some companies were considering relocation of factories to other areas for concerns of residential development near their factories causing land use mixture and inhibition of efficient production activities or logistics activities. This case indicates that escalation in land use mixture issue can lead to deterioration of local industry and loss of employment opportunities.

In order to prevent such land use mixture, there is a necessity to promote systematic land-use planning, including restriction of ex-post facto residential development at areas to which location of logistics facilities is planned to be induced.

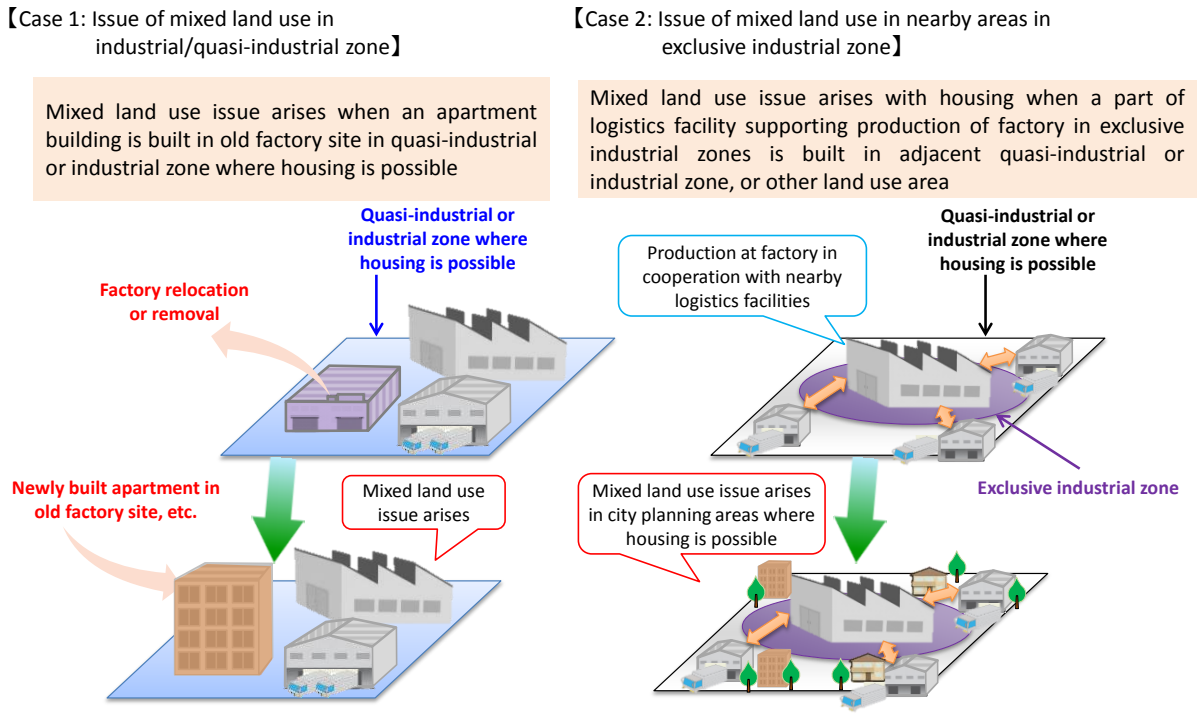


Figure 14. Two Patterns of Mixture of Land Use

(3) Response to aging of logistics facilities

There exist areas (e.g., coastal area) in TMA where logistics facilities aged over 30 years after construction are concentrated. Old logistics facilities may have issues of not having logistics functions required in late years for logistics facilities (e.g., distribution processing) and, in many cases, of not having adequate aseismic performance. Especially in the coastal area, many companies have intentions to rebuild aging logistics facilities and the task of

administrative bodies is to appropriately promote feature update of logistics facilities.

According to the data of logistics facilities obtained by Questions to Establishment, about 30% of logistics facilities in TMA were constructed in 1979 or earlier (see Figure 15). Such aged logistics facilities are concentrated in the coastal area of Tokyo Bay and the areas from the northern areas of Tokyo Metropolis over to the southern areas of Saitama Prefecture (see Figure 16).

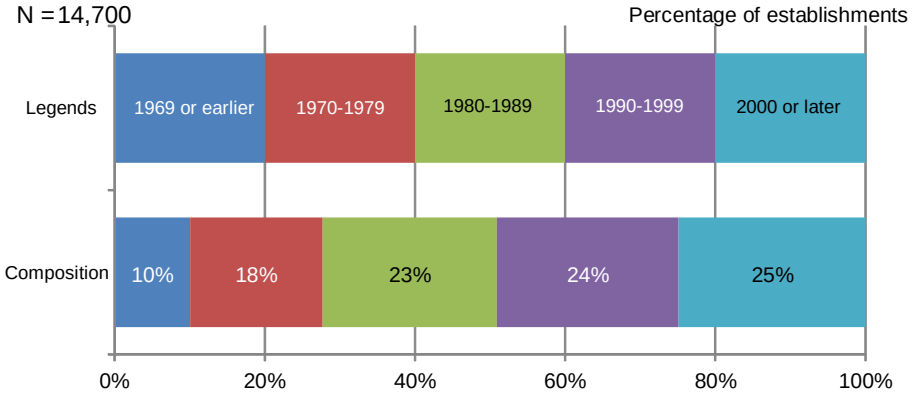


Figure 15. Construction year of logistics facilities in TMA

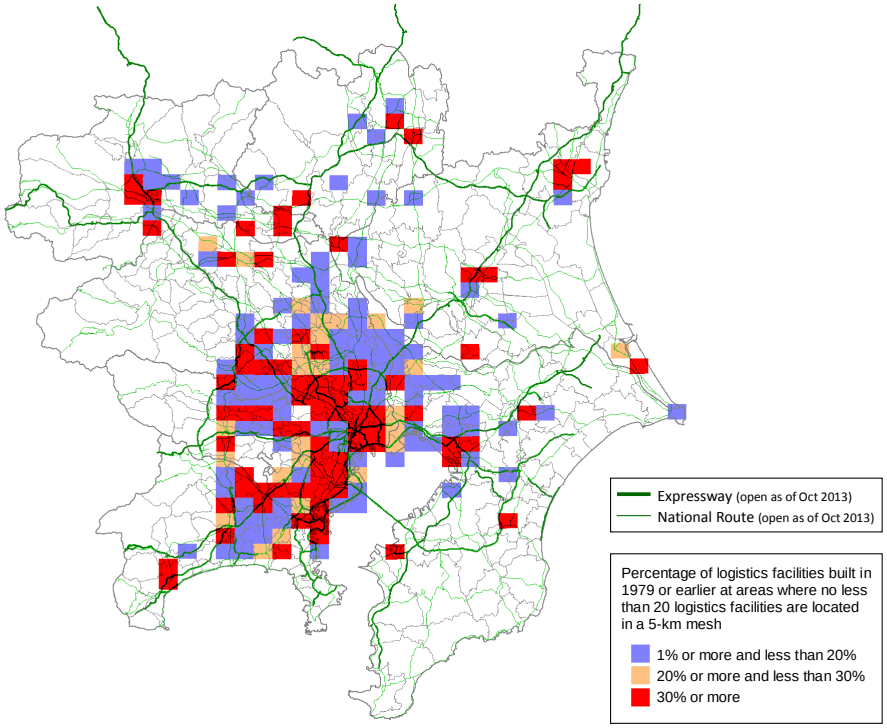


Figure 16. Percentage of logistic facilities built in 1979 or earlier by 5-km mesh

Aging of logistics facilities becomes a hindering factor for companies that are planning to promote technological advancement of logistics and improvement of its efficiency. Questions to Company have found that aged logistics facilities are less equipped with advanced logistics functions that meet the needs of recent years (e.g., distribution processing) and received poorer evaluation by companies, compared to newer facilities (see Figure 17). Additionally, it was found that evaluation of aged logistics facilities by companies was low because they have less working space and do not have adequate capability to handle supplies (see Figure 18).

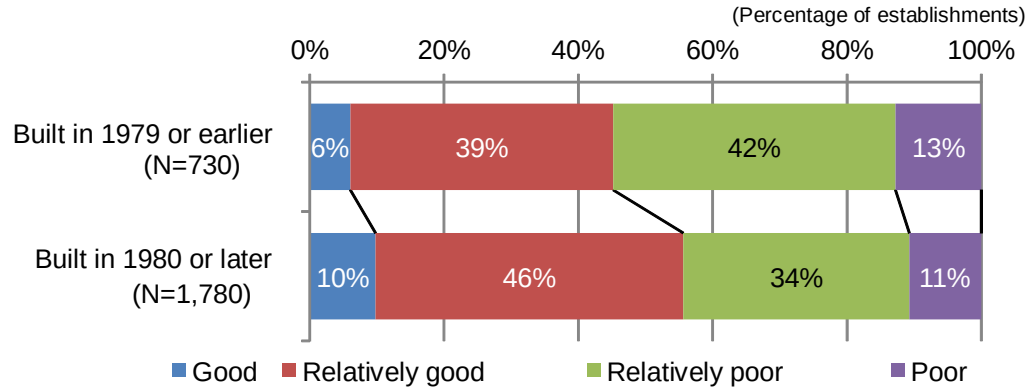


Figure 17. Evaluation of logistics facilities by companies in terms of logistics functions

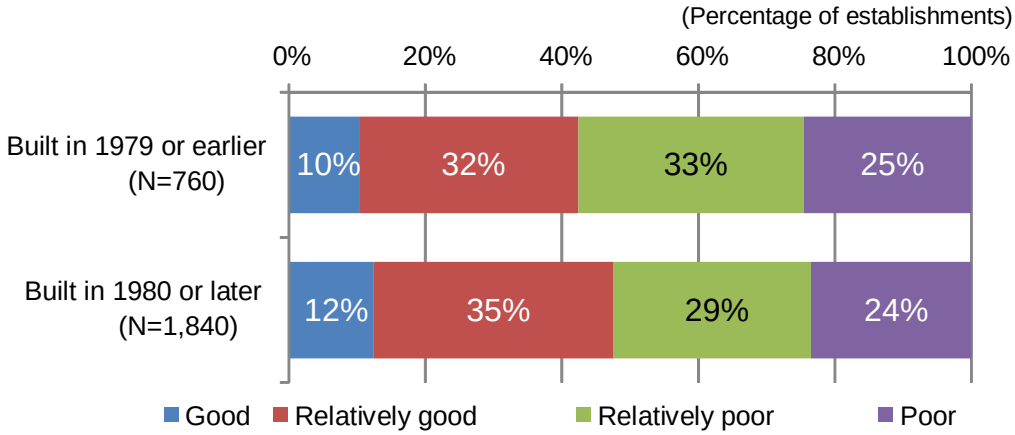


Figure 18. Evaluation of logistics facilities by companies in terms of capability to store and handle goods

Also from the viewpoint of disaster prevention and mitigation, aging of logistics facilities raises concerns. As shown in Figure 15, about 30% of logistics facilities in TMA were built in 1979 or earlier. This fact indicates, considering that the new earthquake resistance standards were introduced in 1981 in accordance with the revised Building Standard Act Enforcement Order, there still exist many logistics facilities built under the former earthquake resistance standards. Location of logistics facilities by seismic intensity estimated for potential Tokyo Inland Earthquake is shown in Figure 19. Figure 19 exhibits that about 50% of logistics facilities in TMA are located in areas where a seismic intensity of upper 6 or greater is estimated, and about 30% of which are old facilities built in 1979 or earlier. Therefore, assuming an occurrence of Tokyo Inland Earthquake in the future, there is a concern over disruption of functions of aged logistics facilities in areas assumed to have strong tremor and resultant confusion in the supply chain involved with TMA.

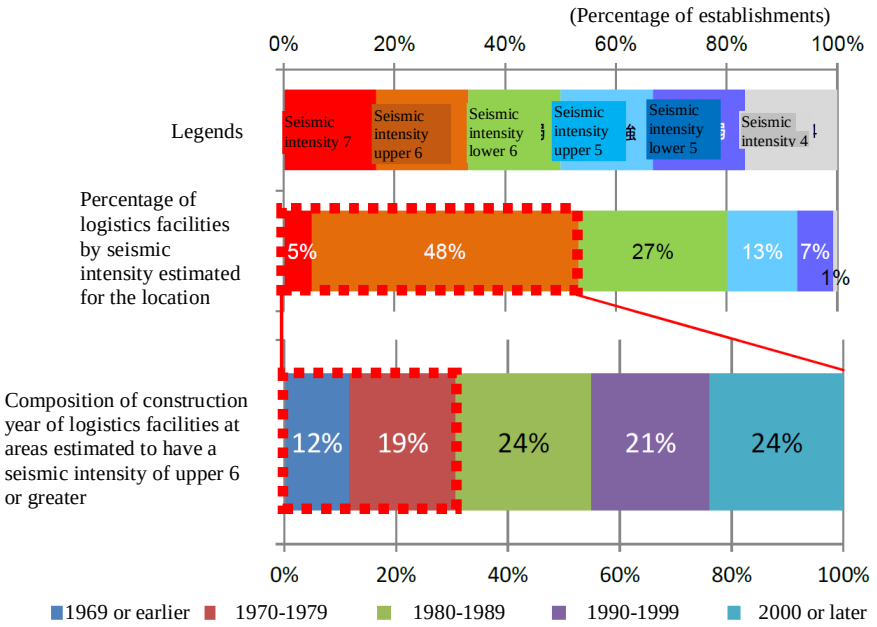


Figure 19. Percentage of logistics facilities by seismic intensity estimated for the location and composition of construction year of logistics facilities located at areas estimated to have a seismic intensity of upper 6 or greater

In addition, Questions to Company identified that about 30% of companies that own logistics facilities in the coastal area of Tokyo Bay have an intention to rebuild aging logistics facilities (see Figure 20). Therefore, especially for the coastal area, it is important to properly promote rebuilding of logistics facilities.

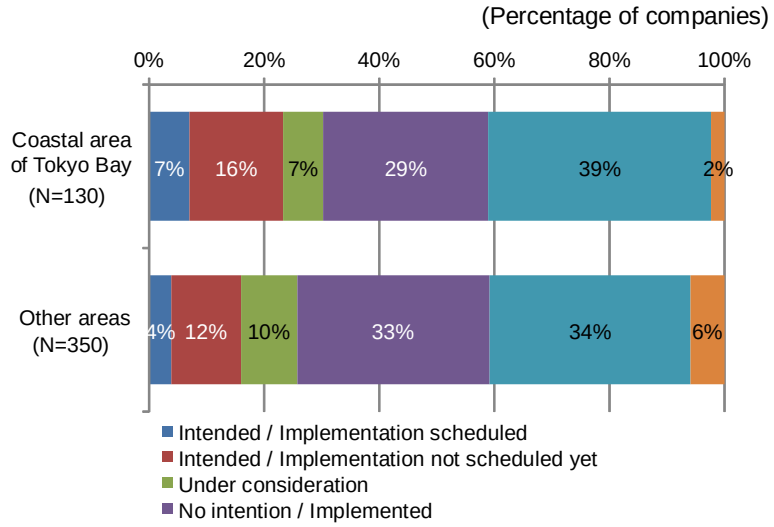


Figure 21. Company intentions on rebuilding logistics facilities

3.3 Directionality of location policies for logistics facilities in TMA

As described in Section 3.2, in TMA, there is a necessity to respond to location demands for large-scale logistics facilities that have become apparent for the coastal area of Tokyo Bay and suburban areas along expressways. In addition, it is desirable to avoid land use mixture of logistics facilities and residences and to properly promote feature update of aging logistics facilities. The logistics policy measures recommended by the Transport Planning Commission of TMA to address such issues are described below.

(1) Measures to support for logistics facilities to locate in the suburban areas along the expressways

As described in Section 3.2, appropriate response to location demands for logistics facilities is required for suburban areas along expressways. However, because controlled urbanization zones widely spread throughout the areas, there also is a necessity to suppress disorderly isolation of logistics facilities.

In order to address the issue above, the Commission recommends policy measures to secure a certain scale of industrial sites and to attract location of logistics facilities for areas where location utility of logistics facilities is estimated high (e.g., areas near expressway interchanges, areas along arterial roads). Suggested methods to secure industrial sites include designation as industrial use zone, introduction of district planning, and effective use of existing industrial parks.

However, control on land use is required for controlled urbanization zones. For that reason, for suburban areas where location utility of logistics facilities is estimated high, the Commission recommends promoted attraction of logistics facilities limiting to specific areas with high rationality for companies to perform logistics activities (e.g., near expressway interchanges, along arterial roads, near industrial parks), and systematic land use with suppressing location of logistics facilities for other areas.

(2) Measures to reduce or relieve adverse impacts induced by land use mixtures of logistics facilities and residences

From the viewpoint of maintaining the operational environment at areas to which location of logistics facilities will be attracted as described in (1) (e.g., near expressway interchanges, along arterial roads, near industrial parks), it is important to designate such areas in advance and clearly in the master plan, etc., of urban planning. By designating exclusive industrial zones where residential development is prohibited or by introducing special zoning or district planning for areas designated to attract location of logistics facilities, it becomes possible to suppress ex-post facto location of residences and to prevent land use mixture of logistics facilities and residences.

Some areas of TMA already have mixed land use of logistics facilities and residences. For such areas, the Commission recommends securing sites in areas with no possibility of land use mixture and relocating logistics facilities to such sites. Candidate relocation sites include areas to attract location of logistics facilities described in (1).

(3) Measure to support for rebuilding and updates of aging logistics facilities in the coastal area

As described in Section 3.2, the tasks for the coastal area of Tokyo Bay are to respond to location needs for logistics facilities and to promote rebuilding and updates of existing aged logistics facilities. The hindrance to addressing these tasks is the limitation in sites available in the coastal area. For instance, about 50% of companies thinking to rebuild aged logistics facilities in the coastal area recognize “Unable to secure a temporary relocation site during rebuilding” as the bottleneck of rebuilding (see Figure 22).

Therefore, the Commission suggests promotion of renewal of logistics facilities in the following steps. The first step is to secure specific industrial sites in the coastal area and develop the large-scale logistics facilities having various logistics functions. The second is to relocate logistics companies there from the districts in the coastal area where many aging logistics facilities are concentrated. The third is to demolish the aging logistics facilities after the relocation and rebuild new logistics facilities in the vacant lands. The forth is to relocate companies there from other districts where aging logistics facilities are concentrated. And the

above steps are repeated (see Figure 23).

If interrelated companies become able to smoothly proceed with joint rebuilding of logistics facilities through this successive redevelopment, it is possible to reform the coastal area to an advanced disaster-resilient logistics base that efficiently handles international logistics.

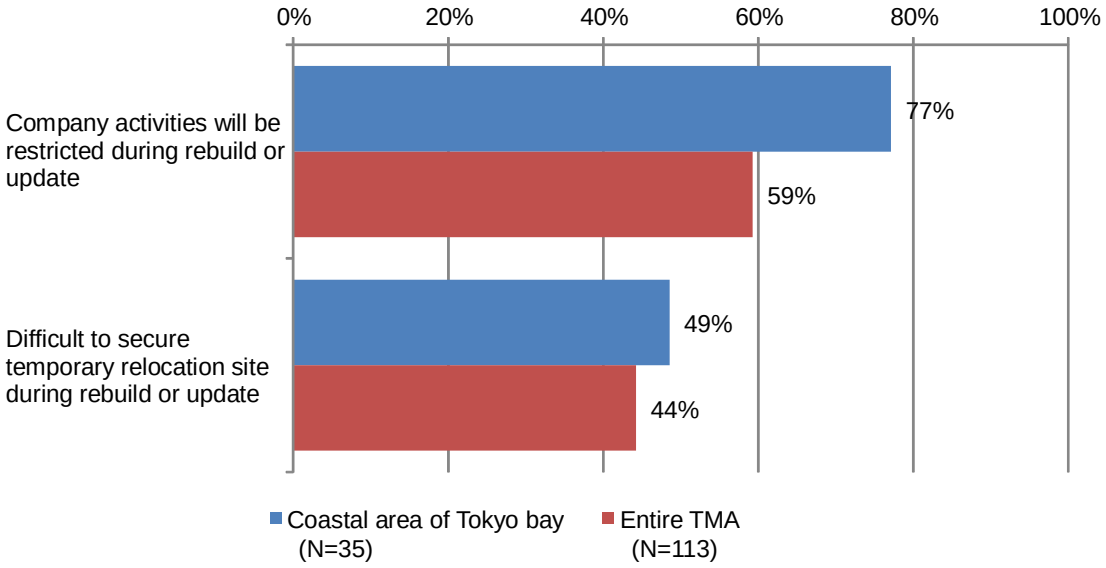


Figure 22. Hindrance to rebuilding of logistics facilities

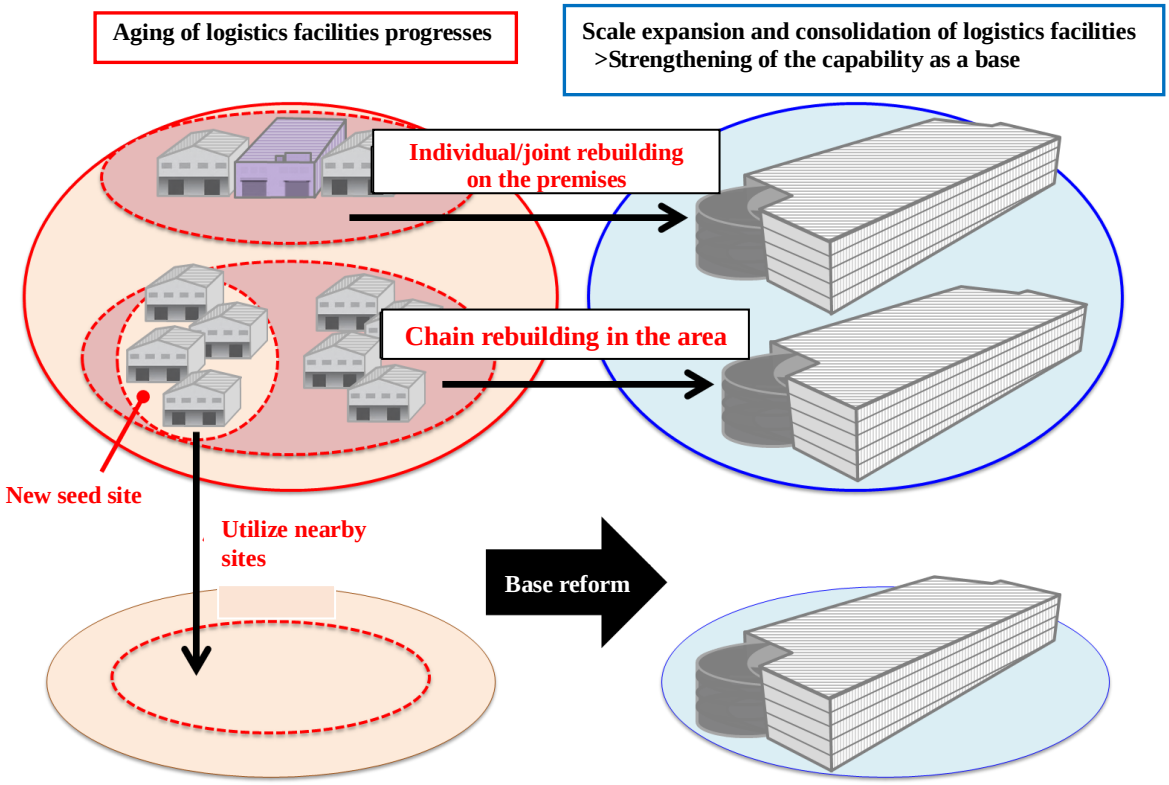


Figure 23. Support for rebuilding of logistics facilities at coastal area

4. FINAL REMARKS

In this paper, we have described the overview of the 5th Tokyo Metropolitan Freight Survey and the policy measures against the logistics problem which was clarified from various analyses using the survey data. Among the measures, we focused on that for logistics facilities location. Based on the survey data analysis, the following three problems in TMA related to logistics facilities were pointed out: 1) necessity to make a response to location demands in coastal and suburban areas, 2) land use mixture of logistics facilities and residences, and 3) necessity to make a response to aging logistics facilities in coastal area. Then, the policy measures for coping with the above problems from viewpoints of urban and transport planning were also described.

Policy measures introduced in this paper are those which the Transport Planning Commission of TMA suggests for the prefectures and major cities in TMA to take in order to address the logistics problems. In the future, the Commission members are expected to explore and implement policies that fit the characteristics of the relevant region. We believe that the objective and scientific analysis using the Tokyo Metropolitan Freight Survey data is also effective in the study of logistics policies at local level.

APPENDIX

The logistics facilities location choice model was established to quantitatively estimate potential areas for large-scale logistics facilities in TMA and the anticipated effects of location choice and guiding location for such facilities. A discrete choice Logit model was selected for location choice by 1km-mesh in TMA using data from the survey of logistics establishments (Questions to Establishment) from the 5th survey. The tertiary mesh (1km mesh) of the National Land Numerical Information service was used for zoning to enable microscopic analysis. The total number of mesh squares was about 18,000 in the areas surveyed.

The estimated parameters of location choice model are shown in Table A1. The table illustrates that accessibility and land-use patterns have significant impacts on the location of the logistics facilities and that the working population is essential to maintaining facility activities.

With the utility value calibrated for each mesh with utility function (location utility) for location choice, the following deviation value was calculated,

$$P_i^r = \frac{10 \times (V_i^r - \overline{V^r})}{\sigma^r} + 50 ,$$

where

P_i^r : deviation value of segment *r*, in mesh *i* ,

V_i^r : location utility of segment *r*, in mesh *i*,

$\overline{V^r}$: average location utility in segment *r*,

σ^r : standard deviation of location utility in segment *r*.

Figures 8, 10 and 11 in section 4 display this deviation value for each mesh in TMA.

Table A1. Estimated parameters of the logistics facilities location choice model

Explanatory Variables			Parameter (t value)
ln (Population density *1)		(1,000 people/km^2)	-0.3111 (-8.53)
ln (Working population in commuting distance)		(1,000 people)	0.4948 (3.77)
ln (Accessibility to manufacturing industry)			0.0211 (2.61)
ln (Accessibility to business place)			0.5078 (6.94)
ln (Distance to expressway IC)		(km)	-0.1521 (-2.49)
ln (Land price)		(1,000 yen/m^2)	-0.2460 (-2.36)
Land use category	Semi-industrial Area	Ratio to inhabitable area (%)	2.8764 (7.78)
	Industrial Area	Ratio to inhabitable area (%)	3.2476 (6.28)
	Exclusive Industrial Area	Ratio to inhabitable area (%)	2.5615 (6.92)
	Urban Control Area	Ratio to inhabitable area (%)	1.1651 (4.88)
Land Attribute Dummy	Suburb	Yes: 1 Otherwise: 0	-2.8108 (-1.85)
ln (office land area) x Land Attribute Dummy	Suburb	Yes: (m^2) × 1 Otherwise: 0	0.3458 (2.04)
Number of employees × Land Attribute Dummy	Suburb	Yes: (people) × 1 Otherwise: 0	-0.0022 (-1.38)
ln (Size Variables) *2		(km^2)	1.0000
Initial likelihood			-1675.1
Final likelihood			-1347.6
Likelihood ratio			0.196
Likelihood ratio with degrees of freedom			0.188
Sample size			326

*1: Population density = mesh population at night/inhabitant land area

*2: Size variables = Inhabitant land area within mesh (km^2)

REFERENCES

Cabinet Office, 2013. Concerning countermeasures against Tokyo inland earthquake (Final report). http://www.bousai.go.jp/jishin/syuto/taisaku_wg/pdf/syuto_wg_report.pdf

Kuse H., Takada K., Takahashi. Y., 2006. Urban logistics management. The Japan Research Center for Transport Policy, Tokyo. (in Japanese)

Oka H., Hagino, Y., Kenmochi, T., Tani, R., Nishi, R., Endo, K. , 2016. An analysis of Truck Route Choice Behavior Based on the 5th Tokyo Metropolitan Freight Survey Data. Paper presented at the 6th International Conference on Transportation and Logistics, Hsinchu, Taiwan.

Transport Planning Commission of Tokyo Metropolitan Area, 2015. Towards Realization of Ideal Logistics in the Tokyo Metropolitan Area. https://www.tokyo-pt.jp/publicity/index.html. (in Japanese)